Combining KIBS and Co-Creation Methods for Public Innovation

Fernando Felix
PhD Student, fernando.felix@edu.uah.es

Luis Rubalcaba
Professor, luis.rubalcaba@uah.es

University of Alcalá, Pl. de San Diego, s/n, 28801 Alcalá de Henares, Madrid, Spain

Abstract

The goal of this paper is twofold: i) it provides a framework for the relationship between KIBS and public services, putting the role of service users at the center, and ii) new empirical evidence from a survey for which we test the impact that business services consultancies (KIBS) associated with the co-creation processes have upon the innovation of public services with methodologies such as co-creation (users' participation) and co-design (design laboratories) processes. The empirical evidence focuses upon the two aforementioned core business service methodologies to improve the quality of the public services provision. In this context, we test three main hypotheses regarding whether KIBS have a positive impact upon the innovation of public services and to what extent user-based methodologies are important. Data comes from the 2020 Co-VAL survey on public service innovation for Spain.

The main conclusion is that KIBS have a higher impact upon public service innovation when users are taken into account through co-creation and co-design methods, acting as facilitators for co-innovation and network processes, than when KIBS is just acting on their own in bilateral relationships with the public sector. The overall positive effects do not mean that all uses of KIBS are always positive, for example, some KIBS consultancies subcontracting may have mixed results, but user-focused multiagent frameworks help promote positive impacts.

Keywords: public innovation services; co-creation; co-design; KIBS & ICT consulting; design labs

poae: Felix F., Rubalcaba L. (2022) Combining KIBS and Co-Creation Methods for Public Innovation. *Foresight and STI Governance*, 16(1), 42–53. DOI: 10.17323/2500-2597.2022.1.42.53

Introduction

Following the work of Adebajo (2018), KIBS consultancies, acting as a service design consultancy, tend to enable public services improvement by using a users-centric view as a way to facilitate value-in-use through the creation of a new process – or an improvement of old processes – and a new outcome (if that it´s allowed by the public administration in the contract made to the KIBS consultancy). So, very probably, by quoting Adebajo (2018, p. 575) "…new value propositions are created through the development of new existing practices and resources or through new ways of integrating these practices and resources". This integrative process occurs while the KIBS and ICT consultancies made the value-proposition process they were hired for inside the public administration offices or units of work.

In this paper, we follow that line of thinking by trying to delineate the way through the value-proposition that KIBS and ICT consultancies make to public administrations contractors, to improve or create a new way to deliver the services that could have value-aggregated for business services, enterprise organizations or simply any main or complemented processes that the unit of work provides to the public. These processes can be ICT, human resources, or input provisions that at the end of the line improve the services delivered by the public administrations (Lapuente, Van de Walle, 2020, p. 463).

In this same path, the research hypothesis of this work is to test whether KIBS and ICT consultancies have a positive and significant impact on the processes of innovation of public services by making use of the knowledge provided precisely by the main users of government services – what it is called the users centre of view. Also, a part of the analysis made in this document is to test different channels of the value-generating processes that KIBS and ICT consultancies have utilized to establish short term or long-term impact of innovations at the public units of work that were consulted in the Co-VAL 2020 survey – as for example design thinking tools or user`s participative involvement in the improvement of processes (Amara et al., 2008, p. 1541). Therefore, the hypothesis to be tested is very close to the work of Desmarchelier et al. (2020, p. 2), who express that innovation for established organizations is made in the form of interactions with third-party agents – mainly KIBS – and that these consultancies are specialized in the accumulation and processing of knowledge which they place at the disposal of their clients, whom in the Co-VAL survey are public units of work of diverse organizations in Spain. It also alienates to the conclusions exposed by the Public Governance and Territorial Directorate of the OECD (2017, p. 3) which reports that to meet the innovation challenge governments need to, among other propositions, facilitate the flow of information, data and knowledge across the public sector and use it to respond creatively to new challenges and opportunities which is exactly what is tested in this research whether the support of KIBS and ICT consultancies, utilizing knowledge tools and interactive design processes, produced innovation in public units of work in Spain, generally in the form of better processes (Gupta et al, 2008, p. 146).

The interaction of the KIBS with the users of the public services is very relevant to the main core findings of the paper in the sense that exposes the impact that methodology channels and innovative design process followed by the consultancies have on the improvement of existing delivery of public services in a way to honor the contract signed with the unit of work (public administrations) (Whicher, Crick, 2019, p. 292). These findings revealed that co-creation and co-design processes are key to improve the delivery of public services by KIBS by reinforcing the methodology used by these consultancies and by being a key value-in-proposition process that the KIBS consultancies provided for the public administration's unit of work in the Co-VAL 2020 experience.

Literature Review and Conceptual Framework

In this line of thoughts, Zięba and Kończyński (2017, p. 1075), propose that a client co-production process in KIBS could be called successful only if the perception of the customer anticipates positive changes in the long term, in which the tangible form of this value-proposition is the newly obtained knowledge and a developed and written strategy. He also exposes that some of the factors that have a great influence on the co-production process are teamwork, trust, communication, and knowledge flows, all these components to be very important in the creation and development of the value proposition. In this paper, we take this positive interaction between the customer and the KIBS consultancy provider to search for the creation of a new process or the improvement of the existing public services in order to generate a different and more pro-business kind of public administrations (den Hertog et. al., 2010, p. 493).

Misaruca & Viscusi (2015, p. 311) enhance the roles that users´ participation have on creating public value with two points of views, one internal referring to the policies that e-government have on being evaluated with respect to the quality of the services delivered to citizens and a second one been referred as an internal experience regarding the ability to improve the governance system at various levels of implementation (Azad, Faraj, 2008, p. 78). In this paper, the first, the internal one,

point of view is selected to find at what extent the KIBS and ICT consultancies improve the quality of the services been delivered to the public in using user´s centre methodologies. Also, Criado & Gil-Garcia (2019, p. 445) expose a comprehensive vision of what smart government involves identifying it as a multidimensional phenomenon with diverse elements which are essential for public value generation.

Alves (2012, p. 678), resumes some of the main of the postulates of this line of thinking in regarding that with the co-creation of value, many of the problems faced by government organisations transform into parts of the solution to the hypothesis to be solved and that, similarly, raising citizen consent levels and improving the image of the state sector, may be attained through the involvement of citizens in resolving problems and developing innovations as those feel that the innovations are created with them and not for them by basically being part of the solution (Fuglsang, 2018, p. 5).

Similarly, Osborne et al. (2018, p. 23) explain the specific characteristics of co-design and co-innovation as having a locus "…upon the conscious and voluntary involvement of service users in the co-design and improvement of existing public service systems and the co-innovation of new forms of service delivery". They emphasize that most of the service innovations are being derived directly from user involvement in the innovation process which is particularly the case of this paper.

Finally, Sanders & Stappers (2008, p. 5) explain the evolution in design research from a user-centred approach to a co-designing role in which there could exist interactive changes in the position of the designer, the researcher and the person formerly known as user. These authors state that those roles are getting mixed-up as explained in recent works and that even if the person who will eventually be served could play a large role in knowledge development, idea generation and concept development, there is still a need for a formal designer who plays a critical role in giving form to the storm of ideas.

This is where KIBS and ICT consulting comes into the equation as formerly providers of the structure where the co-design ideas come into reality given that users of public services could provide a very rich contribution of those value-propositions (Chew, 2015, p. 485). Therefore, as Pinto et al. (2019, p. 59) state, consultancies are more critical on the identification of opportunities than in the innovation implementation, even that they can act also as project managers. Also, Vinogradov et al (2018, p. 470) explain, that single-source procurement of KIBS is an important indicator of procurement efficiency as they are one of the most-efficient methods to achieve a high satisfaction statement and uniquely the most popular to promote the absorption of services being delivery by those KIBS consultancies. And finally, Lewis et. al. (2017, p. 303) recall that networking derives positively associations with self-rated innovation capacity, innovation drivers and leadership types of public sector administrations that support innovation.

The main objective of this paper is to test some of the ideas exposed by the theorists of the positive impact that KIBS are having on the welfare of the European Union's citizens through the utilizing of co-creation and co-design innovation methodologies into the innovative processes of public administration's units of work (Windrum et al., 2016, p. 153; OECD, 2020, p. 19). Some of these spillovers are: i) improvement of the governance system; ii) raising citizen consent levels; iii) improvement of the image of the state sector; iv) procurement efficiency; v) a lift in the self-rated innovation capacity and vi) the explosion of innovation drivers.

Specifically, the redesign of the role of the government in terms of the increasing public value that KIBS and KIS have on the provision of the public services is tested by exposing the direct and indirect links that these consultancies have on the innovative processes is taking place at the public administration's unit of work – in this draft in Spain specifically (Yuan, 2019, p. 125).

Definition and Scope of Public Innovation

One way public innovation can take place is as of the improvement of the government services it provides to its citizens or to enterprise organizations which is reflected by the reduction of time being spent at the units of work of public services, by the less time-value wasted at doing a necessary process to pursue the implementation of a right for the citizen or for the entrepreneurial organization – which in fact is a service that institution is providing its club members – or simply an improvement if the way the government service is provided making the public having a feeling that the government makes an effort to provide better and – in some cases – sustainable services, which in the overall generates a good evaluation of the public administration that is trying to make the processes work much better and less costly for its citizens (a feeling that taxes are working for the good of the people) (Sangiorgi, 2015, p. 334).

This is the way that Rubalcaba et al (2011, p. 21) expose the identification of public sector organizations as they are institutions that react to user needs and preferences through the day-to-day interaction with citizens at the service level, bottom-up – also having a top-down initiative implemented policies – and that also they are to

be considered production units where processes may vary from regulation and resource allocation to service and welfare.

As the Observatory of Pubilc Sector Innovation (OPSI) (OECD, 2017, p. 3) states, in order for governments to foster public innovation they recommend some general activities like i) address the investment in public servants as those are the catalyst of innovations; ii) facilitate the flow of information, data, and knowledge across the public sector; iii) promote new organizational structures to improve approaches and tools, and iv) ensure that internal rules and processes balance their capacity to mitigate risks.

The OPSI synthesizes in five main categories what innovation organizations' do, like support and coordinate for innovative solutions, experimentation, supporting service delivery, investment and funding of public projects, and networking support (OECD, 2017, 146). This same observatory exposes many tools that can impulse public innovation, among those are the co-creation and lab design tools which are the main positive contributors to the impacts analyzed in this paper.

The OPSI explains that co-creation through co-production and co-delivery can assist innovation teams in implementing projects that meet users` needs and make them feel a part of the result, therefore engaging many users in creating these solutions which helps to create ownership and ensures better results and, therefore, helping to secure tolerance for potential failures. Also, the OPSI states that innovation labs and units can overcome some of the barriers to public sector innovation, providing space to develop new ways of doing things (OECD, 2018, pp. 52-53).

Reinforcing this approach, in a multi-agent framework, Windrum et al (2016, p. 162) find out that co-creation of novel services on social innovations is guided by the prominent position that citizens, social entrepreneurs, or third sector organizations (NGOs or charities) take in the innovation processes, therefore shaping the inter-linkages between service and social innovations.

So, from now on, the role of the paper is to test those ideas utilizing the general linear modelling framework based upon probit regressions and path analysis – structural equation modelling (sem) –. These regressions are set to test the direct and indirect causality that KIBS and ICT covariates – and co-creation and co-design variables – are having on public services innovation processes. Probit regressions and the like were defined to estimate binomial distributions as the main dependent variables tend to behave like those functions (as the general statistics describe that patterns) and the use of the maximum likelihood estimation results in consistent, asymptotic to normality and, in some cases, efficient coefficients which were the main estimations of the paper.

In order to test the hypothesis of the impact of KIBS in the innovation of public services in this paper we follow the work of Adebajo (2018) and Zięba & Kończyński (2017), who proposed that KIBS consultancies in public services may take a user-centric view of how innovation affects the user in terms of facilitating value-in-use through the creation of a new process (or an improvement on an old process), which is called co-creation, and that co-design fosters reciprocal learning among the participating actors and potentially positions the service design consultant as an important catalyst for value creation in the public sector.

In this line of thinking, KIBS and ICT consultancies mainly help administrative unities that provide public services in a two-fold way. In that sense, KIBS and ICT services first act directly as consultancy providers in public services related to business or enterprise communities, and second, they interact with users´ interaction methodologies in the innovation processes, providing their know-how technology to the administrative unit and helping them to improve the innovative process as design laboratories.

In the following graph (Figure 1), these two-fold processes can be seen.

Both interactions are reinforced by users´ participation (co-creation) and users´ contribution (co-design) in the innovation processes of the KIBS and ICT consulting services to improve the public services. These co-participation processes contribute strongly to the innovative hub developed by administrations to pursue a better provision of public service (Yu, Sangiorgi, 2017, p. 82). Therefore, these innovations expose that public innovation strongly cooperates with KIBS or ICT services that heavily rely on users´ interactive processes (Schmidthuber et al. 2019, p. 345).

Descriptive Statistics of the Co-VAL`s Database and Reasoning of the Estimated Methods

Description of Co-VAL's Survey and the database used in this paper

In 2020 the European Union (the H2020 EU project, Co-VAL) conducted a new survey related to the main channels of innovation processes in the public sector driven by KIBS and users' intense methodologies. The unity of work was defined as the main area under the responsibility of the respondent which included all the employees under direct supervision. The unit of organization was defined as the government entity that hired the public manager and it could be an agency, ministry,

or a public department inside the municipal, regional, or national level or even a think-tank working for different levels of government.

Specific questions of Co-VAL Survey's included the main characteristics of the unique administrative offices, the principal users of the new or improved public sector services or processes, and the significant characteristics of the innovation processes driven by KIBS with the help of users' intense participation methodologies like co-creation and design laboratories.

Innovation is defined as a new or improved service or a process that differs significantly from previous ones implemented on the respondent´s unit of work. Also, some specifications were made as innovation has to be: i) new or substantially improved only over the respondent´s unit of work; ii) it could be partially or fully implemented and iii) it could have multiple characteristics – a new service could it be combined with improved processes for service delivery.

The KIBS sectors identified from this survey are:

- management, scientific and technical consultants (NACE 70.22 & 72.20);
- computer systems design and related services (NACE 62.01, 62.02 & 62.09);
- others professional KIBS which include Legal services (NACE 69.10) and Accounting (NACE 69.20); and,
- other creative KIBS which include Specialized design services (NACE 74.10 & 74.90) and Advertising, public relations, and related services (NACE 73.11, 73.12 & 73.20).

As the own Co-VAL (2021, p. 3) explains, the main H2020 Co-VAL survey was conducted as a statistically representative example from 1,036 public sector managers in six countries (Spain, France, Hungary, Netherlands, Norway, and United Kingdom)[1]. In Spain, the response rate was 37.7%. In this country, which is the principal objective of this paper, 79.5% of 264 work units of this survey expressed to be innovators, which is a lower percentage than that expressed by similar units in the Netherlands, Norway, or the United Kingdom (around 90%). Some key findings are that around 87% of the managers, surveyed in those six countries, declared that the involvement of users in the development of a "*most important innovation*" is very common. Also, that 14.5% of those managers reported obtaining assistance for a most important innovation from organizations such as design firms, innovation labs or living labs that often involve users in developing innovation. Although this is a small part of the managers that report having user involvement into innovation activities, in this paper we have found evidence, at least for Spain, that those processes are significant for being considered as an innovative public work unit delivering a service to an enterprise organization or directly to business.

The variables, the hypothesis, and the model

From the survey we decided to gather business services related variables in order to test whether there exists a direct and positive relationship between KIBS consulting and the improvement of public services; we also extracted variables related to main core business services methodologies like co-design and co-creation as specific ways to improve the quality of the public services provision. All these variables were utilized with the ones that expose public services innovation.

The variables of the survey that are related to knowledge-intensive business services are: i) C7ag (innovations that came from businesses, including consultants); ii) C11d (assistance of business, including consultants); iii) C11e (design firms or innovation laboratories) and iv) C11f (assistance of providers of specialized software or ICT equipment). The variables that represent users` intense participation and design innovation methodologies are a) C12 (methods used to develop innovations); b) C13 (methods used to obtain inputs from users); c) C15 (effects of involving users on outcomes) and d) C16 (innovations effects).

Finally, the three variables describing the innovation of public services are: 1) B1d (innovation of public services for business or enterprise association users); 2) B1e (innovation made in support activities for the organization – ICT, maintenance, shopping, accountability, human resources, etc.) and 3) B1f (innovation of public production processes or services).

Descriptive statistics

Next, the main statistics of the variables referred to in the previous section are shown (Table 1).

Most variables have large standard deviations meaning that the confidence levels have to be wide. Only two of the variables exposed have a complete record in all the database, the rest have a high proportion (30% or more) of the data as not available, so the degrees of freedom for them diminish at a fast rate. The variable related to the KIBS (C7ag) consultancy has a high kurtosis coefficient and high skewness coefficient with both indicators translating into having a spike around a point in the data (zero) and by being

[1] https://www.co-val.eu/public-deliverables/, accessed 16.09.2021.

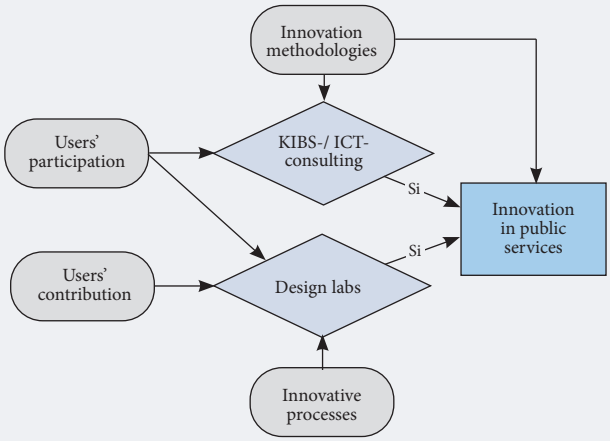
skew to the left which is an indicative of a binomial distribution with a high proportion of the zeros to be happening. The variable related to the public innovation to business services (Pinn2B) also has the same pattern as a binomial distribution as exposed for the variable KIBS but with a lesser kurtosis coefficient.

The variables which describe the innovation processes related to KIBS and ICT consultancies and design laboratories innovation (C11d, C11e and C11f) behave like binomial distributions.

The variables related to the business services methodologies, from C12 to C16, and co-creation (users` participation) described in Table 1 are diverse at their distributions. Among those are methodologies for identifying and development the users´ contribution and a variable that reflects the user´s contribution to the innovation processes – C12 and C15 – which behave like a normal distribution; then there is a variable that defines the co-creation process – C13 – which behaves kind-like a normal distribution and a variable that behaves like a negative binomial distribution (C16).

For example, two of the main variables that are part of the analysis like the one describing the public innovation to business process – Pinn2B (B1d) – and the business services consultancies variable – KIBS (C7ag) – are closer to binomial-like distributions and not to normal-like distributions (See Table 1). Those characteristics of the binomial distributions are also shown in the variables related to the innovation made by methodologies used by KIBS consultancies – B2PInn (C11d), design laboratories – dInnLabs (C11e), and by ICT and hardware consultancies – ICT (C11f).

Figure 1. **Two-fold processes of KIBS and design laboratories improvement of public services**



Source: authors.

It is also revealed by the general statistics that the same kind of distribution applies to the variables that expose the innovations in support activities related to the unit of work kind of like ICT, maintenance, buying, accountability, and human resources (B1e) or for processes related to the production or service deliveries (B1f).

Also, it can be seen from the covariance matrix (Table 2) that, in the first equation, the three variables that have the most influence on the innovation in public services related to business or enterprise organization variable (B1d), those related to KIBS consulting (C7ag) and KIBS centre methodologies (C11d) and those reflecting innovation effects (C16). Kind of the same story it is what it happens to the second and third equations in which ICT and KIBS consulting processes, with the support of design laboratories and co-creation activities – have a positive influence on the innovation of public services variables in which the general improvement in production processes or service delivery – PprodServ (B1f) – is reflected or the service support activities – PInnSuppA (B1e) – is analyzed.

With similar tables, it can be expressed that support activities related to the unit of work (ICT, maintenance, buying, accountability, human resources) – QB1e – which are classified as KIS or KIBS consultancies are most influenced by design innovative laboratories (C11e) and ICT software consulting or hardware provision (C11f) and co-creation methodologies (C13). And finally, with the same analysis of the covariance matrix it can be tell that the variables having most influence in the processes related to the production or service deliveries (B1f) are KIBS methodologies, design innovative laboratories (C11e) and business-like innovative methodologies (C12).

From all these relationships it can concluded that different levels of integration tend to relate within these variables.

So, to prove these hypotheses, we first test the following three simple equations:

$$Y1 = a1 + b1*X1; \quad (1)$$

$$Y2 = a2 + b2*X2; \quad (2)$$

$$Y3 = a3 + b3*X3. \quad (3)$$

Where Y1, Y2, Y3 represent the public innovation's dependent variables and X1, X2 and X3 are the KIBS independent variables.

Then the interaction of KIBS and user-centre methodologies is tested as these processes tend

to be the main sources of value-added in their consultancies, by the following three equations which are slightly more complicated than the ones expressed before:

$$Y1 = a1 + b1*X1 + c1* Z1; \quad (1A)$$

$$Y2 = a2 + b2*X2 + c2*Z2; \quad (2A)$$

$$Y3 = a3 + b3*X3 + c3*Z3. \quad (3A)$$

Where Y1, Y2, Y3 represent the public innovation's dependent variables, X1, X2 and X3 are the KIBS independent variables and Z1, Z2 and Z3 are the variables having the users' centre interaction with KIBS and with public services' innovation.

The interaction between KIBS and public services' innovation it's not linear as will be proven in the next section of the paper but, in contrast, has non-linearities which can be seen in the next diagram where we can see that the Z's variables have a direct relationship with the public innovation variables and that they also have a linear impact on KIBS and, therefore, and indirect impact on public services' innovation.

These non-linearities can be seen in the following diagrams that explain the indirect effects of the user´s centre methodologies.

able 1. **Descriptive statistics of the main variables.**

Variable	mean	std	cv	skewness	kurtosis	n	n.a.
PInn2B (B1d)	0.137	0.34	2.51	2.114	2.47	1109	0
PInnSuppA (B1e)	0.330	0.47	1.40	0.740	1.50	1109	0
PprodServ (B1f)	0.220	0.42	1.90	1.300	2.80	1109	0
KIBS (C7ag)	0.039	0.19	4.98	4.785	20.93	1109	0
B2PInn (C11d)	0.177	0.38	2.16	1.696	0.88	627	482
dInnLabs (C11e)	0.341	0.47	1.39	0.672	−1.55	645	464
ICT (C11f)	0.631	0.48	0.77	−0.544	−1.71	710	399
m2Pinn (C12)	4.158	2.26	0.54	−0.06	−0.84	785	324
m2CoCrea (C13)	1.818	1.54	0.85	0.485	−0.72	736	373
CoCreaEff (C15)	12.599	5.41	0.43	−0.089	−0.55	613	496
InnEff (C16)	27.227	8.42	0.31	−0.97	0.39	789	320

Source: based on data by H2020 EU project, Co-VAL.

Logit, probit, and SEM models

The Co-Val survey was held with the design of gathering data to understand the drivers of innovation in public services and the database was gathered to have a binary answer as a positive or no innovation process being held by the public´s unit of work. Therefore, logit or probit models for explaining the interaction of the covariates that determine the positive or not of that improvement processes are a good way to explain the interaction explained in previous paragraphs.

Logit estimations are mostly used in econometric tests to model the probabilities that the response belongs to the reference class (in this case a positive innovation process) by applying the logistic transformation to a proposed equation of our dichotomous dependent variable model to insert non-linearities at the estimation process and to narrow the probability range to a 0 or 1 decision as in the Co-Val survey. From that point of view, we utilized a maximum likelihood algorithm to estimate the logistic regression parameters to find the probability of belonging to a reference group – the innovative one. After calculating the logarithm of the odds for the proposed estimated equation we can express the right estimated equation among the co-variates – which are now linear – and the dependent variable (Davidson, 2018).

Alongside the logistic regression models are the probit regression estimations which assume that the distribution of the errors behaves like a normal one. In this paper, we assume the proposition that the cumulative distribution function is standard normal, being a consequence of the statistics of the main data variables. Also, the econometric results of the logit and the probit models for the data are very similar and the main advantage of this Gaussian normal distribution model is that it directly generates the marginal effects of the co-variates on the dependent variable. Therefore, the probit estimation models were used to generate the marginal effects of the covariates over the innovation process binary response variable, with similar results to those obtained for logit regression models being held simultaneously and being exposed at the summary results table.

Following Hanck et al. (2020), we assume that the expectation of the dependent variable based on the co-variates is described by the following equation:

$$E(Y|X)=P(Y=1|X)=\Phi(\beta 0+\beta 1X),$$

were $\beta 0+\beta 1X$ plays the role of a quantile z and that $\Phi(z)=P(Z\leq z)$, and where $Z\sim N(0,1)$ behaves as a Gaussian normal distribution, such that the probit coefficient $\beta 1$ is the change in z associated with a one-unit change in X (i.e. a marginal effect in economics). Although the effect on z of a change

able 2. **Covariance matrix of the main variables**

Variable	PInn2B (B1d)	KIBS (C7ag)	B2PInn (C11d)	dInnLabs (C11e)	ICT (C11f)	m2PInn (C12)	m2CoCrea (C13)	CoCreaEff (C15)	InnEff (C16)
PInn2B (B1d)	**0.1184**	**0.0100**	**0.0200**	0.0053	0.0093	0.0803	0.0285	–0.0331	**0.3079**
KIBS (C7ag)		**0.0373**	**0.0181**	**0.0130**	0.0069	**0.0668**	**0.0444**	0.0243	0.0514
B2PInn (C11d)			**0.1459**	0.0018	**0.0232**	**0.1627**	**0.0823**	–0.3332	**0.2749**
dInnLabs (C11e)				**0.2251**	**0.0479**	**0.1958**	**0.0864**	**0.6130**	0.3060
ICT (C11f)					**0.2332**	0.2472	**0.1305**	**0.4241**	0.0889
m2PInn (C12)						**5.1000**	**1.5700**	**4.3181**	**3.3074**
m2CoCrea (C13)							**2.3641**	**2.3390**	**1.7439**
CoCreaEff (C15)								**29.2374**	**12.6696**
InnEff (C16)									**70.9370**

Source: based on data by H2020 EU project, Co-VAL.

in X is linear, the link between z and the dependent variable Y is nonlinear since Φ is a nonlinear function of X.

Besides obtaining the marginal effects from the probit and logit models, we tested a simultaneous equation model approach to try to delineate what are the main processes that impulse the innovation at public units of work. And it seems that various processes are binding together, not always the same ones are gathering together obviously, to generate good practices at the innovative processes being held at public services´. So, we tested those hypotheses with the structural equations model instruments using path analysis.

Structural equation models (SEM) were picked up to try to delineate the various interactions among the variables that generate the innovation processes in the public units of work of the Co-VAL survey, reflecting the consulting procedures that expose the results of the innovation procedures without imposing a specific distributional assumption on the data. SEM models use partial least squares (PLS) estimations to provide causal explanations over the related variables for which there are not *a priori* established relationships among them, and these estimations are based on the theorized relationships that were the previous out on the probit and logit models. In that way, the use of SEM models, by using them with path analysis structure, is like a two-step regression model in practice or simultaneous equation models used in two-step general least squares´ estimation.

Path analysis is a subset of structural equation models, and it is also called analysis of covariance structures, where exogenous variables are, generally, correlated between them and have direct or indirect effects, through another exogenous variable, to the dependent variable. In this paper, the exogenous variables related to co-creation and lab design processes indirectly affect the dependent variable which becomes the innovation process being held by the public unit of work.

Path analysis is based on a closed system of nested relationships among variables that are represented statistically by a series of structured linear regression equations[2]. Therefore, to do path analysis is to test simultaneously equations models and it becomes the responsibility of the researcher to give it the proper structure to be tested that one that has an economic sense.

To utilize SEM models with path analysis we first gather the results obtained in the probit and logit models choosing the co-variates with high covariance to the dependent variables to be estimated in a first step estimation procedure, and in the second-step estimation procedure, we load the path analysis in the SEM software (lavaan for R statistical package), with the appropriate equations obtained in the previous regression stage. The results are exposed in the following diagrams of the next section of this paper.

Main Econometric Findings

Interaction between KIBS centre methodologies and KIBS consulting for the improvement of public services used by business or enterprise associations is calculated using equation (1A) (Figure 2)[3].

$$PInn2B = a1 + b11*KIBS + b12*B2PInn + c11*m2PInn + c12*m2CoCrea + c13*InnEff \quad (1A)$$

Interaction between user´s centre methodologies and co-design and ICT consulting for the improvement of support activities of the unit of

[2] https://www.publichealth.columbia.edu/research/population-health-methods/path-analysis#readings, accessed 14.08.2021.

[3] These covariances among users' co-creation and KIBS impact on public services innovation are well described in the work of Adebajo (2018).

work or organization (ICT, maintenance, buying, accountability, human resources, etc.) is calculated using equation (2A) (Figure 3)[4].

$$PInnSuppA = a2 + b21*dInnLabs + b22*ICT + c21*m2PInn + c22*CoCreaEff + c23*InnEff \quad (2A)$$

Interaction between KIBS and co-design methodologies and KIBS consulting for the improvement of production processes or public services delivery is calculated using equation (3A) (Figure 4)[5].

$$PprodServ = a3 + b31*B2Pinn + b32*dInnLabs + c31*m2Pinn + c32*m2CoCrea \quad (3A)$$

Results of the Multivariate Analyses

Once the main correlates of the dependent variables were expressed, the binomial distributions were approximated using logit estimators, and the results can be seen in the following semesters.

From Table 3, the impact of KIBS, ICT, and design laboratories have on public innovation services is tested in a two-fold. First, traditional KIBS and ICT consultancy variables have a positive and significant impact on the innovative processes to improve public services, especially those that are related to business services or pro-enterprise organizations to provide support activities for the public unit of work or for production or processing public services. All the public services asked to be subject to innovative processes have a positive impact on the KIBS and co-design consultancies on their improvement. Second, the integration of co-creation, co-design, and business-like improvement methodologies in the analysis only improves the positive and significant impact of the KIBS consultancies on the public services processes. Therefore, having a positive and impulse-like covariate function on KIBS and ICT services and, consequently, a positive, channeled-through the KIBS and ICT services, consequence on the improvement of the processes of the public units of work of the Co-VAL survey.

In this economic way, it can be concluded that a dynamic way of the integration´s path of KIBS and ICT consultancies with co-creation and design laboratories methodologies results in a positive and significant improvement of the innovation processes of public services units of work which the 2020 Co-VAL survey on public service innovation was designed to extract in Spain during 2020.

Discussion

In this paper, the kind of interaction that business services methodologies have on public services innovation has been exposed. The role of service users at the centre of the innovative process was tested as the impact that business services consultancies (KIBS) associated with co-creation processes have on the innovation of public services with the main help of methodologies like co-creation (users' participation) and co-design (design laboratories) processes.

The model builds on the work of Adebajo (2018) and of Zięba, M. & Kończyński, P. (2017), as both authors recall the importance of the interaction among the customer (in this case the public administration or unit of work) and the KIBS consultancy provider inside the innovative process as a way of creating a new service or improving the public administration services delivered to business services, enterprise organizations or just to lease the internal adjustment regarding the provision of those processes; these two ways of innovating in the provision of public services also relied on upon making more efficient use of the software, the hardware, the human resources or other key resources in the unit of work, in this case, the public administrative offices.

In this context, we tested three main hypotheses regarding whether KIBS have a positive impact on the innovation of public services and to what extent users-based methodologies are important. All three hypotheses had a positive and significant indirect effect on the co-design and co-creation methodologies over the KIBS consultancies and, therefore, over the quality improvement of public sector innovative processes

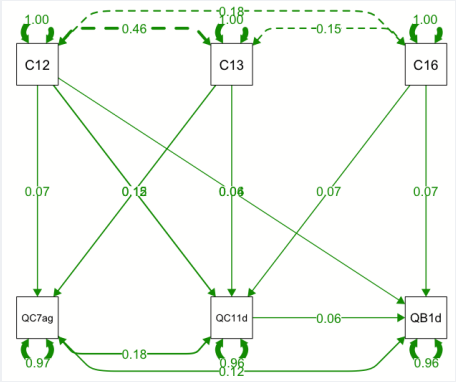
As these effects proved positive and significant on both types of regressions, the probit and SEM – path – analysis, tested on this paper, the main policy for public innovation is to reinforce and upgrade the quality of these consultancies to generate more and increase value-added in the public sector provision of services.

Yet the empirical estimation procedures used through this paper have inherent limitations. First, the logit and probit tests are relying on the assumptions of a gaussian normal distribution – probit – and on the independent distributions of the error terms – for both estimations -, which we supposed based on the statistical qualities of the database. This distribution supposition can

[4] Following Sanders & Stappers (2008) on the impact that design laboratories have on public services innovation's performance.

[5] Taking the involvement of users of public services, like Osborne et. al. (2018) describe in the process of co-innovation of new forms of service delivery.

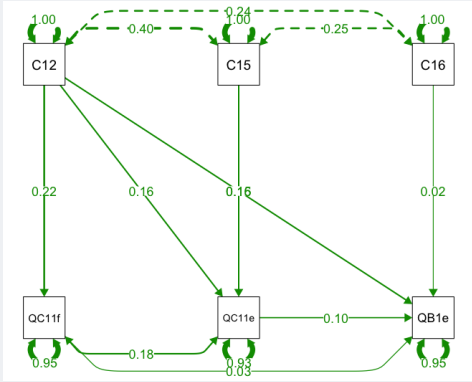
Figure 2. **Diagram of equation 1A**



Inputs:
C12 = methods used to develop innovations (m2Pinn)
C13 = methods used to obtain inputs from users (m2CoCrea)
C16 =innovations effects (InnEff)
C7ag = innovations that came from businesses, include consultants (KIBS)
C11d = assistance of business, include consultants (B2PInn)
Output:
B1d = innovation of public services for business or enterprise associations users (PInn2B)

Source: based on database of H2020 EU project, Co-VAL with path regression analysis.

Figure 3. **Diagram of equation 2A**



Inputs:
C12 = methods used to develop innovations (m2Pinn)
C15 = effects of involving users on outcomes (CoCreaEff)
C16 = innovations effects (InnEff)
C11e = design firms or innovation laboratories (dInnLabs)
C11f = assistance of providers of specialized software or ICT equipment (ICT)
Output:
B1e = innovation made in support activities for the organization – ICT, maintenance, shopping, accountability, human resources, etc. - (PInnSuppA)

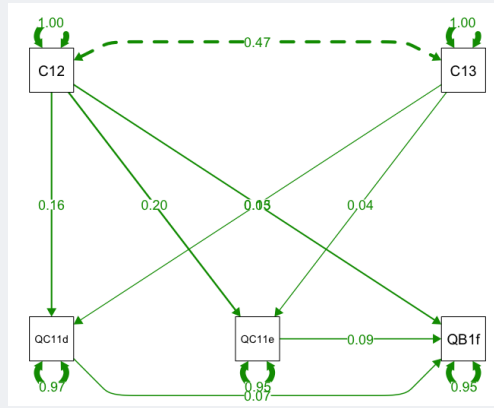
Source: based on database of H2020 EU project, Co-VAL with path regression analysis.

be improved with more tests over distribution characteristics. Also, the premise of the identical and independent distribution of the errors could prove flawed as we estimated simultaneous equations that had covariation among two or three variables, therefore making this kind of procedure is more realistic than estimating separable probit or logit equations. In the end, the estimations using simultaneous – by using path analysis – equations modelling proved superior (to the single dichotomous models), as having more realistic coefficients (with better t-statistics) and captured the channels of indirect effects of the processes that help KIBS and ICT consultancies to improve innovative processes of public units of work.

Conclusions

The two main core business services methodologies of co-design and co-creation were tested as specific ways to improve the quality of the public services provision. In both cases of the users at the centre of methodologies the results explicitly tell us that there is a positive indirect effect over the KIBS and ICT consultancies in the improvement of public services provision. Therefore, users at the centre of methodologies show to have a reinforcement effect

Figure 4. **Diagram of equation 3A**



Inputs:
C12 = methods used to develop innovations (m2Pinn)
C13 = methods used to obtain inputs from users (m2CoCrea)
C11d = assistance of business, include consultants (B2PInn)
C11e = design firms or innovation laboratories (dInnLabs)
Output:
B1f = innovation of public production processes or services (PprodServ)

Source: based on database of H2020 EU project, Co-VAL with path regression analysis.

Table 3. **Main Econometric Findings with Probit Regressions**

	Dependent variable					
GLM	PInn2B		PInnSuppA		PprodServ	
Regressors	Eq. 1	Eq. 1A	Eq. 2	Eq. 2A	Eq. 3	Eq. 3A
KIBS	0.877*** (4.39)	1.85 *** (2.54)				
B2PInn		1.35 ** (2.02)			0.2416 (1.80)	1.27 (1.56)
dInnLabs				1.24 * (1.89)		1.28 ** (2.03)
ICT			0.2251* (2.29)	1.21 * (1.69)		
m2PInn		1.04 (0.72)		1.15 ** (2.26)		1.26 *** (3.98)
m2CoCrea				1.08 (1.29)		
CoCreaEff.						
InnEff		1.11 * (1.74)				
Constant	–1.142*** (–23.30)	0.40 *** (–13.97)	–0.2811*** (–3.58)	0.71 *** (–3.80)	–0.5513*** (–9.45)	0.55 *** (–8.50)
Obs.	1107	612	708	583	625	583
X^2		19.41 ***		26.74 ***		30.21 ***
Pseudo R^2 (Cragg-Uhler)		0.05		0.06		0.07
BIC		635.02		805.12		723.82
Log-likelihood	–434 on 1107 d.f.		–485 on 708 d.f.		–385 on 625 d.f.	
Degrees of freedom	868		708		625	

Source: based on data produced by H2020 EU project, Co-VAL with path regression analysis..

over the KIBS and ICT services over public services innovation which is complementary to the direct effect that KIBS have on public innovation services.

The main conclusion is that KIBS have a higher impact on public services innovation when users are considered through co-creation and co-design methods, acting as facilitators for co-innovation and network processes, than when KIBS is just acting by their own in bilateral relationships with the public sector. Overall positive effects do not mean that all use of KIBS is always positive, as far as some individual KIBS consultancies subcontracting may have mixed results, but user-centred multiagent frameworks help to promote positive impacts.

Therefore, one of the main conclusions of this paper is that public innovation processes could be redirected to have a more insight-kind of consultancies in the improvement of the services being exposed to publicly results testing – with inside-gathering of information as co-creation and lab design proved to have a plus over the innovative process, which are the ones that help citizens and enterprise organizations to generate private value (Skålén et al., 2015, p. 139). As a secondary outcome, the contracting of KIBS and ICT consultancies *per se* does not necessarily generate a positive innovative process and that even having that counted as innovative for the unit public of work does not necessarily produce an increase in public value: if cocreation is not managed in a right way, value destruction may even happen. So, the main policy advice for public managers is that the innovative processes of public units can benefit from an integrated co-creation approach to innovation as far this is be directed to a public goal, aligning public and private aims, that generates public value.

References

Adebajo A. (2018) *The role of service design consultancy in public sector: Inferences from KIBS and service innovation perspectives*. Paper presented at the ServDes2018 - Service Design Proof of Concept, 18-20 June, Milano, Italy. https://servdes.org/wp/wp-content/uploads/2018/07/47.pdf, accessed 17.12.2020.

Alves H. (2013) Co-creation and innovation in public services. *The Service Industries Journal*, 33(7–8), 671–682. https://doi.org/10.1080/02642069.2013.740468

Criado J., Gil-García J. (2019) Creating public value through smart technologies and strategies. From digital services to artificial intelligence and beyond. *International Journal of Public Sector Management*, 32(5), 438–450. https://doi.org/10.1108/IJPSM-07-2019-0178

Davidson J. (2018) *An Introduction to Econometric Theory*, New York: John Wiley & Sons. https://doi.org/10.1002/9781119484905

Desmarchelier B., Djellal F., Gallouj F. (2020). Mapping social innovation networks: Knowledge-intensive social services as systems builders. *Technological Forecasting and Social Change*, 157, 120068. https://doi.org/10.1016/j.techfore.2020.120068

Hanck C., Arnold M., Gerber A., Schmelzer M. (2020) *Introduction to Econometrics with R*, Duisburg: University of Duisburg-Essen.

Lewis J., Margot L., Hans E. (2018) How innovation drivers, networking and leadership shape public sector innovation capacity. *International Review of Administrative Article Sciences*, 84(2), 288–307. https://doi.org/10.1177/0020852317694085

Misuraca G., Viscusi G. (2015) Shaping public sector innovation theory: An interpretative framework for ICT-enabled governance innovation. *Electronic Commerce Research*, 15, 303–322. https://doi.org/10.1007/s10660-015-9184-5

OECD (2017) *Fostering Innovation in the Public Sector*, Paris: OECD.

OECD (2018) *How do we Make it Happen: Implementing Public Sector Innovation*, Paris: OECD.

Osborne S., Strokosch K., Radnor Z. (2018) *Co-Production and the Co-Creation of Value in Public Services. A Perspective from Service Management*. In: Co-Production and Co-Creation. Engaging Citizens in Public Services (eds. T. Brandsen, T. Steen, B. Verschuere), New York: Routledge, pp. 18–26. https://doi.org/10.4324/9781315204956

Pinto M., Saur-Amaral I., Brito C. (2019) Boosting service innovation: The role of consultancies. *Journal of Innovation Management*, 7(3), 41–68. https://doi.org/10.24840/2183-0606_007.003_0004

Rubalcaba L., Di Meglio G., Gallouj F., Pyka A., Windrum P., Green L., Sundbo J., Weber M., Dachs B. (2011) *ServPPIN: A review of scientific findings*, Brussels: European Commission. https://hal.archives-ouvertes.fr/hal-01111766, accessed 14.06.2021.

Sanders E., Stappers P. (2008) Co-creation and the new landscapes of design. *Co-Design*, 4(1), 5–18. https://doi.org/10.1080/15710880701875068

Vinogradov D., Shadrina E., Doroshenko M. (2018) KIBS for public needs. *Economia e Politica Industriale*, 45, 443–473. https://doi.org/10.1007/s40812-018-0106-0

Windrum P., Schartinger D., Rubalcaba L., Gallouj F., Toivonen M. (2016) The co-creation of multi-agent social innovations: A bridge between service and social innovation research. European Journal of Innovation Management, 19(2), 150-166. https://doi.org/10.1108/EJIM-05-2015-0033

Zięba M., Kończyński P. (2017) Client co-production in knowledge-intensive business services (KIBS) – Case study analysis. https://mostwiedzy.pl, accessed 23.07.2021.