Journal of
Theoretical and Applied Electronic Commerce Research

MDPI

Article

User Communities: The Missing Link to Foster KIBS' Innovation

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Abstract: In today's knowledge-driven economy, collaboration among stakeholders is essential for the framing of innovative trends, with knowledge-intensive business services (KIBS) playing a core role in addressing market demand. Users' involvement in shaping products and services has been considered in innovation ecosystem frameworks. Fewer risks in service/product development, and more sustainability and market acceptance, are a few of the benefits arising from including the user community (UC) in innovation partnerships. However, the need for resources, absorptive capacity and tacit knowledge, among other capabilities, is often a reason for overlooking this important contributor. KIBS possess a vast knowledge base, cater to digital tools, and mediate and propel innovation with different partners, benefiting from exclusive cognitive proximity to remix extant knowledge with emergent information from communities into new products and services. The aim of this study is to assess and quantify the effect of the collaboration with UC through three active forms of collaboration (co-creation, mass customization, and personalization) on different innovation types developed in KIBS. The significance of the user community was proven across all innovation types. Robustness analysis confirmed the results for both P-KIBS and T-KIBS. P-KIBS may be better suited to co-creation policies for product and service innovation, personalization of processes, and organizational and marketing innovations. T-KIBS can focus on mass customization, ensuring good innovation success. Additionally, co-creation with user community is best for product innovation.

Keywords: KIBS (knowledge-intensive business services); user community; innovation; co-creation; mass customization; personalization; CIS

Citation: Costa, J.; Brandão, R.d.P. User Communities: The Missing Link to Foster KIBS' Innovation. *J. Theor. Appl. Electron. Commer. Res.* **2024**, *19*, 2088–2113. https://doi.org/10.3390/jtaer19030102

Academic Editor: Ja-Shen Chen

Received: 28 May 2024
Revised: 14 August 2024
Accepted: 16 August 2024
Published: 23 August 2024

1. Introduction

Economic prosperity invariably causes a shift in economic structure [1]. Most economies are strongly reliant on the service sector [2]. The industrial sector is falling while the service sector is expanding, resulting in organizational and economic shifts in all developed economies—a phenomenon called "Service Economy" [3,4]. Consequently, a growing body of literature has concentrated on understanding the innovation processes of advanced economies due to the significant role that services play in these economies [5–8]. Personalized consumer demands have blurred the line between goods and services, requiring seamless integration within products ("goods-to-services continuum") (e.g., [9,10]). Consequently, service numbers have grown in employment rates, as has theshare of value-added due to the development of ICT (information and communication technologies), IoT analytics (internet of things), AI (artificial intelligence), digitalization, higher education, and the rising return of skills [4,11,12].

Servitisation emerged as a strategic approach for manufacturing companies to expand their product range with services, enhancing their competitive advantage [13]. As economies became increasingly knowledge-based, innovation was no longer confined to a company's boundaries, leading to alternative servitisation through collaborative partnerships between manufacturers and KIBS (knowledge-intensive business services) [14,15], which are able to create, collect, and share knowledge in non-material, intangible, bespoke services, including IT, accounting, management consultancy, advertising, market research, engineering, and technical services, leveraging from the innovation ecosystem and engaging with user communities to meet client needs and reduce costs [16–19].

Governments are responsible for choosing their desired innovation ecosystem types. Prior innovation models (e.g., the National Systems Approach) regarded innovation as a firm-driven pursuit dictated by market conditions [20], often emphasizing government interests. Etzkowitz and Leydesdorff [21] suggested a Triple Helix Model as a core framework for the social reproduction of innovation dynamics, balancing industry, academia, and government interests [22]. However, such a framework fails to address the intricacies of higher complexity knowledge production and innovation by leaving out important innovation agents (i.e., user community) [23] (pp. 7–8), [24] (p. 2). User communities (UC) are free and accessible sources of information that can be leveraged to bypass some Triple Helix Model limitations, namely industrial secrecy and government bureaucracy. User/consumer innovation centricity gathered interest from industry and academia due to their role as active collaborators in value co-creation, personalization, and mass customization [18,25], enabling firms to carry fewer risks in service/product development, ensuring sustainability and market acceptance. Consequently, other frameworks were developed, such as the Quadruple Helix Model including the "civil society" (Community) dimension and the Quintuple Helix, adding to the former "natural environments of society" [26].

Moreover, firms often face resource and capability constraints, thereby limiting their capacity to innovate [27] (p. 1). KIBS address these deficiencies, facilitating firm-level and collaborative innovation [28,29], and allowing companies to use their own resources for other endeavors, leveraging collaborative digitalization tools to increase performance [30,31].

Still, although KIBS companies can leverage from UC for their own innovation practices, to the best of our knowledge there are no studies providing a holistic vision of the user community role in spurring KIBS innovation. The existing studies focus on specific contexts, such as software development [18,32], games [33,34], and creative industries [35,36], to name a few, completely overlooking KIBS innovation [24].

As we alluded to previously, KIBS can leverage from UC. KIBS interact with and receive input from diverse multicultural communities. To our knowledge, there is currently no empirical evidence on the User Community impact on KIBS innovation through collaborative formats, e.g., personalization, mass customization, and co-creation. Understanding the role of UC in knowledge-intensive economies is crucial for innovative companies, offering several advantages: unrestricted access to affordable information, the ability to create marketable products and services, and reduced research and development costs [37]. These benefits make UC an essential factor in the success of knowledge-intensive businesses.

It is important to select a region with a significant number of KIBS companies, and the government of which targets innovation policies towards their development. Portugal provides a suitable example for both. Firstly, through public policy (overshooting) efforts to facilitate the creation and development of KIBS, interacting with the Quadruple Helix Model (Community) in a globalized manner. Recent innovation efforts and policies are often aimed at tertiary services, especially KIBS (e.g., Lisbon is the home of Europe Startup Nations Alliance (ESNA) [38] and Unicorn Factory Lisboa). Despite being a moderate innovator [39], Portugal made the leap from industry to KIBS. The government favors these entities in the innovation ecosystem by implementing policies that positively discriminate KIBS innovation to catch-up with more knowledge-intensive economies. Interestingly, although KIBS innovation is currently a topic of extensive research amongst academics, with over 200 publications available since 2000 (Scopus search on publications related to "KIBS Innovation"), their focus lies on highly advanced or digitally advanced countries, e.g., Canada [40,41] or Germany [42], compared to Moderate Innovators. Furthermore, only eight studies from our SCOPUS research selected Portuguese KIBS companies exclusively as their data feed.

Considering that innovation involves diverse actors and industries, that it is becoming increasingly knowledge-based [43], that UC is highly linked to technology-intensive industries, and that KIBS are capable of supplying knowledge and technology-intensive content directly to other sectors and indirectly to the entire economy [41], this sector is expected to exercise the ability to innovate through the three collaborative forms discussed with the UC: customization, mass customization, and co-creation. We will use the Community Innovation Survey (CIS) to conduct our research on KIBS innovation, which is one of the most recognized sources for KIBS innovation research [44], and draw our data from Portuguese KIBS companies.

The aim of this study is to assess and quantify the effect of the collaboration with UC on different types of innovation developed in KIBS. To do that, we will break our aim into three major questions: (RQ1) How does the User Community impact innovation in KIBS? (RQ2) Which types of innovation are most affected? (RQ3) Which channel of interaction matters the most? Having this gap in mind, we aspire to provide theoretical contributions by involving the UCs in KIBS innovation studies. On a practical level, our findings will provide a comprehensive perspective to managers and policy makers, leveraging novel insights from integrating this "new" player, refining current business and innovation models for better KIBS performance and innovation output.

The remainder of the article is organized as follows: Section 2 presents the theoretical overview, Section 3 provides the materials and methods, Section 4 presents the empirical results, and Section 5 concludes.

2. Theoretical Overview

2.1. KIBS

Most economies heavily rely on the service industry [45]. The industrial sector is declining, whereas the services sector is growing, leading to organizational and economical transformations [1]. Knowledge drives innovation and economic growth by creating new services, developing competencies, and boosting productivity of economies [46–48]. Knowledge-intensive business services (KIBS) are services that include knowledge creation and dissemination or accumulation [49]. These are focused on serving other companies, co-producing with their clients, and providing tailored, high-value business services as a subset of the knowledge economy [50–52]. KIBS impact innovation activities both directly and indirectly as sources or bridges for innovation, facilitating the absorption of knowledge and client inputs to develop innovative services [53,54].

KIBS will be examined from four perspectives: knowledge intensity, (business) client focus, innovation enablement, and collaboration emphasis [47,55]. Firstly, the knowledge in these services is often challenging to formalise and transfer because it is rooted in the organisation's culture, sustained through specific networks, or held by individuals [56]. This difficulty leads to problems in standardising the non-material products of KIBS. Secondly, KIBS involve extensive information exchange between providers and clients, distinguishing them from standardized services [57]. The exchange of knowledge goods requires interaction due to uncertainties and information asymmetries in quality evaluation [58]. Lastly, these firms operate as an innovation partner involving the adaptation of specialized knowledge to meet client needs [59]. In Table 1 below, the four lenses retrieved from the extant literature are explained.

Table 1. KIBS definitions.

Dimension	KIBS Definition	Study (Year)
Knowledge Intensity	Delivery of complex services from a highly distinct qualified team.	[27] (p. 2)

Table 1. *Cont.*

Dimension	KIBS Definition	Study (Year)
Knowledge Intensity	Production and dissemination of knowledge, vital to the innovation process.	[60] (p. 44)
	Services dependent on knowledge related to a given field.	[61] (p. 505)
Business focus	Knowledge services provided to companies and public organizations.	[47] (p. 53), [62] (p. 126)
	Expert-based business-to-business services	[63] (p. 394)
Innovation Enabler/Facilitator	Companies serving as innovation intermediaries and sources of Innovation.	[28] (pp. 1–2), [64] (p. 192)
	Companies acting as co-creators of innovation for their clients.	[61] (p. 505)
Collaboration Synergy	Characterized by their reliance on intensive co-operation between service providers and consumers.	[65] (p. 443)
	KIBS combine knowledge gained via collaborative efforts with pre-existing data, increasing total absorption capacity and allowing further knowledge processing.	[47] (p. 78)

In a nutshell, KIBS play three roles in the economy as facilitators, carriers, and sources of innovation. Their nature encompasses two critical features: physical entities as clients and a close KIBS–client co-operation to deliver knowledgeable and customized solutions.

Subsampling KIBS

Table 1 in the previous chapter highlighted four common perspectives on KIBS' operations. Nonetheless, despite our thorough examination of their collaborative nature and ability to offer personalized services with high added value to their B2B client, debates exist regarding the characterization of a KIBS company, the entities offering such services and the industries that fall under this category (e.g., [47,66]). Figure 1 depicts the representation of such defined problems in a pyramid structure.

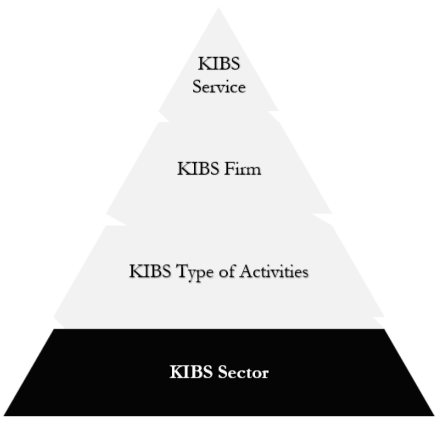

Figure 1. Definition issues related to KIBS.

The most extensive classification of what KIBS are pertains to firms belonging to the KIBS sector, encompassing all firms that provide knowledge-intensive business services. Amongst researchers it is common to categorize them into two primary groups concerning the services offered—P-KIBS and T-KIBS [27]. P-KIBS encompass the conventional professional services such as legal counsel, accounting, bookkeeping, payroll, management, and other consulting; T-KIBS are more inclined towards scientific and technological aspects, including engineering, computer services, technical testing, research, and development. Most studies define KIBS according to the NACE nomenclature (statistical classification of economic activities in the European Union), which seeks to identify KIBS in Europe as a sector comprising information technology, research, development, and other businesses [56]. For the purpose of our study we will consider the research of Miles and Belousova [62], and Schnabl and Zenker [67], and select the following SIC codes: 62, 63, 69, 70, 71, 72, 73, and 74. The following table details our KIBS sampling with its matching KIBS category.

2.2. User Community (UC)

Current innovations require co-operation between different actors due to the resources needed [68] (p. 1). Companies are evolving and participating in a range of open innovation practices, including traditional bilateral agreements and multi-partner collaborations, such as involvement in interorganizational networks or communities [69]. West and Lakhani [70] acknowledged the crucial role of user communities in co-creation, design, and innovation diffusion. Digitalization has facilitated faster and more cost-effective communication, reducing participation costs and enhancing the number and scale of communities [71]. Lately, new product ideas have come straight from users, rather than company insights [72]. Ideas generated by users often display higher quality of originality and customer benefits than those generated by experts [24]. Consequently, a growing number of companies are engaging customers in user innovation through the creation of company-hosted innovation user communities (IUC's) where users participate in innovation activities voluntarily [73,74]. Li and Lu [18] highlighted two types of IUCs: idea-generation IUCs and idea-realization IUCs. A company-hosted UIC serves two purposes: discovery of user innovations to be incorporated into future versions of its product and the promotion of the usage of user innovations among colleagues, increasing the extracted value of the product [75].

Different studies of innovation communities have emerged, focusing on online user communities [76] or catering to innovation communities as a homogeneous population, albeit these include a plethora of internal as well as external actors, namely users, suppliers, employees, and experts (e.g., [77–79]). As Berthinier-Poncet and Dubouloz [80] (p. 576) pointed out in their research, "extant literature deals broadly with "innovation communities" and addresses different forms of communities under this umbrella". The authors categorized them into three types: user communities, communities of practice, and epistemic communities. Generally, user communities enable forum discussions where ideation, creation, and diffusion of innovation occur, allowing modest incremental innovations, product enhancements, upgrades, and complementary products to be developed [71,75]. Table 2 below lists forms of user communities, from which we will clarify our definition in our study.

Table 2. KIBS sector codes and matching category.

SIC	Name	Type of KIBS
74	Other professional, scientific, and technical activities	P-KIBS
73	Advertising and market research	P-KIBS
72	Scientific research and development	T-KIBS
71	Architectural and engineering activities; technical testing and analysis	T-KIBS
70	Activities of head offices; management consultancy activities	P-KIBS
69	Legal and accounting activities	P-KIBS
63	Information service activities	T-KIBS
62	Computer programming, consultancy, and related activities	T-KIBS

Table 3. User Communities Definitions.

Community	Definition	Study (Year)
Brand Community	Structured and specialized social network of brand admirers with common bond and interest in a brand, not limited to a certain geographical region.	[81] (p. 412)
User Community	Informal social networks wherein members exchange information, knowledge, and innovative ideas and artefacts focused on a mutual field of interest.	[82] (p. 177)
User Innovation Community (UIC)	Company-run virtual community where individuals with shared interests participate in innovation efforts to produce new concepts/products and advance existent ones.	[18] (p. 1448)
	Initiatives aimed at co-creating value with the external users of a firm's products.	[83] (p. 901)
	Collaborative network of users within a firm that enables them to submit issues, suggest concepts, and provide solutions.	[84] (p. 4)
	Groups of individuals with a shared interest in resolving a common issue or creating an innovative solution.	[85] (p. 1246)

Amidst these definitions, it is important to acknowledge online user innovation communities (OUIC), similar to UIC and managed through online platforms. Within the user community there are both brand communities and consumer communities, the first focusing on a specific brand or product [81], whilst the second addresses other dimensions of product innovation [86]. Considering these factors, for our study clarification, UC includes everyone that uses or interacts with the company's products/services, whether they have purchased them or they have been made available to them. That may be accomplished online, through specific platforms or physical presence. They can be actual purchasers, recipients of open services, customer support representatives (acting as touchpoints), or others who engage with the asset offered (Table 3).

2.3. KIBS Intertwinement with UC

Businesses have different resources and competencies [87], using various connections to improve performance and innovation portfolios [88]. KIBS knowledge is intricately connected to their workforce, since these employees are often specialized in different areas of knowledge, both technical and scientific, embodying distinctive features such as creativity, a willingness to embrace new challenges, and motivation towards continuous improvement [47] (p. 73). The significance of the process of knowledge creation outweighs the importance of the knowledge held by the company and its employees. Essentially, the main driver of KIBS innovation is established through social interactions between KIBS employees, external colleagues, and customers, thereby forming a community [89]. Despite such evidence, current research has overlooked the UC role in encouraging KIBS innovation. KIBS can establish mutualism with the innovation ecosystem and spark, and support innovation systems on a national and regional level [90] due to their excellency on knowledge-intensity, know-how intermediation, and knowledge processing [28]. KIBS are able to acquire knowledge through different interactions, "remix" it—increasing the absorption capacity—and disseminate it through services or processes for their own innovation practices (see Figure 2) [55,91].

Thus, interaction with UC can lead to better performance in KIBS innovation. Based on this, we hypothesize that:

H1: *User Community has a positive impact on KIBS innovative performance.*

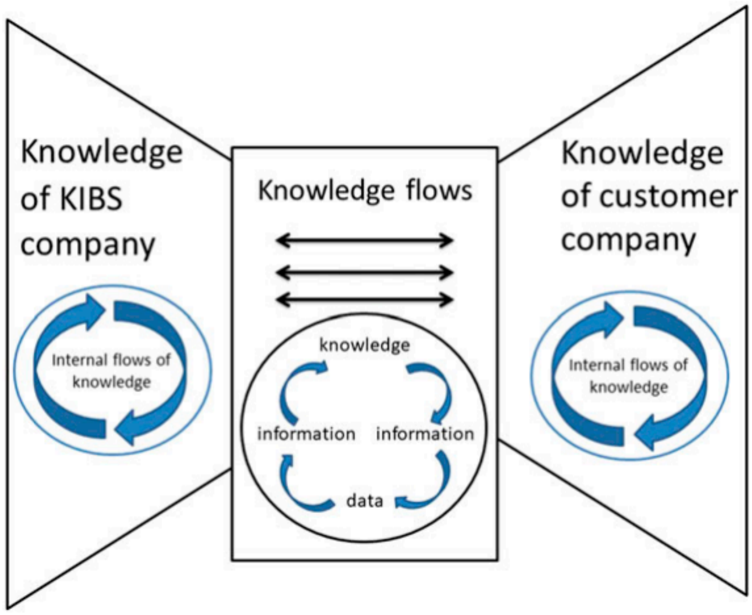

Figure 2. KIBS knowledge flows [47] (p. 132).

2.3.1. Co-Creation

Co-creation emerged due to several factors aligning, namely, widespread development and use of ICT, a shift towards emphasizing services and experiences, and a collaborative approach towards innovation [92]. On a firm level, it has the potential to optimize innovation processes, products, or services (co-innovation, see [93]), elicit competitive advantages [94], improve partnerships, risk sharing, increase generated profits, and reduce speculation towards future trends [95,96]. However, companies often fail to accommodate other partners in their innovation processes due to a lack of resources and absorptive capability [27,97]. KIBS firms primarily engage in the transfer of knowledge and skills between client organizations, as highlighted by Leiponen [98], relying on intensive co-operation to leverage an increase of absorption capacity. Hence, we propose:

H2a: *User Community Co-creation has a positive impact on KIBS' innovative performance.*

2.3.2. Mass Customization (MC)

Toffler's "Future Shock" introduced MC as a concept, revolutionizing production and consumption [99]. Later, Davis [100] defined MC as a system combining mass production efficiency with customization flexibility. Contrary to Mass Production (MP), where low cost achievement is due to economies of scale, MP aims to achieve low costs while still providing personalized products or services tailored to individual customer needs. Costs are mainly reduced through economies of scope, through usage of a single process to produce a wider range of products or services with efficiency [101]. Despite such promising features, companies face challenges implementing MC related to time constraints, cost premiums, and exchanging information with consumers [102]. Piller and Moeslein [103] (p. 437) have argued that customers play a vital role in the development and production of customized products, once successfully integrated into the configuration or design phase. As evidenced by Jost and Süsser [104], MC failed to be implemented in earlier cases due to the limitation of consumers' participation in the market, confined to their choices regarding the purchase of either a standard or customized product. Furthermore, their decision to engage in the market at all is contingent upon their evaluation of the value offered by the product. As demonstrated by Ciriaci, Montresor [105] KIBS have been a supporting player of the manufacturing sector due to their capability in managing consumer integration, leading to successful manufacturing outputs. Thus, we hypothesize that the same may be replicated for their own innovation outputs:

H2b: *User Community Mass Customization has a positive impact on KIBS' innovative performance.*

2.3.3. Personalization

Understanding the customer plays a crucial role in achieving market-successful products or services [106]. One of KIBS main specifications is the interplay of knowledge flows to and from clients (see Figure 2), fostering tight relationships for product and service customization and collaboration [8]. Since KIBS leverage flows from knowledge, "remixing them" for innovation outputs of other parties, as evidenced by different studies (e.g., [28,47,105]), is expected and such a requirement of personalization will spark a change in their own innovation performance. Hence, we suggest:

H2c: *User Community Personalization has a positive impact on KIBS' innovative performance.*

3. Materials and Methods

The econometric models were divided into three groups, the first of which addresses the innovation activities in general, the second highlights the impact of the interaction with the user communities in the different innovation types, and finally the third is an analysis that focuses on the innovative performance. To thoroughly examine the proposed hypotheses, a set of explanatory variables were considered, relating to collaboration with the user community in multiple dimensions; moreover, firms' structural characteristics were included in the analysis and served as controls.

The empirical evidence gathered will support two layers of discussion: one regarding the impact of the reliance upon the user community in the different innovation dimensions, and the second detailing the most significant communication channels to connect with the user community, based on the specific impacts of co-creation, mass customization, and personalization. Also, the connection with the firms' traits will enhance the understanding of the importance of this overlooked source of information for innovation.

3.1. Methods

Firstly, the sub-sample of KIBS responding to the Portuguese CIS 2020 will be addressed through an exploratory analysis to maximise awareness of the sample distribution in the different dimensions in analysis. This procedure will make possible the understanding of the nature of the respondent firms in the pillars of the study, their distribution considering innovation strategies, their connections with the user community, and their profiling regarding their structural traits.

Descriptive statistics will then be implemented to grant the accomplishment of statistical validity and robustness of the data. Moving forward to the econometric estimations, alternative models were run to test the hypotheses previously raised.

In the first dimension of appraisal of the innovative strategies, the dependent variable had a binary nature (whether having performed innovation) and, as such, a binary count model (logit) was run. In the same vein, to break down each innovation type, the nature of the dependent variable did not change, so 5 logit models were also run, one for each type. Despite that, the exogenous variables and the controls were kept constant for each model, allowing inter-model comparisons. As innovation performance was a continuous variable (relative importance of the innovative goods and services in total turnover), the last model was a multiple regression, which will consider the same vectors of explanatory variables and controls.

3.2. Variables in Use

3.2.1. Endogenous Variable(s)

The impact on the innovation strategies will be discussed in multiple dimensions. Firstly, the impact of the explanatory variables will be addressed with regard to innovation in general, disregarding the innovation type. This model will permit us to understand whether the connection with the user community will impact innovation probability, disregarding any other angle.

Then, the analysis will encompass the probability of performing innovation for each innovation type. To understand how each dimension of innovation is more impacted by the connection with user community, we address 5 alternative endogenous variables.

To explain the impact on innovation performance, a model will be run using a proxy relating to the proportion of the firm turnover emerging from new or significantly modified products. Also, the purpose of this empirical modelling relies upon the quantification of the impact of the connection with the user community in the sales turnover emerging from innovations.

3.2.2. Exogenous Variable(s)

The major purpose of the study is to infer the impact of the user community in the innovative strategies of the KIBS. To empirically test this connection, three alternative channels of communication were considered: co-creation, which measures the existence of goods or services developed in strong bidirectional connection with the user-communities, personalization, which identifies if the goods and services were developed specifically to attain the needs of identified users, and mass customization, which relates to the development of goods and services considering the demand of groups of users, to better reach their needs.

3.2.3. Control Variable(s)

The extant literature thoroughly accepts that firms' structural characteristics will affect their overall performance, specifically their innovative performance (see Appendix A). To control the impact of the KIBS structural characteristics, several variables were included in the regression: size, human capital intensity, exports, and reliance on public funding. Considering this set of characteristics and strategic options, the design of the managerial options and the strategic positioning of the firm are believed to be determinant for the successful implementation of innovative practices. The following Table 4 summarizes the existent variables in our study.

Table 4. Variables Summary Table.

Variables	Description	Measurement
gen_innov (1)	Having performed any type of innovation	Binary
prod_innov (2)	Having performed product innovation	Binary
proc_innov (3)	Having performed process innovation	Binary
serv_innov (4)	Having performed service innovation	Binary
org_innov (5)	Having performed organizational innovation	Binary
mkt_innov (6)	Having performed marketing innovation	Binary
innov_perf (7)	Proportion of turnover resulting from new or improved products	Decimal
co_creation (8)	Relying upon co-creation as source of innovation	Binary
mass_cust (9)	Relying upon mass customization as source of innovation	Binary
personal (10)	Relying upon personalization as source of innovation	Binary
size (11)	Firm Dimension	1–3 degree
hum_cap (12)	Human Capital intensity	1–7 degree
export (13)	Proportion of the turnover exported	Decimal
funds (14)	Beneficiary of funds	1 to 4 count

Table 4. *Cont.*

Variables	Description	Measurement
open_innov (15)	Performing inbound and outbound innovation	Binary
sou_univ (16)	Collaboration with Universities	Binary

4. Empirical Results

The analysis of user community role in the innovative strategies of KIBS will be appraised through data provided by the Portuguese Community Innovation Survey (CIS) 2020. The survey is run under the supervision of Statistics Portugal, following the procedures defined by Eurostat, covering the 2018–2020 timeframe. The entire survey was sub-sampled, choosing only firms operating in the KIBS sectors, namely, SIC codes 62, 63, 69, 70, 71, 72, 73, and 74. The total number of companies corresponding to KIBS in the CIS data is 2175 for the intended study period (see Table 5).

Table 5. Distribution of companies according to SIC codes.

Nace Rev 2.0	Number of Firms	Proportion
62	536	24.64%
63	65	2.99%
69	361	16.60%
70	206	9.47%
71	561	25.79%
72	63	2.90%
73	192	8.83%
74	191	8.78%

4.1. Exploratory Analysis

As evidenced in Table 5, our sample is diverse for sectors and industries. A total of 1470 of 2175 firms engaged with the user community. Of our existent 536 computer programming consultancy and related activities firms, 80% reported engaging in at least one form of collaboration and 26% engaged in all forms of collaboration. Conversely, 53% of legal and accounting activity firms did not engage with the user community, and only 7% actively involved themselves in all forms of collaboration (see Table 6). These values may suggest that firm sector plays a role in determining collaboration with the user community. In fact, further analysis showed that over 60% of the innovator firms of this sector engage in personalization and co-creation, whilst only 23% co-create with the user community. In other words, the nature of the work performed may inhibit an active form of collaboration (co-creation) with the UC.

Table 6. User Community engagement across KIBS.

	User Community		
SIC	**None**	**>1 Collaboration**	**All**
62	94	442	142
63	18	47	13
69	193	168	26
70	88	118	36

Table 6. *Cont.*

User Community			
SIC	**None**	**>1 Collaboration**	**All**
71	185	376	80
72	13	50	14
73	66	126	36
74	48	143	44
Total	705	1470	391

From Table 7 we can establish a positive connection between the involvement with user community and the five distinct innovation outcomes. Overall, over 80% of the innovators reported collaborating with the user community.

Table 7. Involvement with UC per Innovation type.

Collab with UC	Prod Innov	%	Serv Innov	%	Proc Innov	%	Org Innov	%	Mkt Innov	%
No	37	8.81%	78	10.32%	203	17.67%	150	16.56%	68	13.20%
Yes	383	91.19%	678	89.68%	946	82.33%	756	83.44%	447	86.80%
Total	420	-	756	-	1149	-	906	-	515	-

From Table 8 we ran a comparison between P-KIBS and T-KIBS, and demonstrated that T-KIBS are greater innovators than P-KIBS across all innovation types measured.

Table 8. Frequency of KIBS per type of innovation.

KIBS	Product Innovation	Service Innovation	Process Innovation	Organizational Innovation	Marketing Innovation
P-KIBS	124	250	471	376	199
T-KIBS	296	506	678	530	316
Total	420	756	1149	906	515

Tables 9 and 10 aim to understand whether the innovation pursued is incremental, radical, or both, and its subsequent impact on business performance. Interestingly, both incremental and radical innovations do not seem to impact business turnover. This may be explained due to the report's narrow time frame of 2 years (2018–2020), through which some innovations take longer to impact business performance.

Table 9. Distribution of radical and incremental innovation across P-KIBS and T-KIBS firms.

KIBS	Radical Innovation	Incremental Innovation	Both Innovation
P-KIBS (n = 950)	37 (3.89%)	132 (13.89%)	83 (8.74%)
T-KIBS (n = 1225)	67 (5.47%)	222 (18.12%)	210 (17.14%)
Total	104	354	293 (13.47%)

Table 10. Impact on Business turnover of radical and incremental innovation across KIBS.

Radical Innovation			**Incremental Innovation**		
Business Turnover	**KIBS**	**Percentage**	**Business Turnover**	**KIBS**	**Percentage**
0%	1778	81.75%	**0%**	1528	70.25%
From 0% to 25%	247	11.36%	**From 0% to 25%**	334	15.36%

Table 10. *Cont.*

Radical Innovation			Incremental Innovation		
Business Turnover	**KIBS**	**Percentage**	**Business Turnover**	**KIBS**	**Percentage**
From 25% to 50%	89	4.09%	**From 25% to 50%**	155	7.13%
From 50% to 75%	22	1.01%	**From 50% to 75%**	52	2.39%
From 75% to 99%	18	0.83%	**From 75% to 99%**	66	3.03%
100%	21	0.97%	**100%**	40	1.84%
Total	2175	100%	**Total**	2175	100%

Table 11 details our sample according to size and innovation funds, and the subsequent outcome on innovation success. Most firms are of smaller size without reported funding sources.

Table 11. Innovation outcomes from KIBS firms grouped by size and funding sources.

P-KIBS	No Innovation	Innovation	T-KIBS	No Innovation	Innovation
10–49 Employees	**n = 378**	**n = 398**	**10–49 Employees**	**n = 366**	**n = 542**
No funding	51.11%	48.89%	**No funding**	47.15%	52.85%
Funding	33.01%	66.99%	**Funding**	11.05%	88.95%
50–249 Employees	**n = 47**	**n = 99**	**50–249 Employees**	**n = 70**	**n = 200**
No funding	35.48%	64.52%	**No funding**	32.42%	67.58%
Funding	32.19%	67.81%	**Funding**	12.50%	87.50%
250+ Employees	**n = 3**	**n = 25**	**250+ Employees**	**n = 10**	**n = 37**
No funding	12.00%	88.00%	**No funding**	25.00%	75.00%
Funding	0.00%	100.00%	**Funding**	13.33%	86.67%
All	45.1%	54.9%	**All**	36.4%	63.6%

4.1.1. Collaboration with UC

The collaboration with user communities was measured across three levels of interaction: co-creation, personalization, and mass customization. Firstly, we briefly analysed the number of companies by sector and industry that engage with the user community in any given format. Afterwards, firms were grouped across each level of interaction.

Across all 2175 firms, 705 firms (32.41%) reported not connecting with UC in any format, 1470 firms engaged in at least one form of collaboration, and 391 firms (18%) engaged in the three forms mentioned. For both P-KIBS and T-KIBS, there was a higher predisposition towards personalisation, followed by mass customization and co-creation.

Furthermore, we observed the correlation between engaging with the user community and pursuing each innovation type. Across all innovation forms there was a direct correlation with the user community (see Table 7).

4.1.2. Breaking Down the Sample into P-KIBS and T-KIBS

Our study will refer to five types of innovation retrieved from the CIS survey, namely, product innovation, service innovation, process innovation, organizational innovation, and marketing innovation. A total of 40% of KIBS firms reported not having performed any type of innovation. A total of 8% of all KIBS reported performing the five innovation types (see Table 8).

Further analysis into P-KIBS vs. T-KIBS demonstrates that the latter are more prone to innovate across all five types of innovation.

For assessing whether KIBS firms deploy radical or incremental innovation, we coded two variables "innov_rad" and "innov_increm", that included the % of increased turnover resulting from new or improved products that were new to the market, or similar/identical to current ones developed in 2018–2020, respectively. We then assessed the results, and converted to 1 or 0, if any improvement in turnover resulted from these innovation performances, or none. Table 9 below shows that both types of KIBS tend to innovate more incrementally, and on average T-KIBS innovate more across all innovation types. Table 10 includes the self-reported impact of innovation on business performance.

Notwithstanding the presented data, it is important to consider that this reported increase for 2020 is for innovations carried out in 2018–2020. Specifically, there is a caveat. Some innovations may impact business within the short-term, as opposed to others that take longer to impact business performance (especially radical innovations). At times, there may be a gap between innovation and its commercialization, due to adoption barriers conditioning overall market acceptance [107].

Historically, governments and policy makers have been innovation propellers through modulating their innovation ecosystem types. Studies on both p-KIBS and t-KIBS have shown that firms receiving public financial support are more likely to introduce innovations that are either "New-to-firm" or "New-to-market", compared to those who are not receiving such support [108]. The CIS survey includes four different sources of innovation: local and regional authorities, regional administration, horizon 2020 EU programme, and another EU institution financial support. Firstly, most of the firms in our sample did not benefit from public/EU funding (P-KIBS (n = 822, 86.53%) or T-KIBS (n = 950, t = 77.55%).

Table 11 provides a detailed breakdown of the distribution of p-KIBS and t-KIBS based on their innovation outcome and the existence of funding sources across different ranges of firm sizes. Overall, our data suggest that T-KIBS are more prevalent and tend to innovate more, compared to P-KIBS. Additionally, both types of KIBS are dominated by smaller firms, and most firms, regardless of type, do not have identified funding sources.

4.2. Econometric Estimations

Table 12 reports the descriptive statistics and zero-order correlations of the variables summarized in Section 3.2.3. A total of 60% of our existing sampled KIBS are performing some form of innovation; process innovation is the most prominent type of innovation, followed by organizational innovation (42%), service innovation (35%), and, lastly, marketing innovation (24%). The sampled KIBS show low levels of interaction with academia (only 1%), and actively engage with user communities through personalization, mass customization, and co-creation (49, 43, and 37%, respectively). In addition, only 23% of these firms are present in international markets. The statistical analysis shows that the variables of co-creation, mass customization, and personalization consistently and positively influence all types of innovation. Additionally, these coefficients are statistically significant with a p-value of less than 0.01. These results strongly support the idea that the collaboration between KIBS and user communities significantly improves firms' innovation performance. Innovation Performance is most strongly correlated with service innovation, suggesting that service innovation significantly impacts overall innovation performance. Service Innovation appears as a critical mediator showing strong correlations with both product and process innovations and performance. Firm size, human capital, export, funds, and open innovation performance also show various positive correlations with innovation types and performance, although generally weaker than the core innovation relationships. Interestingly, involvement with universities has positive correlations with product, process, and service innovations, albeit only a minority of KIBS engage with academia.

By conducting various estimations, our objective was to evaluate the influence of the interaction between firms and user communities on different innovation outcomes. To accurately assess this impact, we opted for binary logistic regressions (see Table 13). We also considered the specific characteristics of the dependent variables, and KIBS type (Table 15).

Table 12. Descriptive statistics and correlations of study variables.

Variable	Min	Max	Mean	S.D.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
gen_innov (1)	0	1	0.6	0.49															
prod_innov (2)	0	1	0.19	0.395	0.401 **														
proc_innov (3)	0	1	0.53	0.499	0.867 **	0.311 **													
serv_innov (4)	0	1	0.35	0.476	0.598 **	0.587 **	0.508 **												
org_innov (5)	0	1	0.42	0.493	0.693 **	0.265 **	0.705 **	0.408 **											
mkt_innov (6)	0	1	0.24	0.425	0.457 **	0.278 **	0.483 **	0.402 **	0.503 **										
innov_perf (7)	0	100	15.97	30.026	0.436 **	0.546 **	0.373 **	0.676 **	0.327 **	0.302 **									
co_creation (8)	0	1	0.37	0.482	0.227 **	0.256 **	0.211 **	0.274 **	0.222 **	0.162 **	0.245 **								
mass_cust (9)	0	1	0.43	0.495	0.277 **	0.196 **	0.239 **	0.268 **	0.192 **	0.186 **	0.155 **	0.230 **							
personal (10)	0	1	0.49	0.5	0.306 **	0.220 **	0.277 **	0.295 **	0.263 **	0.202 **	0.224 **	0.497 **	0.278 **						
size (11)	1	3	1.26	0.511	0.155 **	0.072 **	0.148 **	0.235 **	0.130 **	0.142 **	0.124 **	0.032	0.104 **	0.034					
hum_cap (12)	1	7	5.75	1.711	0.211 **	0.127 **	0.183 **	0.224 **	0.164 **	0.145 **	0.184 **	0.159 **	0.138 **	0.197 **	0.120 **				
export (13)	0	100	23.55	33.656	0.101 **	0.057 **	0.108 **	0.116 **	0.088 **	0.119 **	0.165 **	0.098 **	0.096 **	0.120 **	0.159 **	0.187 **			
funds (14)	0	4	0.27	0.658	0.205 **	0.223 **	0.195 **	0.262 **	0.163 **	0.144 **	0.230 **	0.164 **	0.086 **	0.147 **	0.117 **	0.152 **	0.093 **		
open_innov (15)	0	2	0.391	0.624	0.385 **	0.419 **	0.357 **	0.510 **	0.272 **	0.291 **	0.371 **	0.246 **	0.217 **	0.238 **	0.281 **	0.222 **	0.148 **	0.376 **	
sou_univ (16)	0	1	0.01	0.095	0.049 *	0.063 **	0.062 **	0.071 **	0.016	0.026	0.048 *	0.087 **	0.014	0.04	0.064 **	0.048 *	0.023	0.429 **	0.140 **

** Pearson correlation is significant at the 0.01 level (2-tailed). * Pearson correlation is significant at the 0.05 level (2-tailed).

Table 13. Logit models for different types of innovation.

	Gen Innov				Innov Perf		Gen Innov		Prod Innov		Proc Innov		Serv Innov		Org Innov		Mktg Innov	
	B	Exp(B)	B	Exp(B)	B	Exp(B)	B	Exp(B)	B	Exp(B)	B	Exp(B)	B	Exp(B)	B	Exp(B)	B	Exp(B)
user_comm_gen	-	-	−1.606 **	0.201	4.211 ***	-	-	-	-	-	-	-	-	-	-	-	-	-
co_creation (8)	-	-	-	-	-	6.977 ***	0.086	1.09	0.698 ***	2.009	0.123	1.131	0.426 ***	1.532	0.329 ***	1.389	0.151	1.163
mass_cust (9)	-	-	-	-	-	1.774	0.728 ***	2.07	0.536 ***	1.709	0.551 ***	1.735	0.66 ***	1.934	0.375 ***	1.455	0.488 ***	1.629
personal (10)	-	-	-	-	-	3.712 ***	0.821 ***	2.273	0.391 ***	1.478	0.688 ***	1.989	0.674 ***	1.963	0.645 ***	1.907	0.521 ***	1.684
size (11)	0.225 **	1.253	0.273 **	1.314	0.507	0.707	0.261 **	1.298	−0.226 *	0.798	0.232 **	1.261	0.547 ***	1.727	0.256 ***	1.291	0.256 **	1.292
hum_cap (12)	0.145 ***	1.156	0.103 ***	1.109	1.069 ***	1.071 ***	0.1 ***	1.105	0.043	1.044	0.078 ***	1.081	0.158 ***	1.171	0.093 ***	1.097	0.103 ***	1.108
export (13)	0.001	1.001	0.000	1.000	.074 ***	0.075 ***	0	1	−0.002	0.998	0.001	1.001	−0.001	0.999	0	1	0.003 **	1.003
funds (14)	0.538 ***	1.713	0.476 ***	1.610	4.976 ***	4.886 ***	0.402 ***	1.495	0.188 **	1.207	0.293 ***	1.34	0.306 ***	1.358	0.178 **	1.195	0.064	1.066
open_innov (15)	1.624 ***	5.074	1.401 ***	4.059	12.507 ***	12.499 ***	1.406 ***	4.082	1.271 ***	3.564	1.012 ***	2.75	1.459 ***	4.302	0.524 ***	1.689	0.668 ***	1.95
sou_univ (16)	−1.834 **	0.160	0.548 ***	1.729	−15.927 **	−16.658 **	-	-	-	-	-	-	-	-	-	-	-	-
Constant	−1.271 ***	0.281	−1.644 ***	0.193	−4.091 *	−4.046 *	−1.651 ***	0.192	−2.944 ***	0.053	−1.668 ***	0.189	−3.811 ***	0.022	−2.096 ***	0.123	−3.136 ***	0.043

*** Significant at the 0.01 level (2-tailed); ** significant at the 0.05 level (2-tailed); * significant at the 0.10 level (2-tailed).

4.3. Robustness Checks

To validate the results obtained in the exploratory analysis, we pre-emptively conducted a robustness check of our first model, for general innovation, treating P-KIBS and T-KIBS separately. The results are shown in Table 14.

Table 14. Binary logit model for general innovation for T-KIBS and P-KIBS.

	T-KIBS			P-KIBS		
	Gen Innov					
	B	**Sig.**	**Exp(B)**	**B**	**Sig.**	**Exp(B)**
co_creation	0.470	0.001	1.600	0.142	0.466	1.153
mass_cust	1.084	<0.001	2.957	0.697	<0.001	2.008
personal	0.802	<0.001	2.230	1.153	<0.001	3.167
Constant	−0.500	<0.001	0.607	−0.555	<0.001	0.574

For Model 1, the regression included co-creation, mass customization, and personalization as dependent variables. Although mass customization and personalization support general innovation for both KIBS types, personalization does not show significant values for P-KIBS. This suggests that the determinants may differ for KIBS with regard to general innovation. We followed our analysis with Model 2, in the same vein, to analyse each innovation type, without changing the dependent variables, so five logit models were also run, one for each type. The results are shown in Table 15.

Table 15. Logit models for different types of innovation for T-KIBS and P-KIBS.

	T-KIBS														
	innov_prod			innov_proc			innov_serv			innov_org			innov_mkt		
Variables	**B**	**Sig.**	**Exp(B)**	**B**	**Sig.**	**Exp(B)**	**B**	**Sig.**	**Exp(B)**	**B**	**Sig.**	**Exp(B)**	**B**	**Sig.**	**Exp(B)**
Co-creation	0.753	<0.001	2.124	0.420	0.002	1.522	0.482	<0.001	1.619	0.534	<0.001	1.705	0.165	0.264	1.179
mass customization	0.745	<0.001	2.107	0.858	<0.001	2.358	1.045	<0.001	2.842	0.668	<0.001	1.950	0.914	<0.001	2.493
personalization	0.471	0.003	1.602	0.689	<0.001	1.992	0.632	<0.001	1.881	0.587	<0.001	1.798	0.597	<0.001	1.817
Constant	−2.205	0.000	0.110	−0.723	<0.001	0.485	−1.450	<0.001	0.235	−1.165	0.000	0.312	−1.980	0.000	0.138
	P-KIBS														
	innov_prod			innov_proc			innov_serv			innov_org			innov_mkt		
Variables	**B**	**Sig.**	**Exp(B)**	**B**	**Sig.**	**Exp(B)**	**B**	**Sig.**	**Exp(B)**	**B**	**Sig.**	**Exp(B)**	**B**	**Sig.**	**Exp(B)**
Co-creation	1.012	<0.001	2.750	0.211	0.255	1.236	0.810	<0.001	2.247	0.343	0.056	1.409	0.541	0.007	1.718
mass customization	0.506	0.017	1.659	0.549	<0.001	1.731	0.460	0.006	1.584	0.288	0.055	1.334	0.216	0.216	1.241
personalization	0.791	0.003	2.205	1.016	<0.001	2.763	1.091	<0.001	2.977	1.032	<0.001	2.806	0.770	<0.001	2.160
Constant	−2.988	0.000	0.050	−0.711	0.000	0.491	−2.076	<0.001	0.125	−1.109	<0.001	0.330	−1.994	<0.001	0.136

For T-KIBS, co-creation significantly increased the likelihood of four types of innovation—product, process, service, and organizational. Interestingly, co-creation did not significantly impact marketing innovation. Moreover, the chances of product innovation were found to be twice as high when considering this variable. Mass customization demonstrated statistical significance across all types of innovation, thereby providing a dual probability for each innovation type. Personalization was also shown to affect all types of innovation, positively and significantly.

For P-KIBS, co-creation positively and significantly affected product, service, and marketing innovations. Mass customization positively and significantly affected process innovation.

To further validate our results, and to understand whether user community plays a complementary or independent role in fostering innovation in KIBS, we proceeded with five logit models to test the impact on general innovation by firms' structural characteristics only, and then integration of each separate helix (Industry/Value_Chain; Government; Academia; and the User Community). For Model 1, our regression included Gen_Innovation as a dependent variable, with a firm's structural characteristics as control variables. The results revealed that both human capital and firm size were statistically significant.

In Model 2 we followed the same logic, but added the variable Value_Chain. This interaction has a significant positive effect on general innovation. The effect of the other variables, although lower, remained significant.

In Model 3 we broadened our interaction to include Government, which was computed through combining both reliance on public funds and innovation funds. This change did not impact our previous estimation for the firm's structural characteristics (although showing a minor decrease in exports), and increased the effect of the Value_Chain. In other words, the ability to rely on and utilize governmental aids ensured better partnership outcomes within the value chain.

In Model 4, we coded the variable Academia, here represented by collaboration with universities and laboratories. It is observable as a negative effect on general innovation, as well as a minor negative impact on the remaining variables.

Finally, in Model 5, we include the user community which has a positive significant effect on general innovation. The remaining variables remained significant, validating prior estimations. Nonetheless, it is worth mentioning that export decreased when we increased the number of helices involved. See Table 16.

Concluding, it becomes clear that the most important forms of partnership are within the value chain. There is an added boost from including more helices, nonetheless, exports lack relevancy as we increase our variables, and academia seems detrimental to the other forms of interaction (see Table 16).

Furthermore, when establishing the direct role of UC, we also assessed its impact alongside firm structural characteristics using general innovation and innovation performance as dependent variables. Moreover, we tested value chain (Table 16) for the same dependent variables.

Concerning the firm's structural characteristics, we may observe Human Capital and Size are significantly positive for general innovation and innovation performance across all models. Exports loses it significance when we add the user community, for general innovation (Model 2). Although it remains statistically significant in Models 3 and 4, there is a decline with the inclusion of UC. Overall UC improves the model fit and possesses a significantly positive effect for both general innovation and innovation performance.

- **P-KIBS vs. T-KIBS:**

Finally, we separated the pre-existent KIBS in P-KIBS and T-KIBS to test the helices' involvement in both models, using general innovation and innovation performance as dependent variables.

We started by running two models for each KIBS type, assessing the UC impact alongside firm structural factors, on general innovation.

Human capital and size remained positively statistically significant across all models.

Concerning exports, there were differences between P-KIBS and T-KIBS. P-KIBS showed a significant statistical impact on general innovation, displaying coefficients slightly above 1. However, for T-KIBS, export was not significant for either Model 3 or 4.

Concerning model fit, there was an improvement when the UC variable was added in both Models 2 and 4 (see Table 17).

Table 16. Robustness check summary of general innovation and innovation performance across the 4 helices.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Variables	Model 1	Model 2	Model 3	Model 4	Model 5
			Gen_Innov						Innov_Perf		
hum_cap	1.251 *** (0.224)	1.239 *** (0.214)	1.217 *** (0.196)	1.217 *** 0.196)	1.144 *** (0.135)	**hum_cap**	7.057 *** (0.374)	6.602 *** (0.372)	5.857 *** (0.369)	5.836 *** (0.369)	4.201 *** (0.370)
size	1.793 *** (0.584)	1.675 *** (0.516)	1.634 *** (0.491)	1.629 *** (0.488)	1.683 *** (0.521)	**size**	4.051 *** (1.244)	2.876 *** (1.279)	2.608 * (1.243)	2.527 ** 1.243)	2.507 ** (1.223)
export	1.003 ** (0.003)	1.003 ** (0.003)	1.002 (0.002)	1.002 (0.002)	1.000 (0.0003)	**export**	5.768 *** (0.019)	5.593 *** (0.019)	5.235 *** (0.019)	5.197 *** (0.019)	4.503 *** (0.019)
Value_Chain		7.103 *** (1.960)	4.972 *** (1.604)	7.184 *** (1.972)	6.589 ** (1.885)	**Value_Chain**		5.707 *** (3.546)	4.454 *** (3.542)	4.947 *** (3.890)	4.937 *** (3.828)
Government			3.266 *** (1.184)	3.376 *** (1.217)	2.814 *** (1.035)	**Government**			7.865 *** (1.619)	8.095 *** (1.634)	7.115 *** (1.620)
Academia				0.230 * (−1.472)	0.249 * (−1.390)	**Academia**				−2.149 ** (7.198)	−2.135 ** (7.084)
UC					4.534 *** (1.512)	**UC**					8.442 *** (1.339)
Constant	−1.674	−1.562	−1.587	−1.587	−2.199	**Constant**	−3.190	−2.305	−5.747	−2.221	−3.596
−2log likelihood	2789.103	2764.602	2686.650	2683.604	2462.598	**−2log likelihood**	-	-	-	-	-

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 17. Robustness check summary by KIBS type on Gen_Innov and Innov_Perf.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
	General_Innov				Innov_Performance			
	P-KIBS		T-KIBS		P-KIBS		T-KIBS	
hum_cap	1.174 *** (0.038)	1.113 *** (0.041)	1.327 *** (0.038)	1.231 *** (0.041)	2.473 ** (0.484)	1.472 (0.482)	6.902 *** (0.553)	5.276 *** (0.559)
size	2.002 *** (0.163)	2.158 *** (0.172)	1.631 *** (0.129)	1.695 *** (0.137)	3.271 *** (1.818)	3.302 *** (1.785)	2.406 ** (1.679)	2.346 ** (1.650)
export	1.006 ** (0.002)	1.004 ** (0.003)	1 (0.002)	0.998 (0.002)	2.653 *** (0.030)	2.233 ** (0.030)	3.823 *** (0.025)	3.424 *** (0.025)
UC	-	4.301 (0.146)	-	5.519 (0.149)	-	5.971 *** (1.726)	-	6.618 *** (2.075)
Constant	0.196	0.107	0.180	0.081	−1.070	−1.972	−2.972	−4.207
−2log likelihood	1252.042	1145.469	1520.913	1381.072	-	-	-	-

Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In sum, this suggests that human capital and size are robust predictors for general innovation. Export may prove significant for P-KIBS, but not for T-KIBS, especially when considering the user community. UC has a significant and strong positive impact on General Innovation in both contexts, enhancing the model's explanatory power.

The differences between P-KIBS and T-KIBS firms highlight the varying impacts of export and the stronger effect of human capital in T-KIBS for general innovation.

However, when the innovation performance was assessed, we found that adding UC to P-KIBS made Human Capital become non-significant, without affecting the significance of the remaining variables. This suggests that leveraging from this user community may posit benefits for companies that may lack human capital intensity. Overall model fit improved with the inclusion of UC, highlighting its significant positive impact on innovation performance.

Lastly, we assessed the impact of the four helices (Value Chain, Government, Academia, and User Community) with firms' structural characteristics for both general innovation and innovation performance, to better understand how these interactions may work and identify differences between KIBS types.

Concerning our structural characteristics, there were no changes to the previous tables' findings. Human capital and size proved statistically significant for both KIBS types, whilst exports proved insignificant for T-KIBS.

The helices value chain and government exhibited significant positive effects on general innovation for both types of KIBS. When we included Academia, there was an insignificant impact on P-KIBS, however, there was a positive impact on T-KIBS. Considering P-KIBS include conventional professional services, it makes sense that the role of academia may not be significantly impactful in their innovation practices. Nonetheless, for T-KIBS, which are more technological and scientific in nature, there was a positive impact on general innovation outcomes. However, as we have seen thus far, such business-wise innovations might not impact performance.

For our last robustness check, we reran these models for our innovation performance variable.

There were observable differences in the firm-structure traits as we increased our helices. Human capital was positively statistically significant across all T-KIBS models. For P-KIBS, however, when we added the first helix, it ceased being significant and stayed as such throughout all models. On the other hand, size was statistically significant for all P-KIBS models, nonetheless, for T-KIBS it ceased significance once the first helix was introduced. Exports managed to stay significantly positive across all models for both P-KIBS and T-KIBS, displaying more pronounced effects for T-KIBS.

Value chain was significant across both types of firms, and may outperform human capital in the case of P-KIBS, whilst compensating for lack of size in T-KIBS.

Government was also significant across both KIBS, showing higher impacts for T-KIBS. In this case, these companies may rely more on public funding since they have higher odds of increasing their innovation performance.

Academia was not significant for P-KIBS innovation performance, but impacted T-KIBS negatively once there was interaction between all helices. Despite academia perhaps being able to assist with generally perceived innovation outcomes, as seen from Table 18, its participation seems detrimental to performance. In other words, such involvement does not necessarily translate into increased business performance. Finally, the user community showed similar significant positive impact for both types of KIBS, enhancing the importance of leveraging from this source of information.

In sum, human capital proved very important for T-KIBS, whilst size ceased to be significant once we improved the existing collaborations. Value chain showed more impact for P-KIBS, whilst Government support vastly increased innovation performance in T-KIBS. Academia was detrimental to innovation performance in both, albeit statistically significant for T-KIBS. Lastly, we recommend gathering insights from the user community, given its overall impact on business performance. See Table 19.

Table 18. Robustness check of the 4 helices' interactions with general innovation.

Variables	General Innovation									
	P-KIBS					T-KIBS				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
hum_cap	1.1744 *** (0.0382)	1.162 *** (0.038)	1.151 *** (0,039)	1.151 *** (0.039)	1.096 ** (0.041)	1.328 *** (0.038)	1.315 *** (0.038)	1.286 *** (0.039)	1.287 *** (0.039)	1.199 *** (0.042)
size	2.002 *** (0.163)	1.852 *** (0.167)	1.896 *** (0.167)	1.886 *** (0.167)	1.987 *** (0.176)	1.632 *** (0.129)	1.533 *** (0.131)	1.425 *** (0.134)	1.418 *** (0.135)	1.463 *** (0.143)
export	1.006 ** (0.002)	1.006 ** (0.745)	1.006 ** (0.003)	1.006 ** (0.003)	1.004 * (0.002)	1.000 (0.002)	1.000 (0.002)	0.999 (0.002)	0.999 (0.002)	0.998 (0.002)
Value_Chain	-	6.711 ** (0.745)	5.794 ** (0.749)	6.92 ** (0.802)	6.059 ** (0.833)	-	7.711 *** (0.731)	4.278 * (0.745)	8.200 ** (0.932)	8.226 ** (0.980)
Government	-	-	1.96 *** (0.214)	2.003 ** (0.216)	1.632 ** (0.227)	-	-	4.716 *** (0.204)	4.951 *** (0.209)	4.289 *** (0.216)
Academia	-	-	-	0.267 (1.389)	0.335 (1.386)	-	-	-	0.162 * (1.040)	0.161 * (1.067)
UC	-	-	-	-	4.135 *** (0.147)	-	-	-	-	5.035 *** (0.154)
Constant	0.196	0.223	0.211	0.212	0.122	0.180	0.199	0.198	0.198	0.095
−2log likelihood	1252.042	1241.428	1231.092	1230.271	1131.598	1520.913	1506.684	1432.869	1430.109	1311.852

Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 19. Robustness check of the 4 helices' interaction with innovation performance.

Variables	Innovation Performance									
	P-KIBS					T-KIBS				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
hum_cap	2.473 ** (0.484)	1.942 * (0.478)	1.615 (0.476)	1.61 (0.476)	0.746 (0.475)	6.902 *** (0.553)	6.67 *** (0.552)	6.036 *** (0.547)	6.027 *** (0.547)	4.681 *** (0.553)
size	3.272 *** (1.818)	1.947* (1.838)	2.14 ** (1.825)	2.082 ** (1.83)	2.121 ** (1.802)	2.406 ** (1.679)	1.81 * (1.699)	1.341 (1.679)	1.3 (1.678)	1.32 (1.656)
export	2.654 *** (0.03)	2.449** (0.03)	2.287 ** (0.03)	2.285 ** (0.03)	1.92 * (0.029)	3.823 *** (0.025)	3.71 *** (0.025)	3.569 *** (0.025)	3.501 *** (0.025)	3.168 *** (0.024)
Value_Chain	-	5.623*** (4.967)	5.077 *** (4.97)	5.11 *** (5.075)	5.024 *** (5.00)	-	3.202 ** (4.901)	2.046 ** (4.914)	2.652 *** (5.757)	2.645 *** (5.68)
Government	-	-	4.079 *** (2.466)	4.13 *** (2.483)	3.671 *** (2.455)	-	-	6.179 *** (2.158)	6.357 *** (2.174)	5.626 *** (2.164)
Academia	-	-	-	−0.683 (15.254)	−0.615 (15.023)	-	-	-	−1.734 (8.934)	−1.708 * (8.815)
UC	-	-	-	-	5.516 *** (1.698)	-	-	-	-	5.853 *** (2.061)
Constant	−1.07	−0.005	−0.207	−0.174	−1.008	−2.972	−2.541	−2.406	−2.378	−3.499

Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5. Conclusions

5.1. Theoretical and Empirical Findings

With increased service numbers in both employment rates and the share of value-added commodities, a propensity towards a service economy, led by ICTs, IoT, AI, and overall digitalization development, innovation is no longer restricted to company limits. In fact, recent models of governance have been accommodating multiple agents in the innovation ecosystem, namely, the user community [26]. This user centricity has been actively researched, due to accrued benefits of innovation development, such as reduced market, development, and sustainability risks. However, firms often lack resources to fulfil and integrate users' feedback [27]. Current KIBS research highlights their knowledge base, use of digital tools, collaborative and intermediated innovation, and absorptive capacity to remix existent knowledge into new products and services [28–30,47]. Nonetheless, existent studies that relate to communities are often context-dependent, i.e., focus on software development and games, etc., bypassing the user community impact on KIBS innovation [24].

Our study was aimed at investigating whether user communities' involvement with KIBS affects their innovation performance. Based on the empirical evidence gathered, it can be concluded that the interaction between user communities and firms does, indeed, enhance their innovation outcomes (across different types of innovation). Despite such results, we also uncovered that higher levels of general user community engagement are associated with lower innovation performance (B = −1.606 **). This finding suggests that there may be a trade-off between satisfying the user with innovations that do not necessarily contribute to increased business performance (minor incremental innovations). Furthermore, there may be a gap between the development of these innovations and added business performance, which may take longer than the 2-year timeframe of the questionnaire to materialize.

Additional evidence from empirical data reinforces the existence of significant differences in how the user community influences different types of innovation. Our results demonstrate that co-creation plays a significant role in innovation performance, product innovation, service innovation, and organizational innovation. Furthermore, the more pronounced effects are seen in product innovation for both P-KIBS and T-KIBS. Subsequent examination is warranted, as Product Innovation stands out as the most resource-intensive approach to innovation, yielding the highest anticipated outcomes. Our robustness checks also highlighted that the significant positive effect in organizational innovation is only observable for T-KIBS. On the other hand, mass customization has a significant positive effect on all innovation types. This is true for T-KIBS in our sample, however, for P-KIBS it is only visible for process innovation. Finally, personalization significantly influences innovative performance and all five types of innovation outcomes. Nonetheless, our robustness check demonstrated that the effect is not as significant on product innovation.

Concerning our control variables—firm size, human capital, funding, and open innovation—they demonstrated significant positive effects in all innovation outcomes. These results are aligned with the literature's current findings, since larger firms tend to be more innovative, and international firms are more likely to engage in innovation activities. Additionally, the presence of human capital intensity, funds, and openness to innovation raise the propensity towards innovation.

5.2. Limitations and Future Research

The present study employed the CIS database, encompassing 2175 KIBS firms based in Portugal, to conduct the analysis. Consequently, the findings derived from this research may be directed to the innovation system of Portugal. As a potential avenue for future investigation, it would be beneficial to replicate this study using CIS databases from different nations. Additionally, it is worth noting that the financial data obtained from the database posed certain limitations, resulting in a limited number of valid observations. Consequently, financial factors were not taken into consideration in this analysis. However, the inclusion of financial factors could potentially provide valuable insights for academics, practitioners, and policymakers.

Given the quantitative nature of our study, and the unidirectional survey results provided from the CIS questionnaire (targeted to firms only), there may be a bias in such findings concerning perception. For example, firms may envisage collaborating with the UC, whilst the latter may not hold a similar view. Future research is warranted towards studying this relationship fully. Additionally, it is worth highlighting that a qualitative study to better assess depth, regularity, and intensity of these interactions could prove useful towards understanding their perceived nature.

Considering the underwhelming evidence of radical and incremental innovations' impact on business turnover, it could be worth exploring the nature of these innovations resulting from user community engagement.

For future research, we suggest investigating the relationship between KIBS and universities or research institutions, as indicated by the variable sou_univ. The findings show some discrepancies (weaker but significant correlations with several innovation types, but lacking statistical significance for organizational and marketing innovation, and showing a detrimental effect on innovation performance). This highlights the vulnerability of such partnerships and the absence of productive exchanges between businesses and academia in Portugal [109] (refer to Tables 12 and 13).

5.3. Policy Recommendations

According to the data, there is a direct link between the interaction with user communities and the innovation performance of firms. As a result, it is crucial for innovation policymakers to prioritize the promotion and enhancement of these interactions. Firms need to understand the significance of engaging with user communities and how to facilitate this process efficiently. Moreover, providing financial incentives can also play a key role in encouraging this type of engagement.

There are differences between P-KIBS and T-KIBS concerning successful partnerships with the user community for innovation outcomes. There is no one-size-fits-all. Specifically, co-creation did not reach statistical significance for general innovation in P-KIBS, however, results were significant when the intended outcome was product or service innovations (over double the success chances). Mass customization only proved effective for process innovation, and it was less effective than personalization. As a guideline, these types of companies may be better suited to co-creation policies for product and service innovation, and personalization for process, organizational, and marketing innovations. This strategy ensures at least double odds for achieving innovation success. On the other hand, T-KIBS policies of involvement with the user community can be more aligned with mass customization, ensuring a better chance for achieving all innovation types. Additionally, specifically for product innovation, the best form of engagement with the user community is through co-creation for both firms, which is also supported by existent literature due to its costly nature and frequent co-operation requirement.

Author Contributions: Conceptualization, J.C. and R.d.P.B.; methodology, J.C.; software, R.d.P.B.; validation, J.C.; data curation, J.C.; writing, R.d.P.B.; revision, J.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The research used data from the CIS 2020; this database is available on demand, being constructed and treated by Statistics Portugal under the supervision of the European Commission.

Acknowledgments: The authors acknowledge Statistics Portugal for the data provision.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Title	Authors	Year	Database	Country	Dependent Variable(s) - Explained	Independent Variable(s) - Explained	Significance/Signal	Control Variables	Significance/Signal	Results | Addtional Commentary
Knowledge management practices and innovation propensity: A firm-level analysis for Luxembourg	Mangiarotti G.	2012	CIS 2016	Luxembourg	Probability of Innovation	Knowledge Management	**(+) Positive and Significant** correlation between Knowledge Management and Probability of Innovation	Size Industry Group Affiliation	(+) Positive correlation of control variables with Probability of Innovation	
Determinants of innovation capacity: Empirical evidence from services firms	Jose Madeira Silva M.; Simões J.; Sousa G.; Moreira J.; Wagner Mainardes E.	2014	CIS 2006	Portugal	Innovation Capacity (Product or Service Innovation)	Internal R&D activities External acquisition of R&D Acquisition of machinery Equipment and software Acquisition of other external knowledge and other procedures	**(+) Positive and increasing effect:** The greater the financial investment in acquisition of machinery, equipment and software, in internal R&D, in acquisition of external knowledge, in marketing activities and other procedures, the greater the propensity for firms to innovate in terms of services	Firme Size Activity Sector	(+) size has a positive and increasing effect on service innovation Services firms based on technology are more likely to innovate in products/services than firms providing other types of services.	
Variety in external knowledge sourcing and innovation novelty: Evidence from the KIBS sector in Spain	Rodriguez M.; Doloreux D.; Shearmur R.	2017	Spanish Technological Innovation Panel (PITEC) 2013 CIS 2013	Spain	Degree of Innovation (novelty)	Internal R&D Innovation expenditures Internal sources Market sources Research sources General sources Cooperation	**(+) Positive connection between the degree of novelty and of variety knowledge sourcing**. Positive association between Variety of market sources and the introduction of new-to-firm and new-to-market innovations. Internal sources are positively related to the introduction new-to-market innovations (-) variety of research-related knowledge sources and degree of innovation : a higher variety of research sources is associated with a lower propensity to introduce new-to-market innovation	Size Age Exports Group Public financial support		On the whole t-KIBS and p-KIBS assign similar levels of importance to different knowledge sources, although, when there is a difference, it is systematically t-KIBS which assign more importance.
Developing Dynamic Innovative Capabilities: The Growing Role of Innovation and Learning in the Development of Organisations and Skills in Developed and Emerging Nations of Europe	Makó C.; Mitchell B.; Illéssy M.	2015	Surveys, CIS(*)	Cross-Country (focusing on Hungary and Slovakia)	Firms Innovation Capacity Discretionary learning organisation	The 'learning capability' of the work organisation The 'other forms of learning' in the firm index Self-assessment of quality; Learning new things at work; Tasks rotation requiring different skills ('multi-tasking + multi-skilling') The 'innovation index' (IUS)	According to the authors: The aggregated country-level data did not help to understand the drivers and enablers of innovation.	intensity of participation of employees		
Knowledge strategies for environmental innovations: The case of Italian manufacturing firms	de Marchi V.; Grandinetti R.	2013	CIS 2006-2008	Italy	Environmental Innovation	Knowledge Strategies	(+) Positive relationship between multiple knowledge strategies and introducing environmental innovation: Green innovators draw information from and cooperate with a larger value network than non-green innovators.	Turnover Group Export Industry Knowledge Strategies		
Measurement of innovation activities in the knowledge-intensive services industry: a trademark approach	Gotsch M.; Hipp C.	2012	2011	Germany	Innovation Success	Turnover with new products/services Knowledge-intensive services Knowledge-intensive business services High-tech manufacturing Low-tech manufacturing Use of trademarks Use of patents Use of industrial design Use of copyrights R&D intensity Innovation cooperation	(+) Positive effect of the presence of KIS and KIBS on a firm leading to innovation success (+) trademarks has a positive and significant effect on innovation success	Market Competition Type of Activity Age Turnover Size Group Competition	(+) standardised services boosts trademark registration (NS) All other control variables in the model are insignificant.	
Shaping innovation in European knowledge-intensive business services	Hipp C.; Gallego J.; Rubalcaba L.	2015	2002–2004 (CIS4)	EU-27	Innovation Performance	Innovation intensity, Cooperation arrangements Appropriation activities	KIBS on average more on both domestic and international networks for innovation as opposed to manufacturing sector			
Innovation, creative destruction and structural change: firm-level evidence from European countries	Dachs B.; Hud M.; Koehler C.; Peters B.	2017	1998–2000 (CIS3), 2002–2004 (CIS4), 2004–2006 (CIS2006), 2006–2008 (CIS2008) and 2008–2010 (CIS2010)	EU-26	Employment Growth	Product innovation Share of sales in year Organisational innovation	(+) Overall, there is a positive net contribution of innovation to employment growth	Domestic group firms Foreign-owned firms Firm Size Country-specific two-year GDP growth rate		The variation in employment growth across the sample is rather the result of sectoral and industry differences in the share of innovative firms or in additional sales from new products each firm creates

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