# Renewable knowledge in socio-technical systems: a service science perspective on public information infrastructures

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**Abstract:** Amid the accelerating digital transition, the knowledge systems face growing risks of fragmentation and epistemic discontinuity. To address these challenges, the public libraries are increasingly recognized as strategic socio-technical infrastructures that sustain the recovery, renewal, and long-term preservation of knowledge. Building on the view of knowledge as a *renewable resource* - one that can be created, reinterpreted, and recombined across social contexts - this paper introduces the concept of *renewable knowledge*, defined as the dynamic property of knowledge to be continuously updated, co-created, and adapted through human-service-technology interaction for public value creation. Anchored in the Service Science and Knowledge Commons theory, the study examines how public libraries operate as aggregators of renewable knowledge through the open data mediation, big data valorisation, and AI-assisted information services. Employing a mixed-methods design (survey and structured interviews across Romanian and European public libraries), the empirical results identify six conceptual clusters reflecting how libraries enact renewable knowledge via creation, utilization, organization, and distribution. Findings demonstrate that libraries move beyond static information management toward participatory knowledge stewardship, fostering resilience, sustainability, and collective intelligence within socio-technical ecosystems.

**Keywords:** Service Science, Renewable Knowledge, Service Ecosystem, Knowledge Assets, Knowledge Stewardship.

# Cunoașterea regenerabilă în sisteme socio-tehnice: o perspectivă a științei serviciilor asupra infrastructurilor publice de informare

**Rezumat:** În contextul tranziției digitale accelerate, sistemele de cunoaștere se confruntă cu riscuri tot mai mari de fragmentare și de discontinuitate epistemică. Pentru a răspunde acestor provocări, bibliotecile publice sunt tot mai des recunoscute ca infrastructuri socio-tehnice strategice, care susțin procesele de recuperare, reînnoire și conservare a cunoașterii pe termen lung. Bazându-se pe perspectiva cunoașterii ca *resursă regenerabilă* - una care poate fi creată, reinterpretată și recombinată în diferite contexte sociale - această lucrare introduce conceptul de *cunoaștere regenerabilă*, definit ca proprietatea dinamică a cunoașterii de a fi actualizată continuu, co-creată și adaptată prin interacțiunea dintre oameni, servicii și tehnologii, în scopul generării de valoare publică. Ancorată în teoriile Științei Serviciilor și ale Bunurilor Comune ale Cunoașterii, cercetarea examinează modul în care bibliotecile publice funcționează ca agregatori ai cunoașterii regenerabile prin medierea datelor deschise, valorificarea resurselor de tip big data și furnizarea de servicii informaționale asistate de inteligență artificială. Utilizând un design metodologic mixt (chestionar și interviuri structurate aplicate bibliotecilor publice din România și Europa), rezultatele empirice identifică șase clustere conceptuale care reflectă modul în care bibliotecile manifestă cunoașterea regenerabilă prin procese de creare, utilizare, organizare și distribuire. Constatările demonstrează că bibliotecile depășesc funcția tradițională de gestionare statică a informației, evoluând către un model participativ de administrare a cunoașterii, care promovează reziliența, sustenabilitatea și inteligența colectivă în cadrul ecosistemelor socio-tehnice.

**Cuvinte-cheie:** știința serviciilor, cunoaștere regenerabilă, ecosistem de servicii, active de cunoaștere, administrarea cunoștințelor.

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# 1. Introduction

The article builds on J.E. Stiglitz's view of knowledge as a global public resource that expands through use rather than depletion, underpinning social and economic progress (Stiglitz, 1999). In the digital era, characterized by the rise of AI, big data, and open information infrastructures, knowledge has become a renewable common resource essential for innovation, sustainability, and societal resilience (Hilbert, 2020; Floridi, 2020). The efficient management, reuse, and sharing of data are now central to development, while the European policy frameworks actively promote open access and the reuse of public information for the collective benefit (Janssen, Charalabidis & Zuiderwijk, 2012). Public libraries, as critical infrastructures for equitable access to knowledge, play a strategic role in this socio-technological transition. They mediate between information, users, and technologies, being transformed into key actors of the renewable knowledge ecosystem by facilitating responsible access, continuous learning, and community engagement (Williamson & Piattoeva, 2019). Data governance has become fundamental for an effective institutional response and crisis management, supporting decision-making in diverse domains such as urban planning, health, and environmental protection (Hilbert, 2020). Access to information and participation in knowledge creation are recognized as universal rights in the UN and EU charters, empowering citizens to become active contributors to knowledge renewal.

As access to digital resources expands, information literacy emerges as a core civic competence enabling individuals to understand and use data critically (Kitchin, 2021). Emerging technologies - blockchain, AI, and open APIs - enhance transparency, security, and participation in data governance (Neisse, Steri & NaiFovino, 2017; Cagigas et al., 2021). Combined with citizens' capacity to co-create information, these tools foster a more democratic and sustainable knowledge society. In this context, innovation becomes an ongoing process of knowledge creation, integration, and application (Nonaka & Takeuchi, 1995), while information-centric services, supported by digital architectures, drive societal advancement (Léonard, 2020). From a socio-technical perspective, progress depends on the joint optimization of human, institutional, and technological dimensions that shape the collective intelligence and adaptive knowledge systems (Trist & Emery, 1960; Mumford, 2006).

The design of this article is also thoughtfully put to achieve concepts and methods at its best. Although Section 1 discusses the conceptual setting of the domain of investigation in respect of the study (provides an overview of the research problem, in order to place the research problems in the context of broader scientific debate), Section 2 presents the scope and relevance of the research to the (re)organisation of the Romanian and European contexts, emphasizing the theoretical and practical significance of the renewable knowledge perspective. Section 3 draws conceptual on renewable knowledge and makes this concept clear, locating it as an important point within conventional service science, knowledge management, and socio-technical systems theory. These are explored in Sections 4 and 5 further building on this theoretical foundation with the study of public libraries as socio-technical infrastructures and cognitive ecosystems that enable knowledge activation, circulation, and renewal. The mixed-methods research design, including the research instruments, the questionnaire and interview protocols, coding procedures, and triangulation strategies are presented extensively in Section 6. Section 7 presents the analysis findings, focusing on four semantic categories of action, and six conceptual clusters based on quantitative and qualitative analyses. In Section 8, the implications of these findings for service innovation, participatory governance and the strengthening of cognitive resilience in public information infrastructures are also discussed. Finally, Sections 9 and 10 state the main limitations and formulate conclusions and suggestions for further strengthening the theoretical construction of renewable knowledge in public library ecosystems.

# 2. Added value in the Romanian and European contexts

This article advances three original contributions to the international literature on libraries and service science. First, it operationalises the concept of ″renewable knowledge″ within the public library domain, defining it through four actionable dimensions - Creation, Use, Organisation,

and Distribution - and a six-cluster typology reflecting how practitioners understand and implement renewal, from basic awareness to technology-driven modernization and lifelong learning. Second, it reconceptualises libraries as socio-technical service ecosystems, explicitly linking the renewable knowledge to the service-dominant logic and to the interaction among people, services, and technologies as a foundation for the smart information design. Third, it empirically validates the construct through a mixed-methods approach (questionnaire and structured interviews) that demonstrates its analytical coherence and practical relevance.

The study also offers the first systematic mapping of the renewable knowledge practices in the Romanian public libraries, supported by comparative European evidence showing convergent trends in digital services and participatory governance. The findings provide a policy-oriented roadmap that includes a shared vocabulary and metrics for renewable knowledge, guidelines for smart service design integrating openness and knowledge management, and capacity-building priorities in data mediation, assistive technologies, and AI-supported workflows. Collectively, these results support the repositioning of the public libraries - from passive repositories to active socio-technical platforms that generate sustainable community value and knowledge renewal across European contexts. The four dimensions of renewable knowledge - Creation, Utilization, Organization, and Distribution - and the six conceptual clusters were empirically derived and validated through a mixed-methods research design. The survey and structured-interview data (explained in detail in Section 7) document the coding protocol, the inter-coder reliability procedures, and the stability of the final cluster solution. By triangulating the quantitative survey responses with the qualitative coding outcomes, the study ensures that the proposed framework is grounded in empirical evidence rather than remaining purely conceptual. This methodological linkage reinforces the internal validity of the results and supports the operationalization of renewable knowledge within socio-technical information infrastructures.

## 3. Definition of renewable knowledge and related work

Renewable knowledge is defined by four related dimensions, which follow an explanation of the ways in which a new knowledge regenerates itself within large-scale socio-technological structures:

- **Social interactivity** represents the flow of Knowledge through the social networks in which individuals exchange information and legitimize expertise (Granovetter, 1985);
- **Contextual updating** refers to the ability of an organization to re-interpret and utilize their existing knowledge within changing social, technological, and organizational contexts (Storper, 1993; Maskell & Malmberg, 1999);
- **Techno-mediation** emphasises the use of digital technologies and infrastructures for accessing, transferring, and preserving knowledge (Mina et al., 2007);
- **Value co-creation** focuses on the collaborative activities that users and communities engage in collaboratively creating, modifying, and using knowledge to create common pool benefits (Vargo & Lusch, 2014).

Collectively, these dimensions situate renewable knowledge as an evolutionary and experiential mode of ongoing genetic reshuffling shaped by human interaction, contextualization, and technology. The specialised literature has created a number of models that provide an understanding on how knowledge production, management and dissemination are carried out through some mediation processes - from the formal organisation of the information to common goods collective governance. In establishing RK within such an epistemological landscape it requires to be distinguished from the cognate paradigms, but more significantly emphasised as complementary. Knowledge Management (KM) regulates the knowledge cycle-life, such as capture, codification and sharing - in other words how it is organised. Knowledge Commons (KC) delineates the institutional structure for the governance of the collective stewardship and access norms, while Open Knowledge (OK) is what we give -reusable tools, content and licenses. In contrast, Renewable Knowledge (RK) represents the dynamic nature of knowledge in that it is constantly updated and changed based on the combination and co-creation between people,

services and technologies through the social technical mediation (Storper, 1993; Vargo & Lusch, 2014). RK is therefore defined by temporality, by concerns for the public value of knowledge and sustainability - knowledge's capacity to be renewable, to being actualized anew. While some studies have examined the dynamic capabilities (Barney, 1991), organizational learning (Easterby-Smith & Lyles, 2003), and the governance of knowledge commons (Hess & Ostrom, 2007), few provide an integrated treatment that includes temporality, co-creation, and public value in public information infrastructures. This article attempts to address this lack and introduces the concept of renewable knowledge as a systemic property in the socio-technical ecosystems - primarily libraries - where it is constantly reshuffled (interacted with, disseminated). Recent research aspects presented here have been inspired by several publications in the Romanian Journal of Information Technology and Automatic Control (RRIA) - including Dumitrache, Stănescu & Paraschiv (2023) on AI in e-Government and Zamfir, Giura & Crăciun (2024) on Metaverse and digital governance - which indicate the streamlining of the public services through new technologies. By drawing on these findings, this article extends the concept of technological efficiency to that of regeneration as applied to knowledge within the public library ecosystems and operations with an introductory model that interconnects ongoing updating practices, co-created activities, and added value.

## 4. Public libraries as spaces for activating a renewable knowledge

Public libraries are repositories of communal memory that have been transformed from custodians of facts and knowledge to cognitive spaces where the community members interact, learn together, exchange across generations and innovate socially (Connell & Voola, 2007). The concept of renewable knowledge frames libraries as vibrant social spaces where traditional collections meet digital and social infrastructures to facilitate the ongoing unmaking and remaking of knowledge. These sorts of interdependent relations among people, organizations, and technologies are crucial for the maintenance of the community cognitive capital (Grant, 2023).

Following the commons imaginary, libraries act as shared vehicles for controlling and giving practical application to the intellectual capital. As Hess and Ostrom (2007) argue, knowledge operates as a common-pool resource whose worth is contingent upon openness, collaboration, and democratic governance.

## 5. Public libraries as ecosystems of knowledge and knowledge transfer

Libraries are traditionally seen as repositories of the shared knowledge created for public use and governed by community norms that provide open access and outlaw abuse (Hess & Ostrom, 2007). Social networks appearance and their increased permeation of all levels of life have redefined that role as libraries are no longer seen simply in terms of information hubs but also as knowledge builders. Learning is not constrained to institutions: it occurs in communities of practice and open learning spaces such as libraries, where the knowledge is co-produced and disseminated (Polese et al., 2018).

In this context, libraries can be considered as cognitive ecologies in which knowledge generation and exchange is produced, transferred and re-combined among interconnected users and institutions. The difference between information as a non-rival and non-excludable public good and knowledge, particularly in terms of tacit knowledge, continues to be the key for interpreting these transformative processes (Polanyi, 1966). As Hess and Ostrom (2007) stress, knowledge ecosystems are complex multi-actor systems which take their form under self-organizing and adaptive dynamics. In the new global knowledge economy, libraries serve as strategic nurseries for the cultural and cognitive capital, using preservation to induce innovation in order to encourage a cooperative learning, creative behavior, and social progress.

## 6. Methodology

The methodology applied consists of the methodical combination of two main tools: a survey on modern library services and structured interviews on renewable knowledge. From a theoretical perspective of the renewable knowledge, the authors consider that the libraries are capable of

combining their civilising function with modern digital service infrastructures to become active carriers of regenerative learning for their users. The methodology used is therefore that of the interpretive action research: a continuous social experiment centred on the cooperation between researchers and respondents, in cyclical clusters of data collection - reflection - action, with the aim of developing practices that respond to needs (Reason & Bradbury, 2008).

The proposed objectives were:

- Diagnosing the current state of the public libraries;
- Testing different hypotheses in real conditions;
- Adapting librarians' practices so that they adopt and effectively leverage this concept of progressive knowledge renewal.

The data source comes largely from the decision-makers in over 15 European countries. The analysis methods used include a thematic coding, clustering and descriptive statistics. Through this investigation, which is both qualitative and exploratory, the authors have identified viable solutions to strengthen the participation of the public libraries in the creation, storage and transmission of the renewable knowledge. This can be achieved either through the use of technological resources, the development of new community skills and practices, or a combination of both. As society evolves, libraries are forced to reconfigure their infrastructures to respond to the complex needs of the users. They have evolved from book archives to community centres, idea aggregators and interactive DIY spaces, now covering complex social, symbolic and informational functions (Weinberger, 2012; Mattern, 2014). As intellectual infrastructures, the public libraries connect physical, social and epistemological fields to store a common cultural memory, promote shared co-creativity and circulate good practices on a large scale (Mattern, 2014; Klinenberg, 2018). In this way, they enable people to access, reuse and recombine information. The transition of the libraries to Library 2.0 has transformed them into ubiquitous platforms that can support networks of ideas - both fragile and sustainable - providing society with globally connected local infrastructures (Weinberger, 2012; Storper, 2013). This type of transformation gives them a democratic value and ultimately places them at the centre of the socio-technical information ecology (Weinberger, 2012; Klinenberg, 2018).

To give scientific validation and credibility to the current research, the authors adopted the following methods:

- Use of a questionnaire for the librarians to measure the level of familiarity and practical use of the concept of renewable knowledge;
- Ensuring that decision-makers in both Romania and Europe are interviewed in a structured manner to reveal the obstacles encountered in adopting the model;
- Quantitative thematic analysis - which includes both coding and clustering, as well as triangulation with quantitative (i.e., statistically based) data to identify relevant patterns - plus a qualitative analysis following the validation of the hypotheses through reflection, ending with participants' feedback when an iterative cycle of action/interpretation is consistent.

The questionnaire consisting of 14 questions was distributed to the public library managers in Romania (n = 50, with 46 responses) and in over 15 European countries (n = 50 with 14 responses). The data were compared between Romania and Europe, supplemented with information from the official European databases or reports published at the national level. The aim of this exercise was to determine how much knowledge there is of the modern library services and the involvement of these information and documentation institutions in the process of "renewable knowledge". In addition, the library services were classified into generic types and their availability and frequency in libraries were investigated.

The empirical analysis was carried out with a purpose selected sample of public library managers that took into account various criteria aimed at recovering institutional diversity and geographical representation. The institutions were libraries of different size (small municipal

libraries, medium county institutions and large metropolitan or national-level libraries. A total of 50 questionnaires were handed out in Romania with a return ratio of 46 valid responses (92%) resulting in strong internal validity for the national record. In the European case, the survey was sent to 50 library directors in 15 countries and 14 responses were collected (a lower but still manageable number that allowed for cross-cultural comparisons and identification of local variances). Although the Romanian sample is quite representative of the national public library network, those from Europe should be read carefully since they are small and uneven distributed in space. Nevertheless, these constraints should not detract from the exploratory nature of the study. But they also suggest the need for an extended, longitudinal research that accurately captures the scope of service innovation and renewable knowledge adoption on the European library ecosystems campaign. The data from the questionnaire were statistically analysed by IBM SPSS Statistics, supported by R-based routines for description and inferences. The reliability of the questionnaire items (all >0.75) was tested using Cronbach's alpha coefficients to confirm the internal consistency following the thematic coding that separated responses into pre-defined conceptual clusters (Creation, Use, Organisation and Distribution).

The objectives of the questionnaire were as follows:

- What is the level of understanding of the library managers regarding the concept of renewable knowledge?
- What types of modern service models are available in the library?
- To what extent such systems are suitable for preserving renewable knowledge.
- What relationships exist between technology, modern services and renewable knowledge.
- Whether or not it is possible to build a hub for renewable knowledge at the infrastructure level.

The Structured interview on renewable knowledge consisted of 14 questions and was completed by library managers from Romania (n = 36) and Europe (n = 7). The analysis focused on cultural, organisational and interface differences at the European level. For the structured interviews, NVivo software was used to perform the qualitative coding and clustering, with an inter-coder reliability verified through Cohen's kappa scores (values > 0.70). The triangulation between the quantitative (survey-based) and qualitative (interview-based) findings was applied to enhance the construct validity, while the thematic saturation was monitored to ensure the comprehensive coverage of the renewable knowledge perceptions. Although the small number of European respondents limited the statistical power of some comparative tests, the mixed-methods approach strengthened the robustness of the analysis and provided convergent validity across instruments.

The purposive selection aimed at institutional representativeness and geographical diversity: (i) decision-making role (directors/managers and middle-management), (ii) library size (small/ medium/large, including county/metropolitan/national), (iii) type of locality (large urban/small urban/rural), (iv) NUTS region (Romania: all 8 development regions; Europe: minimum 15 countries from North/East/South/West), (v) digital maturity (self-reported). The geographical and institutional distribution is summarized in a table with absolute/relative frequencies by country/region and size class. The response rates were 92% (Romania) and 28% (Europe); the interpretation of cross-national comparisons takes into account this asymmetry.

The coding protocol combined both a deductive and an inductive framework. Deductively, the first-level categories were derived from the four dimensions of the renewable knowledge (Creation, Utilization, Organization, Distribution). Inductively, the authors conducted open coding on a pilot sample (20% of the interviews), generating a unified codebook after two rounds of consensus. The Inter-coder reliability was assessed using Cohen's κ (κ_global > 0.70; acceptance threshold = 0.60), with discrepancies resolved through discussion and agreement. Based on the case × code matrix, there were conducted in NVivo: (i) Matrix Coding Queries, (ii) Similarity Metrics (Jaccard/Pearson), and (iii) Hierarchical Cluster Analysis using Ward's method. The six-cluster

solution was determined by inspecting the dendrograms and applying the “elbow” criterion on intra-cluster variance; the stability was validated through resampling and triangulation with the questionnaire-derived categories. The final clusters were assigned semantic labels according to code density and anchor quotations.

The objectives of the structured interview were:

- Gaining a deep understanding of leaders' perceptions of the concept of 'renewable knowledge';
- Identifying the degree of use and application of this concept;
- To assess the social and community effects of knowledge and the application of this concept.

This study used a combination of quantitative and qualitative approaches. The analysis method highlights the use of both qualitative and quantitative methods, includes graphs and uses statistical software packages, including thematic coding, grouping and cross-cultural comparisons.

Theoretical foundations and interpretative framework: The theoretical framework included: Polanyi (1966) - separation of tacit and explicit knowledge; Nonaka & Takeuchi (1995) - knowledge creation processes; Popper (1959); Popper (1963); and Popper (1972) - differentiation of the three worlds (W1 physical, W2 mental, W3 cognitive/objective), and respectively Sveiby (1994) and Sveiby (2000) - organisational intellectual capital management. The interview method was designed based on the above methodical and progressive frameworks, from general to specific (definitions to application in libraries), presenting non-professional and intuitive hypnotic perspectives. Figure 1, created by the author, illustrates the positioning of public libraries as renewable knowledge hubs, highlighting the interconnections among people, services, and technologies that enable the continuous creation, updating, and circulation of knowledge within socio-technical ecosystems.

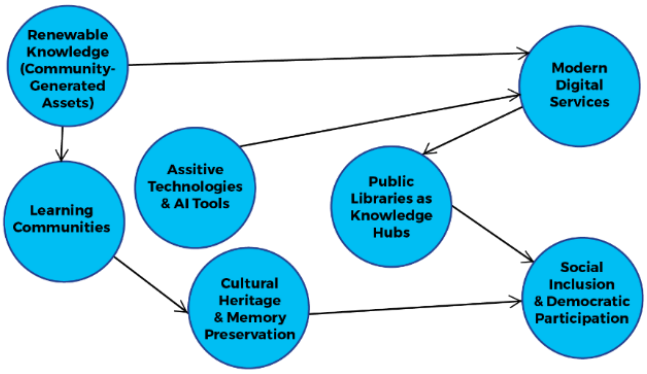


**Figure 1.** Public libraries as renewable knowledge hubs (Authors’ own research)

Analysis of responses and interpretation of the concept of ‘Renewable Knowledge’

Based on the 36 responses from Romania, six types of perception were identified:

- Unaware of the concept;
- Association with innovation, adaptation and knowledge refreshment;
- Links to the modernisation of services through technology;
- Focus on non-formal learning and mentoring;
- Valuing sustainability and flexibility;
- Understanding of library collections as a whole and digital access.

This resulted in four thematic categories of action in libraries: CREATION, USE, ORGANISATION, and DISTRIBUTION of renewable knowledge. According to the analysis of the responses, the idea of renewable knowledge is becoming a new dimension in the library and information science, situated at the intersection between the public library services and the

challenges posed by today's digital society. The public library is no longer simply a place where people have access to information - it legitimises the production of cognitive capital in communities, encourages processes of co-creation and reinterpretation of knowledge, and will provide public recognition for what is valuable (Jaeger, 2022). Figure 2, belonging to the author herself, presents the six conceptual clusters derived from the qualitative analysis, showing the spectrum of perceptions ranging from limited awareness of the concept to advanced interpretations linked to technological modernization, sustainability, and lifelong learning.

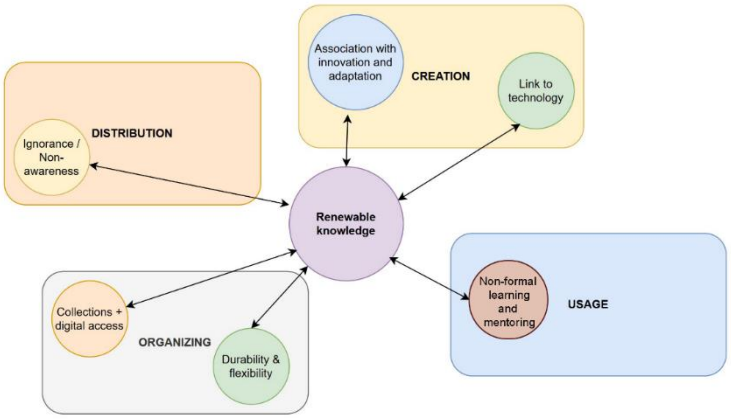


**Figure 2.** Clustering of library managers' perceptions of the concept of renewable knowledge (Authors' own research)

The analysis of the responses revealed six distinct conceptual clusters that reflect the diversity of perceptions regarding the notion of Renewable Knowledge. At one end of the spectrum, some respondents demonstrated little or no awareness of the concept, denying its relevance or existence. Others, however, perceived renewable knowledge as a dynamic process of change and adaptation, whereby new insights emerge from the continuous recombination of the pre-existing knowledge, generating co-created value and indispensable cognitive resources. A significant group linked the concept directly to the modernization and transformation of the library services, emphasizing technology-driven updates designed to meet the evolving user needs. Another cluster interpreted renewable knowledge through the lens of lifelong learning and non-formal education, highlighting the library's role in mentoring, guidance, and community-based training initiatives. Equally important were the respondents who associated the term with broader qualities such as flexibility, cyclicality, sustainability, and resilience in the cultural and intellectual domain. Finally, some participants defined renewable knowledge pragmatically, as the aggregation of collections, information resources, and intellectual assets curated by libraries and made accessible to communities both physically and digitally. Taken together, these clusters illustrate the multifaceted nature of the renewable knowledge and underscore its relevance as both a theoretical construct and a practical driver of service innovation in the public libraries.

From the six clusters of concepts analysis, three main perspectives emerge regarding renewable knowledge. First, this type of knowledge is seen as communal intellectual property capable of continuously creating its own added value through the reuse, reinterpretation and contextualisation of information (Polanyi, 1966). The second perspective considers the library spaces, creative hubs and digital platforms as places where renewable knowledge is created and distributed. It confirms that the info-documentary networks are part of the mechanism for generating social capital, which is of urgent importance for the contemporary society itself (Mattern, 2014; Klinenberg, 2018). The third point of view emphasises the importance of a smart and cooperative governance, where services, big data and stakeholders work together to provide access and participation in the representation of true knowledge at the highest level available to the society as a whole (Schöpfel, 2018). Public libraries are now seen as complex socio-cognitive spaces, where the co-creation of knowledge occurs in both physical and virtual environments, between heterogeneous individuals and communities, becoming infrastructures of cognitive resilience in the digital age. The library has practically become an infrastructure for general knowledge and cognitive resilience because people within the library walls live in such close proximity to one

another that there can be no permanent social divisions (Weinberger, 2012). Therefore, libraries function as an adaptive common of knowledge, capitalising not only on explicit information, but also on tacit knowledge from daily experiences and practice (Nonaka & Takeuchi, 1995). This research also highlights the need to redefine the library services in terms of renewable knowledge, with an emphasis on participatory design, open infrastructures and inclusive information policies (Micle & Tîrziman, 2021). The development of the concept of the smart library (Poon, 2019), which includes the integrated civic, educational and cultural functions, will contribute significantly to the democratisation of knowledge and the social capital increase (Schöpfel, 2018; Jaeger, 2022).

## 7. Results

The empirical findings are based on the data collected through 46 valid questionnaires from the Romanian public library managers and 14 responses from the managers across 15 European countries, complemented by 36 structured interviews in Romania and 7 at the European level. The statistical analysis of the questionnaire data revealed four primary categories of action associated with renewable knowledge in libraries: Creation, Use, Organisation, and Distribution. Within these categories, six conceptual clusters were identified, reflecting the heterogeneous ways in which the respondents understand and apply the concept of renewable knowledge. These clusters include: (1) unawareness or denial of the concept, (2) associations with adaptation, change, and value-added co-creation, (3) connections to service modernization through technology, (4) links with lifelong learning, mentoring, and non-formal education, (5) associations with flexibility, sustainability, and resilience, and (6) pragmatic understandings that equate renewable knowledge with library collections and their accessibility. The comparative analysis indicates a higher degree of familiarity and operationalisation of the concept in the Romanian sample, while the European responses, although fewer, highlight emerging trends toward digital services and participatory governance. The statistical validation confirmed the internal consistency of the survey items (Cronbach's alpha > 0.75), and the qualitative coding of the interviews produced convergent categories, reinforcing the robustness of these empirical findings. This research provides a solid conceptual map for understanding how library professionals with different decision-making levels perceive 'renewable knowledge'. Identifying types of perception helps define the directions for developing library service policies and strategies. The four semantic actions (Creation, Use, Organisation, Distribution) can guide the design and implementation of services oriented towards renewable knowledge. The research results show that, in the perception of the public library professionals, the renewable knowledge is not just a reusable information resource, but a strategic dimension of the community's cognitive infrastructure. Public libraries have moved beyond their role as repositories of information, transforming themselves into hubs for the co-creation and aggregation of the knowledge with social, economic and cultural value, in a model of distributed knowledge economy (Weinberger, 2012; Jaeger, 2022). Figure 3, created by the author, depicts the three complementary approaches to renewable knowledge, renewable intellectual capital, collaborative practices, and smart participatory governance, emphasizing the multidimensional nature of the concept across library ecosystems.

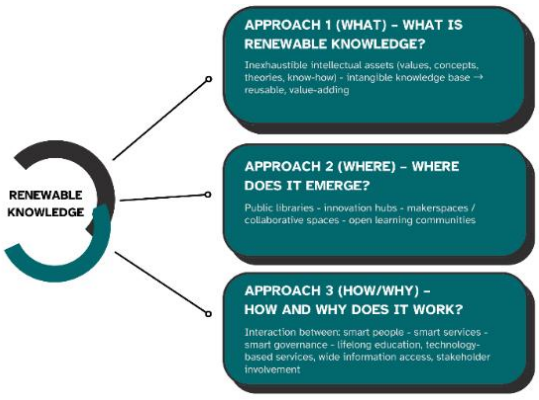


**Figure 3.** Graphical illustration of the three identified approaches to renewable knowledge (Authors' own research)

The analysis of the clusters resulting from the questionnaires and interviews identified three complementary approaches to the concept. The first one positions renewable knowledge as part of a collective, inexhaustible intellectual capital that can be perpetuated by integrating and recontextualising experiences and ideas for the benefit of the community (Sveiby, 1997). The second perspective associates the concept with a living collection of practices, solutions and information validated through a collaborative use, specific to open environments such as makerspaces, innovation hubs or interactive digital libraries (Storper, 2013; Mattern, 2014). The third approach highlights the importance of a smart ecosystem in which people, services and governance structures co-create, validate and distribute renewable knowledge, leveraging digital technology, artificial intelligence and participatory processes to democratise access (Coe, Paquet & Roy, 2001; Schöpfel, 2018).

## 8. Discussion and perspectives

The variety of the responses implies that the renewable knowledge is still a nascent and debatable term within the LIS domain. The differences in knowledge of the term made by the respondents suggest that conceptualization and professional training are called for. Concurrently, the listing of those clusters that connect renewable knowledge with adaptation, technological modernization and lifelong learning indicates a vision of libraries as active socio-technical systems able to co-produce cognitive value among their user communities. And the focus on sustainability - and adaptability - is consistent with the literature about knowledge commons (Hess & Ostrom, 2007) and service-dominant logic (Vargo & Lusch, 2014), where renewable knowledge is treated as a strategic resource for both community empowerment and institutional innovation. The pragmatic alignment of renewable knowledge with collections centres the ongoing nature of an enduring perspective, but its coalescence with more fluid definitions suggests a professional shift from custodial to coproducing. The international comparison also indicates that if the Romanian libraries are still rather weakly familiar with this concept, the European Libraries are experimenting with the digital infrastructures and participative governance models which could promote the uptake of renewable forms of knowledge. Collectively, these insights underpin the case that public libraries need to transform to socio-technical ecosystems which implement renewable knowledge such that their position may be strengthened as important actors in the sustainable societal development and knowledge resilience.

The conclusions show that smart libraries (Freyberg, 2018) cannot function without an adaptable and participatory socio-technical infrastructure. These information and documentation institutions are called upon to simultaneously ensure sustainability, informational relevance and organisational resilience, cultivating a climate conducive to collaboration and co-production of cognitive content (Klinenberg, 2018). An important conclusion is the need to ensure partnership networks between libraries, public authorities, communities of practice and social innovation organisations in order to harness renewable knowledge resources for the benefit of the community.

Moreover, the present research highlights that the existence of accessible and interactive public spaces, digitally and functionally integrated, is essential for strengthening the renewable knowledge infrastructure. In this sense, transforming the public libraries in Romania into collaborative co-creation spaces is not only timely but necessary to reduce the socio-informational gaps and strengthen the community social capital (Micle & Tîrziman, 2021; Nicolescu, 2024). This article makes a significant contribution to strengthening the conceptual framework of the notion of renewable knowledge in the context of the modern public library services. Starting from the assumption that libraries not only disseminate information but also actively participate in the (re)creation of knowledge within communities, the study intended to investigate the relationship between the information and documentation infrastructure, modern services and the regenerative dynamics of knowledge (Nonaka & Takeuchi, 1995; Jaeger, 2022). The results obtained from the Questionnaire on the modern library services and the Structured Interview highlighted a convergence of opinions between the respondents in Romania and those in Europe on the need to modernise the library services and align them with the digital paradigm. A direct correlation was found between the use of assistive technologies, digital storytelling, open online infrastructures and

the ability of the libraries to generate and preserve renewable knowledge. Thus, libraries are perceived not only as conservative institutions of the information heritage, but also as dynamic platforms for co-creation and aggregation of the community knowledge (Weinberger, 2012). Figure 4, created by the author, illustrates how renewable knowledge is situated in relation to information and conventional knowledge categories, emphasizing its dynamic, cyclical, and value-generating character within modern public library infrastructures.

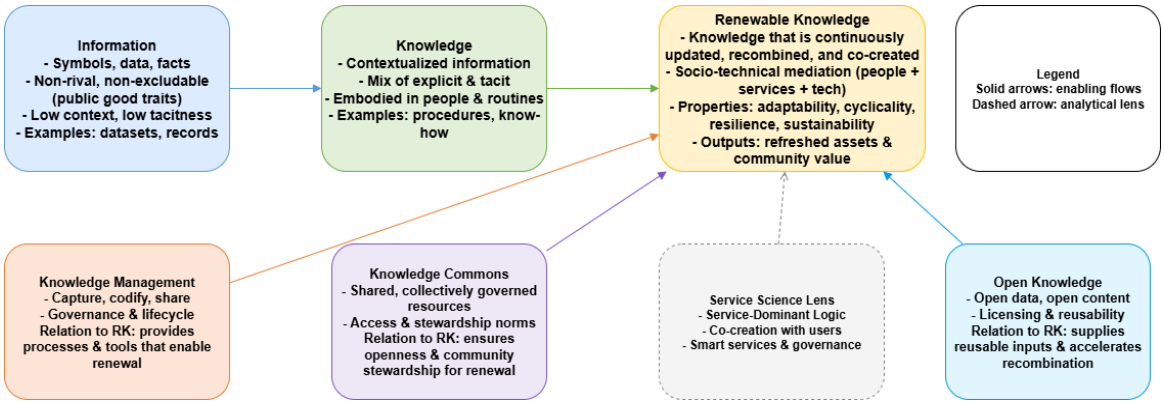


**Figure 4.** Positioning renewable knowledge in relation to information and knowledge (Authors' own research)

One of the original contributions of the study is to propose a terminological clarification for the concept of renewable knowledge, distinguishing it from the traditional ecological meanings. In this article, renewable knowledge refers to those collective, emerging cognitive resources that can be revalued, reinterpreted and reintegrated into the social and educational circuit through the digital and collaborative facilities (Polanyi, 1966; Schöpfel, 2018). The six conceptual clusters extracted from the qualitative data validate the existence of three integrative approaches: as a renewable intellectual asset, as a result of collaborative spaces, and as a product of a participatory information governance (Mattern, 2014; Klinenberg, 2018).

The study also reveals that there is a growing concern in public libraries to expand their services into the digital realm in order to make knowledge accessible and diversify the ways in which the local cognitive capital is exploited. In particular, accessible digital storytelling, mobile services and co-creation hubs are becoming priorities in the institutional strategies, as they are considered catalysts for the regeneration of the community knowledge (Micle & Tîrziman, 2021; Nicolescu, 2024). This article proposes, among others, a working hypothesis that public libraries can play an essential role in knowledge governance at the local and regional levels, functioning as knowledge commons infrastructures capable of stimulating cognitive resilience in the face of the current socio-technological challenges (Weinberger, 2012; Jaeger, 2022).This approach involves redefining the library services in the logic of the open knowledge, integrating the AI technologies and developing partnerships with the educational and cultural ecosystems.

## 9. Limitations and future work

This study is subject to several limitations that should be taken into consideration. First, this new knowledge resource concept of renewable knowledge is still relatively fresh and not yet well grappled in the literature. So, although sociotechnical theories and knowledge management frameworks may be useful as bases, the mixing of terms such as knowledge commons, open knowledge, and renewable knowledge introduces some conceptual ambiguities that potentially can lead to interpretation issues. This difficulty is even greater when referencing distinct places, cultures, organizations and institutions: the very same idea can be regarded as a process of agile adaptation in one case (in another institution or geography) or mere warehouse of intellectual assets. Second, the empirical evidence was provided through a relatively small cross-national data. Despite

the good representativeness reached by the Romanian subsample, the limited number of respondents in other European countries omitted to draw conclusions among other general geographical areas. As an upshot, the comparative work reveals trends and differences, but no patterns of adoption or resistance to renewable knowledge in public libraries can yet be stated. And third, methodological decisions also entail limitations. Triangulation through survey and structured interview data enhanced the validity, but self-reported perceptions might have been biased. Additionally, the statistical power of the comparisons was restricted due to the unevenness in subsample size, implying that the cross-national distinctions have to be interpreted with caution. In the next sequel, we believe that a follow-up study should be conducted to extend our findings by overcoming these limitations from various perspectives. At a conceptual level, more work is required to tease out and consolidate how renewable knowledge differs in its definition from the established constructs (knowledge management, knowledge commons and open knowledge).

# 10. Conclusions

The conclusions of this study highlight that public libraries operate as essential socio-technical infrastructures for the activation and regeneration of knowledge within communities, thereby validating the relevance and applicability of the renewable knowledge concept within the field of service science. The mixed-methods analysis, based on questionnaires and structured interviews, enabled the identification of four semantic categories of action - Creation, Use, Organisation, and Distribution - along with six conceptual clusters that reflect the diversity of library professionals' perceptions regarding the ways in which knowledge is renewed, contextualised, and co-created within complex socio-technical ecosystems. The study confirms the transition of libraries from their traditional role as custodians of information to that of dynamic platforms for co-creation, digital mediation, and cognitive stewardship, capable of supporting resilience, innovation, and community participation.

The main theoretical contribution of this work lies in the clarification and operationalisation of the renewable knowledge concept, while its practical contribution is reflected in the development of an applicable framework for designing intelligent services oriented toward participation and equitable access. The research also opens new avenues for strengthening knowledge infrastructures, integrating emerging technologies, and developing collaborative governance mechanisms necessary to amplify the regenerative potential of public libraries.

## Author contributions

Conceptualization: V.S. and I.C.; Methodology: V.S. and I.C.; Data Curation: J.R. and I.C.; Investigation: I.C.; Theoretical argumentation and problematisation: I.C.; Validation: V.S. and J.R.; Writing - original draft: V.S., J.R. and I.C.; Writing - review and editing: V.S., I.C. and J.R. All authors have read and agreed to the published version of the manuscript.

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