



The usefulness of knowledge from library staff, faculty and students for developing service innovations in academic libraries

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ABSTRACT

Academic libraries involve library users and external organizations in developing innovations, yet there is limited evidence on the usefulness of knowledge obtained from different users and via different participation methods. Drawing on open innovation and innovation ecosystem perspectives, this paper analyses how consultation, co-creation, and collaboration with external partners contribute to the usefulness of knowledge for innovation. The study uses survey data from 290 academic libraries in 31 European countries to examine the usefulness of knowledge from library staff, faculty/researchers, and students for identifying innovation challenges and developing solutions. The results show that co-creation has a stronger positive association with knowledge usefulness than consultation. Library staff are the most useful source of knowledge across both challenges and solutions. Faculty/researchers are almost twice as likely as students to participate in co-creation and are perceived to provide more useful knowledge than students. The analyses identify complementary and substitution effects between knowledge sources. Collaboration with external partners complements knowledge from library users and library staff, while substitution effects show that co-creation with one user group can reduce the perceived usefulness of knowledge from another group. Different actors contribute different types of knowledge, requiring academic libraries to strategically combine participation mechanisms and knowledge sources.

Introduction

Academic libraries face increasing expectations from students and other library users to continuously update their services to stay abreast of technological advances (Jantz, 2012), to improve sustainability, and support the well-being, mental health and comfort of students (Khalil et al., 2024; Yeh & Walter, 2016). New services and spaces (both considered here as services) can be developed using knowledge on the views and experiences of library users (faculty/researchers and students) to improve the quality and relevance of new services or to bridge the divide between user expectations and the library's capacity to fulfil them (Islam et al., 2015; Llewellyn, 2019).

Knowledge from library users can be obtained through non-interactive 'consultation' methods such as ethnographic research and surveys or through interactive methods that encourage two-way communication such as workshops and focus groups. Interactive methods can also be supported by 'design thinking' methodologies that actively engage users through a dialogue with innovation designers

(Brown, 2008; Kelley, 2005). This can potentially occur throughout the innovation process, from the identification of problems to the creation of ideas for new service solutions (Terstriep et al., 2020). Interactive methods can result in the co-creation of library service innovations by non-management personnel (defined in this paper as library staff), library users, and innovation designers. Academic libraries can also obtain relevant knowledge for innovation from external organizations such as other libraries or businesses (Brundy, 2015).

Evidence on the benefits of user involvement in public sector innovation is largely limited to a few case studies (Nordli et al., 2025) that are often unrepresentative of the organizations under study because they intentionally select cases with high-level support for co-creation (Fledderus et al., 2016; Voorberg et al., 2015). The purpose of this study is to evaluate the benefits of involving library users and library staff in developing innovations, but instead of drawing on case studies it uses a representative survey of innovation activities in European academic libraries. The benefits of user and library staff involvement in innovation is measured through the degree of usefulness of knowledge

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for innovation obtained through different methods from library users and staff. The survey also collects data on collaboration with several types of external sources.

The study pursues four related goals: 1) estimate the prevalence of consultation and co-creation for involving library users and library staff in the development of service innovations; 2) examine whether co-creation, despite being more resource-intensive than consultation or relying on the knowledge of library staff (Hurley et al., 2018; Torfing et al., 2019), provides more useful knowledge for innovation, focusing on two types of library users—students and faculty/researchers; 3) investigate whether different knowledge sources act as complements or substitutes in supporting innovation; and 4) identify the organisational factors associated with the usefulness of knowledge obtained from library staff and library users.

The results contribute to both theory and practice. It provides evidence on the value of different forms of user involvement in innovation and extends public sector innovation ecosystem perspectives by showing how multiple knowledge sources interact in the development of service innovations. In addition, the study provides practical guidance for library managers on how to combine participation mechanisms and knowledge sources to support innovation.

Innovation and co-creation in academic libraries

Although academic libraries can serve tertiary institutions such as polytechnics and colleges (Akpohonor, 2015), this study is limited to the main libraries of universities that grant PhD degrees. We first define innovation and co-creation, followed by a review of the literature on the use of co-creation and consulting methods, different sources of knowledge of relevance to academic library innovations, and factors that can influence the use of co-creation and hence the usefulness of knowledge obtained from different sources.

Definitions

A challenge for research on library service innovation is the use of multiple terms in the literature and by librarians to describe basic concepts (Rubalcaba et al., 2023). We define ‘innovation’ as the implementation within the previous three years of new or improved processes or services that were new to the library (OECD/Eurostat, 2018). There is also a plethora of terms that may refer to interactive methods of involving student users of libraries in developing innovations, including student engagement (Dollinger et al., 2023), student voices (Guay, 2026); student participation, partnerships, collaboration, user-centred design, UX, design thinking (Appleton, 2020; Guay, 2026), co-creation (Lystbæk et al., 2019) and co-design (Salisbury et al., 2020).

Islam et al. (2015) note that innovation in library services occurs through interaction and collaboration. Research on academic libraries has identified the use of interactive methods with users to improve access to library resources, develop new services based on web-portals, blogs, and social media, and to transform existing spaces or construct new spaces for flexible workspaces, media labs, living labs, and makerspaces (Eroğlu & Çakmak, 2025; Fletcher, 2020; Islam et al., 2017; Johnston, 2025; Li & Lin, 2025).

The International Association of Public Participation (IAP², 2018) identifies different levels of user participation in developing innovations. The entry level is one-directional, with the library collecting data on user needs from interviews, ethnographic research, and surveys, which the IAP² defines as consulting methods. The next two levels, involve and collaborate, include two-way interactions between the library and its users to ensure that user concerns are consistently understood and considered. The collaborate level includes interactions with users to define the challenges that the innovation should address and the solutions to solve them. The IAP² levels have been used in research on innovation in academic (Dogunke, 2020) and municipal libraries (Hapel, 2020; Hider et al., 2024; Kranich, 2021).

This paper uses the term co-creation to encompass the IAP²'s involve and collaborate levels. Our measures of co-creation cover interactive methods of library user involvement that may occur at various stages within the innovation process, but which may not meet the definition of collaboration for innovation, which requires “co-ordinated activity to address a jointly defined problem” and the “explicit definition of common objectives” (OECD/Eurostat, 2018, p. 134). In addition, the term “collaboration” is frequently associated with businesses and other organizations, whereas co-creation is limited to individuals, such as students or faculty members.

Open innovation and the creation of knowledge for innovation

Open innovation encompasses strategies and activities to obtain knowledge (the practical understanding and application of information) for innovation from a range of external actors, in contrast to producing all such knowledge within the organization (Chesbrough, 2017). The acquisition of external (distributed) knowledge is the primary purpose of open innovation (Xiao et al., 2022). Co-creation is an interactive method for acquiring and integrating knowledge from the innovating organization with sources of external knowledge (Strokosch & Osborne, 2020; Torfing et al., 2019).

A major advantage of co-creation is that it can access tacit, experiential knowledge on the ‘lived experience’ of service users (Jaspers & Tuurnas, 2023). In the library sector, co-creation with users and other actors can help define the problem to be addressed by the innovation and to develop solutions to identified problems (Hapel, 2020). The interaction between different knowledge sources can potentially create novel insights (Mahr et al., 2014) that none of the actors could produce on their own (Torfing et al., 2023). Open innovation can also occur without the use of interactive methods, for instance through consulting library users and external organizations.

The use of multiple knowledge sources can provide knowledge that complements other types of knowledge (Laursen & Salter, 2006), but using two or more knowledge sources can also provide similar knowledge, with one source a substitute for a second source, producing redundant knowledge (Mahr et al., 2014). An example is when front-line library staff provide knowledge on the needs of users that is also obtained from the users themselves.

Accessing external knowledge is costly in terms of developing the capacity to obtain, interpret and apply knowledge (Cox, 2023; Torfing et al., 2019). In addition, the use of co-creation methods incurs extra costs to find library users that are willing to participate and the time of library staff to manage co-creation (Dietrich et al., 2017; Hurley et al., 2018; Mahr et al., 2014). Given these costs, library managers may seek complementarity while avoiding costly activities that obtain redundant knowledge.

Bridging public service logic and innovation ecosystems

Both interactive and non-interactive methods of obtaining knowledge from library users are supported by Public Service Logic theory (Osborne et al., 2016) that identifies the central role of users in creating the value of services (Vargo & Lusch, 2016). The act of consuming a service gives users experiential knowledge of its advantages and disadvantages and how to improve it (Osborne et al., 2016; Torfing et al., 2019; Trischler & Westman Trischler, 2022). This knowledge can be used by library staff or innovation designers to improve the service. Consulting is expected to produce less useful knowledge on user experiences than interactive methods that support a dialogue with library users (Bentzen, 2022).

The increasing involvement of a wider range of stakeholders in the development of service innovations has led to the concept of an “innovation community” in academic libraries (Xiaobin & Jing, 2009). This concept is closely aligned with public sector innovation ecosystem theory, which views innovation as the outcome of interactions among

multiple actors drawing on both tangible and intangible knowledge from multiple sources (Adner, 2017; Fuglsang & Sundbo, 2005; Osborne et al., 2022; Saari et al., 2015; Trischler & Charles, 2019).

Academic libraries that function as “innovation communities” take an active role in fostering strong relationships and effective communication between library users and library staff. They connect people and information, encouraging knowledge exchange, interaction and sharing, which in turn enhances the circulation, integration, and value of knowledge. The formation of innovation-driven communities, coupled with effective knowledge transfer, enables academic libraries to fulfil their social responsibilities both on campus and with society (Schöpfel et al., 2015). A consequence is increasing interest in developing service innovations with users to co-create value.

The combination of public sector logic and innovation ecosystem theories provides strong support for co-creating innovations with library users (Johnston, 2025) and other groups or organizations.

Sources of knowledge for library innovations

The library innovation ecosystem includes students and faculty as library users, library staff who can provide information on user behaviour and needs (Dogunke, 2020; Henkel et al., 2018), and external organizations such as other libraries with experience with similar innovations or businesses with relevant technical expertise.

Only a small number of studies have explored if and how academic library users are involved in developing library innovations, with users often limited to university students. Rowley (2011) suggests that libraries should engage users in developing an innovation strategy, while Islam et al. (2017) point to the benefits of gaining knowledge on the specific needs of library users (Islam et al., 2017). Scupola and Nicolajsen (2010), in a case study of a Danish university, found that users were mostly involved through consulting at the implementation stage, but played a lesser or almost no role in the initiation stage. Islam et al. (2015) used open-ended questions on how librarians learn about user needs in a small survey of 21 academic libraries in several countries. Most of the examples given by the librarians involved consulting, such as using social media, surveys, and informal face-to-face conversations when responding to user requests. Other studies of American (Decker, 2020), Canadian (Guay, 2026) and German (Dogunke, 2020) academic libraries found a similar focus on obtaining input from students through consulting methods.

Over time the interactive involvement of library users may have increased with a growing belief that interactive methods obtain better quality information than consulting (Decker, 2020). The Manchester University library, for example, shifted from consulting to obtain user feedback to employing students to work collaboratively on the development of services for students (Blake et al., 2020). Similarly, the La Trobe University library in Australia used two student employees when it wanted a higher level of participation (Salisbury et al., 2020). A survey of Australian librarians found that library leaders ranked service improvement through interactive student partnerships as a high priority for the future (Dollinger et al., 2023).

An important user type in academic libraries is university faculty and associated researchers. Faculty involvement in library innovation focuses on services of specific interest to faculty, such as archives, collections, and learning services for students (Corrall & Jolly, 2019; Douglas & Rabinowitz, 2016; Eldridge et al., 2016; Gaspar & Wetzel, 2009; Gilman et al., 2017). Collaboration between library staff and faculty members fosters innovation by aligning library services more closely with faculty and student needs, helping to create tailored and effective learning opportunities. As library staff have developed new roles in parallel with the changing nature of academic libraries, new forms of cooperation with academic staff have emerged to provide an embedded model of service delivery (Llewellyn, 2019).

Library staff liaise between the library and students (Church-Duran, 2017) and faculty (Corrall & Jolly, 2019) and can gain extensive

knowledge on the needs and experiences of library users. As a result, they can serve as an alternative to the direct involvement of users in developing library innovations. Cruz et al. (2020) found that Brazilian academic libraries were more likely to learn about user needs from front-line staff than from library users. Another development is the “personal librarian” model, where library staff build individualised relationships with specific student groups, such as mature students or international students (Moniz & Moats, 2014). This could increase the amount of knowledge that library staff obtain on student experiences and needs.

The value of library staff as an alternative to users varies by user relevance and the costs of co-creation. Library users may have limited insights into their needs and the possibilities of meeting them, for instance users may lack an understanding of the capabilities of new digital technologies (Ewert & Evers, 2014). Second, co-creation is demanding of staff time and effort and therefore library staff may prefer to avoid co-creation, either by drawing on their own knowledge of user experiences or limiting user participation to consulting.

External partners include other libraries, educational and research institutions, governments, businesses, non-profits, and library associations (Cruz et al., 2020). The goal is to exchange expertise and diverse viewpoints, allowing academic libraries to tackle complex and large-scale challenges through effective partnerships (Atkinson, 2018). In an analysis of the development of research data services in 209 academic libraries, Cox et al. (2019) found that approximately half included an external partner, often to overcome a lack of resources or knowledge.

The source of the original idea for an innovation could influence the value of knowledge for innovation attributed to different sources, both because the idea is part of knowledge and because individuals that proposed the idea, such as library staff or users, could be motivated to put greater effort into developing the innovation.

Factors influencing the usefulness of knowledge

Four types of factors could influence the use of co-creation and other methods to obtain knowledge, thereby indirectly affecting the usefulness of knowledge obtained from different sources.

First, activities to obtain knowledge for innovation can be influenced by university or library policies that enable management support for innovation, staff motivation to think of ideas for innovation (Martins et al., 2004), and goals to improve the experiences of library users or take advantage of new technologies such as digitization and artificial intelligence. Strategic planning for academic libraries can either enable or constrain collaboration for innovation through decisions related to resource allocation, organisational support, leadership commitment, and partnerships with internal and external knowledge sources (Yeh & Walter, 2016).

Second, co-creation requires internal resources and capabilities, for instance the presence of staff with design thinking or user experience (UX) skills (Moring & Schreiber, 2022) and financial resources for innovation (Cruz et al., 2020). Previous experience with a variety of innovation types could create internal capabilities for identifying and applying knowledge from diverse sources (Torfing et al., 2019; Wiewiora et al., 2016).

Third, obstacles could reduce the use of co-creation. These include a lack of resources, including time pressures and a lack of experience in how to develop innovations; and a library culture that does not support innovation or user involvement in innovation (Dollinger et al., 2023).

Fourth, the use of co-creation could vary by the technical characteristics and novelty of the innovation to the library. Innovations that involve advanced digital technologies could be unfamiliar to users and consequently users could be less likely to provide useful knowledge. In contrast, library staff may be more knowledgeable about digital innovations.

Low novelty innovations are those that are familiar to librarians and for which the expected outcomes of the innovation are predictable (Moring & Schreiber, 2022). Low versus high novelty innovations are

identified by the innovation mode, or how the innovation was developed. A library can simply adopt service innovations that had already been developed, trialled, and implemented in other libraries, with few or no additional changes and consequently with little need for input from library users or other sources. Other innovation modes identify different degrees of novelty. Modification could be required if the service was developed for different types of library users or in different countries. In this case, steps to modify the service to local needs could benefit from user input and lead to additional service characteristics. Innovations with very unpredictable outcomes, such as those that are new to the library community, could benefit the most from input from users or other sources (Cruz et al., 2020). These innovations are more likely to be developed through collaboration with a variety of sources or by developing the innovation entirely in-house.

Theoretical framework

Fig. 1 presents the conceptual framework used in this study. Consistent with innovation ecosystem and open innovation perspectives, the framework conceptualises useful knowledge for innovation as the outcome of a process linking knowledge sources, knowledge acquisition mechanisms, and organisational conditions. In this framework, knowledge flows from different sources through specific acquisition mechanisms, resulting in knowledge that is useful for innovation. Following Public Service Logic, the framework distinguishes between different types of experiential knowledge. In addition, the framework includes external sources, such as other libraries, firms, and public or non-profit organizations, reflecting the broader innovation ecosystem in which academic libraries operate.

The model identifies three mechanisms for obtaining knowledge from different sources: consultation with users, co-creation with providers and users, and collaboration with external sources other than users. The contribution of the three main sources of interest (library staff, faculty/researchers and students) is contingent on their competences and preferences (Lancaster, 1966; Windrum & Rubalcaba, 2024). Competences refer to the knowledge, experience, skills, and problem-solving capacities that individuals contribute, while preferences refer to their needs, priorities, motivations, and willingness to participate in innovation activities. The usefulness of knowledge obtained through these mechanisms is evaluated for identifying challenges and developing solutions. The use and effectiveness of these mechanisms are further influenced by organisational and network factors, including library strategies and capabilities, innovation characteristics, and the source of

the idea for the innovation. The framework posits that innovation-relevant knowledge is context-dependent and shaped by both the attributes of knowledge sources and the organisational conditions under which participation in innovation activities occurs.

Methodology

The literature was searched for previous surveys of innovation in libraries and in the public sector more generally, with a focus on questionnaires that covered co-creation or sources of knowledge for innovation. The questionnaire design built on a few useful surveys for libraries (Cruz et al., 2020; Islam et al., 2015) and other public sector organizations (Arundel et al., 2015; Lykkebo et al., 2021; Nordli et al., 2025). A draft version of the questionnaire underwent seventeen cognitive testing interviews with academic library managers in the Netherlands, Denmark, France and Spain to ensure that respondents could understand each question as intended and were able to provide accurate responses (Arundel, 2023a). To avoid differences in how respondents understand terms such as innovation and ‘co-creation’, the questionnaire never uses the term ‘innovation’, instead referring to “new or improved services or processes”, while questions describe activities for obtaining input from library users instead of referring to ‘co-creation’.

The questionnaire asks about innovation in the previous three years and includes two sections: section A asks general questions on the library's innovation activities (goals, staff skills, types of innovations, drivers and obstacles) while section B asks for a brief description of an innovation that was “of high-priority to your library or of high expected value for your library users”, with all questions in section B focused on this innovation. The limitation to a single high-priority innovation maximizes data quality (Arundel, 2023b) by ensuring that key variables, such as for consulting, co-creation and knowledge usefulness, refer to the same innovation. The full questionnaire in English and seven other languages is available at doi:10.34894/X8NK3C.

The sample includes two groups of universities. In nine countries with a project research partner (Austria, Belgium, Denmark, Finland, France, Germany, Greece, the Netherlands and Spain) all universities with a PhD program were eligible. A second sample included all PhD granting European universities that were a LIBER (Association of European Research Libraries) member.

The survey combined online and postal methods to increase response rates (Arundel, 2023a). The questionnaires were sent to one identified senior manager per university library. LIBER provided contact details for

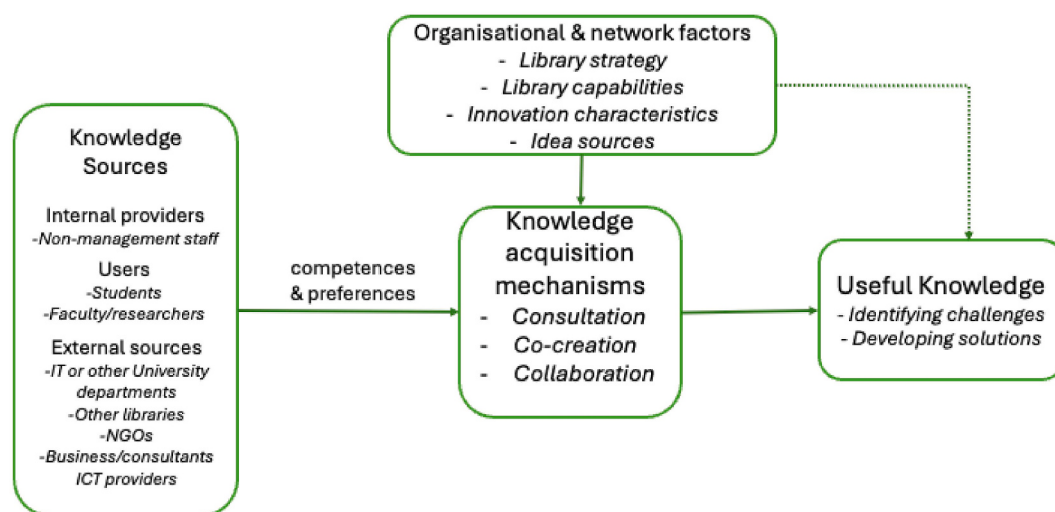


Fig. 1. Conceptual framework for obtaining useful knowledge for innovation in academic libraries
Source: Author's elaboration.

member libraries while research partners in each country represented by a consortium partner obtained contact details for non-LIBER libraries. Library managers received an email invitation letter to complete the questionnaire online. The letter described the purpose of the survey, provided a unique web link password, stated that submitting the questionnaire gave consent, and stressed that participation in the survey was voluntary, with respondents able to withdraw permission at any time. All correspondence was sent to a named respondent at each university library, except for non-Liber universities in France, where the questionnaire was distributed through the French association of university librarians.

In total, 165 non-LIBER universities were surveyed from May 2024 and 343 LIBER universities from September 2024 until March 2025, for a total sample of 508 academic libraries. Survey follow-up included two email reminder letters followed by a mailed paper version of the questionnaire. The response rate for completing both sections A and B, necessary for the analyses, was 61.2% and included responses from one or more universities in 31 European countries. Out of 311 responses that completed section A and B, 15 process only innovators and 6 cases with one or more missing values were excluded, leaving 290 cases for analysis.

Variable descriptions

Annex A provides the exact wording, in English, of all survey questions used to construct the variables included in the regression analyses.

Dependent variables

The dependent variables for the regressions equal the usefulness of knowledge from each of three key groups (library staff, faculty/researchers, and students) for “the challenges to be addressed” by the high-priority innovation and the “solutions (final characteristics)” to these challenges. All methods of obtaining knowledge contribute to usefulness, including workshops and focus groups, informal conversations with users, surveys, crowdsourcing, and unspecified methods such as desk research. The dependent variables are measured on an ordinal usefulness scale that ranges from 1 (none/not asked for input), 2 (low), 3 (moderate) to 4 (high).

Knowledge acquisition variables

Ten explanatory variables capture the main sources and mechanisms through which knowledge and ideas for innovation are acquired. Consulting equals 1 if the library obtained useful input for its high-priority innovation from either “one-on-one conversations between library staff and users” or “surveys on experiences with previous or similar services or processes” and zero otherwise. Three variables for co-creation (with library staff, faculty/researchers and students) equal 1 if the group was “involved in focus groups or workshops to identify challenges or solutions” for the high-priority innovation and zero otherwise. The variable “sum high usefulness sources” can equal 0, 1, 2 or 3 depending on the importance of the three other key sources (including other). For instance, if the dependent variable is the usefulness of knowledge from students, two other key sources are faculty/researchers and library staff.

The variable “sum external collaboration partners” equals the number of seven high importance partners, including 1) “IT or other departments of your university”, 2) “other university, national or municipal libraries”, 3) “library associations”, 4) “government agencies or departments”, 5) “NGOs or non-profits”, 6) “businesses including consultants” and 7) “providers of specialized software or ICT equipment”. The two idea variables ‘library employees’ and ‘library users’ are equal to 1 if they contributed to the original idea for the high-priority innovation and zero otherwise. A variable for good practices equals 1 if the library evaluated “good practices of other university, national or public libraries” and zero otherwise. The use of design services equals 1 if the library used “services of design firms, innovation labs, or living

labs” to develop their high-priority innovation and zero otherwise.

Innovation support variables

Eleven variables measure general conditions within the library to support innovation (five variables), innovation drivers (three), and innovation obstacles (three).

A variable for management support is an ordinal measure of how often “senior management strongly supported developing new or improved services or processes” (1 = almost never, 2 = sometimes, 3 = mostly, 4 = almost always). A second variable for staff support uses the same four-point scale to measure how often “library staff were highly motivated to think of new ideas for new or improved services or processes”. Third, the presence of design thinking or related skills of value to developing innovations equals 1 if respondents reported “design thinking or user experience (UX) to involve users in plans for library improvements” and zero otherwise. Fourth, experience with a diversity of innovations equals the sum of eight types of innovations implemented in the library in the previous three years: “services to support research”, “services to support students”, “processes for delivering services”, “methods for communicating with library users”, “administrative or back-office processes”, “digitalization of collections or access to collections”, “changes to the building design or use of library space”, and “other”. Fifth, the importance of activities to create “connection” between library users equals the sum of importance for two activities: “holding community or cultural activities (seminars, exhibits, etc.)” and “providing space and equipment for user projects, such as makerspaces, fablabs, podcast studios, 3D printers, video rooms, etc.”. The importance of each activity is measured on a scale of low (1), moderate (2), and high (3) importance.

General innovation drivers are measured on a five-point ordinal importance scale. The three drivers are public funding (“European, national, regional, local or other external funding for your library”), improving user experience (“goal to improve the experience of your new or current users”) and new technologies (“digitalization, artificial intelligence, etc.”). General obstacles to innovation are measured on a four-point ordinal scale (0 = none, 1 = low, 2 = medium, 3 = high importance). The two general obstacles are: “unrealistic time pressures” and a lack of staff expertise (“Insufficient library staff with expertise on developing new or improved services or processes”). A second obstacle measure equals the sum of five ‘high importance’ obstacles to user inclusion in co-creation activities for the high-priority innovation: 1) “reluctance of library staff to include users”, 2) “lack of experience in involving library users”, 3) “difficulties in finding potential or current library users willing to participate”, 4) “insufficient time or financial resources for including library users”, and 5) “other”.

Innovation characteristics

Two variables capture the characteristics of the high-priority innovation, which could influence the usefulness of knowledge from different sources. Respondents selected one of four descriptions for how the high-priority innovation was developed (the innovation mode): 1) adopting or 2) modifying “a service or process already in use by other libraries or organizations”; 3) “collaborating with other libraries or organizations”, and 4) “primarily in-house or with your university (little or no assistance from other libraries or organizations)”. The variable digital innovation equals 1 if the high-priority innovation required or applied at least one of four technologies: digitalization of data, automated systems, apps for devices, or artificial intelligence and zero otherwise.

Control variables

Finally, three control variables account for differences in library characteristics: library size (50+ staff = 1 and zero otherwise), membership of the LIBER library association (yes = 1 and zero otherwise), and respondents' experience in the library sector (less than five years, five to less than ten years, and ten years or more).

Regressions

The dependent variables for the usefulness of knowledge obtained from the three key groups are measured on an ordinal scale (1–4), requiring ordered logit models. Specifically, we estimate six mixed-effects ordered logit models, each including country-level random intercepts to account for unobserved heterogeneity across the 31 countries in the sample. The models are estimated separately for library staff, faculty/researchers and students, and for the usefulness of their knowledge in identifying innovation challenges and developing innovation solutions. In three models, the country-level variance is negligible (approaching zero), indicating that country-specific factors explain little additional variation after accounting for the other variables. The remaining three models show positive country-level variance, justifying the inclusion of country-level intercepts. For consistency and transparency, we present all models using the same specification.

Substitution is suggested when the co-creation variable for the target source (e.g. library staff in Table 2) is positive and significant, while that of another source is negative and significant, indicating that the other source reduces the usefulness of the target source. Complementarity is observed when both variables are positive, suggesting mutual reinforcement. Complementarity is also identified when the variable for “other highly useful sources” (the number of high importance external collaboration partners) is positive and significant, implying that the usefulness of the target source increases with the number of other knowledge sources.

Results

Prevalence of co-creation and consulting

Table 1 presents the share of academic libraries by size that reported, for their high-priority innovation, consultation with staff or users, co-creation with each of three key groups, and consultation only without co-creation. Consultation with library users was reported by 84.9% of small and 84.8% of large academic libraries. However, compared to large libraries, small libraries (<50 employees) are more likely to rely on consultation-only (35.6% versus 26.6%, $p < .10$). Co-creation most frequently involves library staff, reported by 61.4% of small and 64.6% of large libraries, followed by faculty (44.7% in small and 49.4% in large libraries). Co-creation with students occurs at almost half the rate for faculty, reported by 25.0% of small and 25.3% of large libraries.

The pattern for co-creation applies to the mean usefulness of knowledge obtained from the three key groups. As shown in Tables B1, B2 and B3 in Annex B (mean dependent variable), library staff have the highest mean scores, both for challenges (2.18) and solutions (2.19). In comparison, the mean scores for faculty/researchers are respectively 1.94 and 1.69 and 1.31 and 1.10 for students. These patterns remain

Table 1
Percent academic libraries that used consultation or co-creation methods to involve different groups in developing the key innovation.

	< 50 employees	50+ employees	All libraries
N	132	158	290
Consultation			
Library users or staff	84.9	84.8	84.8
only consultation*	35.6	26.6	30.7
Co-creation			
Co-creation with staff or users	73.5	79.8	76.9
Co-creation by type of partner			
Library staff	61.4	64.6	63.1
Faculty	44.7	49.4	47.2
Students	25.0	25.3	25.2

* Significant difference ($p < .10$) between small/medium and large libraries.

when limited to respondents that reported “high” usefulness (table not provided), with 60.7% of libraries obtaining knowledge of high usefulness to developing their high-priority innovation from library staff, followed by faculty/researchers at 44.1%. Students are least regarded as highly useful sources of knowledge (24.8%), possibly reflecting their shorter-term engagement and more limited familiarity with library processes. Except for library staff, the perceived usefulness of knowledge is lower for solutions compared to challenges.

Regression models for the usefulness of knowledge for innovation

To facilitate interpretation, the results are discussed following the same sequence used to describe the explanatory variables in the methodology: (1) knowledge acquisition variables, (2) innovation support variables, and (3) innovation characteristics and controls.

Table 2 provides a summary of the statistically significant regression results for the six regression models for factors associated with the usefulness of knowledge for the three key groups in this study: library staff, faculty members/researchers and students. The summary lists large, moderate, and small associations between each variable and knowledge usefulness, based on the size of statistically significant coefficients for each variable. The full regression results with coefficients and the level of statistical significance (p values) are given in Annex B in Tables B1 for library staff, B2 for faculty/researchers, and B3 for students. The notes to Table 2 explain the assignment to large, medium and small associations.

Knowledge acquisition variables

In all six regression models (two for each key group), co-creation has a large statistically significant and positive association with the usefulness of knowledge. For instance, Table 2 (group 1 columns) shows that co-creation with library staff has a large positive association with the usefulness of knowledge for both challenges and solutions from this group. Similarly, co-creation with faculty/researchers (group 2 columns) has a large positive association for challenges and solutions for the usefulness of knowledge for this group. Similar large associations are observed for students (group 3 columns). These positive associations are considerably larger than those for all other binary variables for knowledge acquisition (consulting, the two idea sources, evaluation of other library practices, and use of design firms/living labs), indicating that co-creation has a substantial positive association with the usefulness of knowledge from library staff, faculty/researchers, and students.

Substitution effects are also observed in each model, as shown by a negative association between co-creation with a different key group on the usefulness of knowledge. For library staff, (group 1 columns) co-creation with faculty/researchers is negative and therefore reduces the usefulness of knowledge from library staff, for faculty/researchers co-creation with both library staff and students reduces the usefulness of knowledge from faculty/researchers, and for students (group 3 columns) co-creation with faculty/researchers reduces the usefulness of knowledge from students. In each model the absolute size of the negative coefficient for substitution (shown in the Annex B tables) is less than the size of the positive coefficient for the target group, suggesting that substitution does not fully replace the usefulness of knowledge from library staff, faculty/researchers or students.

Consulting with users is not significantly associated with the usefulness of knowledge from library staff or students. In contrast, consulting with library users has a moderate positive association for challenges for faculty/researchers and a small association for solutions (Group 2 columns). This shows that consulting with faculty/researchers complements (increases) the usefulness of knowledge from co-creation with faculty/researchers.

The sum of other “high usefulness” sources has no statistically significant association for library staff or for students, but there is a moderate positive association for faculty/researchers. Conversely, the sum of high importance external collaboration partners has a moderate positive

Table 2

Summary of statistically significant associations between explanatory factors and the usefulness of knowledge for challenges (C) and solutions (S).

Explanatory factors	Group 1		Group 2		Group 3	
	Library staff		Faculty / Researchers		Students	
1. Knowledge acquisition variables	C	S	C	S	C	S
Consulting with library users			++	+		
Co-creation with library staff	+++	+++	—	—		
Co-creation with faculty/researchers	—	—	+++	+++	—	—
Co-creation with students			—	—	+++	+++
Sum other highly useful knowledge sources			++	++		
Sum high importance external collaboration partners	++	++	+		+	
Idea from library users (faculty, researchers or students)			++		++	+
Used design firms/innovation labs		—		+		
2. Innovation support variables	C	S	C	S	C	S
Strong mgmt support for innovation	—					
Strong staff support for innovation	+					
Staff with design thinking skills					+	
Connection					+	++
Driver public funding	—					
Driver improving user experience	+++	+++				
Driver new technologies			++			
Obstacle: lack staff expertise for innovation			++	+		
Sum of obstacles to user involvement			+			
3. Innovation characteristics and control variables	C	S	C	S	C	S
Innovation mode: Modifying			++	+		
Innovation mode: Collaborating			++	+		+
Innovation mode: In-house	—		+	+		
Digital technology		+				
Large library (50 + staff)			+		—	
Respondent time in library sector		—	+	+		
LIBER library						+

Notes: Only statistically significant associations from Tables B1, B2, and B3 in the annex are included. As a result four variables with zero significant effects are not included in Table 2 but are present in Tables B1, B2 and B3 (idea from library employees, evaluation of other library good practices, time pressure as an obstacle, and innovation experience).

For binary variables, association strength is based on the coefficient for the change from 0 to 1. Positive associations for binary variables are classified as Large (+++) when the coefficient is ≥ 2.0 , Moderate (++) when the coefficient is 1.0–1.99, and Small (+) when the coefficient is < 1.0 . For ordinal and count variables, association strength is based on the coefficient multiplied by the standard deviation of the explanatory variable, representing a one-standard-deviation increase: Small (+) = SD-adjusted coefficient < 0.30 ; Moderate (++) = 0.30–0.49; Large (+++) = ≥ 0.50 . Negative signs (–) indicate statistically significant negative associations.

association with the usefulness of knowledge from library staff for both challenges and solutions, and a small positive association for challenges for faculty/researchers and students. The contribution of library users (faculty/staff or students) to the original idea for the innovation has a moderate positive association with the usefulness of knowledge for challenges from faculty/researchers and students and a small effect on solutions for students, but there is no association for library staff.

The evaluation of good practices in other libraries has no effect on

the usefulness of knowledge from the three target sources. The use of design firms/living labs decreases the usefulness of knowledge from library staff for solutions, but increases the usefulness of knowledge for solutions among faculty/researchers.

Innovation support variables

The innovation support variables have sporadic positive effects on the usefulness of knowledge, with no consistent effects across all three knowledge sources. Innovation experience and time pressures as an obstacle have no significant associations in all models and therefore are not included in Table 2. The presence of staff with design thinking skills is only associated with the usefulness of knowledge for challenges in the models for students.

The greatest effect of innovation support variables is for library staff, where the driver to improve user experiences has large positive associations with challenges and solutions and strong staff support for innovation has a small positive association with challenges. Conversely, strong management support for innovation and public funding as a driver are negatively associated with the usefulness of knowledge for challenges. Strong management support for innovation could result in greater attention to obtaining knowledge from faculty/researchers or students, but this is not the case, with no effect of strong management support on the usefulness of knowledge from faculty/researchers or students.

The innovation support variables have weaker effects on the usefulness of knowledge from faculty/researchers and from students. For faculty/researchers, there are only small positive associations on the usefulness of knowledge for new technology as a driver for challenges, a lack of staff expertise to innovate for both challenges and solutions, and the sum of obstacles for user involvement for challenges. For students, connection has a small positive association with challenges and a moderate positive association with solutions, and staff with design thinking skills has a small positive effect for challenges.

Other variables: Innovation characteristics and controls

The reference category for the innovation mode is adoption. In-house development of the innovation is negatively associated with the usefulness of knowledge obtained from library staff for challenges, but collaborative development has a positive association for students for solutions. The method for developing the innovation plays a more important role for the usefulness of knowledge from faculty/researchers. Compared to adoption, modifying and collaborating are moderately associated with the usefulness of knowledge from faculty/researchers and in-house development has a small positive association.

The digital characteristic of the high-priority innovation has only a small positive association with knowledge usefulness (from library staff for solutions), indicating little difference in the usefulness of knowledge from faculty/researchers and students for digital versus non-digital innovations.

Membership in LIBER has no association with knowledge usefulness except for solutions for the usefulness of knowledge from students, indicating that LIBER libraries are more likely to obtain useful knowledge from students for solutions than non-LIBER libraries.

Discussion

This study analyses representative survey data to explore the usefulness of knowledge from several sources to develop a high-priority service innovation in European academic libraries. The analyses evaluate 1) the prevalence of consulting with library users and co-creation with users and library staff 2) the contribution of consulting with users and co-creation to the usefulness of innovation-related knowledge from library staff and two types of library users, faculty members/researchers and students, 3) complementarity and substitution between multiple knowledge sources, and 4) the effect of library activities to support innovation on knowledge usefulness.

Prevalence of consulting and co-creation

Consulting with library users is reported by 84.8% of academic libraries to develop high-priority innovations. However, the use of co-creation is more selective, likely due to the costs and resources required. While 47.2% of libraries report co-creation with faculty/researchers, only 25.2% involve students in co-creation. The relatively low levels of co-creation with students indicate that their involvement is less institutionalised than that of staff and faculty. This confirms research showing the importance of consulting methods, particularly to obtain knowledge from students (Dogunke, 2020), and suggests that librarian interest in interactive methods of involving students in developing innovations, as noted by Dollinger et al. (2023), remains partly aspirational. The higher prevalence of co-creation with faculty/researchers could align with both the types of innovations that are of high-priority (Eldridge et al., 2016) or easier institutional access to faculty/researchers through library committees or advisory groups (Farrell, 2011). This is consistent with innovation ecosystem perspectives, where innovation depends not only on the presence of multiple actors, but also on their accessibility, role, and ability to participate in coordinated knowledge exchange (Baldwin et al., 2024).

The higher rate of co-creation with library staff (63.1%) compared to both types of users supports research on their value to innovation through high levels of domain knowledge (Church-Duran, 2017), knowledge on user needs gained through interactions with library users (Cruz et al., 2020), and ready availability for inclusion in co-creation activities.

Usefulness of knowledge

Library staff have the highest mean scores (provided in the Annex B tables) for the usefulness of their knowledge, both for challenges and solutions. These results indicate that the practical experience of library staff could give them insights into both operational challenges and viable improvements, permitting them to play a bridging role between problem recognition and formulating practical solutions. In this sense, library staff are knowledge workers that draw on local, experiential, and tacit knowledge (Daland, 2016). Another factor in their favour is their close involvement in day-to-day library operations, which makes it easier for them to participate regularly in innovation activities (Eldridge et al., 2016).

The lower mean scores for faculty/researchers for knowledge usefulness (1.94 for challenges and 1.69 for solutions) could reflect more specialized engagement. Their higher mean scores for identifying challenges than developing solutions suggests their expertise is more relevant to problem framing and diagnosing unmet needs and specialized service gaps than developing concrete service solutions. The lowest mean scores for knowledge usefulness are for students (1.31 and 1.10). While they are essential end-users whose experiences shape service demand, they could contribute the least feasible or applicable knowledge for developing services (Trischler et al., 2019). However, their contribution increases for high-priority innovations to support connection activities, most of which are oriented to students.

The regression models demonstrate that co-creation is strongly associated with the usefulness of knowledge for developing academic library innovations obtained from library staff, faculty/researchers, and students. Co-creation has a consistently larger positive association with knowledge usefulness than other methods including consulting, evaluation of good practices in other libraries, idea sourcing, and collaboration with external partners.

External collaboration partners can provide diverse skills, resources, and knowledge that can broaden organisational learning and stimulate new perspectives (Sørensen & Torfing, 2018). The number of high importance external collaboration partners has positive effects on knowledge usefulness for identifying challenges for library staff, faculty/researchers and students, but their positive effect on solutions is

limited to library staff. A possible explanation is that internal staff translate externally sourced ideas and information into operational solutions, thereby increasing the value of staff knowledge for both challenges and solutions. External partners could improve the usefulness of knowledge for challenges from faculty/researchers and students by assisting problem scanning, benchmarking needs, and identifying new demands.

Complementarity and substitution

The results identify complementarity and substitution effects from the use of co-creation and collaboration with external knowledge sources, with the latter complementing the usefulness of knowledge for library staff and for faculty/researchers.

The most complex interplay is observed for faculty/researchers for both challenges and solutions, with substitution effects from co-creation observed for both library staff and students while consulting with users (faculty/researchers or students) has a positive complementary effect. The latter suggests that consulting and co-creation could capture different types of knowledge from faculty/researchers, with consulting providing broader input and co-creation enabling more in-depth and context-specific insights. The combination of both mechanisms increases the usefulness of knowledge from faculty/researchers, indicating that multiple modes of engagement can capture different dimensions of knowledge from the same source. However, consulting with users has no significant association with the usefulness of knowledge from library staff (Table 2, models 1) or students (Table 2, models 3). This suggests that passive forms of user input are insufficient to mobilise the experiential knowledge of students, whose contributions appear to depend more on interactive engagement (Omland et al., 2025).

Of interest, a substitution effect for the usefulness of knowledge from students is only observed for faculty/researchers, with no substitution effect detectable for library staff. This suggests that library staff are unable to provide knowledge on student experiences or needs, in contrast to other research (Church-Duran, 2017; Cruz et al., 2020). However, faculty/researchers can substitute for knowledge from students, possibly because of their awareness of student needs and experiences for learning-related service innovations.

The usefulness of knowledge from library staff (Table 2, models 1) is unaffected by consulting with library users (students or faculty/researchers) or co-creation with students, with only co-creation with faculty/researchers showing substitution. The implication is that knowledge from library staff is primarily drawn upon when knowledge from students is viewed as unnecessary, whereas knowledge from students is obtained when library staff lack relevant knowledge. This could point to an efficient use of knowledge sources, as also suggested by the positive effect on the usefulness of knowledge from students when library users are the source of the idea for the innovation and the positive association between connection (an indicator of student-oriented innovations) and the usefulness of knowledge from students.

An alternative explanation of the results is that many high-priority innovations are developed with very little input from students, as suggested by the low rate of co-creation with this group. Obtaining student participation in co-creation activities may require overcoming organisational and practical obstacles, including recruitment challenges, alignment of expectations, and sustaining participation over time (Lystbæk et al., 2019). In contrast, faculty/researchers may constitute a more accessible and consequently more important source of relevant knowledge for identifying challenges. This interpretation is consistent with the positive association between the sum of obstacles to user inclusion and the usefulness of knowledge from faculty/researchers for identifying challenges, whereas no such association is observed for students.

These patterns have implications for innovation ecosystem theory. First, they show that the value of involving multiple knowledge sources depends not only on their diversity, but also on the mechanisms used to

access and activate their knowledge. In this sense, different modes of engagement, such as consulting, co-creation and collaboration, do not generate equivalent outcomes. Second, collaboration with external partners is complementary, particularly for identifying challenges, suggesting that external sources contribute distinct and non-overlapping knowledge of value to challenges (Crescenzi & Gagliardi, 2018).

Other factors

The absence of common patterns across the three key knowledge sources for factors that could support or hinder innovation indicates that the contribution of these factors varies by the knowledge source. For example, the improvement of user experience as an innovation driver and the support of library staff for innovation are only positively associated with the usefulness of knowledge from library staff. The implication is that these two factors motivate library staff, but have no effect on the involvement of faculty/researchers or students in developing the innovation.

The importance of connection services to the usefulness of knowledge from students can be explained by the strong relevance of these services to students, such as innovations related to providing spaces and resources for user-led activities and projects. Libraries are more likely to seek student input for these types of innovations.

The positive influence of new technology on the usefulness of knowledge from faculty/researchers may reflect faculty members' extensive use of advanced tools and digital resources to access and generate research-related knowledge, which can enhance the relevance of their contributions. At the same time, a lack of staff expertise in innovation (an obstacle) is positively associated with the usefulness of knowledge from faculty/researchers, suggesting that libraries may rely more on faculty input when internal capabilities are limited.

The effects of design firms/living labs on the usefulness of knowledge are modest. Whereas the correlation is positive for faculty members, albeit only for developing solutions, it is negative for library staff. The positive correlation in the former case highlights the importance of these innovation-support settings in promoting co-creation with users, as they possess proven expertise and user-centred methodologies (Fuglsang & Hansen, 2022; Gago & Rubalcaba, 2025). The negative effect for library staff could also be due to a shift in emphasis to obtaining experiential knowledge from users instead of library staff.

The innovation mode is mostly relevant for faculty/researchers. Compared to adopting an existing innovation, developing an innovation through modification, collaboration, or in-house is associated with a higher usefulness of faculty/researcher knowledge for both identifying challenges and developing solutions. This suggests that faculty input is more useful for non-routine innovations for which there is a lack of information and which therefore require greater internal effort to develop.

Conclusions

Overall, these findings suggest that the usefulness of knowledge obtained from external sources for high-priority service innovations in academic libraries depends on the alignment between the expertise held by each source, participation mechanisms, and sometimes the existing level of knowledge about the innovation. This supports a more selective view of open innovation and innovation ecosystems.

Open innovation concerns the purposive use of distributed knowledge, beyond the boundaries of the organization, to improve innovation processes. Our evidence shows that academic libraries follow this logic by combining knowledge from library staff, faculty/researchers as library users, sometimes students as library users, and external collaboration partners. However, the results also indicate that knowledge sources are not equally valuable across all key groups or innovation tasks. Knowledge from faculty/researchers and students is more useful for identifying challenges than for developing solutions, while library staff provide consistently useful knowledge across both stages. This

suggests that the value of incorporating knowledge from different key groups depends on the strategic alignment between knowledge sources and innovation needs.

The findings indicate that innovation ecosystems are shaped not only by complementarities among actors, but also by substitution effects. Ecosystem approaches often stress the benefits of combining heterogeneous resources, competences, and perspectives across multiple stakeholders. Our results partly confirm these benefits. At the same time, several sources of knowledge can substitute for one another, as co-creation with one source can reduce the perceived usefulness of knowledge from another source. This indicates that innovation ecosystems are not frictionless arenas of collaboration, but structured systems in which actors may overlap, compete for attention, or displace one another. Ecosystem performance therefore depends on orchestration: deciding which actors to involve, when, and for what purpose.

These findings also have implications for innovation management in academic libraries. As different sources contribute different types of knowledge, effective innovation management requires the deliberate combination of knowledge sources according to the nature and stage of the innovation process. Rather than relying on a generic participation strategy, managers should design selective portfolios of contributors whose strengths match specific innovation tasks.

Library staff emerge as the most consistently useful source of knowledge in academic libraries and appear especially important in translating external ideas and user input into operational solutions. This suggests that receptiveness to open innovation is insufficient: academic libraries require internal actors capable of interpreting, adapting, and implementing distributed knowledge. Faculty/researchers are useful for specialized, uncertain, or non-routine innovations that require expert input, adaptation to academic needs, or the development of new research and learning services. Students may be most valuable for innovations linked to user experience, accessibility, communication, and services shaped by lived experience, where direct insight into student needs and expectations is important. External partners are most valuable for identifying challenges, but their contribution to practical solutions may depend on the capacity of internal staff to understand, adapt, and implement externally sourced knowledge.

A question raised by these results is whether there should be more extensive use of co-creation, particularly with students as library users. For high-priority innovations, co-creation has the largest effect on the usefulness of knowledge obtained from library staff, faculty/researchers, and students, with co-creation considerably more effective than consulting. Yet co-creation with students is reported by only 25.2% of academic libraries versus 47.2% that report co-creation with faculty/researchers. There are plausible explanations for this difference, such as differences in the types of innovations and the ability of faculty/researchers to provide an alternative source of knowledge on student experiences.

Conversely, there is some evidence that students are less likely to be considered as contributors to innovation development. First, the lack of substitution effects for students in the model for library staff indicates that staff are not fully informed about student needs and experiences, whereas library staff know a great deal more about faculty/researcher needs, as shown by the substitution effects between these two sources. Second, the goal to improve user experiences as a driver increases the usefulness of knowledge from library staff, but has no effect on the usefulness of knowledge from students. Third, the use of design firms, experts in involving service users in developing innovations, increases the usefulness of knowledge from faculty/researchers, but has no significant effect on the usefulness of knowledge from students. These three results suggest that less emphasis is given to obtaining knowledge from students than from faculty/researchers. This could be explained by difficulties in involving students (Lystbæk et al., 2019), but a concern is that academic libraries (particularly non-LIBER libraries) are under-using a potentially valuable source of knowledge.

Regarding the limitations, this study relies on managerial

perceptions of usefulness rather than objective innovation outcomes and focuses on one high-priority innovation per library. These innovations are the most likely to involve co-creation, so the results for the prevalence of co-creation are likely to overestimate its use for all library service innovations. Future research could examine whether the same patterns hold for other measures of innovation performance, different innovation types, and longitudinal changes in participation strategies.

CRediT authorship contribution statement

Anthony Arundel: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Conceptualization. **David Gago:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization. **Nordine Es-Sadki:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

No AI was used for data collection, analyses, research, or writing of this paper.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Annex A. Variables, question wording, response options, and variable construction

Variable	Question number & exact wording	Response options	Variable construction
Dependent variables			
Usefulness of knowledge (challenges)	B.9. How useful was input from the following groups on the challenges to be addressed by your selected new or improved service or process? Measured separately for library staff, faculty/researchers, and students.	None (not asked), Low, Medium, High	Ordinal scale: 1 = None (not asked for input), 2 = Low, 3 = Medium, 4 = High usefulness.
Usefulness of knowledge (solutions)	B.10. How useful was input from the following groups on the solutions (final characteristics) of your selected new or improved service or process? Measured separately for library staff, faculty/researchers, and students.	None (not asked), Low, Medium, High	“
1. Knowledge acquisition variables			
Consulting with library users	B8. Did your library use [either] of the following methods to obtain useful input from library staff or library users for developing your selected new or improved service or process? 8c. One-on-one conversations between library staff and users; 8d. Surveys on experiences with previous or similar services or processes.	Yes, No, Don't know	Binary variable equal to 1 if the library obtained input through either 8c or 8d (yes); 0 otherwise.
Co-creation			
Co-creation with library staff	B11. Were any of the following groups involved in focus groups or workshops to identify challenges or solutions for your selected new or improved service or process? 11b. Administrative or front-line library staff involved in focus groups or workshops to identify challenges or solutions.	Yes, No, Don't know	Binary explanatory variable equals 1 if yes, 0 otherwise.
Co-creation with faculty/researchers	11c. Faculty or researchers as library users involved in focus groups or workshops to identify challenges or solutions.	“	“
Co-creation with students	11.d Students as library users involved in focus groups or workshops to identify challenges or solutions.	“	“
Sum of other highly useful sources	B.9 How useful was input from the following groups on the challenges to be addressed by your selected new or improved service or process? OR B.10 How useful was input from the following groups on the solutions (final characteristics) of your selected new or improved service or process? (for both B.9 and B.10) b) Administrative or front-line library staff c) Faculty or researchers as library users d) Students as library users e) Other	None (not asked for input), Low, Medium, High	Count variable equal to the number of other highly useful knowledge sources, excluding the source used as the dependent variable. Managers (which was an option in the questionnaire) are excluded to avoid respondents' self-assessment of their own usefulness. Variable ranges from 0 to 3.
Sum of high importance external collaboration partners	B7. How important were the following external sources for collaboration partners, technical knowledge, or assistance for developing your selected new or improved service or process? a) IT departments, b) other university, national or municipal libraries, c) library associations, d) government agencies or departments, e) NGOs or non-profits, f) businesses including	None / Don't know, Low, Medium, High	Count variable for the number of external collaboration partners rated as of “High” importance. Variable ranges from 0 to 7.

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Variable	Question number & exact wording	Response options	Variable construction
	consultants, g) providers of specialized software or ICT equipment.		
Original idea from library employees	B4a. The most important contributor to the original idea for your selected new or improved service or process? c) Yourself or other library employees	Option c selected	Binary explanatory variable equal to 1 if selected, 0 otherwise.
Original idea from library users	B4a. The most important contributor to the original idea for your selected new or improved service or process? d) Library users (faculty, students, researchers, etc.)	Option d selected	“
Evaluation of good practices	B6. Did your library a) Evaluate good practices of other university, national or public libraries as part of developing your selected new or improved service or process?	Yes, No, Don't know	Binary explanatory variable equal to 1 if yes, 0 otherwise.
Use of design firms/ living labs	B8. Did your library use any of the following methods to obtain useful input from library staff or library users for developing your selected new or improved service or process? f) Services of design firms, innovation labs or living labs.	Yes, No, Don't know	Binary explanatory variable equal to 1 if B8f = yes, 0 otherwise.
2. Innovation support variables			
Management support for innovation	A2. In the last three years, how frequently did the following statements apply to your library? a) Senior management strongly supported developing new or improved services or processes.	Almost always, Mostly, Sometimes, Almost Never, Not relevant	Ordinal explanatory variable: 1 = almost never, 2 = sometimes, 3 = mostly, 4 = almost always. Excludes “not relevant” answers.
Staff support for innovation	c) Library staff were highly motivated to think of ideas for new or improved services or processes.	“	“
Design thinking / UX skills	A3. In the last three years, did your library employ one or more staff who were highly skilled in b) Design thinking or user experience (UX) to involve users in plans for library improvements.	Option b selected	Binary explanatory variable equal to 1 if selected, 0 otherwise.
Innovation experience	A4. In the last three years, did your library introduce any of the following types of new or improved services or processes: a) Services to support research b) Services to support students c) Processes for delivering services to new or current library users d) Methods for communicating with new or current library users e) Administrative or back-office processes (IT, maintenance, purchasing, accounting, human resources, etc.) f) Digitization of collections or access to collections g) Changes to the building design or use of library space h) Other (please describe)	Tick all that apply	Count variable equal to sum of different innovation types introduced by the library during the previous three years. Variable ranges from 1 to 8.
Connection activities	A1. How important are the following activities to your library? b) Holding community or cultural activities; c) Providing space and equipment for user projects.	Low, Moderate, High	Ordinal variable equal to the sum of the importance assigned to b) and c). Each item coded 1 = Low, 2 = Moderate, 3 = High. Variable ranges from 2 to 6.
Drivers	A5. In the last three years, how important were the following factors as drivers of your library's new or improved services or processes?	Low, Medium, High, Very high, Not relevant / Don't know	Ordinal variable coded 0 = Not relevant/Don't know, 1 = Low, 2 = Medium, 3 = High, 4 = Very high.
Driver: public funding	a) Public funding (European, national, regional, local) or other external funding for your library	“	“
Driver: improving user experience	b) Goal to improve the experiences of your new or current users.	“	“
Driver: new technologies	c) New technologies (digitization, artificial intelligence, etc.).	“	“
Obstacles	A6. In the last three years, how important were the following factors as obstacles to developing new or improved services or processes in your library? (include both ongoing and occasional obstacles)	None, Low, Moderate, High	Ordinal variable coded 0 = None, 1 = Low, 2 = Medium, 3 = High.
Obstacle: time pressure	a) Unrealistic time pressures.	“	“
Obstacle: lack of innovation expertise	b) Insufficient library staff with expertise on developing new or improved services or processes.	“	“
Sum of obstacles to user involvement	B12 How important were the following factors as obstacles to involving library users in focus groups or workshops as part of developing your selected new or improved service or process? a) Reluctance of library staff to include library users b) Lack of experience in involving library users c) Difficulties in finding potential or current library users willing to participate d) Insufficient time or financial resources for including library users	None, Low, Medium, High, Not relevant	Ordinal variable equal to the sum of the number of user-involvement obstacles (a to d) rated as “High” importance. Variable ranges from 0 to 4.
3. Innovation characteristics and control variables			
Innovation mode	B.5 Which of the following sentences best describes how your library developed your selected new or improved service or process:	One option selected	Categorical explanatory variable equals 1 if option selected, except for adoption which is the reference

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Variable	Question number & exact wording	Response options	Variable construction
	a) By adopting a service or process already in use by other libraries or organizations*, with very few or no additional changes b) By modifying a service or process already in use by other libraries or organizations* c) By collaborating with other libraries or organizations* d) By developing this service or process primarily in-house or with your university (little or no assistance from other libraries or organizations) *Other organizations' include businesses, NGOs, consultants, governments, etc.		category (= 0). Included as dummy variables in regression models.
Digital technology	B3 Did your selected new or improved service or process involve developing or applying technologies such as: a) Digitization of data (photos, text, collections, administrative records, etc.) b) Automated systems c) Apps for mobile phones, tablets, or personal computers d) Artificial intelligence (AI) (includes natural language processing, large language models, optical character recognition, handwritten text recognition, etc.	Tick all that apply	Binary explanatory variable equal to 1 if the innovation involved any of options a to d, 0 otherwise.
Library size	C1. How many employees (head count) work at your library?	<50; 50–249; 250+	Control variable equal to 1 if the library employed 50 or more staff and 0 otherwise.
Respondent experience	C2. How long have you worked in the library sector?	<5 years; 5–<10 years; 10+ years	Ordinal control variable based on years worked in the library sector: less than 5 years, 5 to less than 10 years, and 10 years or more.
LIBER library	LIBER membership was identified from the sample frame.		Control variable equal to 1 if the responding academic library was a LIBER member and 0 otherwise.

The full questionnaires in English and other languages are available at:

"*LibrarIN - Survey of University Library Managers - Survey questionnaire translations*", doi:10.34894/X8NK3C

Annex B.

Table B1

Ordered logit model for the usefulness of knowledge from library staff.

<i>Knowledge acquisition variables</i>	Challenges			Solutions		
	Coef.	p-value		Coef.	p-value	
Consulting with library users	0.095	0.802		0.278	0.424	
Co-creation with library staff	2.243	0.000	***	2.269	0.000	***
Co-creation with faculty/researchers	−1.110	0.000	***	−0.948	0.001	***
Co-creation with students	0.190	0.561		0.413	0.219	
Sum other high usefulness sources	0.091	0.631		0.248	0.190	
Sum high imp. External collab partners	0.302	0.023	**	0.352	0.010	**
Idea from library employees	0.090	0.844		0.635	0.156	
Idea from library users (faculty, students)	0.105	0.715		0.293	0.300	
Evaluation of other library good practices	0.335	0.309		0.192	0.557	
Used design firms/innovation labs	−0.591	0.111		−0.678	0.073	*
<i>Innovation support variables</i>						
Strong mgmt support for innovation	−0.428	0.019	**	−0.200	0.263	
Strong staff support for innovation	0.379	0.057	*	0.058	0.763	
Staff with design thinking skills	−0.072	0.825		−0.182	0.571	
Innovation experience	0.130	0.144		0.122	0.171	
Connection	0.006	0.958		−0.130	0.279	
Driver public funding	−0.214	0.036	**	−0.146	0.147	
Driver improving user experience	0.658	0.000	***	0.613	0.000	***
Driver new technologies	−0.036	0.810		−0.222	0.130	
Obstacle time pressures	−0.188	0.239		0.017	0.911	
Obstacle lack staff expertise innovation	−0.177	0.298		0.059	0.722	
Sum of obstacles to user involvement	0.097	0.553		−0.017	0.915	
<i>Innovation characteristics</i>						
<i>Innovation mode¹</i>						
Modifying	−0.449	0.311		−0.542	0.218	
Collaborating	0.054	0.909		−0.358	0.430	
In-house	−0.766	0.068	*	−0.403	0.319	
Digital technology	0.428	0.196		0.623	0.060	*

Control variables

(continued on next page)

Table B1 (continued)

<i>Knowledge acquisition variables</i>	Challenges			Solutions		
	Coef.	p-value		Coef.	p-value	
Large library (50 + staff)	−0.341	0.213		−0.445	0.107	
Respondent time in library sector	−0.275	0.281		−0.443	0.092	*
LIBER library	−0.057	0.846		−0.239	0.410	
Mean for dependent variable	2.18			2.19		
SD dependent variable	1.01			1.02		
Country-level variance σ^2	0.000			0.000		
Observations	290			290		
Chi-square	95.8			90.1		
Prob > chi2	0.000			0.000		
Akaike crit. (AIC)	623.4			627.8		

*** $p < .01$.** $p < .05$.* $p < .1$.¹ : Reference category is adoption.

Table B2

Ordered logit model for the usefulness of knowledge from faculty/researchers.

<i>Knowledge acquisition variables</i>	Challenges			Solutions		
	Coef.	p-value		Coef.	p-value	
Consulting with library users	1.006	0.003	***	0.686	0.037	**
Co-creation with library staff	−1.045	0.000	***	−0.951	0.001	***
Co-creation with faculty/researchers	3.077	0.000	***	2.460	0.000	***
Co-creation with students	−1.379	0.000	***	−0.955	0.003	***
Sum other high usefulness sources	0.577	0.003	***	0.665	0.000	***
Sum high imp. External collab partners	0.249	0.058	*	−0.031	0.806	
Idea from library employees	−0.480	0.270		−0.236	0.565	
Idea from library users (faculty, students)	1.043	0.000	***	0.168	0.543	
Evaluation of other library good practices	0.491	0.149		−0.049	0.880	
Used design firms/innovation labs	0.236	0.539		0.737	0.045	**
<i>Innovation support variables</i>						
Strong mgmt support for innovation	−0.266	0.131		0.025	0.883	
Strong staff support for innovation	0.201	0.326		−0.101	0.581	
Staff with design thinking skills	0.051	0.874		−0.113	0.705	
Innovation experience	0.048	0.593		0.013	0.874	
Connection	−0.059	0.628		−0.106	0.348	
Driver public funding	−0.006	0.953		0.072	0.447	
Driver improving user experience	0.129	0.431		−0.037	0.816	
Driver new technologies	0.363	0.018	**	0.175	0.233	
Obs. time pressures	0.088	0.568		0.188	0.190	
Obs. lack staff expertise innovation	0.414	0.013	**	0.278	0.078	*
Sum of obstacles to user involvement	0.333	0.038	**	0.161	0.274	
<i>Innovation characteristics</i>						
Innovation mode ¹						
Modifying	1.107	0.007	***	0.904	0.021	**
Collaborating	1.101	0.011	**	0.986	0.019	**
In-house	0.762	0.047	**	0.659	0.075	*
Digital technology	0.382	0.266		0.153	0.640	
<i>Control variables</i>						
Large library (50 + staff)	0.634	0.024	**	0.332	0.205	
Respondent time in library sector	0.437	0.082	*	0.499	0.042	**
LIBER library	−0.063	0.836		−0.013	0.965	
Mean for dependent variable	1.94			1.69		
SD dependent variable	1.07			1.09		
Country-level variance σ^2	0.052			0.211		
Observations	290			290		
Chi-square	131.1			98.30		
Prob > chi2	0.000			0.000		
Akaike crit. (AIC)	621.4			729.3		

*** $p < .01$.** $p < .05$.* $p < .1$.¹ : Reference category is adoption.

Table B3

Ordered logit model for the usefulness of knowledge from students.

	Challenges			Solutions		
<i>Knowledge acquisition variables</i>						
Consulting with library users	0.533	0.125		0.199	0.570	
Co-creation with library staff	0.309	0.252		0.011	0.968	
Co-creation with faculty/researchers	−1.366	0.000	***	−0.994	0.000	***
Co-creation with students	2.823	0.000	***	2.420	0.000	***
Sum other high usefulness sources	0.102	0.575		0.033	0.859	
Sum high imp. External collab partners	0.245	0.056	*	−0.014	0.908	
Idea from library employees	−0.573	0.177		−0.423	0.316	
Idea from library users (faculty, students)	1.154	0.000	***	0.584	0.031	**
Evaluation of other library good practices	0.035	0.914		−0.066	0.839	
Used design firms/innovation labs	0.230	0.518		0.481	0.173	
<i>Innovation support variables</i>						
	Coef.	p-value		Coef.	p-value	
Strong mgmt support for innovation	−0.166	0.323		−0.106	0.526	
Strong staff support for innovation	0.251	0.176		0.266	0.162	
Staff with design thinking skills	0.698	0.020	**	0.410	0.176	
Innovation experience	0.025	0.765		−0.030	0.717	
Connection	0.225	0.044	**	0.276	0.015	**
Driver public funding	−0.020	0.830		0.023	0.814	
Driver improving user experience	0.047	0.768		−0.105	0.515	
Driver new technologies	−0.016	0.908		−0.167	0.250	
Obs. time pressures	0.037	0.795		0.067	0.645	
Obs. lack staff expertise innovation	0.164	0.281		0.128	0.420	
Sum of obstacles to user involvement	−0.118	0.420		−0.072	0.628	
<i>Innovation characteristics</i>						
Innovation mode ¹						
Modifying	0.106	0.791		0.305	0.455	
Collaborating	0.541	0.192		0.882	0.043	**
In-house	0.204	0.581		0.102	0.791	
Digital technology	0.211	0.520		0.210	0.523	
<i>Control variables</i>						
Large library (50 + staff)	−0.430	0.097	*	−0.377	0.149	
Respondent time in library sector	0.334	0.196		0.377	0.134	
LIBER library	0.245	0.365		0.702	0.013	**
Mean for dependent variable	1.31			1.10		
SD dependent variable	1.15			1.12		
Country-level variance σ ²	0.000			0.052		
Observations	290			290		
Chi-square	115.6			90.0		
Prob > chi2	0.000			0.000		
Akaike crit. (AIC)	696.0			707.1		

*** p < .01.

** p < .05.

* p < .1.

¹ : Reference category is adoption.

Data availability

The data that has been used is confidential.

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