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## **Innovation and public procurement: from fragmentation to synthesis on concepts, rationales and approaches**

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Public sector procurement is increasingly seen as an important instrument for inducing innovation in the private sector. Yet, a broad range of different concepts, each with their own associated rationales, and approaches, are used in literature and practice to describe the stimulation of innovation through public procurement. Due to a lack of an overview on the use of concepts, rationales and approaches to stimulate innovation through public procurement in literature and practice, it remains difficult for public organisations to decide why, how, and to what extent they will stimulate innovation in the private sector through public procurement. The contributions of this article to mitigate this problem are threefold. First, it provides a review of the different streams of literature, dichotomies and typologies on public procurement with respect to inducing innovation. Second, it discusses various approaches to stimulate innovation through public procurement individually and compares them in a structured overview. Finally, it provides guidance on the suitability of the use of these approaches in different situations.

**Keywords:** Public procurement; public purchasing; innovation; procurement policy; demand-side innovation policy; innovation procurement

### **Introduction**

The role of the government in stimulating the development of innovations in the private sector was essential for the development of society as we know it today (Geroski 1990; Mazzucato 2011). Three concrete examples are: (1) the role of the Defence Advanced Research Projects Agency (DARPA) in funding the formation of computer science departments, contributing to semiconductor research and the development of the internet, (2) the discovery of molecular antibodies in public medical research labs in the UK, which provided the foundation of the biotech industry, and (3) the National Science Foundation research grant, which funded the development of the algorithm that led to the success of Google (Mazzucato 2011).

Given the impact of governments on private sector innovation, and the recognition of the need for demand-side innovation policy instruments in addition to supply-side instruments, we have seen a considerable increase of interest in demand-side innovation policies and the stimulation of innovation through public procurement in specific (Lember, Kalvet,

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and Kattel 2011). On a European level, the interest started with a number of reports and policy documents stressing the need to use demand-side innovation as well as supply-side instruments, in order to achieve socioeconomic and R&D targets (European Commission 2003; Kok 2004; Edler et al. 2005; Aho et al. 2006; Edler and Georghiou 2007). Nowadays, public procurement and the use of regulations and standards are a central part of innovation policy in Europe (European Commission 2010a, 2010b; OECD 2011; Directive 2014/24/EU 2014). Although most academic literature and policy documents on this topic stem from Europe, other countries, such as Australia (Berman and Squire 2011), Brazil (Ribeiro and Furtado 2015), China (Li 2013), India (Mani 2003), Japan (Myoken 2010), Korea (Lee 2011) and the United States (Vonortas 2015), have also shown interest in demand-based innovation policies and public procurement in relation to stimulating innovation. Despite the recent rise in interest, the notion of public procurement as an innovation policy instrument is not new. Various studies in the 1970s promoted the potential of public demand to stimulate innovation (Mowery and Rosenberg 1979; Rothwell and Zegveld 1981; Geroski 1990). Geroski (1990) concluded that public procurement could be a far more efficient instrument to stimulate innovation compared to R&D subsidies.

Various concepts are used in literature to describe the use of public procurement to stimulate innovation in the private sector. These concepts distinguish themselves from innovative procurement, such as e-procurement (Moon 2005), due to the fact that they focus on stimulating innovation in the private sector and not in the procurement process itself (Kautsch, Lichoń, and Whyles 2015). Yet, there are some profound differences between these concepts. These concepts differ with respect to:

- (1). The reason for stimulating innovation through public procurement,
- (2). What is considered as innovation, and
- (3). Which approaches and methods are included within the definition of the concepts.

Confusion can arise in cases where the same terms and abbreviations are used to refer to more than one concept. As a consequence, it may not always be clear to which concept the term refers. This in turn leads to ambiguity in the reason for stimulating innovation, what is considered as innovation, and which approaches and methods are used to do so. Furthermore, the use of terms and what they refer to varies across different streams of literature, authors and individual papers.

Further, a comprehensive discussion and structured overview of approaches that are used to stimulate innovation through public procurement is still missing in literature. Such an overview, in combination with insights on the suitability of various approaches in different situations, is valuable in public procurement practice as it provides information on the various ways to stimulate innovation and the conditions under which specific approaches might be useful.

The aim of this article is to provide insight on the use of concepts, rationales, approaches and associated methods for stimulating innovation through public procurement in literature and practice. Furthermore, it aims to support procurement policy on the use of approaches for stimulating innovation through public procurement on the level of public organisations.

After discussing the research approach the paper is structured in three parts. The first part focusses on different *types* of public procurement with respect to inducing innovation in the private sector, by reviewing the use of terms, associated concepts, dichotomies and typologies in literature. The second part discusses a broad range of *approaches* with their

associated *rationales* and *methods* for stimulating innovation through public procurement in depth, after which they are presented in a structured overview. The last part of the paper focusses on the *suitability* of the discussed approaches for use in different situations with respect to several factors. Management implications and suggestions for future research can be found in the conclusion.

## **Research approach**

Over the last two decades many articles and policy documents have been written on the use of public procurement as an instrument to stimulate innovation. A preliminary review of the literature showed that: (a) these articles and policy documents use different concepts to describe this phenomenon, and (b) these concepts are associated with different rationales for stimulating innovation, as well as different approaches to achieve this. Further, a lack of a systemic overview was identified on the use of concepts, rationales and approaches to stimulate innovation through public procurement. The motivation for this literature review was to address this lack by providing an overview and in-depth discussion on the use of concepts, rationales and approaches for stimulating innovation through public procurement. In addition, the selection of a suitable approach to stimulate innovation through public procurement in different situations was added as an important topic in this review.

After the preliminary review, a peer-reviewed article search on public procurement in relation to stimulating innovation was carried out in the Scopus, Web of Science and Google Scholar electronic databases (English articles only). Several phrases and terms were used to find a comprehensive selection of articles on different approaches for stimulating innovation through public procurement: e.g. public procurement; public purchasing; innovation; innovation policy; procurement policy; demand-side innovation policy, and public procurement of/for/and innovation. This led to a selection of a considerable amount of papers (e.g. “public procurement and innovation” resulted over 160 articles in Scopus; over 100 articles in Web of Science; and over 100.000 results in Google Scholar). Therefore, the articles were first sorted on relevance and then selected based on the relevance of their title and abstract in relation to the topic and the number of times they were cited.

After this initial search, references in the selected peer-reviewed articles were used to find other relevant articles, books, policy documents and reports. This resulted in a final selection of 130 peer-reviewed articles, 5 doctoral theses, 18 policy reports, and 13 books which were reviewed in-depth. The peer-reviewed articles are scattered across many journals of which the most prominent for this literature review were: *Journal of Public Procurement*, *Research Policy*, *European Planning Studies*, *Technology in Society*, *Technological Forecasting and Social Change*, *Technovation*, *R&D Management*, and *Innovation: The European Journal of Social Science Research*.

The selected literature was analysed with a focus on the use of concepts, rationales and approaches for stimulating innovation through public procurement. The first step of the analysis was to read the selected articles while making notes and marking parts related to the purpose of the analyses. The second step was to make an overview of the scientific articles including: journal, authors, year of publication, title, abstract, and summarising research methods, main conclusions and notes during the review process. In the third step, a preliminary version of the paper was written to structure the results found in the review and snowballing was used to find relevant books, policy documents and reports to add to the review. These were analysed by making notes and marking relevant

information for the review. Finally, the literature review was improved by several rounds of going back and forth through the literature to corroborate findings from different sources.

## **Types of public procurement in relation to inducing innovation**

### ***Major streams, terms and associated concepts***

As discussed above, the use of public procurement to stimulate innovation has been discussed under numerous headings, which are based on different concepts, rationales and associated methods. An analysis of the selected papers, books, theses and policy reports showed that the literature on this topic is fragmented on the use of concepts, rationales and associated methods for stimulating innovation through public procurement. Lember, Kattel, and Kalvet (2014) p.14 state that “*one can identify two main approaches how public procurement is associated with innovation in current literature.*”

The first approach is referred to as Public Procurement for Innovation (PPI) or Public Technology Procurement (PTP), which can be understood as the procurement of something new, which does not yet exist, in order to address a specific need or societal challenge (Edquist and Hommen 2000; Lember, Kattel, and Kalvet 2014; Edquist, Vonortas, and Zabala-Iturriagoitia 2015). Sometimes the term innovation procurement is used to refer to the same concept (Uyarra and Flanagan 2010). Somewhat confusing, the OECD (2017) provides its own definition of this term, which is “any kind of public procurement practice (pre-commercial or commercial) that is intended to stimulate innovation through research and development and the market uptake of innovative products and procurement” (OECD 2017). In addition, they use “Strategic use of Public Procurement for Innovation” to refer to the original concept.

The second approach identified by Lember, Kattel, and Kalvet (2014) is Public Procurement of Innovation (PPoI or PPI), which has a far broader perspective and is first defined by Max Rolfstam as “*purchasing activities carried out by public agencies that lead to innovation*” (Rolfstam 2012, 2013; Lember, Kattel, and Kalvet 2014). As opposed to the first approach, this broader perspective includes all purchasing-related activities throughout the entire commissioning or procurement cycle that lead to innovations of some kind. Based on this definition, Public Procurement of Innovation can be considered as an umbrella term covering all public procurement related activities which lead to the “process of innovation” (Dosi 1988).

A second definition of the term Public Procurement of Innovation is provided by Yeow and Edler (2012) who refer to “*public procurement of innovation as the commissioning and procuring of goods and services which are new to the purchasing organisation and enable a novel service to citizens or enable a more efficient or effective delivery of that service*”. One can clearly distinguish different rationales associated with the two definitions of PPoI. In the first definition, the process of innovation itself is the focus, with PPoI seen as an innovation policy tool. The latter definition focuses on the outcome of the procurement activities, considering PPoI as a tool to deliver new or improved public services.

Edler and Yeow (2016) provide a third definition of the term Public Procurement of Innovation. In this article the term refers to “the purchase of a solution that is novel to the buying organisation in order to serve an organisational need”. This concept is very similar to, and builds forth on, the concept of Public Procurement *for* Innovation as described above. However, Edler and Yeow (2016) take the perspective of the buying organisation with respect to what is considered as an innovation. As such, they include the adoption of innovations which are new to the buying organisation in their definition.

Table 1. Overview of terms and abbreviations used to refer to different concepts.

Term	Source	Concept	Alternative or strongly related terms
Demand-side innovation policies	Edler and Georghiou (2007)	All public measures to induce innovations and/or speed up diffusion of innovations through increasing the demand for innovations, defining new functional requirement for products and services or better articulating demand	
Public procurement	Uyarra and Flanagan (2010)	The acquisition of goods and services by government or public sector organisations	Government procurement, public sector purchasing
Public procurement for innovation (PPI)	Edquist, Vonortas, and Zabala-Iturriagoitia (2015), Edquist and Zabala-Iturriagoitia (2012)	Occurs when a public organisation places an order for the fulfilment of certain functions within a reasonable period of time (through a new product, service or system)	Public technology procurement (PTP), Innovation Procurement
	OECD (2017)	Any kind of public procurement practice (pre-commercial or commercial) that is intended to stimulate innovation through research and development and the market uptake of innovative products and procurement	
Public procurement of innovation (PPI/PPoI)	Rolfstam (2013, 2012)	Purchasing activities carried out by public agencies that lead to innovation	
	Yeow and Edler (2012)	The commissioning and procuring of goods or services that are new to the purchasing organisation and enable a novel service to citizens or enable a more efficient or effective delivery of that service	
	Edler and Yeow (2016)	The purchase of a solution that is novel to the buying organisation in order to serve an organisational need	

(Continued)

Table 1. Continued.

Term	Source	Concept	Alternative or strongly related terms
Public procurement of innovative solutions (PPI)	European Commission (2014b)	Procurement where contracting authorities act as a launch customer for innovative goods or services which are not yet available on a largescale commercial basis, and may include conformance testing	
Pre-commercial procurement (PCP)	European Commission (2008), Edquist and Zabala-Iturriagoitia (2015)	An approach to procuring R&D services, one which involves risk–benefit sharing at market conditions but excludes state aid	Small business innovation research programme (SBIR), Small business research initiative (SBRI)
Innovation-friendly public procurement	Uyarra and Flanagan (2010), OECD (2011)	Conventional (regular) procurement practices that favour (or at least do not hinder) innovative solutions	
Innovative procurement	Kautsch, Lichoń, and Whyles (2015)	Buying something in an innovative way – i.e. in a way that is not usual for the situation in which the procurement is being undertaken	Innovative public procurement

Table 1 presents an overview of commonly used terms and concepts in the field of innovation and public procurement. This overview shows the ambiguity of the abbreviation PPI as it can refer to three different terms and even more concepts. These concepts vary in the rationale/reason for stimulating innovation, the approaches used and what is considered as innovation or an innovative solution.

### **Dichotomies**

In order to clarify the exact topic under discussion, and to distinguish different types of public procurement in relation to innovation, several dichotomies and typologies have been used in the literature. A first distinction was made by Edquist and Hommen (2000). They distinguished regular public procurement of off-the-shelf products and services from Public Technology Procurement (PTP), which requires R&D from the supplier prior to delivering the products or services. Over time, the concept of Public Technology Procurement been replaced by Public Procurement for Innovation, reflecting a broadening of the notion (Edquist and Zabala-Iturriagoitia 2012).

Edler and Georghiou (2007) differentiate between general procurement and strategic procurement with respect to innovation. This differentiation may appear similar to how Edquist and Hommen (2000) differentiate between regular procurement and Public Technology Procurement / Public Procurement for Innovation but is actually quite different.

Both general procurement and regular procurement are used to obtain products and services needed on a daily basis (Yeow and Edler 2012). However, in general procurement, public procurement activities are organised in such a way that “*innovation becomes an essential criterion in the call for tender and assessment of tender documents*” (Edler et al. 2005; Edler and Georghiou 2007). Hence, it functions to stimulate innovation through procurement in general. Regular procurement, on the other hand, does not involve the stimulation of innovation. Further, according to Edler and Georghiou (2007) public procurement becomes strategic with respect to innovation, “*when demand for certain technologies, products or services is encouraged in order to stimulate the market*”. Public Procurement for Innovation, on the other side, uses public procurement strategically to address a need which cannot be met by conventional solutions.

### **Typologies**

A first typology on Public Procurement for Innovation was provided by Hommen et al. (2005) and is called the Hommen matrix (see Table 1). This typology was built on a preliminary typology of Edquist and Hommen (2000), which contrast direct (or intrinsic) procurement from catalytic (or extrinsic) procurement, and the procurement of adaptive innovations from the procurement of developmental innovations (Hommen et al. 2005; Rolfstam 2013). Procurement is seen as direct, or intrinsic, when the procuring organisation is also the end-user of the procured products and services. As such, the procuring organisation procures in order to satisfy its own (intrinsic) needs. If the procuring organisation primarily acts to satisfy the needs of others, either public or private, the procurement is considered catalytic or extrinsic. Hommen et al. (2005) added the *cooperative* type of public procurement to this dimension of the preliminary typology. Cooperative procurement occurs when the need for the procured goods and services are shared between procurement organisations and/or users.

In the second dimension of their preliminary typology, Edquist and Hommen (2000) distinguish between the procurement of products and systems that are completely new to the world (developmental), and the procurement of products and systems that are not entirely new but nevertheless require R&D or incremental innovation by the supplier prior to delivery (adaptive). Hommen et al. (2005) related these types of innovations to the phases of the technology lifecycle and the way the procurement of these innovations influences the development of the market. Developmental procurement targets innovations which are entirely new to the world, and as such, may contribute to the initiation of a new market. Adaptive procurement, on the other hand, may contribute to the diffusion of an innovation and the escalation of a market. Building forth on this reasoning, Hommen et al. (2005) also included the *consolidation* of markets, through standardising technical standards and performance criteria for procured products and services, as a role of public procurement of innovation in relation to market development (Hommen et al. 2005; Rolfstam 2013).

In an extended version of the Hommen matrix Rolfstam (2013) added one element to each dimension (see Table 2). Rolfstam considers Public Procurement of Innovation (PPoI) to have a *distributed* need when a public organisation provides potential suppliers with an opportunity without stating a specific problem or committing itself to procure something. As such, it is up to a supplier in responding to this opportunity to identify a need of public or private users and develop a solution for it. For example, the public organisation can publish information as part of procurement activities, which can be used to develop a new product or service. Note that a *distributive* type of “Public Procurement for Innovation” cannot be possible by definition, as Public Procurement for innovation requires the



Table 2. Extended version of the Hommen matrix (adapted from Rolfstam 2013).

Type of social need	Role in relation to the market			
	Initiation Development	Escalation Adaptation	Consolidation Standardisation	Destruction Removal
<b>Direct</b>	Direct Initiation	Direct	Direct	Direct
Intrinsic		Escalation	Consolidation	Destruction
<b>Catalytic</b>	Catalytic	Catalytic	Catalytic	Catalytic
Extrinsic	Initiation	Escalation	Consolidation	Destruction
<b>Cooperative</b>	Cooperative	Cooperative	Cooperative	Cooperative
Congeneric	Initiation	Escalation	Consolidation	Destruction
<b>Distributed</b>	Distributed	Distributed	Distributed	Distributed
Identified and satisfied externally	Initiation	Escalation	Consolidation	Destruction

commitment to procure something by placing an order (Edquist and Zabala-Iturriagoitia 2012). Alongside initiation, escalation and consolidation of markets, Rolfstam (2013) states that Public Procurement of Innovation (PPI) can also have a *destructive* effect on the market for certain products and services. That is, if new technologies mature, they could destroy or reduce the market for other technologies, products and services.

Edquist and Zabala-Iturriagoitia (2012) developed the preliminary typology of Edquist and Hommen (2000) in a different direction, by including another *dichotomy* often used to distinguish several types of public procurement in relation to innovation (see Table 3). This dichotomy separates commercial procurement, i.e. the procurement of products and services on a commercial basis, from pre-commercial procurement. Pre-Commercial Procurement (PCP) concerns the procurement of R&D services prior to commercialisation, where new solutions for a specific social need or challenge are developed in competition with risk-benefit sharing between the public organisation and potential suppliers (European Commission 2008; Edquist and Zabala-Iturriagoitia 2015).

Uyarra and Flanagan (2010) provide a distinctive typology on public procurement in relation to innovation which is based on Kraljic's model and Storper's categorisation of product types and focusses on the nature of the procured products and services. These products and services can be based either on specialised production processes or on standardised production processes. Furthermore, the products can be developed for a dedicated or a generic market, leading to four types of public procurement as shown in Table 4.

Table 3. Typology on different types of procurement in relation to stimulating innovation (adapted from Edquist and Zabala-Iturriagoitia 2012).

Type of social need	Type of procured products and services		
	<b>Pre-commercial procurement</b> R&D services	<b>Developmental PPI</b> Radical innovation	<b>Adaptive PPI</b> Incremental innovation
<b>Direct</b>	Direct	Direct Developmental	Direct Adaptive
Intrinsic	PCP	PPI	PPI
<b>Catalytic</b>	Catalytic	Catalytic	Catalytic Adaptive
Extrinsic	PCP	Developmental PPI	PPI

Table 4. A fourfold typology of public procurement (adapted from Uyarra and Flanagan 2010).

Type of market	Type of production process	
	Specialised	Standardised
Dedicated	<b>Experimental</b> procurement	<b>Adapted</b> procurement
Generic	<b>Technological</b> procurement	<b>Efficient</b> procurement

The selection of a particular type of public procurement in relation to innovation is important since each type: requires the procuring organisation to adopt a specific role in its interaction with suppliers; relates to different practices that potentially drive innovation; stimulates distinctive kinds of innovation; is based on different motivations in awarding the procurement contract; and poses other innovation-related supply-side risks (Uyarra and Flanagan 2010).

Despite the relevance of the previously discussed typologies we do not consider any of them to be particularly suitable as a framework for discussing individual approaches and presenting a structured overview of these approaches. To be suitable for this task, the categorisation needs to be sufficiently broad to include all relevant approaches for stimulating innovation through public procurement, but also able to effectively group similar approaches. With these criteria in mind, the categorisation presented by the OECD (2011) was considered the best fit for our purposes.

This categorisation distinguishes between three types of public procurement: *regular procurement* that can be made more innovation-friendly; *strategic procurement*, where public organisations demand new technologies, products or services for the delivery of a public service or to address a specific need or societal challenge; and the *procurement of R&D services*, where targeted subsidies are used to trigger the development of new products and services for addressing specific needs and/or societal challenges.

As shown in Table 5, these procurement categories have contrasting characteristics in terms of the main type of product or service procured, the main rationale for the procurement, and the time and resources needed by the public organisation to apply these approaches.

### Approaches for stimulating innovation through public procurement

In this section, seven approaches for stimulating innovation through public procurement are discussed and compared with respect to a number of aspects: their rationale, associated terms, definition/description, and the process and methods used. At the end of this section an overview of these approaches is presented in Table 6. Both the discussion and overview are structured according to the categorisation of the OECD (2011):

- (1). Regular and innovation-friendly procurement,
- (2). Strategic procurement of innovations, and
- (3). Procurement of R&D services.

#### *Regular and innovation-friendly procurement*

It is important to recognise that public procurement might affect innovation whether or not procurement policy focusses on stimulating innovation. For example, regular procurement can affect innovation through stating a demand for certain products or services, and specifying requirements and standards for procured products and services (Dalpé, DeBresson, and Xiaoping 1992; Dalpé 1994). Regular procurement covers procurements made on a

Table 5. Characteristics of three categories of public procurement approaches in relation to innovation (based on OECD 2011).

Categories of approaches:	Regular procurement	Strategic procurement	Procurement of R&D services
Main type of products and services procured:	Commercially available products and services	Products and services that are not yet commercially available	R&D services and potentially also newly developed products and services
Main rationale for procurement:	Procurement of products and services necessary for the delivery of public services on a daily basis	Procurement of innovative solutions for the delivery of public services or addressing societal challenges	Developing new solutions for specific needs or a societal challenges
Time and resources needed by public agency:	Medium	High	High to very high

daily basis in order to delivery necessary public products and services (Yeow and Edler 2012), and covers items such as office supplies, ICT and physical infrastructure including roads, buildings and bridges. Unlike strategic and R&D procurement, regular procurement does not usually involve the procurement of an innovation or the development of new products and services. Moreover, stimulating innovation is generally not an explicit goal in regular procurement. Therefore, innovation can be considered as a potential by-product of regular procurement (Aschhoff and Sofka 2009).

The term innovation-friendly procurement is used to refer to regular procurement practices that favour (or at least do not hinder) innovative solutions (Uyarra and Flanagan 2010; OECD 2011; Edquist, Vonortas, and Zabala-Iturriagoitia 2015). There are four rationales for making regular procurement more innovation-friendly. First, innovation-friendly procurement is likely to improve the value-for-money of procured products and services. Second, existing solutions are likely to be insufficient to meet future needs. For example due to the aging of the population, increasing effects of global warming and the gradual deterioration of existing physical public infrastructure. Third, innovation-friendly procurement is expected to enhance the competitiveness of suppliers and sub-suppliers. Four, regular innovation-friendly procurement can influence

Table 6. Pre-commercial procurement in combination with a commercial tender in relation to the Innovation Partnership procedure (based on European Commission 2008; Edquist and Zabala-Iturriagoitia 2015).

Procurement procedure	Phase	Activities	Deliverables	
Innovation partnership	Pre-commercial procurement (PCP)	0	Pre-commercial tender	Solution idea
		1	Solution exploration	Solution design
		2	Prototype development	Prototype(s)
		3	Development and testing of first products and services	Test products and test results
	Commercial tender (PPI)	4	Development to commercial quantities of products and services	Commercial products and/or services

innovation on a far larger scale compared to strategic procurement and procurement of R&D services, due to the limited resources and time required for each tender.

In most cases stimulating innovation through procurement also requires some changes or innovation in the procurement process itself (Knutsson and Thomasson 2014). Five methods for making individual procurements more conducive to innovative solutions were identified during the analysis of literature.

The first method is to carry out a *market consultation* alongside a market analysis prior to the formal tendering. The use of a market consultation is covered by Directive 2014/24/EU article 40 and Directive 2014/25/25/EU article 58 of the European Parliament and Council. During a market consultation period, information is shared between the public agency, potential suppliers and other stakeholders concerning the needs of the public agency and other stakeholders on one hand, and possible solutions to these needs that can be supplied by the market on the other hand. The information obtained during the market consultation phase can be used to optimise the specification of requirements and the award criteria in the tendering procedure.

A second method to make procurement more innovation-friendly addresses the way requirements are specified in the public tendering documents. Traditionally, public agencies use technical specifications to define their needs, leaving little room for suppliers to provide alternative solutions (Geroski 1990). For example, with respect to the use of materials or variations in the design. Instead, public agencies can also use functional specifications to define their needs, leaving the translation of these requirements into solutions up to the suppliers (Dalpé 1994; Wilkinson et al. 2005; Edquist, Vonortas, and Zabala-Iturriagoitia 2015).

A third method, the explicit *acceptance of alternative solutions* in the tendering procedure, can provide further possibilities for suppliers to propose innovative solutions. This may be combined with traditional technical specifications indicating the needs and proposed solution by the procurement agency (European Commission 2007).

A fourth method for stimulating innovation relates to the mechanism for awarding public contracts. In regular procurement contracts are often awarded to the tenderer who offers to deliver the required products and services, in line with the specifications stated in the tender documents, against the lowest price. However there are two other award mechanisms which can be used for the award of contracts that are more likely to stimulate innovation.

The most common award mechanism to stimulate innovation is *performance-based tendering*, which uses quality criteria and price, or quality criteria and a fixed price for the award of contracts. *Performance-based tendering* is often referred to as “Most Economical Advantageous Tendering” (MEAT) or “Economically Most Advantageous Tendering” (EMAT) (Wilkinson et al. 2005; Dreschler 2009). Performance-based tendering, especially if combined with functional specification of the requirements, may be very effective in inducing innovation since the former can provide the incentive and the latter the possibilities to potential suppliers to provide innovative solutions.

The second award mechanism which may stimulate innovation is *life-cycle costing*. Life-cycle costing includes a part or all costs, of a number or all phases, of the life cycle of the products and services procured (Dragos and Neamtu 2014). Examples are acquisition costs, user and maintenance costs and costs for demolition or recycling. Assessment methods for life cycle costing should be based on objectively verifiable and non-discriminatory criteria.

The fifth method to stimulate innovation is to include *high quality standards* in tenders for products and services, which may provide incentives to suppliers to innovate (Geroski 1990; Dalpé 1994). In addition to these methods, there are many factors which can have an influence on innovation through public procurement, such as market engagement, the

bundling or division of demand, and management of intellectual property rights, risks, resources and competences (Rolfstam 2009; Uyarra et al. 2014; Dale-Clough 2015).

### ***Strategic procurement of innovations***

Strategic procurement of innovations occurs when public organisations procure specific technologies, products and/or services, which are not yet available on a commercial scale, for the delivery of a public service or to address a specific need or societal challenge (Edquist and Zabala-Iturriagoitia 2012). Four approaches are associated with strategic procurement: Public Procurement of Innovative Solutions (PPI or PPOI), Public Procurement for Innovation (PPI), Forward Commitment Procurement (FCP) and the use of procedures which provide possibilities to negotiate with potential suppliers (Competitive Dialogue and Competitive Procedure with Negotiation).

### *Public procurement of innovative solutions*

Public Procurement of Innovative Solutions (PPI) is a term used by the European commission to refer to “*procurements where contracting authorities act as a launch customer of innovative goods and services, which are not yet available on a large-scale commercial basis, and may include conformance testing*” (European Commission 2014a, 2014b). The process of, or methods used in, the Public Procurement of Innovative Solutions are not explicitly defined, although it requires at least a commercial tender for innovative goods and/or services in some form. This could be a regular tender, but also involve a pilot study or a design contest (Edler et al. 2005). This approach has been introduced as a policy instrument to promote sustainable economic growth by stimulating the uptake of innovative solutions through public procurement. In addition, the use of Public Procurement of Innovative Solutions is promoted by the European Commission as an approach which can contribute to addressing societal challenges and improving the quality and efficiency of public services (European Commission 2014b). The Public Procurement of Innovative Solutions is closely related to Pre-Commercial Procurement in that it can be used to perform a commercial tender after one or more solutions have been developed in a Pre-Commercial Procurement. The term Innovation Procurement is often used in practice and policy reports, when referring to Public Procurement of Innovative Solutions as well as Pre-Commercial Procurement when discussed together (European Commission 2014b). However, in the scientific literature, Innovation Procurement refers to “the procurement of innovations that do not yet exist” (Uyarra and Flanagan 2010; Edquist and Zabala-Iturriagoitia 2012; Yeow and Edler 2012). This definition excludes pre-commercial procurement of R&D services without a commercial tender for an innovation afterwards.

### *Public procurement for innovation*

Public Procurement for Innovation occurs when “*a public organization places an order for the fulfilment of certain function within a reasonable period of time through a new or improved product*” (Edquist and Zabala-Iturriagoitia 2012; Edquist, Vonortas, and Zabala-Iturriagoitia 2015). The rationale behind this concept/approach is to “*satisfy human needs, solve societal problems or support agency missions or needs*” (Edquist and Zabala-Iturriagoitia 2012; Edquist, Vonortas, and Zabala-Iturriagoitia 2015). Unlike the Public Procurement of Innovative Solutions approach several stages are defined in this approach:

- (1). Identify a societal challenge or need of the agency,
- (2). Translate this challenge or need into functional specifications,
- (3). Call for tender,
- (4). Assess tender offers and award contracts, and
- (5). Manage the delivery process of products and services (Edquist and Zabala-Iturriagoitia 2012; Edquist, Vonortas, and Zabala-Iturriagoitia 2015).

#### *Forward commitment procurement*

The third approach in strategic procurement, Forward Commitment Procurement (FCP), addresses the perceived risks for potential suppliers due to the uncertainty over future public demand for an innovative product or service (DBIS 2011; Uyarra et al. 2014). Mitigating this risks is especially important in the scaling up phase of innovations, before commercial sales of products and/or services start, because the required investments by private parties are high and the possibilities for governmental support are low (van Meerveld, Nauta, and Whyles 2015; Whyles, Van Meerveld, and Nauta 2015).

The FCP approach consists of three phases:

- (1). The identification phase,
- (2). The market engagement phase, and
- (3). The procurement phase.

During the identification phase, possible future problems and unmet needs, or opportunities for which new solutions are needed are identified. Subsequently, a project proposal addressing this problem, unmet need or opportunity is written and approved by the management of the public organisation to *ensure commitment* to the project. By guaranteeing commitment to the project, the uncertainty over future demand decreases, giving potential suppliers a greater incentive to invest in the development of new products and services (DBIS 2011; van Meerveld, Nauta, and Whyles 2015).

After project approval, the market engagement phase starts in which potential suppliers are notified of the requirements of the forthcoming procurement. Further, the feasibility of the project's requirements and the availability of solutions are tested through taking a *market sounding*. After this, a *market consultation* is usually performed to improve interaction with potential suppliers in order to refine the project's requirements and optimise the procurement approach (DBIS 2011; Whyles, Van Meerveld, and Nauta 2015). In the final procurement phase, the procurement strategy is developed and the procurement process carried out. The information obtained in the market engagement phase can be used to establish a pro-innovation procurement strategy, for example through feedback on possible qualitative award criteria and outcome-based project requirements. More comprehensive discussions on Forward Commitment Procurement and example case studies are provided by DBIS (2011) and Whyles, Van Meerveld, and Nauta (2015).

#### *Use of procurement procedures which provide opportunities for negotiation with potential suppliers*

The final strategic procurement approach is the use of procurement procedures which provide additional opportunities to negotiate with potential suppliers. Two procurement

procedures providing additional opportunities for interaction and negotiation were identified: (1) the Competitive Dialogue and (2) the Competitive Procedure with Negotiation.

The *Competitive Dialogue* (CD) is a procurement procedure that provides additional opportunities for negotiations during the dialogue phase of procurement (Wilkinson et al. 2005; Directive 2014/24/EU 2014). The competitive dialogue approach aims to align the complex needs of contracting authorities with the potential solutions offered by suppliers (Hoezen et al. 2010). The procedure is especially useful in large complex projects, where it is often difficult for contracting authorities to define the means of satisfying their needs or to assess what potential suppliers are offering in terms of technical, financial or legal solutions (Wilkinson et al. 2005; Hoezen, Voordijk, and Dewulf 2012; Directive 2014/24/EU 2014). This is also often the situation when procuring an innovative solution for a specific need or societal challenge, which makes this procedure relevant to strategic procurement of innovations.

A Competitive Dialogue consists of three sequential phases:

- (1). The selection phase,
- (2). The dialogue phase, and
- (3). The contract-awarding phase.

During the selection phase, the needs and requirements of the contracting authority are published in a contract notice and tender documents, along with the criteria to be used in selecting the most economically advantageous tender (UK OGC and HM Treasury 2008; Directive 2014/24/EU 2014). Prior to selecting candidates to participate in a Competitive Dialogue, market research and/or a market sounding may take place.

In the dialogue stage, a number of discussion rounds are conducted with all the candidates individually to determine which solutions are likely to meet the needs and requirements of the contracting authority (Hoezen et al. 2010). Each discussion should be based on the solutions offered by that specific supplier and may address all aspects of the contract. However, it is not permitted to make use of ideas and solutions offered by other suppliers in the discussions without their agreement (European Commission 2005). Moreover, all suppliers should be treated equally and the contracting authority may not provide information that may give one supplier an advantage over another. After one or more suitable solutions have been identified, the dialogue phase is concluded and the suppliers of the potential solutions are requested to submit their final tenders based on the solutions discussed in the dialogue phase (UK OGC and HM Treasury 2008).

In the final phase, the submitted offers are assessed against the predefined award criteria and the contract is awarded to tenderer with the best valid offer. During this phase, communication between the contracting authority and the tenderers is restricted to avoid distorting the competition or introducing a discriminatory effect. More comprehensive discussions on the Competitive Dialogue can be found in European Commission (2005), UK OGC and HM Treasury (2008) and Hoezen, Voordijk, and Dewulf (2012).

With the new European procurement directive, the *Competitive Procedure with Negotiation* becomes available as a new procedure. This procedure is closely related to the Competitive Dialogue as both procedures provide possibilities for negotiation, have a similar purpose and the same conditions for use (Directive 2014/24/EU 2014; Telles and Butler 2014; Semple 2015). The main difference between the Competitive Dialogue and the Competitive Procedure with Negotiation approach is that the latter starts with an initial tender as a basis for subsequent negotiation, whereas the former does not. As a result of this, the procurement organisation must specify its needs and requirements in far more detail at the start

of the Competitive Procedure with Negotiation compared to the Competitive Dialogue procedure (Telles and Butler 2014; Semple 2015). Another distinction is that in the Competitive Procedure with Negotiation the contract award criterion can also be based on lowest price or life-cycle costing.

### ***Procurement of R&D services***

The aim of procuring R&D services is to develop new solutions for specific needs or societal challenges and to make them available for future procurement or direct procurement after the development.

*Pre-Commercial Procurement* (PCP) approach is used to develop new products or solutions for a specific need or challenge, up to the point of initial field testing of the developed products. The pre-commercial procurement approach should be considered as a supply side innovation policy instrument as it essentially subsidises the development of new solutions under competition and risk/benefit sharing (Edquist and Zabala-Iturriagagoitia 2015). As such the WTO General Procurement Agreement (GPA) is not applicable on the pre-commercial procurement approach. However, as the commercial procurement of developed solutions is not part of the PCP approach itself, a separate commercial tender is required in order to procure one or more of the developed solutions on a commercial scale. As such, other potential suppliers who did not participate in the PCP approach are allowed to compete and should be treated equally in subsequent commercial tenders.

In addition to the PCP approach, there are other approaches that are very similar to PCP, such as the Small Business Innovation Research (SBIR) programme and the Small Business Research Initiative (SBRI) (Audretsch 2003; Cooper 2003; Innovate UK 2015). As these approaches have so much in common with the PCP approach, they are not discussed separately in this article.

The *Innovation Partnership* procedure is used to procure R&D services for the development of solutions for a specific need or challenge, and subsequent procurement of one or more of these solutions on a commercial scale (Georghiou et al. 2014). As such, the WTO GPA does apply to the Innovation Partnership procedure, which is also regulated under article 31 of the European procurement directive (Directive 2014/24/EU 2014).

The various phases of Innovation Partnership and PCP approach are presented in Table 6. Both approaches start with a tender for the development of products and solutions for a specific need or societal challenge. In the subsequent phases, possible solutions are explored, different prototypes are developed and initial field tests performed. At the end of each phase, one or more suppliers are selected to proceed to the next phase based on a performance assessment of the product ideas, designed solutions and prototypes as appropriate (European Commission 2008). At this point the PCP procedure ends, whereas the innovation partnership does not and follows by a commercial procurement of one or more solutions on a commercial scale.

### ***Structured overview of various approaches***

In the first part several concepts, dichotomies and typologies were discussed with respect to the inducing innovation through public procurement. Subsequently, various approaches and methods for stimulating innovation through public procurement were discussed. A structured overview of these approaches based on the categorisation of the OECD



Table 7. Structured overview of approaches to stimulate innovation through public procurement.

Categories	Approaches	Definition/description	Rationale for using approach	Methods and steps
<b>Regular procurement</b>	<b>Innovation-friendly procurement</b>	Innovation-friendly procurement refers to conventional (regular) procurement practices that favour (or at least do not hinder) innovative solutions	<ul style="list-style-type: none"> <li>- Increase the value-for-money of procured products and services</li> <li>- Ensure quality of future public services</li> <li>- Increase competitiveness of suppliers</li> </ul>	<ul style="list-style-type: none"> <li>- Market consultation</li> <li>- Allow variants</li> <li>- Functional specification</li> <li>- Performance-based tendering</li> <li>- Request high quality standards</li> </ul>
<b>Strategic procurement of innovations</b>	<b>Public Procurement of Innovative Solutions (PPI)</b>	Public Procurement of Innovative Solutions involves contracting authorities acting as a launch customer for innovative goods or services that are not yet available on a large-scale commercial basis, and may include conformance testing	<ul style="list-style-type: none"> <li>- Promote sustainable economic growth</li> <li>- Address societal challenges</li> <li>- Increase the quality and efficiency of public services</li> </ul>	<ul style="list-style-type: none"> <li>- Commercial tender aiming at procurement of innovative goods or services which are not yet available on a large-scale commercial basis</li> <li>- Design contest</li> <li>- Pilot study</li> </ul>
	<b>Public Procurement for Innovation (PPI)</b>	Public Procurement for Innovation occurs when a public organisation places an order to fulfil a certain function within a reasonable period of time through a new or improved product	<ul style="list-style-type: none"> <li>- To satisfy human needs, to solve societal problems or to support agency missions or needs</li> </ul>	<ol style="list-style-type: none"> <li>(1). Identification of social challenges or agency needs</li> <li>(2). Translation of this need or challenge into functional specifications</li> <li>(3). Tendering process</li> <li>(4). Assessment of tenders and awarding of contract</li> <li>(5). Delivery process</li> </ol>

**Forward Commitment Procurement (FCP)**

Forward commitment procurement reduces uncertainty of future demand for innovative products and services through providing information on future needs and stating a forward commitment to procuring certain products and services in the future

- To address problems, unmet needs or opportunities which require innovation
- Stimulate private investment in R&D and innovation by reducing uncertainty of future demand

- (1). Identification of unmet needs or opportunities and ensure commitment for the project
- (2). Market engagement through market soundings and market consultation
- (3). Actual procurement

**Using procurement procedures which provide possibilities for negotiations with suppliers**

Some procurement procedures provide possibilities for negotiations with potential suppliers before submitting final tenders, such as the Competitive Dialogue and Competitive Procedure with negotiation

- Aligning the complex needs of contracting authorities with possible solutions offered by suppliers
- Determining potential solutions that could satisfy the needs of the procuring organisation
- Improve solutions offered by suppliers prior to the final tender

- Competitive Dialogue:
  - (1). Selection stage
  - (2). Dialogue stage(s)
  - (3). Award stage
- Competitive procedure with negotiation:
  - (1). Initial Tender stage
  - (2). Dialogue stage(s)
  - (3). Award stage

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(Continued)

Table 7. Continued.

Categories	Approaches	Definition/description	Rationale for using approach	Methods and steps
<b>Procurement of R&amp;D services</b>	<b>Pre-Commercial Procurement (PCP)</b> Related terms: SBIR and SBRI	Pre-Commercial Procurement involves the procurement of research and development services under market conditions while sharing the risks and benefits, and includes phased competitive development up to the point of testing initial prototypes	<ul style="list-style-type: none"> <li>- Driving innovations to ensure sustainable high quality public services</li> <li>- Addressing societal challenges for which either commercially stable solution do not yet exist, or existing solutions exhibit shortcomings requiring further R&amp;D</li> </ul>	<ol style="list-style-type: none"> <li>(1). Competitive tender for R&amp;D services</li> <li>(2). Solution design</li> <li>(3). Prototype development</li> <li>(4). Original development and testing of limited volume of initial products and/or services</li> </ol>
	<b>Innovation partnership</b> Related term: innovation procurement	In an innovation partnership, pre-commercial procurement is combined with the commercial procurement of developed products/services from the involved tenderers	<ul style="list-style-type: none"> <li>- Driving innovations to ensure sustainable high quality public services</li> <li>- Addressing societal challenges for which either commercially stable solution do not yet exist, or existing solutions exhibit shortcomings requiring further R&amp;D</li> <li>- Procurement of R&amp;D services as well as of the developed products and services on a commercial scale</li> </ul>	<ol style="list-style-type: none"> <li>(1). Competitive tender for R&amp;D services</li> <li>(2). Solution design</li> <li>(3). Prototype development</li> <li>(4). Original development and testing of limited volume of initial products and/or services</li> <li>(5). Procurement of a commercial volume of products and/or services</li> </ol>

(2011) can be found in [Table 7](#). In this table a definition/description is presented for each of these approaches, along with their rationale for stimulating innovation and associated steps/methods.

When comparing the approaches on the basis of their rationale for stimulating innovation through procurement they can be categorised in two groups of rationales (Edler et al. 2015). In the first group, the rationales stem from an *external policy perspective* with respect to the procurement organisation. For example, to foster the competitiveness of suppliers in specific sectors or to stimulate sustainable economic growth. The second group adopts an *internal organisational perspective* where rationales focus on how public procurement of innovation contributes to achieving organisational goals of the procurement organisation, for example by increasing the value of procured products and services, ensuring the quality of products and services procured in the future, and addressing specific needs and/or societal challenges.

### **Assessing the suitability of public procurement of innovation approaches in different situations**

So far, this article discussed different concepts, dichotomies and typologies on the use of public procurement to stimulate innovation for different purposes. Further, it discussed various approaches for stimulating innovation through public procurement and compared these with respect to their definitions, rationales for stimulating innovation and their associated methods. In addition, a structured overview of various approaches is presented.

However, such an overview provides little insight into the suitability of the approaches in specific situations encountered in procurement practice. Hence, from a public procurement perspective, the question remains: “*what approaches can be suitable for inducing innovation in a particular situation?*” This is not an easy question to answer since it depends on a large number of factors. In the remainder of this article an initial attempt is made to shed light on this issue by comparing the characteristics for each category of approaches in [Table 7](#), with respect to a number of factors. These factors were partly derived from Uyarra and Flanagan (2010).

As can be observed from [Table 8](#), the approaches within each category have similar characteristics with respect to several factors, such as the required time and resources, the type of user-producer interaction, the rationale for stimulating innovation and the main degree of innovation towards the approaches are oriented. Yet, it is important to note that the characteristics of individual approaches may vary to some extent.

In order to get an initial idea of the suitability of specific approaches for a particular situation, the characteristics of these approaches should be compared with:

- The characteristics of the procurement organisation,
- The characteristics of what is to be procured in terms of needs and requirements, and
- The current maturity/technology readiness level of solutions which may be offered by suppliers.

Characteristics to consider with respect to the procurement organisation include: the available resources in terms of time, budget and staff, the maturity of the organisation with respect to public procurement, and its experience with public procurement of innovation (Uyarra et al. 2014). If, for example, the availability of skilled procurement staff is limited, this will reduce the suitability of approaches in the *strategic procurement* and *procurement of R&D services* categories as they require considerable effort and expertise

Table 8. Factors guiding the selection of an approach for stimulating innovation through public procurement (partly based on Uyarra and Flanagan 2010).

Factor	Categories of approaches		
	Regular procurement (innovation-friendly)	Strategic procurement	Procurement of R&D services
Required resources and time from public organisation	Medium	High	High to very high
User-producer interaction	Arm's length or recurrent interaction	Recurrent interaction or partnership	Supervisory interaction or partnership
Required resources and time from supplier	Medium	High	High to very high
Rationale(s)	<ul style="list-style-type: none"> <li>- Ensuring quality of public services in the future</li> <li>- Obtaining high quality solutions</li> <li>- Stimulating innovation in the private sector</li> </ul>	<ul style="list-style-type: none"> <li>- Procuring a solution for a specific need or societal challenge</li> <li>- Improving the quality of public services</li> <li>- Supporting SMEs</li> </ul>	<ul style="list-style-type: none"> <li>- Developing new solutions for a specific public need or societal challenge</li> <li>- Improving the quality of public services</li> <li>- Supporting SMEs</li> </ul>
Motivation for procurement award	<ul style="list-style-type: none"> <li>- Best value for money</li> </ul>	<ul style="list-style-type: none"> <li>- Best available solution</li> <li>- Best value for money</li> </ul>	<ul style="list-style-type: none"> <li>- Feasibility, quality and costs of proposed solutions</li> </ul>
Oriented to	Incremental innovation	Incremental/Radical innovation	Radical innovation
Relevant methods and approaches	Methods: <ul style="list-style-type: none"> <li>- Market consultation</li> <li>- Allowing variants</li> <li>- Functional specification</li> <li>- Performance-based tendering</li> <li>- Requesting high quality standards</li> </ul>	Approaches: <ul style="list-style-type: none"> <li>- Public procurement of innovative solutions</li> <li>- Public procurement for innovation</li> <li>- Forward commitment procurement</li> <li>- Using procurement procedures which provide possibilities for negotiations with suppliers</li> </ul>	Approaches: <ul style="list-style-type: none"> <li>- Pre-commercial procurement</li> <li>- SBIR</li> <li>- Innovation partnership</li> </ul>

by the procurement organisation in the tendering process (Knutsson and Thomasson 2014). This can be mitigated to some extent by involving external experts.

In addition, the public procurement of innovation approach should also fit with the products and services to be procured, in terms of needs and requirements (Edquist, Vonortas, and Zabala-Iturriagoitia 2015). If one wants to procure an improved solution for products and services which are procured on a daily basis, it might be appropriate to opt for an innovation-friendly approach within *regular procurement* to obtain additional value with respect to standard solutions offered by suppliers. On the other hand, if the aim is to address a specific need or societal challenge which cannot be sufficiently satisfied by current solutions, it might be more appropriate to opt for either a *strategic procurement* approach, or a *procurement of R&D services* approach to develop new solutions to that specific need or challenge.

Finally, carrying out market research and consulting potential suppliers are valuable steps in determining whether the needs and requirements of the public agency can be delivered by suppliers and provides an indication of the amount of research and development which is necessary before a solution can be delivered (Knutsson and Thomasson 2014). If suppliers already have prototypes that are likely to satisfy the needs of the procuring agency, a regular but innovation-friendly procurement approach or strategic approaches are often more suitable compared to approaches for the procurement of R&D services. If, on the other hand, potential solutions are still conceptual, non-existent, or have to be adapted to such a degree that considerable R&D effort is needed, it is better to opt for the procurement of R&D services to stimulate the development of new solutions.

Based on our analysis of the literature, we argue that for most situations in daily procurement practice the use of the *strategic procurement* and *procurement of R&D services* approaches cannot be justified given the time, resources and expertise required. Therefore, the relevance of these methods/approaches can be questioned with respect to regular procurement practices (Uyarra and Flanagan 2010). However, in certain cases these approaches can be very useful. Such cases often have a specific rationale for stimulating innovation through strategic procurement or procurement of R&D services. For example, when a specific problem or need cannot be adequately addressed using commercially available solutions, when the procuring organisation is unable to define the means required to satisfy its needs or cannot assess what potential suppliers can offer (Edquist and Zabala-Iturriagoitia 2012; Edquist, Vonortas, and Zabala-Iturriagoitia 2015).

### **Scientific contribution, policy implications and future research**

This review of the literature shows that a range of different concepts are used in academic articles and policy documents to describe the phenomenon of stimulating innovation through the use of public procurement. Second, it points out that these concepts are associated with different rationales and approaches for stimulating innovation through public procurement. As a result, confusion on the used rationales and approaches for stimulating innovation can arise in cases where the same abbreviations and terms are used to refer to different concepts. This study provides an overview on the use of terms and abbreviations which refer to different concepts in scientific literature and policy documents.

This review also reveals several typologies that have been developed, and a broad range of approaches to stimulate innovation through public procurement. These

approaches can be found scattered across the literature. A systemic overview on the use of these typologies and approaches in literature was still missing.

This article provides three important contributions. First, it provides a structured review and overview of approaches to stimulate innovation through public procurement based on the categorisation of the OECD. Second, it provides initial insights in the suitability of each category of approaches for different situations based on their characteristics. Lastly, it identifies three important factors for assessing the suitability of the approaches in different situations in this study: (1) the characteristics of the procurement organisation, (2) what is to be procured in terms of needs and requirements, and (3) the current maturity/technology readiness level of solutions which may be offered by potential suppliers.

### ***Policy implications***

This study supports procurement policy on the use of procurement approaches for stimulating innovation on the level of public organisations by providing insights in the different rationales and approaches for stimulating innovation. Some of these approaches require more, and some require less, resources and time from the procurement organisation as well as potential suppliers. Public procurement of innovation can be used as an external policy instrument to foster the competitiveness of firms in specific sectors and stimulate economic growth. On the other hand, it can be used as an instrument to contribute to internal organisational goals of the procurement organisation or to address specific needs or societal challenges.

The use of innovation-friendly regular procurement can be used on a far larger scale compared to strategic procurement approaches and approaches for the procurement of R&D services, as it requires less resources and time to perform. Strategic procurement and procurement of R&D services, on the other hand, are more suitable to address specific needs and challenges. In addition, the selection of a suitable approach is largely dependent on the development stage of potential solutions of suppliers. Performing market research and consulting potential suppliers can be very helpful in assessing the development stage of potential solutions.

### ***Suggestions for future research***

This study has been a first attempt to provide an overview of the various approaches available to stimulate innovation through public procurement and to assess the suitability of these approaches in different situations. We suggest that more research should be performed on the suitability of individual approaches in different situations and how the use of these approaches influence tender offers provided by tenderers. Edler et al. (2015) state that “the evaluation of demand-side innovation policies is still in its infancy”. To tackle this problem, more research is needed on the effectiveness of public procurement of innovation in stimulating innovation in private firms, and how these innovations contribute to the needs of public organisations and addressing societal challenges. Finally, this study identified continuous learning and knowledge exchange with respect to the use of public procurement of innovation within public organisations, and how this can be supported, as a blind spot in literature. This can be a valuable line of inquiry as the lack of knowledge, skills and resources in public organisations has been identified as an important barrier for the use of public procurement of innovation (OECD 2011; Georghiou et al. 2014; Uyarra et al. 2014).

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