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FROM WHENCE THE KNOWLEDGE CAME: HETEROGENEITY OF INNOVATION PROCUREMENT ACROSS EUROPE

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ABSTRACT. To induce innovation in the public sector, Directive 2014/24/EU encourages internal and external consultation during the procurement process. However, little is known regarding the prominence of these practices. Determining the extent of knowledge sourcing in innovation procurement across 28 European countries, this paper presents an institutional cluster analysis, examining heterogeneity across knowledge sourcing activities, procurement areas, and tender innovation outcomes for 1,505 public procurers from 2008-2010. Building upon existing taxonomies, three types of procuring agencies are identified: Large collaborative agencies practicing public procurement of innovation (31%); supplier-focused pre-commercial procurers (20%); and direct procurers at the municipal level (49%). Validation supports this heterogeneity, using innovation outcomes and policy drivers. At the country level, Spain, the United Kingdom, Italy, Germany and Poland are most represented in respective clusters. Findings enable predictions regarding impacts on agencies and innovation from the new public procurement directive's translation into national law by Member States.

INTRODUCTION

Directive 2014/24/EU encourages public procurers to induce innovation in government services and private firms, supporting efficiency in public spending and societal goals (European Commission {EC], 2014, p. 65). Changes in the new directive promote interactions with other governments, potential suppliers, and users

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that can be achieved by using *innovation procurement*: an approach to improve purchasing through process management, which may "help the market uptake of innovative products and services" (European Research Area and Innovation Committee [ERAC], 2015, p. 2).

As used here, innovation procurement consists of public procurement of innovation (PPI), pre-commercial procurement (PCP) and innovation partnerships. Innovation procurement has received only limited study (e.g., Edler and Yeow, 2016; Uyarra et al., 2014), with many more studies instead concentrating on innovative criteria (EC, 2013; Nissinen, Parikka-Alhola, & Rita, 2009; Wegweiser et al., 2009). Although public purchasing across Europe amounts to 19% of GDP (ERAC, 2015), innovation procurement remains uncommon (Uyarra et al., 2014) and varies across institutions and countries (ERAC, 2015). The potential of innovation procurement to improve public services has not yet been realized (EC, 2013), and little is known regarding differences in practices.

A critical component of consultation in innovation procurement is *knowledge sourcing*: drawing upon the "expertise, experience, advice, and opinions" of others to "supplement" (Gray & Meister, 2006, p.142) the expertise of a public purchaser such as on technology or market trends and supplier capability (EC, 2005, p. 27). Examples of knowledge that can be gathered in procurement consultation are market information from potential suppliers, requests from users, learnings or tools from other procurers, and special advice from experts. Knowledge sourcing is an example of an instrument "to embed innovation procurement" in organizations, which can increase awareness of organizational innovation potential, strategy, and procurer skill (Georghiou, Edler, Uyarra, & Yeow, 2014). The *organizational learning* resulting from knowledge sourcing activities supports professionalization of public procurement, where better knowledge on behalf of procuring agencies increases efficiency (EC, 2014, p. 88). Knowledge sourcing can also affect *product or service and market evolution* when information shared is embedded into tenders that drive innovation. As such, gathering information through consultation supports a number of innovation procurement measures, including tender openness, more innovative demands, and procurer capability (Uyarra et al., 2014). Wider demand-side influence of public procurement, such as market signaling (Rolfstam, 2014),

can also be leveraged through enhanced market dialogue coinciding with consultation activities. Given this, there exists ample opportunity for a better understanding of knowledge sourcing within procurement to support innovation procurement.

Taxonomies can provide a platform from which to study these consultations in innovation procurement with respect to interactions at the 1) organizational and 2) product or service and market level[1] (Aschhoff & Sofka, 2009; Edquist & Hommen, 2000; Hommen & Rolfstam, 2009). Hommen and Rolfstam (2009) refer to these classifications as "learning" and "evolution", respectively. However, these concepts have not been tested using empirical data at the European level (i.e., beyond case studies and national surveys), and their applicability is limited in the face of novel policy distinctions between certain innovation procurement mechanisms. Most notably, Hommen and Rolfstam (2009) provide a taxonomy relevant to discussions of consultation, including "modes of interaction." With the exception of Edquist and Zabala-Iturriagagoitia (2015), no academic efforts have differentiated between emerging concepts of public procurement of innovation (PPI), pre-commercial procurement (PCP), and innovation partnerships, which are distinct in terms of learning and evolution. As such, there is a need for empirical study of consultation practices in innovation procurement processes to test and improve taxonomies.

In addressing this research gap, this paper presents the first European-wide, survey-based analysis of the extent to which different innovation procurement mechanisms are practiced according to knowledge sourcing activities at the agency level. To uncover the prominence of these practices, this paper tests innovation procurement taxonomies by conducting a cluster analysis at the organizational level. Cluster analyses can be used as a tool to classify organizations into groups according to degrees of similarity across variables. Here, cluster analysis identifies heterogeneity across knowledge sourcing practices (consultation of potential suppliers, users, other procurers, and experts), procurement areas (purchasing innovations or R&D services), and organizational characteristics of public agencies. Clusters are validated using tender innovation outcomes (service innovation or reduced service costs), national policy frameworks, and countries.

The findings identify three distinct types of public agency with respect to different knowledge sourcing in innovation procurement: Large collaborative organizations practicing public procurement of innovation (31%), supplier-focused pre-commercial procurers (20%), and direct procurers at the municipal level (49%). Validation supports this heterogeneity, using innovation outcomes and policy drivers. At the country level, Spain and the United Kingdom, Italy, and Germany and Poland are most represented in respective clusters. The new directive is predicted to impact these three types of agencies and their innovation differently, often stimulating interactions between them.

LITERATURE REVIEW

Taxonomies can be used as identification schemes to identify heterogeneity within groups. Applied to the study of innovations and institutions, taxonomies have been used successfully to support studies of technological regimes (Nelson, 1977) as a reflection of technical competency (Pavitt, 1984), and for mapping rates, sources, and types of innovation within organizations (de Jong & Marsili, 2006). However, in comparison with private sector innovation, public sector innovation has received little analysis, both generally and regarding classifications. While similarities with private functions exist, such as cost reduction drivers, differences like profit seeking versus policy or socioeconomic growth means that innovation taxonomies for public institutions cannot readily draw parallels with literature on the private sector. In terms of innovation capacities, separation of innovation within the two spheres have evolved from the organizational theory period of the 1960's to the turn of the century, during which time the two were viewed similarly (Kattel et al., 2014). With respect to impacts of public procurement on markets, however, the European Commission Expert Group on Public Sector Innovation still deems the public sector as a "Schumpeterian Innovator" (EC, 2013, p. 12) for its creation of new (and temporary) markets for private sector innovation. This latter perspective is reflected in studies of innovation procurement amongst demand-side measures and its interactions with markets. For example, Edler (2013) situates public procurement within a typology of such measures as having the most direct connection to market stimulation, and Aschhoff and Sofka (2009) find it to be equally as influential as university knowledge spillovers. While market impact is

indeed an effect of successful innovation procurement, better understanding knowledge sourcing within procurement processes requires a focus on procurer practices.

Innovation procurement taxonomies capture features of public purchases according to organizational learning and product or service and market evolution. The concept of learning is marked by "interactive learning" in non-anonymous market interactions (Lundvall, 1992, pp. 8-10). Public intervention is necessary for stimulating innovation in cases of perfect market competition (Edquist & Hommen, 2000), as is typical of innovation procurement, where knowledge and information additional to price and quantities is gathered (Edquist & Hommen, 1999). Viewing innovation procurement as that which introduces novelty to the purchasing organization, Edler and Yeow (2016) focus on the enhancement of organizational capabilities of public procurers – including the abilities to establish linkages between internal and external actors "in the process of defining needs, exploring solutions, conducting the procurement and adopting and using innovations" (p. 415). It is this view which underpins the use of innovation procurement in this paper – to capture a new method or process in procurement by public agencies. Whether this novelty results in an innovation, and whether this innovation is introduced to the public buyer, depends in part on the modality of the procurement.

Three modalities characterize innovation procurement, distinguished first by evolution: public procurement of innovation (PPI), pre-commercial procurement (PCP), and innovation partnerships. *Public procurement of innovation* is a demand-side measure which seeks to modify the rate and/or direction of technological change (i.e., innovation) (Dalpé, 1994; Edquist & Hommen, 2000; Geroski, 1990) through public intervention. In this modality, purchasers select criteria for innovations that require at least some degree of novelty – in this paper, underpinned by trends to more broadly conceptualize innovation, PPI is not limited to technological change. At earlier stages in product or service life cycles – and ceasing prior to commercialization – PCP creates demand for R&D services that may bring ideas as far as the prototyping and field testing stage (Edquist & Zabala-Iturriagagoitia, 2012; Izsak & Edler, 2011; Rigby et al., 2012). Pre-commercial procurement is often required for procurement of radical innovations (Tsipouri, Edler,

Rolfstam, & Uyarra, 2010), although separate from PPI in that it does not necessarily entail any product development past a prototype (Edquist & Zabala-Iturriagagoitia, 2012). In an *innovation partnership*, a buyer works together with a single supplier over a multi-year period toward the purchase of a product or service at the point of commercialization (Georghiou et al., 2014).

A number of classifications further differentiate these innovation procurement modalities. Regarding the degree of technological change induced by a procurement, Edquist and Hommen (2000) define *developmental* and *adaptive* procurement, where the former is new to the world and the latter is only new to a country, requiring only small modifications to fit local conditions. This terminology will not be applied here, however, as while they are attractive concepts they are incompatible with the modern procurement modalities outlined in the previous paragraph. In a more process-oriented definition, Edler and Yeow (2016) distinguish between innovation procurements where tendering *triggers* development of a new innovation (e.g., PCP/innovation partnerships), and those where the tendering *responds to* some innovation already in the market (e.g., PPI).

Other classifications are based on who is the end user. In *direct* procurement, purchases are intended to directly meet the needs of the procuring agency, whereas in *catalytic* procurement another end-user is intended and the purchase more directly stimulates markets (Edquist & Hommen, 2000). Building upon these elements in terms of learning structures and contexts, demand structure, and needs addressed, Hommen and Rolfstam (2009) introduce *cooperative* procurement, where public agencies work together with other public agencies toward common goals. Further classifications specific to knowledge sourcing (learning) and innovation (evolution) within each of these are given.

DATA

Data for public procuring organizations across Europe were obtained from Innobarometer 2010 (Gallup, 2011). The survey was conducted jointly by UNU-MERIT, the European Commission and Gallup Europe. The Innobarometer 2010 provides the most comprehensive international dataset available to date that includes details regarding public procurement, and has been used for analyses published in highly reputed journals (e.g., Arundel, Casali, &

Hollanders, 2015). While dedicated datasets on public procurement allow for better tailoring of questions, these are either national-level (e.g., Uyarra et al, 2014) or case studies (e.g., Edler and Yeow, 2016). The Innobarometer 2010 provides a cross-section of public procurement and associated innovation to gain insight into activities across and within European countries.

Covering a three-year period, 4,063 public agencies were interviewed for the Innobarometer 2010 to measure innovation strategies at the level of their organization from 2008-2010 inclusive, obtaining 3699 valid responses.[2] A random sample of 27 EU Member States, Switzerland, and Norway was selected from organizations at each country level. The number of responses obtained from each country was partially influenced by country size and the number of institutions available through the sampling bodies. Organizations served local, regional, and national geographic areas, and ranged from 10 employees to over a thousand. Interviews were conducted via telephone, and respondents were general managers or strategic directors, answering for their immediate institutions (Gallup, 2011).

To conduct the analysis in this paper, a number of steps were taken to gather a valid sample from the total responses. First, to better focus on public agencies in this paper, not-for-profit or private sector organizations were removed from the sample, leaving respondents representing either a government organization, or one owned by the government. Next, responses with missing information or no response to questions associated with any of the fourteen focus variables (presented in Table 1, below) were removed. These variables were selected from the survey based on literature for use in clustering based on knowledge sourcing, tendering areas, and organizational information. This left a sample consisting only of public agencies who procured goods or services from private businesses between 2008-2010, in areas of ICT, technologies, service consulting, and R&D, as these were the organizations whom were further questioned regarding consultation practices. A dummy variable to test for the presence of a domestic innovation policy framework was introduced from a list of updated innovation procurement initiatives around Europe (EC, 2015), as further detailed in the later discussion on variables used for validation.

One notable limitation of the dataset is the comparability between countries. This is due to the small representation of countries in

certain subgroups, as well as country-specific factors such as the degree of public agency autonomy (Gallup, 2011). Due to these attributes, the results are not suitable for comparisons between countries, but rather "across broad institutional segments" (Gallup, 2011, p. 7). For this reason, while a number of countries are used in validating the model presented in this paper, these are not used for

TABLE 1
Variables of Knowledge Sourcing, Tendering Area, and Organizational Information Used to Develop the Clusters

Variable	Description	Interpretation
Knowledge sourcing		
devl_indep	Process/organization innovations developed **independently**	Yes=1; No=0
devl_supp	Process/organization innovations developed in **collaboration with private business**	Yes=1; No=0
Info_supp	Importance of **information from enterprises (as suppliers)** in developing innovations *- Dummy variable created by combining categories of "somewhat important" with "very important"*	Somewhat /Very important=1 Not important=0
consul_supp	Consult potential **suppliers**/contractors before tendering	Yes=1; No=0
consul_user	Consult **service users** before tendering	Yes=1; No=0
consul_gov	Consult **other organizations** conducting similar procurements	Yes=1; No=0
inno_imp	Innovation is at least as important as cost for an applicant to be successful in winning a tender from their organization. *- Dummy variable created by combining categories of "innovation is more important than cost" with "innovation and cost are equally important"*	Innovation>= cost=1 Cost>innovation =0

TABLE 1 (Continued)

Variable	Description	Interpretation
Tendering areas (goods or services)		
tender_ict	ICT equipment/ systems	Yes=1; No=0
tender_tech	Other types of technology	Yes=1; No=0
tender_serv	Provide one or more user services	Yes=1; No=0
tender_servinno	Consulting to recommend/design/pilot test service innovations	Yes=1; No=0
tender_rd	R&D for new technologies and services	Yes=1; No=0
Organizational information		
org_empl	Employee number *- Dummy variable created by combining categories of 10-49, 50-99, 100-249, 250-400 to make one category, and 500-999 with 1000 or more to make the other category*	>=500=1 10-499=0
org_geo	Geographic area served by organization *- Dummy variable created by combining regional and national*	Regional/ National=1 Local=0

cluster development, and weightings across clusters are only compared within countries rather than across countries. A second limitation is that, while information on the sectors in which these public entities were purchasing would have provided greater insight, the ability for respondents to choose up to three sectors of operation made doing so impossible. Instead, the area in which they tender provides some insight into their areas of operation.

Clustering Variables

Building upon the literature on taxonomies of innovation procurers, fourteen variables were selected to test for clusters within the data. The following explains these variables and contextualizes them in relevant literature.

Knowledge Sourcing

Knowledge sourcing variables measured consultation in terms of collaboration, information sourcing, consultation practices, and innovative criteria among public agencies. These were chosen to identify the learning activities of public agencies in their purchasing. Knowledge sourcing activities fall under interactive learning, as a mode of interaction that builds social capital (Hommen & Rolfstam, 2009). In innovation procurement, public sector organizations face difficulties in connecting the right actors with complementary skills and interests at an intra and interorganizational level (Edler & Yeow, 2016, p. 415), reflecting upon knowledge sourcing capabilities.

Collaboration

Collaboration is a public sector strategy which supports public sector innovation (Arundel, Casali, & Hollanders, 2015), where interfaces between public organizations and external actors in innovation procurement "shape the innovation process" (Bloch, 2011, p. 18). Institutional proximity is a common theme in public agency collaboration. Both knowledge flows between actors in innovation procurement and capacities for collaboration (Huxham & Vangen, 2005) are facilitated by common institutional environments (Hommen & Rolfstam, 2009). Greater "institutional closeness" (EC, 2012, p. 37) between public agencies and others helps "maximise learning and often minimise risks" (Bason, 2010, p. 240).

However, while "the majority" of ideas from the public sector are externally sourced, most of the ideas generated in this manner are not often turned into innovations, as found by Hughes, Moore, and Kataria (2011). This supports the definition of innovation procurement used here, where innovation outcomes are not mandatory but possible, such as in the modality of PPI. The variable *devl_supp* measured external orientation as collaboration of public agencies with private businesses in developing process or organizational innovations, supported by the importance of supplier information (*info_supp*). Literature on supplier consultation is presented in the following section. In contrast, *devl_indep* measured the internal orientation and independence of public agencies in developing such innovations. Extensive internal collaboration can help to identify solutions (Corbin, Corwin, & Mittelmark, 2012), with

innovation success influenced by internal diffusion methods (Hughes, Moore, & Kataria, 2011).

Consultation Practices

Regarding knowledge sourcing in the development of tenders specifically, variables tested for the prominence of consultation as a common practice with potential suppliers *(consul_supp)*, service users *(consul_user)*, and other government organizations *(consul_gov).* Consultation of other organizations offering special advice *(consul_spec)* was used as a validation variable, and is discussed in the corresponding section. The relevant question in the survey was phrased as whether respondents "usually consulted" each particular party prior to tendering (Gallup, 2011, p. 195), which is interpreted here as meaning that, in most instances and as a common practice, procuring organizations sought information from the specified source.

Potential Suppliers

Sharing information with potential suppliers – particularly at early stages of procuring a radical innovation (such as in the modality of PCP) – is a form of market signaling that enables planning of capacity and "innovation investment to react to public sector needs" (Tsipouri et al., 2010, p. 41). Currently, suppliers identify a lack of opportunity to present unsolicited ideas as an area for concern (Uyarra et al., 2014), underscoring communication barriers between suppliers and purchasers. Improving the efficiency and use of procurement consultation through dialogue with potential suppliers has been an issue of recent national focus, such as in the UK in improving the design and delivery of procurement processes (HM Treasury, 2013). For suppliers, procurement market consultation is increasingly preferred to competitive dialogues once tenders are open (Uyarra et al., 2014) where the process is becoming more efficient (HM Treasury, 2013). In France, procurers have begun networking with potential suppliers at events since 2014 to connect with high-potential industry partners and to better find SMEs (ERAC, 2015). As well, the type of innovation procurement in general should influence the sourcing of information. For purchasing new technologies, for example, intensified dialogue between the public sector and firms active in R&D is widely perceived to influence public sector innovation (Wegweiser et al., 2009).

Consultation and collaboration are a prerequisite for public-private innovation partnerships, which can be used under the new directive instead of multi-stage tendering with multiple companies in PCP. Public-private partnerships in procurement are a form of cooperation under the New Public Management paradigm (Essig, 2005), where government works more closely external organizations (Walker & Preiss, 2008). In an innovation partnership, which specifically refers to partnership with a private firm, a buyer works together with a single supplier over a multi-year period to purchase the product or service at the point of commercialization (Georghiou et al., 2014). In the new procurement directive, procurers are advised to establish innovation partnerships with companies through procurement mechanisms, particularly for long-term activities in developing new products or services (EC, 2014). Such public-private innovation partnerships are "extremely important" for identifying innovations for significant cost-savings and "improved service quality and accessibility" (EC, 2012, p. 59). Examining partnerships in smart city initiatives, EC (2012) found them to be more common in "either federal or highly decentralized institutional settings" (p. 44) of the UK, Germany, Netherlands, Italy, and Spain.

Service Users

Users are a driving force in public sector innovation (Bloch, 2011), and user-supplier interaction and co-production are mechanisms by which procurement helps to induce or diffuse innovations (Edler, 2013). In innovation procurement literature focusing on communication with the supply side, the procurer is seen as the user (Edler & Yeow, 2016, p. 418). However, particularly when public procurement is seen as first a mechanism to serve the public rather than to stimulate innovation (Edler & Yeow, 2016; Edquist & Hommen, 2000), it is not sufficient to only examine suppliers as a source of knowledge. In examining innovation procurement, users should be clearly distinguished from suppliers, and much about their role in driving public sector innovation remains unknown (Bloch, 2011). Extending evaluation to include users of public services requires recognition of internal processes at public institutions. From the perspective of the public agency, Bloch (2011) identifies potential users as enterprises, other public organizations (with the exception of universities and public research institutions) and citizens (p.18). Importantly, even within public organizations, public purchasers and

public users rarely would be the same entities – especially at agencies serving a larger geographic area, where internal departments exist for buying to concentrate expertise, tasks, and often demand.

The dataset used in this analysis captures this important difference, by including purchaser consultation with service users. Public purchasers consulting with service users in procurement discussions act as critical connections between users and producers, accumulating knowledge on both market potential and user needs. Given this, literature to user-producer interaction in innovation procurement can still be applied with clarifications, based on theoretical agreement that user-producer interactions support innovation through learning (Von Hippel, 1988).

In *catalytic* procurement, the end-user is a third-party (i.e., not the public agency who conducted the purchase) and the government buys a product or service to stimulate a (new) market in a desired way (Edler, 2013; Hommen & Rolfstam, 2009). In procuring for R&D services through the modality of PCP, user consultation is critical at such early stages of innovation. Such market intervention is deemed by Hommen and Rolfstam (2009) as "user-led innovation" (p. 30), where the user is referred to as the purchaser. Associations with solely suppliers during procurement in PCP would help to direct R&D toward meeting what the market identifies as user needs, without consulting users directly. Particularly in such a purchase, the potential for lack of uptake of procured innovations presents societal risk, challenging the core goal of innovation procurement. A dialogue process with potential users "helps improve the acceptability of the marketplace and thus reduce market risks" (Tsipouri et al., 2010, pp. 41-42), whether it be users of new applications, private lead users. User satisfaction (not limited to the purchasing agency) is a common objective in Nordic procuring institutions (Bloch, 2011), such as Denmark, which promotes market dialogue and identification of user needs in innovation procurement (ERAC, 2015).

Other Innovation Procurers

The variable measuring consultation of other organizations conducting similar procurement before tendering complemented other consultation mechanisms. In certain types of procurement, such as *cooperative* procurement, collaboration is mandatory as

procurers work with other public entities to organize the purchase and specify needs together (Hommen & Rolfstam, 2009). In this paper, cooperative procurement includes when multiple agencies are contracting authorities, as well as "joint" procurement (ERAC, 2015), where multiple agencies have control over provider decision-making and objectives. Cooperative procurement indicates organizational innovation practices, as found by Bloch (2011) in the external cooperation of public administration institutes in Nordic countries. However, Member States lack coordination and cooperation across Europe, despite this being a prerequisite for innovation procurement (ERAC, 2015). To support this collaboration, governments across Europe are beginning to stimulate connections between procurers. For example, there is a growing number of examples of cooperative procurements and those involving networks for consultation, with European backing like by EAFIP (*European Assistance for Innovation Procurement*).

Cooperative procurement concentrates demand, which can enable the purchase of more innovative products at a lower price. Knowledge sharing is an important element in achieving these benefits, which can be accomplished with or without internal restructuring. In the Netherlands, category managers assigned to each purchasing sector are tasked with external consultation and communicating knowledge gained to purchasing agencies. In contrast, without establishing a new entity, Austria has developed a clear governance structure across its three ministries cooperating in PCP and PPI to share knowledge, knowhow, and experience between purchasers (EC, 2015). Regardless of the structure, collaborations remain a prerequisite for innovative public finance such as networking grants (Baliey et al., 2010) that can help remove financial barriers to innovation procurement. However, the efficiency of cooperative procurement initiatives is not guaranteed: Metze and Levelt (2012) identified cooperative procurement across Dutch municipalities, finding that best interests or innovation expectations were not always met with by parties.

Importance of Innovation

The variable *inno_imp* indicates whether innovation was at least as important as cost for a supplier to win a tender from a public agency. The question is interpreted here as referring to the

innovativeness of a potential supplier and/or the presence of innovative criteria in a tender. Importantly, the results of knowledge sourcing in innovation procurement should be codified in tenders, with public agencies recognizing and selecting for product or service characteristics with novelty in mind. Supporting tender openness (Wegweiser et al., 2009), innovative criteria can be placed either in calls for tenders (as technical specifications/requirements, also referred to as selection criteria) or award criteria (Nissinen, Parikka-Alhola, & Rita, 2009). Notably, it is assumed that respondents did not just consider innovation in award criteria, but more broadly in innovative calls for tenders. This decision is supported by Nissinen, Parikka-Alhola, and Rita (2009), who found that a number of requirements set in award criteria, such as specific environmental management measures and policies, are in reality selection (knock-out) criteria that should be presented in the tender body.

Tendering Area to Private Suppliers (Goods or Services)

As they reflect upon learning and evolution, examining tendering areas provided insight into which innovation procurement modality respondents undertook. Variables were included for whether agencies purchased particular goods or services in the last three years. These are for ICT equipment/ systems *(tender_ict),* other types of technology *(tender_tech)*, and providing one or more user services *(tender_serv),* and consulting to recommend/design/pilot test service innovations *(tender_servinno)*. *Tender_tech* captured whether respondents tendered technologies that they considered primarily related to neither ICT nor those which improved environmental or energy performance. These variables are analogous to those used by Bloch (2011) in a survey of innovative procurement practices in the Nordic countries. As they all refer to the purchase of an innovation, they are indicative of the practice of PPI. Another variable introduced for tendering area was for the conduct of R&D for new technologies and services *(tender_rd)*. This is analogous to PCP, as the procurement of R&D services, and differentiated from PPI as no innovation is necessarily purchased. If the survey data was for a time period where the new directive applied, this variable might also reflect developmental stages within innovation partnerships. Such an interpretation would be akin to Bloch's (2011) "public private partnerships" question as an indicator of innovation procurement. However, as the mechanism was not included in the previous

directive (Georghiou et al., 2014), the data in this paper is not interpreted with respect to innovation procurement practices.

Organizational Information

Organizations at similar hierarchical levels may conduct innovation procurement similarly due to similar institutional drivers. As well, organizations with more staff may be those better equipped to conduct enhanced knowledge sourcing activities coinciding with innovative procurement. To find commonalities regarding organizational characteristics of the sample, variables for number of employees (*org_empl*) and the geographic area served by the organization (*org_geo*) are used here.

A number of findings have supported relationships between these factors and the degree of innovation in public sectors, although not with respect to innovation procurement. Institutional structure influences the actions of public sector innovators (EC, 2012). According to Arundel, Casali, and Hollanders (2015), the likelihood of service innovation increases with the size of the public institution, where smaller organizations have less external information sourcing compared with larger organizations. Other findings corroborate this, such as Gow (2014), who found larger Canadian institutions were more innovative in terms of adopting novel processes or organizations. With respect to applying the results of procurements, Bloch (2011) found central (i.e., national) government to use their ICT procurements more often to promote innovation in suppliers.

Variables Used for Validation

A number of additional variables were used to validate the cluster analysis. These are displayed in Table 2 and described in greater detail in the following sections.

Consultation Practices: Special Advice

As access to skills is a critical enabling factor of public sector innovation (Hughes, Moore, & Kataria, 2011), consulting external organizations for special advice may be more highly associated with innovation procurement. For example, special skills can help risk adverse organizations begin innovation procurement in the face of

TABLE 2
Variables for Special Advice Consultation, Tender Innovation Outcomes, and Country Criteria Used to Test the Clusters

Variable	Description	Interpretation
consul_spec	Consult other organizations offering **special advice** prior to tendering	Yes=1; No=0
outcome_inno	Tender resulted in **service innovation**	Yes=1; No=0
outcome_cost	Tender resulted in **reduced service provision costs**	Yes=1; No=0
count_inno	Whether country has developed **frameworks** for innovation procurement	Yes=1; No=0
countnord	Whether country is Finland, Denmark, Sweden, or Norway	Yes=1; No=0
(Multiple – according to two-letter EU abbreviations)	27 EU Member States, Switzerland, and Norway – one dummy variable per country used	Yes=1; No=0

complex criteria decisions (EC, 2013). The variable *consul_spec* captures whether procuring agencies usually consulted external organizations that offered special advice in this manner.

Tender Innovation Outcomes

Innovation outcomes from tenders measured whether at least one tender during the 3-year timeframe of the study resulted in service innovation (a "new or significantly improved service provided by or for your organization") *(outcome_inno)* or reduced costs of service provision *(outcome_cost)*. Whether public purchasers offer entrance to lead markets, or act as experimental or lead users, the use of innovations is necessary for their diffusion (Edler, 2013). If public bodies adopt procured innovations themselves, they act as a first user and help establish demand in new markets, while benefiting in their own cost reductions or improved services. Acting as an early user of procured innovations can support the diffusion of cost-effective technology and services, supporting product improvement and speeding up cost reductions (Aschhoff & Sofka, 2009). Also

associated with increasing service quality and cost-effectiveness, tendering for one or more user services indicates outsourcing (EC, 2012) and a better focus on core government mandates. The presence of positive innovation outcomes from tendering is interpreted as indicating PPI and *direct* innovation procurement, where the purchasing entity implements its purchase. Innovation partnerships may also be practiced, although due to its long timelines and multiple phases, this can be concluded with less certainty. In line with innovation procurement goals of societal assistance defined by Edler (2016) and Edquist and Zabala-Iturriagagoitia (2012), service improvement from tendering supports "improved responsiveness" to clients or citizens of public institutions – a critical metric for measuring public sector innovation outcomes (EC, 2012).

Not all tenders from an innovation procurement must result in an innovation, which is complicated by frequent confusion of PCP, PPI, and innovation partnerships (Edquist & Zabala-Iturriagagoitia, 2015). When tenders do not result in innovations benefiting the public agency, modalities of PCP may be practiced instead. Pre-commercial procurement is more likely to be based on longer-term and explorative contracts (EC, 2012), such that it is not inevitable that these contracts result in innovations. The European Commission stresses that PCP activities are necessarily for R&D services and must terminate prior to uptake or commercialization, and therefore exclude activities such as "integration, customization, incremental adaptation and improvements to existing products or processes" (EC, 2007, pp. 2-3). As such, public organizations are not allowed to purchase innovative solutions that have been developed through PCP mechanisms, as this would be covering the costs of commercialization, in contrast to innovation partnerships where doing so is permitted. As well, if the purchase is *catalytic*, the government is not the end user and thus would not implement any innovations that were purchased. Similarly, the implementation of a purchased innovation through *cooperative* purchasing with other public agencies is not guaranteed.

Introducing innovations to public agencies is associated with learning and evolution. Regarding the former, the extent of internal change required for a public organization to adopt a tendered innovation was found by Edler and Yeow (2016) to influence learning and adaptation costs, as well as intermediation needs. With respect

to evolution, Bedin, Decarolis, and Iossa (2014) found that many public R&D initiatives did not require significant effort, and also resulted in organizational innovations and "incremental applied research" (p. 12), such that innovation outcomes from innovation procurement may be quite high. However, Hughes, Moore, and Kataria (2011) identified the quality of ICT infrastructure as a critical organizational enabler of innovation, such that improving infrastructure through the purchase of ICT should be associated with positive outcomes at the public agency level.

Policy Drivers

The policy environment of the public agency was measured by testing whether respondents belonged to a country which had developed frameworks for innovation procurement or not (*count_inno*). In developing this variable, countries who have ongoing or completed PCP projects (the rightmost section in Figure 1) were said to be "innovative", as they have moved through the stages from exploration, to framework development, to identification and pilot preparation (EC, 2015). This was used as an indicator of whether the countries conducted PPI as well – i.e., not procuring R&D services but purchasing a new innovative product or service. As the dataset surveys organizations from 2008-2010, those who are innovative in 2014 would have been in earlier stages of developing policies for this in prior years, and those who in 2014 had not yet begun projects would have been farther behind given the longer timelines for PCP compared with PPI. While remembering that PCP is not the same as the PPI, this was the best approximator for a policy environment conducive to innovation procurement given the lack of comprehensive study in this area. Although the vast majority (94%) of OECD countries policies or strategies to support innovative goods and services, green public procurement, or small and medium-sized enterprises (OECD, 2015), there is currently no data on specifically innovative procurement among European countries. The 2014 procurement directive must be translated by Member States into national law by January 2016, when national legislation will vary across countries dependent upon domestic institutions (Rolfstam, 2014).

FIGURE 1
Implementation of Pre-Commercial Procurement Projects across Europe

Source: EC (2015).

Edquist and Hommen (2000) differentiate between *direct* and *indirect* policies for innovation procurement. The latter sets framework conditions and institutional contexts (such as the EU Procurement Directive), which is recognized by all Member States in the sample. In contrast, direct policies directly intervene in active technology development (Edquist et al., 1998). Both of these policies must be aligned at national levels in order to both increase domestic capacities while meeting social needs (Edquist & Hommen, 2000), as key features of innovation procurement (Edler & Yeow, 2016). The presence or absence of a national framework for innovation procurement tests for such policy alignment. National frameworks uphold "innovation networks" and "knowledge generation" by public entities (Edquist & Hommen, 2000, p. 3). These concepts are being recognized in practice: The European Research Area and Innovation Committee (ERAC) recently recognized the need for countries across Europe to "create a strategic framework for innovation procurement" (ERAC, 2015).

For innovation procurement, policy motivation is a top-down innovation method (EC, 2012). Innovation at the organizational level is often driven by policy (Petkovšek & Cankar, 2013, p. 1331). Arundel, Casali, and Hollanders (2015) found new laws and regulations to be the most important driver of innovation in the public sector, while Hughes, Moore, and Kataria (2011) found organizations with innovation strategies to have better innovation measures.

However, only recently have "dedicated innovation policy approaches" been targeting demand-side measures (Edler, 2013, p. 5). Policies prompting innovation in public procurement are an "example of public sector innovation that combines institutional and administrative aspects (e.g. how bids are evaluated) and technological skills and innovations in the private sector" (EC, 2013, p. 15). These policies go beyond primary policy objectives of public procurement of efficiency and cost effectiveness (OECD, 2015, p. 138).

Countries

To investigate how the cluster analysis mapped according to countries – given variation in innovation procurement practices – one variable for each of the 27 EU Member States, Switzerland, and Norway was introduced during validation. As the Nordic countries have been active in innovation procurement initiatives, including surveying (Bloch, 2011) and academically (e.g., Edquist & Zabala-Iturriagagoitia, 2015; Hommen & Rolfstam, 2009), a dummy variable (*countnord*) was also introduced to test for whether a public agency belonged to Finland, Denmark, Sweden, or Norway. Country variables were weighted by their general population size, as provided by Gallup (2011).

Focusing on 1505 government organizations, a three-stage exploratory analysis was undertaken to examine similarities within subgroups, following the approach of de Jong and Marsili (2006) and Leiponen (2008). While one drawback of cluster analysis is its subjectivity across different data sets and theoretical lenses, its rigour can be enhanced by identifying commonalities between broad categories and clusters in prior analyses. This is intended through comparison with taxonomies of innovation procurement.

PRINCIPAL COMPONENT ANALYSIS

First, a principal component analysis (PCA) was performed to reduce the number of variables to be used in the cluster analysis. Of eighteen potential variables of interest, four variables were removed due to a low individual Kaiser-Meyer-Olkin measure of sampling adequacy score, and later used for validation. With the remaining variables combined, the KMO score was 0.75, and for each individual variable was above the minimum required of 0.60 (Table 5,

Appendix). An extraction technique with varimax rotation was used, and the latent root criterion required that eigenvalues be greater than one. The six components with an eigenvalue greater than one explained a cumulative 42.7% of the variance in the dataset, and a three-dimensional solution explained 33.4% of variance. There was no indication of issues from high multicollinearity, with all values below 0.3634. The determinant for the correlations was 0.3613, which was greater than the necessary 0.00001 (Arundel, Casali, & Hollanders, 2015).

Cluster Analysis

Using the clustering variables, the cluster analysis was performed. While cluster analysis is sensitive to outliers, all variables had standard deviations much lower than the acceptable limit of between 2 and 3, according to Hair et al. (1998). When considering the number of potential clusters, between three and six were considered to be desirable *a priori*, with fewer than three offering little explanatory power and more than six requiring greater literary basis than is available for explanation. Hierarchical and non-hierarchical techniques were combined to define centroids for a k-means cluster analysis based on Ward's Euclidian distances (de Jong & Marsili, 2006; Punj & Stewart, 1983; Singh, 1990).

For the *hierarchical component*, and following Singh (1990) until kappa validation stage, a Ward's linkage with Euclidian distances – as a continuous dissimilarity measure - was generated. Using this, a dendrogram was developed for visual inspection of an appropriate number of clusters to test. Due to the high number of observations, the dendrogram was limited to the top 15 branches (Figure 3, Appendix). From here, 2-5 clusters were seen to be feasible. A three-cluster centroid was then developed using the Ward's linkage.

For the *partitional component,* this three-cluster centroid was used as a starting point in performing a k-means cluster analysis with three clusters. Focus variables were then displayed according to this new k-means cluster solution, then kappa was calculated between the cluster analysis solution and the initial hierarchical solution. Kappa tests for randomness in agreement, and calculates the chance correlated coefficient of agreement. This process was repeated for solutions of 4 and 5 clusters, and the percent agreement compared between the three solutions. The three-cluster solution had the

highest agreement at 77.54% and a kappa of .6199 (Table 3), greater than those for either the 4 or 5 cluster solution (with agreements of 70.96% and 61.53%, respectively).

TABLE 3
Kappa for 3-cluster solution

Agreement	Expected Agreement	Kappa	Standard Error	Z	Prob>Z
77.54%	40.92%	.6199	.0191	32.55	0.0000

DESCRIPTIVE STATISTICS

For a three-cluster solution, Column 5 in Table 4, below, presents the means for each variable used in the cluster analysis and validation. On average, more agencies develop innovations independently (72%) than with suppliers (46%), while more than half value information from suppliers in developing innovations, and consult them for developing tenders. In comparison, consulting other governments conducting similar procurements was more common, and users least common.

More than three-quarters of agencies believe innovation is at least as important as cost for a company to win one of their tenders. Before a dummy variable was constructed for this indicator (*inno_imp*), only 21% (N=316) of organizations said cost was more important than innovation in winning a tender, while 65% (N=983) saw them as equally important and 14% (N=206) as more important.

A higher proportion, on average, conduct PPI, which varies according to what is purchased: it is most common in tendering for ICT (78%) services (68%), and other technology (57%), whereas half tender for consulting to recommend, design or pilot test new or improved services. Only one-third of the agencies conduct PCP (*tender_rd*), in tendering for R&D for new technologies and services. As may be expected, this indicates that solutions which are readily implementable are procured by most, meeting organizational requirements, followed by those which are near to commercialization but may provide a more innovative solution tailored to the organization (indicated by *tender_servinno*). Tenders for earlier-stage

R&D, requiring greater risk and potentially longer-term investment, are expectedly least common.

Regarding organizational characteristics, the majority (78%) of organizations were at the local level, with fewer at the regional (16%, N=240) and national (6%, N=92). The latter two categories were combined such that a total of 331 organizations served regional or national geographic areas. Employee numbers are also quite low: only 19% (N=287) had more than 500 employees. Before a dummy variable for employee number was created, the most common size category was 1-49 employees, at 44% (N=655) of the total sample, supporting the small geographic area served by the many local organizations.

Between the validation variables, means did not vary as greatly, as was expected by their lower KMO scores. Almost three-quarters of organizations had a tender result in a new service innovation, whereas more than half had at least one resulting in significantly reduced costs of providing existing services. Three-quarters were from countries deemed to have policy frameworks for innovation procurement.

Due to the aforementioned challenges in comparing between countries using this dataset (Gallup, 2011), country means were not compared with each other, but rather within countries across clusters. The shorter list of countries displayed in Table 4, below, was chosen due to their higher means and significant variance from the mean (F-Value); the full list is displayed in the Appendix (Section 8, Table 6). The most represented countries are Spain (N=232), Germany (217), and Italy (214). The UK (181), Poland (127) and France (100) are also more highly represented. With the exception of the Netherlands (51) and Romania (54), the other countries have under 50 responses in the sample.

TABLE 4
Cluster Analysis and Validation for a Three-Cluster Solution

Variable	Cluster	Mean			F-Value
	1	2	3		
N	736	473	296	1505	-
Percent	48.9%	31.4%	19.7%	100%	-

TABLE 4 (Continued)

Variable	Cluster	Mean			F-Value
	1	2	3		
Knowledge sourcing					
devl_indep	0.65	0.84	0.70	0.72	27.29***
devl_supp	0.25	0.77	0.48	0.46	192.67***
info_supp	0.49	0.76	0.82	0.64	80.71***
consul_supp	0.47	0.81	0.65	0.61	80.21***
consul_user	0.50	0.83	0.32	0.57	125.16***
consul_gov	0.69	0.97	0.20	0.68	364.39***
inno_imp	0.73	0.87	0.81	0.79	17.96***
Tendering area					
tender_ict	0.65	0.90	0.90	0.78	74.38***
tender_tech	0.37	0.83	0.67	0.57	154.00***
tender_serv	0.49	0.88	0.86	0.68	156.43***
tender_servinno	0.19	0.83	0.76	0.51	453.90***
tender_rd	0.05	0.54	0.70	0.33	405.26***
Organizational information					
org_empl	0.06	0.47	0.07	0.19	212.33***
org_geo	0.14	0.37	0.21	0.22	50.40***
Validation variables					
consul_spec	0.53	0.74	0.75	0.64	41.83***
outcome_inno	0.65	0.84	0.71	0.72	25.50***
outcome_cost	0.48	0.70	0.53	0.55	29.88***
count_inno	0.68	0.92	0.82	0.78	50.26***
countnord	0.07	0.11	0.03	0.23	9.18***
ES	0.05	0.30	0.16	0.15	86.03***
UK	0.08	0.23	0.03	0.12	38.55***
DE	0.21	0.11	0.02	0.14	19.40***
NL	0.03	0.06	0.01	0.03	5.13**
IT	0.13	0.05	0.31	0.14	46.70***
FR	0.07	0.04	0.10	0.07	5.04**
SE	0.02	0.03	0.00	0.02	6.63**
PL	0.13	0.02	0.07	0.08	38.19***
RO	0.05	0.01	0.05	0.04	4.61**
EL	0.02	0.02	0.04	0.02	2.84*
BE	0.02	0.01	0.02	0.02	0.48
PT	0.02	0.01	0.06	0.02	10.98***
IE	0.01	0.01	0.01	0.01	0.30

Notes: * A significance level of 10%; ** A significance level of 5%. (<.05); *** A significance level of 1%. (<.01).

Cluster Analysis

The results of the cluster analysis are presented in Table 4. Cluster 2 is discussed first due to the explanatory power derived from its high scores on most variables. Cluster 3 is discussed next, to focus on the many similarities with Cluster 2 and then point to significant divergences. Finally, Cluster 1 is presented, with the lowest performance in most variables across the clusters.

Cluster 2: Collaborative Innovation Procurers

Public agencies in this cluster have the highest score on almost all variables compared with the other two clusters. They comprise 31.4% (N=473) of the sample. Almost half of these organizations have 500 or more employees, making them much larger than the other two clusters. Their geographic area served also reflects this, as they are more regional and national than the others. Overall, for knowledge sourcing for both public procurement and innovation, they rank highest, with the exception of consulting enterprises (as suppliers) in developing innovations when compared with Cluster 3.

Their knowledge sourcing is a common practice and sources are varied. An equal proportion consult potential suppliers and service users (81% and 83% of organizations, respectively) when developing calls for tenders. Similarly, they consult private businesses when developing processes or organizational method innovations (77%), while at other times relying solely on internal knowledge. This suggests an external orientation and significant knowledge seeking practices from multiple sources. Strikingly, nearly all usually consult other organizations conducting similar procurements, at 97%, in particularly sharp contrast to those in Cluster 3, as detailed below. This strongly signifies cooperative procurement.

Most agencies in this cluster procure ICT equipment or systems (90%), supported by tenders for the provision of user service (88%). In this profile, they are nearly identical to Cluster 3. However, these in in Cluster 2 rank much higher in procuring other types of technology. Notably, across all clusters there are more agencies in Cluster 2 who are active in consulting to recommend, design, or pilot test service innovations, and they also have a more purchasing other types of technologies. In combination with high importance of innovation in winning tenders, this underscores the modality of PPI.

Cluster 3: Pre-Commercial Procurers, Supplier-Focused, Outsourcers

In developing innovations, the 19.7% (N=296) of organizations in Cluster 3 see enterprises (suppliers) as more important than the other clusters, but relatively fewer contact them in comparison when developing tenders. They are particularly different from organizations in Cluster 2 in not consulting service users or especially other organizations conducting similar procurements, at only 32% and 20%, respectively. In these, they rank lowest across the three clusters, which underscores low knowledge souring. This also reinforces the external orientation of Cluster 2, who outsource service provision but still contact users, coinciding with PPI. In contrast, in conducting PCP, user consultation is not important to these agencies. Tendering for service provision to users was nearly as common as in Cluster 2, at 86% of organizations.

Most organizations procured R&D services for new technologies or services, ranking them significantly first among the clusters. The large differences between this and other clusters (at only 54% in Cluster 2 and 5% in Cluster 1) highlights agencies in Cluster 3 as focusing heavily on PCP. As they also engage in a certain degree of tendering in other areas, they also practice a certain degree of PPI. These organizations have small employee numbers (almost identical to Cluster 1), but a higher proportion serve regional or national areas than do those in Cluster 1.

Cluster 1: Direct Procurers

Agencies in Cluster 1, comprising nearly half of the total sample, rank below those in Clusters 2 and 3 in all variables except consulting potential suppliers and others conducting similar procurements prior to tendering. Even though fewer agencies publish tenders across all tendering areas, a higher proportion consult with service users (50%) and others conducting similar procurements (69%) prior to tendering. Only a small proportion consults to recommend, design, or pilot test new or improved services, and almost none (only 5%) conduct PCP, by tendering R&D services. They are primarily local governments, with 94% having less than 500 employees.

Validation

A validation analysis was done to test for significant differences between the identified clusters, following the method of de Jong and

Marsili (2006) by performing a MANOVA test and then applying to additional variables not included in the PCA to the clusters. Validation variables were those excluded due to lower KMO scores, but they were also predicted to vary across clusters. Identifying significance between variables used, a MANOVA test for all variables (Pillai's Trace is 1.2231, F-value = 86.11 (approximately distributed) and $p < 0.001$ [Table 4]) indicated a difference between the 32-dimension mean vectors (32 dependent variables, including short country list) of the three clusters, allowing for the null hypothesis that the mean vectors are the same for the three clusters to be rejected. Findings were confirmed by multivariate regressions for one-way analyses for each variable (Table 4, Column 7).

F-values are highest for variables differentiating between cooperative procurement (*consul_gov*), PPI (including *tender_servinno*) and PCP (*tender_rd*). Also prominent is the F-value for employee number, whose clear distinction across clusters suggests that innovation procurement requires significant internal capacity.

Cluster 2

The validation variables mapped across clusters as expected according to their interpretation. With more tendering and pre-tender consultation by agencies conducting PPI, Cluster 2 also had more innovation resulting from its tenders, and three-quarters of its agencies consult external organizations with special advice. Overall, their tenders have more innovative outcomes than the other clusters, and a higher percentage (92%) of their countries have innovation procurement policies in place to stimulate knowledge sourcing.

Nordic countries were most concentrated here, supported by Bloch (2011) who identified innovation practices in Nordic countries through external cooperation, and supplier and user consultation. As well, there have been more recent cooperative procurement initiatives specifically between the Nordic countries (EC, 2015). At the individual country level, Spain and the United Kingdom are most represented. Both countries are active in conducting cooperative PPI and PCP in a variety of sectors at the municipal to national level, as well as with other Member States (EC, 2015). The UK succeeded in procurement consultation initiatives in leveraging knowledge gained from supplier dialogue toward more efficient procurement processes with market influence (HM Treasury, 2013). Spain has now

embedded PPI and PCP into its research and innovation strategy, providing spending targets for innovation procurement and cross-institutional financial incentives (EC, 2015).

Cluster 3

Similar to Cluster 2, three-quarters of agencies in Cluster 3 consulted external organizations with special advice, suggesting its equal importance in purchasing R&D services and innovations. A PCP and outsourcing approach is supported in this cluster given fewer innovation outcomes for the organization from tendering, as well as lower user consultation (32%) in combination with more tendering for user service provision (86%). Italy is the most represented country, where current initiatives still focus predominantly on PCP, as the country has integrated PCP within its research and innovation framework and provided designated funds for large projects (EC, 2015).

Cluster 1

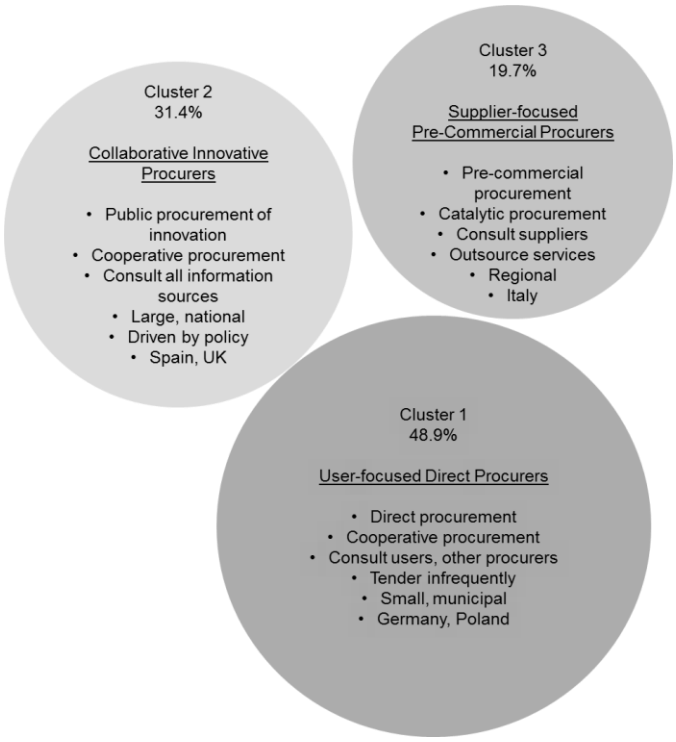
For Cluster 1, all validation variables consistently ranked third across the clusters. As innovation outcomes are on par with the prominence of tendering for innovations, the purchase of their innovations may be more effective than either those in Clusters 2 or 3, or at least targeted more toward improvement attributed to the purchaser's own institution. This indicates direct procurement practices. The most represented countries are Germany – identified as an innovation procurement laggard, especially respect to PCP (Wegweiser et al., 2009) – and Poland, with only scarce contemporary examples of innovation procurement (EC, 2015).

CONCLUSIONS AND POLICY RELEVANCE

From this exploratory analysis, there appears a significant difference between public agencies practicing modalities of PPI and PCP in terms of knowledge sourcing, tendering areas, and organizational characteristics. Comparing findings with taxonomies in literature, three different types of agency practicing innovation procurement across Europe are suggested (Figure 2), before discussing how they may be impacted by changes in the new directive.

Larger, national public agencies focusing on *PPI* (Cluster 2) consult readily with other procurers with expertise, users, and suppliers to inform their innovation procurements. They conduct *cooperative* procurement, and may have diversified procurement portfolios that include a smaller number of PCP, with tendered innovations benefiting from private markets in providing enhanced service provision at a lower cost. In contrast, regional agencies focusing on *PCP* (Cluster 3) do not cooperate with other procurers or consult users in tendering for R&D services. They strongly value innovation from suppliers in developing innovations. What new service innovations are implemented do not reduce service provision costs, as they are new-to-the market and have yet to reach economies of scale. Finally, the majority of public agencies are municipal agencies

FIGURE 2
Visual Summary of Results of Cluster Analysis, Validation, and Interpretation



conducting *direct* procurement (Cluster 1), incorporating knowledge from other procurers and users, and benefiting from cost reductions by adopting innovations from the market. They lack supplier consultation and purchase more "off the shelf" goods and services.

These findings both support and challenge changes to procurement law seen in the updated European Procurement Directive 2014/24/EU. The Directive sets procedural rules for contracts over threshold levels which are not exempt. Compared with the previous Directive 2004/18/EC, it gives agencies more options of procurement type and design, most notably through cooperative procurement with other governments, consultation of potential suppliers in PPI and innovation partnerships, and the tailoring of award criteria to user needs. Other parts of the directive will influence what is purchased, such as the requirement for digitalization of public procurement. The following predicts the effects of changes to the directive given the three types of agencies identified in this paper.

Increases in the importance of innovation for potential suppliers to win tenders, and in user consultation to better define needs, are predicted for all types of agencies based on new recommendations for award criteria development. Procurers can now use the Most Economically Advantageous Tender (MEAT) to develop price-quality ratios, supporting the purchase of high-quality products and services "optimally suited to their needs" (EC 2014, p. 82). Agencies are encouraged to "allow variants as often as possible" (EC 2014, p. 72) due to the importance of innovation. Consulting potential suppliers regarding information to inform pricing and performance options, or other government agencies to assist with methods such as life cycle costing, is also expected.

More cooperative procurement is predicted, particularly between municipal and regional agencies (Clusters 1 and 3), and central agencies across member states (Cluster 2). Agencies are exempt from the new directive if they exercise joint control over a provider with other authorities or have multiple agencies serving as contracting authorities (EC 2014, p. 70).[3] Municipal and regional agencies also have the new option to use a simplified tender publication system, publishing an information notice rather than a European-wide contract notice (EC 2014, Article 48). As such, enhanced cooperation between agencies in Clusters 1 and 3 can be expected, where the user consultation of the former and the stronger

R&D and innovation focus of the latter may help improve innovation procurement in these smaller agencies. For national agencies, the new directive presents clear rules for "cross-border joint public procurement" to support a European single market and drive innovation through demand aggregation and risk sharing. While almost all of the central agencies in Cluster 2 already source knowledge from other governments, the greater clarity regarding cross-border cooperative procurement may increase collaborations between leading countries in innovation procurement such as the UK and Spain with those with room for improvement in PPI, such as agencies in Italy and smaller agencies (Cluster 3). However, the directive provides no direct measures to induce innovation in municipal and regional agencies, rather providing measures to increase efficiency such as in utilities provision and the purchase of "off-the-shelf" goods and services by municipal and regional agencies. Centralized national coordinating services to promote innovation in purchasing, as recommended by the European Research Area and Innovation Committee (ERAC) (ERAC, 2015), may help to connect larger organizations successful in PPI with these municipal agencies so that the latter can learn how to efficiently consult potential suppliers.

Consultation of potential suppliers is expected to increase particularly along with PPI, given broader grounds and greater accessibility to apply competitive dialogue and the new competitive procedure with negotiation (EC 2014, Article 29). These are relevant for cases requiring innovation, design, or adaptation, and can be used when agencies are unable to define means of meeting their needs or assessing market offers, such as in complex projects, and enables pre-market engagement. Provided that direct procurers such as in Cluster 1 have the resources and support to engage in these dialogues, this new addition may increase the innovation procurement in municipal agencies especially. For slightly larger agencies such as in Cluster 3, these rules may help them expand their focus from PCP.

The effects of the new innovation partnership rules are not as predictable. The process can now be used when no market solutions exist and when R&D is required to provide a solution to meet an agency's needs (EC 2014, Article 31). Suppliers can be one or multiple parties, who proceed through a multi-stage elimination

process or with a group purchase at the point of commercialization. The process applies the directive for the first time to R&D services. The agency must select all potential partners and define maximum price and minimum performance at the outset, which must be adhered to in decisions to purchase the fruits of R&D efforts. Due to these restrictions, recent commentary such as Bennett (2015) has questioned whether its impacts will differ from processes using competitive procedures with negotiation. As highlighted by Corvers, Apostol, Mair, and Pantilimon (n.d.), the inability to open the competition to other suppliers once the initiative has begun locks in chosen supplier(s), and for purchases from national agencies especially may exclude competition from abroad. These issues may be exacerbated by the longer timelines and larger contracts coinciding with the purchasing of R&D services and their innovations. Given the findings of this paper, innovative national agencies (Cluster 2) and those leading in PCP (Cluster 3) may be those most likely to pursue innovation partnerships. This modality may be simple to implement, as Bedin, Decarolis, and Iossa (2014) found that many PCP initiatives involved only a single supplier without significant R&D effort. As the innovation partnership applies to direct rather than catalytic procurement (Corvers et al., n.d.), municipal agencies may find it an attractive mechanism for purchasing tailored innovations to meet particular needs rather than cooperative procurement. Whether they have the resources or capacities necessary to do so remains to be seen.

Finally, the directive's requirements for digitalization are expected to impact tendering in certain areas, most notably through an increase in tendering for ICT, and subsequently service innovation and cost-saving results of these tenders. For the first time, all contracting authorities must implement E-procurement – the electronic notification and submission of offers – through a step-wise processwith the penultimate deadline in 2018. Small municipal agencies (Cluster 1) may face particular difficulties in achieving the required digitalization as ICT tendering is more uncommon in comparison with its ubiquitary presence in Clusters 2 and 3. Once implemented, such digitalization will lead to service efficiency improvements, but with initial learning costs – likely anticipated in the multiple deadlines set for Member States. The deadline for national agencies (like those in Cluster 2) to implement fully digital communication a full year before municipal and regional agencies is,

given this evidence, well-founded. As well, the directive simplifies systems and roles for "off-the-shelf" products and services through electronic Dynamic Purchasing Systems (EC 2014, p. 76; Article 34), which frees up resources to support innovation procurement.

In summary, the translation of changes to Directive 2014/24/EU by Member States may increase agency sourcing of knowledge from potential suppliers and other governments especially, providing incentives and greater resources to dedicate to innovation procurement. Its recognition of diversity across agency types according to level of government served begins to acknowledge their heterogeneity, although measures to directly stimulate innovation are not directed to municipal and regional agencies. The recommendation of ERAC for the European Commission to establish a "knowledge-sharing service on innovation procurement" to encourage "mutual learning" (ERAC, 2015, p. 3) is certainly well-founded given the findings in this paper. Improving consultation by public agencies will drive evolutionary aspects of purchases, improving the tailoring of new products and services to needs. In conclusion, this paper calls for 1) an updated taxonomy that encompasses innovation procurement practices, inclusive of new modalities, and learning and evolutionary characteristics; and 2) application of this taxonomy to develop dedicated surveys to monitor innovation procurement practices across Europe.

This research addressed practices of innovative procurement in public agencies by focusing on their learning and evolutionary characteristics. Due to the nascency of this research area and the explorative approach, it did not focus internal dynamics (EC, 2012; Gow, 2014; Hughes, Moore, & Kataria, 2011) or degree of institutional autonomy (Arundel, Casali, & Hollanders, 2015). An improved dataset and indicators dedicated to capturing innovation procurement practices is crucial to providing a baseline upon which to monitor the effectiveness of the new procurement directive. A first step in doing so is to examine new national translations of the directive across Europe.

NOTES

1. While previously referred to as technological change, terminology regarding innovation procurement has widened to include

innovation more generally (Edquist & Zabala-Iturriagagoitia, 2015).

2. The Innobarometer survey measured innovation in public administration (service innovation), developing innovations (regulatory, financial drivers; information sources; intraorganizational dynamics) and effects of innovations (improved user access to information, improved user satisfaction, more targeted services, faster service delivery; administration simplification, working condition improvement, employee satisfaction, service delivery speed, cost reductions). Other measures were human resources supporting innovation (workforce education, development teams, training courses) and public procurement (consultation, tendering practices in innovation-related areas, and administrative benefits from resulting innovations).
3. Agencies are also exempt if the supplier provides at least 80% of its activities for the contracting authorities.

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APPENDIX

TABLE 5
Kaiser-Meyer-Olkin measure of sampling adequacy

Variable	kmo
devl_indep	0.7279
devl_supp	0.7891
info_supp	0.7714
consul_supp	0.6966
consul_user	0.6401
consul_gov	0.6296
inno_imp	0.6374
tender_ict	0.7728
tender_tech	0.7971
tender_serv	0.799
tender_servinno	0.7687
tender_rd	0.7282
org_empl	0.7566
org_geo	0.7357
Overall	**0.7494**

FIGURE 3
Dendrogram for a Cluster Solution Based on Ward's Linkages, Truncated to Show Only 15 Groups

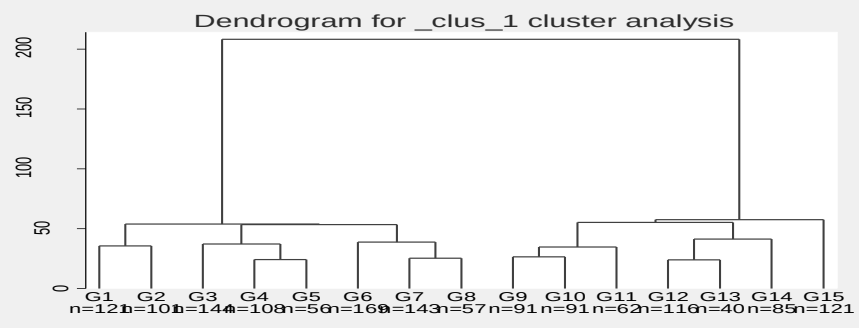

TABLE 6
Countries Applied to Cluster Centroids, Displayed Alphabetically

Country Code	Country	N	Cluster 1	Cluster 2	Cluster 3	Mean
AT	Austria	21	0.016	0.014	0.007	0.014
BE	Belgium	28	0.019	0.014	0.023	0.018
BG	Bulgaria	15	0.013	0.005	0.008	0.010
CH	Switzerland	26	0.013	0.024	0.016	0.017
CY	Cyprus	3	0.003	0.003	0.000	0.002
CZ	Czechoslovakia	28	0.027	0.003	0.019	0.018
DE	Germany	217	0.211	0.107	0.023	0.141
DK	Denmark	7	0.006	0.005	0.000	0.005
EE	Estonia	5	0.005	0.002	0.002	0.003
EL	Greece	35	0.021	0.015	0.040	0.023
ES	Spain	232	0.053	0.299	0.158	0.151
FI	Finland	23	0.014	0.018	0.011	0.015
FR	France	100	0.070	0.036	0.099	0.065
HU	Hungary	13	0.018	0.000	0.000	0.009
IE	Ireland	15	0.010	0.011	0.007	0.010
IT	Italy	214	0.127	0.049	0.315	0.139
LT	Lithuania	8	0.007	0.002	0.006	0.005
LU	Luxembourg	2	0.002	0.000	0.003	0.001
LV	Latvia	10	0.007	0.007	0.006	0.007
MT	Slovenia	1	0.000	0.001	0.000	0.000
NL	Netherlands	51	0.026	0.057	0.013	0.033
NO	Norway	9	0.005	0.012	0.000	0.006
PL	Poland	127	0.132	0.016	0.066	0.083
PT	Portugal	36	0.017	0.013	0.057	0.024
RO	Romania	54	0.049	0.007	0.046	0.035
SE	Sweden	28	0.016	0.032	0.002	0.018
SI	Slovenia	4	0.004	0.000	0.002	0.002
SK	Slovakia	12	0.010	0.001	0.013	0.008
UK	UK	181	0.081	0.230	0.028	0.117