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Beyond the reverse product cycle: An exploration of the digital, social and spatial transformation of libraries[1]

Benoît Desmarchelier [a], Faridah Djellal [b], Faïz Gallouj [c,*], Nassim Gallouj [d]

[a] Sorbonne Paris Nord University, Faculty of Economics and Management, 99 Av. Jean Baptiste Clément, 93430 Villetaneuse, France
[b] University of Lille, Faculty of Economics, Sociology and Geography, Building SH2 - Office 110, 59655 Villeneuve d'Ascq Cedex, France
[c] University of Lille, Faculty of Economics, Sociology and Geography, Building SH2 - Office 223, 59655 Villeneuve d'Ascq Cedex, France
[d] EM Lyon Business School, 144 av. Jean Jaurès, 69007 Lyon, France

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ABSTRACT

Focusing on innovation dynamics in public libraries, this article begins by revisiting one of the very first attempts to construct a theory of innovation in services: the reverse product cycle (RPC), published in Research Policy (Barras, 1986, 1990). With reference to ICT-based innovation trajectories in libraries, the article validates the RPC by identifying a cycle that begins with a stage dominated by process innovations, followed by one dominated by product innovations. It goes further by extending – and in some respects updating – the model, taking into account forgotten technologies and introducing new waves of enabling technologies associated with Industry 4.0 and 5.0. The rise of the internet and digitization posed an existential threat to libraries. Their survival, however, is due to their ability to reinvent themselves – transforming this threat into an opportunity, and embracing innovative trajectories that aren't solely ICT-based. These include book-, object-, individual-, and space-based trajectories.

1. Introduction

Interest in service innovation really took off in the mid-1980s and early 1990s. Barras's reverse product cycle (RPC), published in the journal *Research Policy* (Barras, 1986, 1990), is generally considered one of the first attempts to construct a theory of innovation in services (Gallouj, 2002; Djellal, 2023). This theory, while quite simple, is of undeniable heuristic value, and analyzes the dynamics of innovation in services according to a cycle that begins with a stage dominated by process innovations and is followed by a stage dominated by product innovations. This cycle would, thus, be the reverse of the well-known "normal" cycle described in industrial sectors by Abernathy and Utterback (1978). Information and communication technologies (ICTs), which Barras calls "enabling technologies", are the mainspring of this RPC, which is intended to apply to services.

The aim of this article is to re-examine RPC theory in the light of innovation dynamics within a particular service sector: public libraries. This project serves a number of purposes. First, it aims to fill the theoretical gap that tends to characterize the library science literature on innovation (Desmarchelier et al., 2024, 2025; Potnis et al., 2020; Pellack, 2022). This is above all a qualitative literature in which surveys and (often detailed) descriptions of innovation cases predominate. At its best, it leads to typologies of innovation that endeavor to pinpoint the specificities of innovation in libraries (Potnis et al., 2020; Nicholson, 2017).

The second aim of this article is to address the special relationship that exists between libraries and ICTs. Unlike the services that originally formed the empirical underpinning of the RPC model (i.e. banks, insurance companies, large international audit and consulting firms, local public administrations), library services have an ambiguous and contradictory relationship with ICTs. While ICTs have been, and continue to be, "enabling technologies" for innovation, they have also constituted more of an existential threat to library activity than to other services. Indeed, combined with the digitization of books, the internet has led to a disaffection with libraries, raising fears of their outright disappearance (Flood, 2019; Potnis et al., 2020; MacDonald and vanDuinkerken, 2015). By the late 2000s, then, there was an extensive literature asking questions as to the relevance of libraries in the age of online information

* Corresponding author.
E-mail addresses: Benoit.Desmarchelier@univ-Paris13.fr (B. Desmarchelier), Faridah.Djellal@univ-Lille.fr (F. Djellal), Faiz.Gallouj@univ-Lille.fr (F. Gallouj), nassim.gallouj@edu.em-lyon.fr (N. Gallouj).

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(Smith, 2019). A quarter of a century later, the answer is clear: the library continues to exist. It has – having implemented the processes of adaptation and innovation necessary to its survival – been able to reinvent itself in line with the Schumpeterian logic of "creative destruction" (Schumpeter, 1911). Its survival is due to its ability to transform the existential threat into an opportunity, and embrace innovative trajectories that aren't solely ICT-based. These include book-based, object-based, individual-based, and space-based trajectories.

To account for these processes of adaptation and innovation, this article is based on a review of the literature and empirical material from the European LibrarIN project ("Value-co-creation and social innovation for a new generation of European libraries", Horizon Europe, 2022-2025). The literature review, which also supported other research objectives within the LibrarIN project, covered more than 400 scientific articles and almost 50 books. It allowed us not only to refine our theoretical framework, but also to identify notable examples of innovation in libraries. On the empirical side, the interviews we conducted were mainly with library directors (from national, university, regional and municipal libraries) in France and Canada. Our objective was to gather examples of innovations implemented, either in the library surveyed, or in others. Using a semi-directive interview guide, we collected information on the nature of the identified innovations, their determinants, their impacts, the obstacles faced, and the ways in which the innovation process was organized.

This article is organized into three sections. In Section 2, we offer an overview of the RPC model, in its relationship with the normal product cycle (NPC) model, within the general context of service innovation theories. In Section 3, we endeavor to explore innovation dynamics in libraries using this original model (based on Industry 3.0 technologies). In Section 4, we present an extended, updated RPC model that takes into account the advent of industry 4.0 and then 5.0. We highlight a number of non-ICT-based innovation trajectories that are invisible to this model yet have enabled public libraries to survive the existential threats posed by certain recent developments in ICTs.

2. The reverse product cycle and its relationships with the "normal" cycle

Barras's RPC model follows on from, synthesizes and brings coherence to numerous works that address innovation in services in terms of the impact of ICTs on a range of economic variables including employment, qualifications, productivity, service quality and international trade (Gallouj, 1998). As already mentioned, it describes the innovation cycle in services as the reverse of the traditional ("normal") industrial cycle.

This industrial innovation cycle, which originated in capital goods industries such as ICTs, highlights forms of innovation whose rate of occurrence varies according to the stage of the cycle under consideration (Abernathy and Utterback, 1978). In the initial (fluid) stage, product innovation dominates, then in the subsequent (transitional and specific) stages, once a "dominant design" has been established, process innovations steadily gain in importance and come to dominate, until a new normal cycle is set in motion. In computing, for example, the NPC of mainframes was followed by the NPC of mini- and micro-computing, and then of networks.

Based on empirical work in financial services, auditing and consulting services and local government, but claiming universal application as a theory of innovation in services, the Barras model highlights a product cycle described as 'reverse' insofar as – unlike the "normal cycle" – process innovations precede product innovations.

According to Barras, the innovation dynamic in services is driven by three successive waves of computerization, corresponding to the technologies that enable innovation in services, and originating in the manufacturing sector (the capital goods sector).

The mainframe was the first wave of computerization, and initiated the first stage of the cycle. It was at the root of numerous process innovations affecting the back-office of service activities, aimed at improving the efficiency of delivery of existing services (i.e. reducing costs) especially through economies of scale. Examples include the computerized registration of insurance policies, and the computerization of certain internal functions, such as personnel and payroll records.

The second stage of the cycle corresponds to the second wave of computerization, whose constituent technologies are mini and micro-computing. According to Barras, these new enabling technologies drove radical process innovations, which increasingly happened in the front office. These innovations were based on economies of scope, and helped improve the quality of the service provided. Examples include the computerized management of waiting lists for housing in municipal administrations, online policy quotations in insurance company offices, computerized account-keeping in auditing and accounting firms, and ATMs in banks.

The third stage of the cycle is driven by computer networks. According to Barras, these were the driving force behind such product innovations as home banking and online public information services – as well as electronic services delivered across all service sectors at the point of consumption (at home or at work), rather than at the point of production. According to Barras, once established, these new services-products return to an NPC.

In the updated terminology that reflects current information technologies, we could say that the three types of enabling technologies mentioned by Barras (1. mainframe computers, 2. mini- and micro-computers, 3. computer networks) correspond, respectively, to the following new generic categories: 1. enterprise computing and cloud infrastructure, 2. personal and professional computing, 3. networking and distributed computing. These are radical product innovations that dominate the early stages of the corresponding product life cycles. Each of these product technologies is then accompanied, in subsequent phases of the cycle, by process innovations that will reduce costs and facilitate their diffusion into the service sectors.

According to Barras (1986, 1990), the first phase of the RPC (dominated by incremental process innovations) involves technical progress that is both labor-saving and capital-deepening; the second phase (dominated by radical process innovations) involves technical progress that is relatively neutral in terms of employment, and whose capital-widening and capital-deepening effects are balanced; and the third phase (dominated by product innovations) involves technical progress that is labor-using and capital-widening.

The RPC at work in the consumer goods and services sector is not an isolated cycle. It interacts with the NPC operating in the capital goods industries, which provide it with its enabling technologies. Although not in phase, these two cycles (the normal and the reverse) evolve in parallel and influence one another. Process innovations in the capital goods sector are essentially aimed at reducing the production costs of their radical product innovations – and it is these radical product innovations that serve as the enabling technologies for the RPC. The radical and incremental process innovations that dominate the second and third phases of the NPC play only an indirect role in the RPC; they help facilitate the diffusion of product innovations from the capital goods sector to the service sector, by reducing their prices.

Barras RPC model is both a general theory or quasi-theory of innovation in services, and a theory of the diffusion of technological innovation from the industrial capital goods sector to the service sector (Gallouj, 1998). Therefore, the question of the adoption of these technologies by services is central to implementation of the RPC. Barras (1986) pays particular attention to what he calls the "transmission process" of technology from the production sector to the consumption or use sector (i.e., from the capital goods sector to the service sector). The diffusion of enabling technologies into services is slow, facing two types of delay that are commonly discussed in the literature, and highlighted by Barras: adoption delays and delays in the manifestation of the results of this adoption. The latter reflects the time it takes for users to fully appropriate the technologies adopted and generate their own

innovations from them.

There are two main reasons for the success of the Barras model. The first, as mentioned above, is that it represents a synthesis of the extensive empirical literature accumulated over previous decades, approaching the question of service innovation in terms of ICT impacts (Gallouj, 1998). The second (and more important) reason is that it makes a significant conceptual leap, integrating what is essentially descriptive work into a more sophisticated and ambitious analytical construct.

Our aim in what follows is to test the RPC model on the case of public libraries – in other words, to analyze the extent to which this model can account for innovation dynamics in this type of service.

According to Barras, ICTs are the determining factor in service innovation. In public libraries, as in all other service activities, they seem to exert an enabling power, giving rise to process innovations followed by product innovations (see Section 3). On the other hand, the most recent developments in ICTs are having destructive consequences for traditional library activities, calling into question their very survival. These harmful developments in ICTs (particularly the internet) can only be countered via the implementation of new innovation trajectories (not necessarily based on ICTs), which the Barras model is unable to consider. These trajectories will be discussed in Section 4 of this article.

3. ICTs as enabling technologies for innovation in libraries: a validation and update of the RPC model

In line with the RPC model, the introduction of ICTs in libraries gave rise first to the emergence of process innovations (incremental, then radical), followed by product (service) innovations. It should be noted that a number of studies in librarianship have also attempted to identify stages in the introduction of ICTs into libraries, and analyze their consequences in terms of innovation. While these works may lack the theoretical ambition of the Barras model (of which they are unaware), they still describe interesting innovation dynamics that are consistent with it, since they show a certain precedence of *process* innovations over *product* innovations.

Thus, Borgman (1997) identifies four stages in the spread of ICTs in libraries, reflecting the different aims of computerization: 1. Improving the efficiency of internal operations; 2. Improving access to local library resources; 3. Providing access to resources outside the library; 4. Establishing interoperability of information systems in order to build a Global Information Infrastructure. Similarly, West and Lyman, quoted in Lynch (2000), describe, in three stages, how ICTs have changed libraries over the last few decades: 1. modernization, 2. innovation, 3. transformation. The first stage of 'modernization' is synonymous with the automation/computerization of certain library operations. The aim is to carry out the same activities as before, but more efficiently. The second stage, called 'innovation', involves experimenting with new capabilities such as online public access to library cataloging. The final stage ('transformation') involves the digitization of printed documents, enabling direct and immediate access to the documents themselves. Before launching into a detailed description of the evolution of the RPC, we discuss the adoption dynamics of enabling technologies in the context of libraries.

3.1. ICT adoption dynamics in libraries

Barras (1990) regards financial services as the "vanguard sector" of the information revolution. Banks and insurance companies were, in fact, the first and primary adopters of the various ITs produced by the physical goods sector. Public libraries do not fall into the category of "vanguard services" in the strictest sense of the term. While their adoption of ICTs has been universal, it has also been relatively slow, compared to other sectors (Blackburn, 2011). This delay in adoption can be attributed to various traditional factors identified in the literature, such as: the high cost of IT investment (especially in the initial phase of the capital goods industries life cycle); the fact that public library resources are dependent on public funding (which tends to be shrinking); the risk and uncertainty associated with these investments; the institutional rigidities linked to the public nature of the libraries; their size; their lack of technical expertise; resistance from some users; problems of interoperability of systems; software redundancy; data confidentiality issues; risks of technological lock-ins, etc. (Barras, 1990; Borgman, 1997; Blackburn, 2011; Ashiq, 2025; Martorana and Rizzo, 2024). It should be noted that the first two factors mentioned (cost and risk) are closely dependent on the NPC in the capital goods sector. The costs and risks associated with technological adoption decrease as process innovations take precedence over product innovations in this sector.

It is also important to note that adoption dynamics and delays vary greatly, depending on the type of library being considered (Martorana and Rizzo, 2024). From this perspective, we propose to paraphrase Barras (1990) by stating that, within the library sector, there are "vanguard libraries" that are "early adopters" (Rogers, 1962) or "lead users" (von Hippel, 1986). However, what we refer to as "vanguard libraries" are not "vanguard services" in Barras's sense, insofar as they are slow adopters of ICT compared to, for instance, financial services. These "vanguard" libraries are simply the least delayed in adopting ICTs relative to their peers; they are "vanguard" only in a comparative sense (within the library sector itself). In the field of librarianship, they are more commonly described as "core libraries."

These "vanguard libraries" (in a metaphorical usage) include national libraries and large university libraries (which have transformed into Learning Centers) and are relatively better endowed with financial resources and expertise than the others. These libraries were the first to adopt mainframe computers (Shaw, 1989) and go digital; in many ways, the Barras model seems to apply most effectively to these "vanguard libraries". On the other hand, we do not expect the most sophisticated and expensive technologies to be adopted in small rural, prison, hospital or school libraries.

When investing in new technologies, libraries encounter both uncertainty and risk, as identified by Knight (1921). These can take various forms, including financial, technical, legal and institutional, cognitive, and so on. Cognitive risk, for example, reflects the ongoing need for adaptation to rapidly changing technical expertise, as well as the threat of technological lock-in with equipment suppliers and IT service providers. In this context, "vanguard libraries" also seem better equipped to manage uncertainty and risk as they adopt and implement innovative technologies.

Once adopted, an enabling technology (a product innovation from the capital goods sector) must be appropriated by the user (the library) and used as a resource for its own innovations. This process of appropriation and innovation is intrinsically linked to learning dynamics, and often supported by specialized service providers. However, the process of appropriation and integration into library activity is not immediate. It depends on a number of factors, including available financial resources, the nature of the library's activities, the needs of its users, and the expertise and skills of librarians, etc. During the NPC (at least its first phase), a science-push logic (driven by the R&D efforts of capital goods manufacturers) seems to prevail. In contrast, in the RPC it is a demand-pull logic (focused on user needs) that takes precedence (Barras, 1986). Once again, given their users' needs (primarily students and researchers), the skills of their employees, and their financial resources, "vanguard libraries" are better positioned than others to leverage adopted technologies for introducing their own process and product innovations. To achieve this, they focus on the specific needs of their users, sometimes collaborating with them in a demand-pull logic.

In his analysis of the information and services revolution, Barras

(1990) highlights the radical impact of ICTs on service organizations, particularly in terms of control and decision-making processes, the structure and nature of investment capital (relatively less unproductive capital such as buildings, and more directly productive equipment capital), and the tradability of information. These radical impacts also seem to affect libraries. Indeed, their computerization – which, as we shall see, affects both their general administrative functions and their specific "business" functions (library operations) – has clearly enhanced decision-making and control processes (Saffady, 1989; Martorana and Rizzo, 2024; Ashiq, 2025), especially in larger libraries (national libraries, major university libraries) and those organized into branches. Computerization has also facilitated the establishment of effective, well-coordinated national and international collaborations (global digital connectivity). Library computerization has also had a considerable capital-saving impact on the need for space and buildings, as extensively documented in the literature (Campbell, 2006; Holley, 2013). Lastly, computerization has had a positive impact on libraries, if not in terms of tradability (a term that might seem ill-suited to public services), then at least in terms of the exchangeability and circulation of information. Indeed, the very essence of digitization is its ability to push the boundaries of information storage and circulation – whether in audio, text, video, or other formats – to their extreme limits.

The different dimensions of sustainability (economic, social and ecological) do not seem to be affected in the same way by the different waves of technology adopted by libraries. For example, the adoption of mainframes, along with minicomputers (which primarily affected national and large academic libraries), was primarily geared toward economic sustainability. Although costly, these technologies were designed to automate certain library activities, increase productivity and reduce library operations costs. However, they also generated negative externalities, in terms of ecological and social sustainability. These technologies are, in fact, particularly energy-intensive, even though some of the incremental process innovations they induce may prove environment-friendly (e.g. reduced paper consumption). From a social perspective, since they aim for economies of scale, they favor labor standardization (and a certain de-skilling) and destroy jobs. In contrast, network computing and industry 4.0 technologies establish social sustainability as a key objective, in particular by expanding services aimed at digital inclusion (e.g. free access to the internet and the various services that stem from it). Industry 5.0 technologies, on the other hand, explicitly claim both social and ecological sustainability. Human-centricity and environmental sustainability are, in fact, two of the three core principles explicitly outlined in Industry 5.0 (see Section 4.3).

3.2. Mainframe computing and incremental process innovations

As in many other service sectors (at least, those that are information-intensive), the first wave of computerization (the introduction of the mainframe) reached libraries (particularly in UK and the USA) in the 1960s (Line, 1997). These mainframes are technological product innovations that originated in the capital goods sector, where they initiated the NPC. In libraries, they were primarily used in back-office operations, automating a range of labor-intensive and time-consuming tasks. This led to incremental process innovations that improved service efficiency by lowering production costs, thereby initiating a RPC. Given the high cost of these technologies, only a small number of large libraries (particularly in the USA) adopted mainframes at the start of the RPC. However, as the NPC progressed in the manufacturing sector, the price of mainframes decreased, thanks to process innovations. As a result, these technologies are now more widely used in large libraries in developed countries.

These incremental process innovations can be divided into two groups, according to the library back-office functions they impact (see Table 1). The first group covers *general administrative functions*. The corresponding innovations are the same as those implemented in other service organizations and include computerization of, for example, the personnel and payroll registers, the accounting system, etc. The second group covers *library operations*. Examples include the computerization of acquisition systems; the computerization of cataloging systems (replacing card catalogs with computerized catalogs[2]); shared cataloging with other libraries; the automation of circulation systems to replace the particularly labor-intensive and time-consuming manual circulation system; automated reference services (Saffady, 1989; Lynch, 2000; Bourne and Hahn, 2003).

It should be noted that, in this first stage, other technologies (not mentioned in the Barras model) also played an important role in library activity and innovation dynamics. These included photocopiers (which enabled certain documents to be transmitted tenfold), fax machines (used, in particular, to exchange documents between libraries) and microforms, which contained miniaturized versions of documents that were easier to store, preserve and circulate (Whitmore, 1983). Other formats for transmitting information, knowledge and other forms of leisure – such as radio, tape recorders, video recorders, television and cinema – have sometimes also been seen as factors in the decline of book-reading. These forgotten technologies can be the source of both process and product innovations (photocopying services, film clubs, audio and video tape loans, etc.). However, it seems that, in line with the Barras model, the hypothesis of the predominance of process innovation at this stage of the cycle is not called into question.

3.3. Decentralized computing and radical process innovations

The second wave of computerization (i.e., the introduction of mini- and micro-computing in the 1970s and 1980s) also gave rise to process innovations in libraries, in line with the RPC model. These process innovations were more radical than their predecessors in that their purpose was no longer solely (or primarily) to reduce service costs, but also – and above all, to increase service quality. They were more concerned with the front office of the library service, i.e., the relationship with the user.

Examples (see Table 1) include online public access catalogs (OPACs) and online book reservation systems, available on-site. These systems made it possible to access library catalogs and reserve books not only by using computers made available to users inside libraries, but also through the use of Local Area Networks and dial-up modems (Borgman, 1997). In some libraries, these were now complemented by automated self-service check-in and check-out stations. Radical process innovations also included vending machines installed outside libraries, for example in hospitals (Khan, 2013).

Though implicitly included in this second wave of computerization, Barras neither explicitly mentions a certain number of technological artifacts nor exploits their potential for innovation, either in terms of products or processes. These include printers, DVDs, CDs, CD-ROMs and corresponding players (McClure and Jaeger, 2009), which did play a significant role in the innovation dynamics of libraries. In a way, they heralded the upheavals that were yet to be brought about by the internet and the digitization of books and other documents, and which enabled libraries to make information more accessible to users by making databases, software and information available on digital media.

Though the hypothesized predominance of process innovation does not seem to be called into question at this stage, it should be noted that product innovations were also at work here, as illustrated by access to computers (even if only for word processing) and printers (printing services), as well as CD, DVD and CD-ROM lending services. These, combined with certain innovations from the previous stage (television, cinema, tape recorder, video recorder, etc.), helped transform libraries into *multimedia libraries*.

[2] Cf. MARC (Machine Readable Cataloging) Pilot project conducted by the Library of Congress in 1965 and 1968.

Table 1
The original reverse product cycle applied to libraries, plus the updated version.

Cycle stage	Main forms of innovation	Competitive effort	Enabling technologies	Examples	Library type	Version
Stage 1 Late 1960s, early 1970s	Incremental process innovations	Improvement of service efficiency (cost reduction)	Mainframes *Technologies missing from the RPC Model:* - Photocopiers - Fax machines - Barcodes - Microforms (mid-20th century) - Radio - Tape recorder and audio tapes -VCR and videocassettes - Television - Cinema	*General management functions:* - Computerization of personnel records - Computerization of payrolls - Computerization of accounting systems *Library operations:* - Computerization of acquisition systems (supplier and order management) - Computerization of serials (periodicals) controls - Computerization of cataloging (replacing card catalogs) - Shared automated cataloging (with other libraries) - Computerization of loan systems - Computerization of circulation (automated book storage, circulation and delivery system) - Automated reference services - Computerized management of members (registrations, delays in returning books)	Automated Library	Original Reverse Product Cycle Model
Stage 2 Late 1970s–1980s	Radical process innovations	Improvement of service quality	Mini- and micro- computers *Technologies missing from the RPC Model:* - Printers - DVDs, CDs, CD-ROMs and corresponding players	- Online and on-site public access catalogs (OPAC) - Online and on-site book reservation systems - Self check-in and check-out machines (1990s) - Provision (on-site) of electronic databases - First experiments with book vending machines	Electronic Library	
Stage 3 Early 1990s–2000s	Product innovations	New services	Networks Broadband internet *Technologies missing from the RPC Model:* - Mobile technologies (telephony, computers, iPads, e-readers) - Digitization - Scanning systems	- Free internet access - Training in the use of the internet, and more generally digital literacy training - Online general information provision (timetables, address, access conditions, etc.) - Virtual tours of library collections - Online (web-based) public access catalogs (OPAC) - Online (web-based) system for reserving (and renewing reservation) of books - Online supply of digital books - Online instructions (tutorials) - Online supply of e-journal packages - Online supply of various databases - Catalog 2.0	Digital Library Hybrid Library Library 2.0	
Stage 4 2010–2020	Product innovations	New services	- Artificial Intelligence - Big Data - Internet of Things - Cloud computing - Blockchain - RFID technology and robotics - 3D printing	- Advanced search engine services - Reading recommendation services (based on reading habits) - Conversational AI services (Virtual assistants and chatbots) - Improved AI-assisted accessibility (e.g. for the visually- or hearing-impaired) - AI-assisted content analysis and insights services (summarizing text services, ChatGPT services) - AI-based transcriptions of manuscripts - Cultural heritage cloud	Intelligent Library Smart Library Library 4.0 Participatory Library	Extended or updated Reverse Product Cycle Model

(*continued on next page*)

Table 1 (*continued*)

Cycle stage	Main forms of innovation	Competitive effort	Enabling technologies	Examples	Library type	Version
				- Intelligent seat reservation systems		
Stage 5 2020 -	Product innovations	New services	- Open AI and generative AI - Internet of Everything - Virtual Reality (VR)/ augmented reality (AR), digital twins and metaverse - Drones - Collaborative robots (cobots) - Wearables - Advanced data analytics - Quantum computing	- Immersive learning experiences and collaborative spaces based on VR and AR - Virtual library tours based on VR and AR	Library 5.0	

3.4. Networks and product-service innovation

The third wave of computerization began in the mid-1990s (and continued into the 2000s). It provided the enabling technologies that made it possible to design and implement product-service innovations, i.e. the offering of new services to users (cf. Table 1).

3.4.1. Third wave enabling technologies

For Barras, the third wave enabling technologies of the RPC are networks of computer terminals and the internet. We propose adding other technologies that, while absent from the model, do play an important role in the product innovation dynamics of libraries, such as: mobile technologies (telephony and computers, iPads, e-readers, connected watches, etc.) and the digitization and scanning technologies associated with them.

Because mobile technologies were still in their infancy at the time Barras carried out his work, they are not mentioned in his model. However, insofar as they do not represent a break in the technological trajectory focused on networks and the internet, but rather an exploitation of that trajectory, we include them among the enabling technologies of this third wave. In addition to higher bandwidth, mobile technologies and broadband internet provide faster and more ubiquitous modes of network access. Similarly, in conjunction with the internet, the digitization of books is an essential enabling technology for product-service innovation in libraries.

3.4.2. Product-service innovations driven by networks, mobile technologies and digitization

3.4.2.1. Free internet access. In this third stage of the RPC, the most noteworthy new service is undoubtedly the *free internet access* offered by libraries. For libraries, the internet is not just an enabling technology that gives rise to product-service innovations in line with Barras's analysis, but is in and of itself an essential new service they offer.

Free internet access is now a standard service offered by all libraries in developed countries. A reference work by Jaeger et al. (2007) shows that in the USA, over a period of just over ten years (from 1994 to 2006), the number of libraries offering internet access services rose from 20 % to almost 100 %. Some libraries, particularly in the USA, even provide WiFi to neighborhoods in need, using library vehicles and hotspots.

For financial and/or educational reasons, some fringes of the population still lack access to the internet. The free access offered by libraries aims to combat the "digital divide" and promote equality among citizens. However, in the future, with the democratization of the internet, the number of users of this free access service is likely to be reduced (at least in developed countries) to only the most marginalized populations.

3.4.2.2. Internet-use and digital literacy training services. In multiple fields in which users face more or less complex platforms and a plethora of information of varying quality, free internet access is accompanied by *formal or informal training services in its many uses* (Ginger, 2015), the generic aim being "digital literacy". Examples include digital literacy support/training services in the following areas: use of the internet in general, use of Massive Open Online Courses (MOOCs) (Calenge, 2015; Nicholson, 2017); use of e-government; use of social media; access to reliable health information aimed at diverse audiences (e.g. senior citizens), access to economic information for local entrepreneurs (patent information, business data bases, etc.) (Pellack, 2022), etc. Other examples of digital literacy training services include "technology petting zoos", which are collections of technical tools (e.g. e-readers, laptops, tablets, digital audio-services) made available to users for educational purposes, and "Coding Clubs", which are early learning fun-based sessions in programming, aimed at young children.

3.4.2.3. The many basic services available via the internet. Internet, mobile technologies and digitization are the "enabling technologies" of many other product-service innovations in libraries, in line with the RPC model. These include the simple possibility of sending and receiving emails, as well as the many online services now on offer not only at home, but everywhere, thanks to mobile computing and telephony. Nowadays, no matter where the user is located, consultation of a library website provides practical information (opening hours, addresses, access conditions, etc.), general information on the collections, online tutorials on how to use library services, virtual tours of library collections, personalized 24/7 online librarian consultation services, etc. Also on offer are web-based remote access to the catalog (OPAC), online reservations, e-books, e-journals (Lynch, 2000), and a host of other resources: licensed databases, homework resources, audio and video content (podcasts, audiobooks, etc.), online courses (MOOCs), e-government services, etc.

Third wave technologies enable digitization of personal photos, documents, etc., as a way of conserving local and personal history in "Memory Labs". They also enable access to community engagement platforms (discussion groups, virtual community forums, etc.).

Internet access also opens the door to the many opportunities for interaction offered by what is known as Web 2.0, Participative or Social Web, which allows users to play a more active role in the creation of new services and content. Web 2.0 is reflected in Library 2.0 or "Participatory Library" (Maness, 2006), which encourages various forms of user participation in the design of library activities. The Online Catalog 2.0, for example, enables users to add their own input (comments, notes, tags) to a document (Maness, 2006).

It should be noted that, although product-service innovations dominate this third wave of computerization, they are accompanied by a significant number of process innovations. These concern general internal management functions, such as: the implementation of intranet sites, electronic messaging, electronic diaries, videoconferencing, teleworking, the management of data related to library operations (statistics

on users or on loans, for example), etc. However, these process innovations also concern such library operations as automatic metadata extraction, automated book storage and delivery systems, and web-based interlibrary lending.

Barras (1990) considers that large organizations dominate the first phase of the RPC, while smaller organizations are particularly active in the subsequent phases of radical process and product innovations. This hypothesis is partially confirmed in the case of libraries. For example, "vanguard libraries" (which are also the biggest) had the resources to adopt mainframe and minicomputing, allowing them to design and implement process innovations. By leveraging network computing and the internet (third phase), smaller libraries were able to afford many product innovations, such as providing free access to the internet and a variety of associated services. It is likely that the 4th and 5th waves of enabling technologies, which characterize the extended or updated RPC model (see Sections 4.2 and 4.3), will see a resurgence in the predominance of the largest and most well-resourced libraries. These technological revolutions are in fact the catalysts for innovations whose adoption demands relatively significant resources.

4. ICTs as destructive technologies for libraries, and the exploration of new innovation trajectories

In their latest developments (internet and digitization), ICTs have emerged as competitors to the library. They have actually contributed to a trend away from libraries, and (in combination with other factors such as budget restrictions) even to the outright closure of a number of them. Between 2010 and 2019, almost 800 libraries closed in the UK (Flood, 2019). This existential threat is widely invoked in the mainstream press – as illustrated by, among others, the following publications with their rousing titles: "Don't mourn the loss of libraries - the internet has made them obsolete" (Mcternan, 2016); "Do we need libraries?" (Denning, 2015), and "The Deserted Library" (Carlson, 2001). In the UK, for example, between 1999 and 2020, book lending by libraries fell by 70 %, and library use by 43 % (Touitou, 2020).

The threat posed by (third wave) ICTs to the very existence of libraries can be explained by the informational and cognitive nature of the books, journals or documents. These are now systematically digitized, and can thus be obtained without even visiting the physical space of the library. The endangerment of libraries can be explained not only by the availability of online access to digitized documents (books, articles), but also by the rise of search engines and services such as Google, Google Scholar and Wikipedia, and more recently, artificial intelligence systems such as ChatGPT, which are replacing libraries in the search for information.

As a result of the existence of the internet, and ICTs in general, the social role of libraries is undergoing significant change. In addition to the provision of free internet access and training in the many associated services mentioned in the previous section, the fight against this threat to the library's survival has taken six forms, which will be detailed in the following paragraphs (see Fig. 1). The first and the second involve leveraging a fourth and a fifth wave of ICTs (those linked to the advent of Industry 4.0 and Industry 5.0), to offer new ICT-based services. The third is to explore an innovation trajectory centered on libraries' historical (and original) target: the book. The targets of the other three innovation trajectories are: 1. Physical objects made available to users (the so-called "Library of Things"); 2. The individual themselves as a live performance (user, lecturer, author); 3. The physical space into which objects and individuals are placed for different purposes. These six innovation trajectories, which we will examine below, can be manifested in the six abovementioned generic service categories. As a preamble, we will first discuss these categories in more detail.

4.1. Innovation trajectories and service categories: mapping the space of innovation in libraries

In librarianship, numerous publications have been devoted to defining the missions of libraries and tracing their evolution over time (see, for example, Williamson, 2000; Nicholson, 2017; Gilbert, 2010; Calenge, 2015; IFLA, UNESCO, 2022; British Library and Carnegie, 2019, among many others). For example, Williamson (2000, p. 179) describes the fundamental objectives or social roles attributed to libraries as follows: "information, education, recreation, culture, and economic regeneration". A report by the British Library and Carnegie (2019) considers that libraries meet citizens' needs in areas ranging "from culture, business and research to health, wellbeing and personal growth", and that they provide services addressing the following public policy priorities: 1. Research and education; 2. Health and social policy;

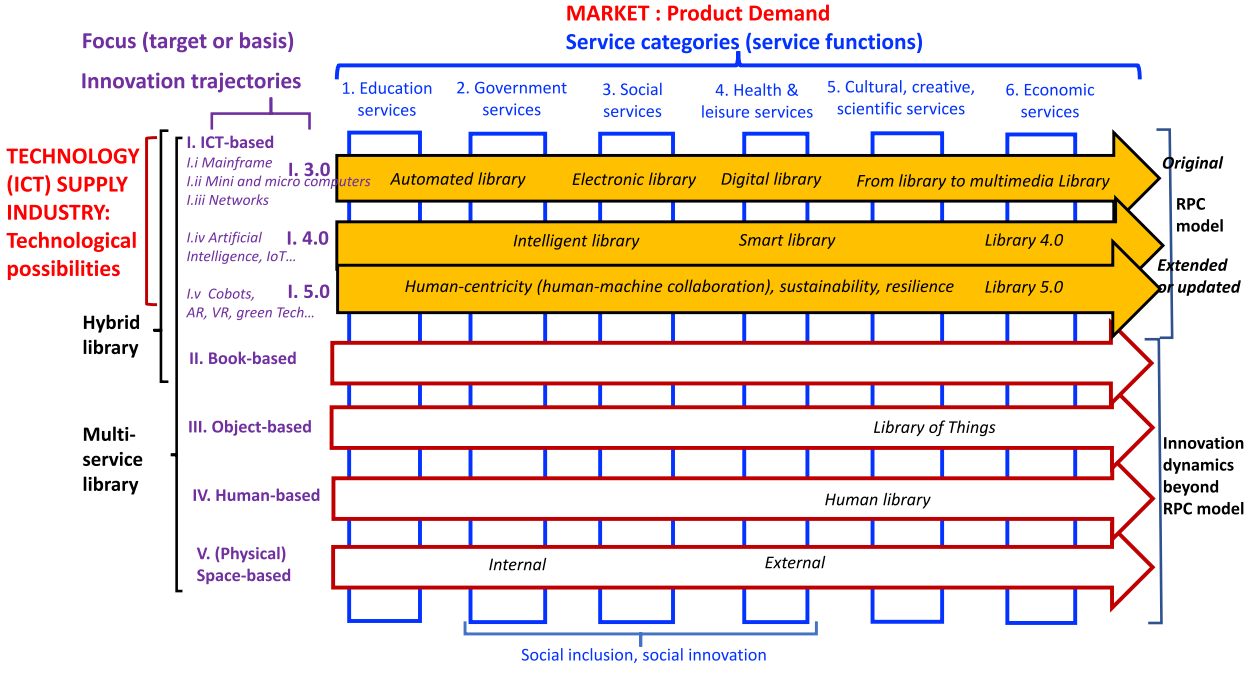

Fig. 1. A typology of innovation trajectories in libraries: Beyond the RPC model.

3. Culture and arts; 4. Business and enterprise; 5. Community development (local government). In an interesting collection of case studies of innovative libraries, Dow Schull (2013) distinguishes the following categories: 1. Work, careers, and service; 2. Health and wellness; 3. Creativity; 4. Information and community connections; 5. Lifelong learning; 6. Financial planning and business development. Nicholson (2017) proposes the following typology, illustrated with hundreds of examples: 1. Programs for leisure, relaxation and hobbies; 2. Health and well-being programs; 3. Programs for minority; 4. Literacy program; 5. Science and technology programs. The typology of library services and missions proposed by IFLA (International Federation of Library Associations and Institutions) and UNESCO (2022) in its "Public Library Manifesto" is authoritative. It includes the following categories: 1. Lifelong learning; 2. Community information and opportunities for community organizing; 3. Health information; 4. Information services to local enterprises, associations; 5. Local and indigenous data, knowledge, and heritage (for local community); 6. Scientific knowledge, research and innovations. On the basis of this extensive literature, we have adopted the following typology, which, using simplified terminology, covers most of the categories identified in the literature: 1. Education services; 2. Government services; 3. Social services; 4. Health and leisure services; 5. Cultural, creative and scientific services; 6. Economic services.

The first category ("Education services") covers traditional (historical) library services. It focuses on support for reading and learning at different life stages: pre-school, school (STEM – science, technology, engineering, and mathematics – services) and lifelong learning for adults.

The "Government services" category covers both general and practical government information services relating to community life (local events, road safety, etc.), and classic government services: administrative services of all kinds, especially tax services.

The "Social services" category covers services aimed at citizens in social difficulty, whose social inclusion is encouraged via the provision of adapted services. These services are aimed, for example, at ethnic minorities (immigrants, refugees), the homeless, the long-term unemployed, students with socio-economic difficulties, people suffering from addiction or mental illness, etc.

The "Health and leisure services" category covers information, advice and training services focused on citizens' well-being and personal growth. Examples include yoga, dietetics and exercise classes, as well as the loan of board games, sports equipment, etc.

The "Cultural, creative and scientific services" category brings together the provision of activities, books, equipment (e.g. musical instruments, 3D printers, etc.) and spaces (makerspaces, living labs, author services, coding workshops, etc.), with a view to facilitating creative activities for users. This includes university and national library services in their "research" dimension.

Lastly, the "Economic services" category brings together services that support citizens in their professional activities (scientific research, job search, business creation or management, etc.). Libraries may also support the local business community by providing information on market trends and patent filings, or offering business coaching classes, etc. (Pungitore, 1995).

Of the various innovations that emerge in the library innovation space (Fig. 1), one category is worthy of special attention: social innovation. Given the inherently social mission of libraries (promoting literacy, inclusion and democracy), it could be argued that all library innovations are, in a way, social. However, this broad definition is not the one we will use, as it is too expansive and ultimately unhelpful. The social innovation we are interested in is a more specific sub-category, namely that focusing on "wicked problems" (Churchman, 1967), which are complex, multi-faceted issues that require the collaboration of multiple stakeholders. Social innovation can be found throughout the library innovation landscape but is especially prevalent in "Government services", "Social services" and "Health and leisure services". Social innovation is an open innovation in two distinct ways. First, it involves upstream openness, which means multiple collaborations between service providers (librarians and other stakeholders) (Gegenhuber and Mair, 2024). Second, it fosters downstream openness, which encompasses collaborations (or discussion groups) between users (Desmarchelier et al., 2024). The open social innovation framework, as described by Gegenhuber and Mair (2024), emphasizes a cross-sectoral and multi-stakeholder approach, rather than one that is organization-centric. This aligns closely with the definition of social innovation proposed by Desmarchelier et al. (2024), which views the process as one involving both an "input-network" and an "output-network".

4.2. A fourth wave of enabling technologies and new ICT-based services

As we pointed out earlier, the Barras model, which dates from the late 1980s, considers three waves of computerization: 1. mainframes, 2. mini- and micro-computers, 3. networks and the internet. However, since the 2010s, a powerful technological dynamic has been at work – one that Barras could not have foreseen. This dynamic is associated with what is known as Industry 4.0 (the fourth industrial revolution), which is based on Artificial Intelligence (AI), Big Data, the Internet of Things (IoT), and Cloud Computing.

This fourth industrial revolution is, of course, also affecting libraries in general, and academic libraries in particular (Cox and Mazumdar, 2024). More generally, the advent of Industry 4.0 and Web 4.0 is reflected, in libraries, in the emergence of a Library 4.0. While this dynamic could be interpreted as a deepening of the third wave of computerization, given its scope it could also be considered more of a fourth wave. Either way, by providing the enabling technologies for new product-service innovations, it is enriching and extending the ICT-based innovation trajectory beyond the scope of the *original RPC model*. To account for this new technological reality, we are introducing the idea of an *extended RPC model* that would complement the *original RPC model* (see Table 1).

AI makes it possible to process gigantic quantities of data, extract trends and make predictions. It opens up new horizons both for access to knowledge, and for its dissemination in libraries. AI enables the implementation of numerous new services (product innovations); examples include (see Table 1) advanced search engine services, intelligent seat reservation systems, reading recommendation services (based on reading habits and preferences), conversational AI services able to offer personalized advice to customers (virtual assistants and chatbots), improved AI-assisted accessibility (e.g. for the visually or hearing-impaired), AI-assisted content analysis and insights services (summarizing text services, ChatGPT services), AI-based transcriptions of manuscripts, the Cultural Heritage Cloud and more (Cox and Mazumdar, 2024).

The various product innovations brought about by the fourth wave of ICTs can be assigned to the six different service categories offered by libraries. Some of these new services are generic and can be applied across all service categories. This is the case, for example, with personalized AI recommendation systems, AI-based language translation services and conversational AI services (virtual assistants and chatbots), which can be implemented in any service category. Other new services in the AI-based trajectory fall into specific service categories. Examples include AI literacy services (programs), educational and training tools using AI. These services more specifically illustrate the "Education services" category, whereas AI-driven image recognition services for the visually impaired, AI-based text to speech and speech to text services for the visually impaired (or those with reading or writing difficulties) fall into the "Social services" and "Health and well-being" categories.

It should also be noted here that, in addition to product-service innovations, the new waves of AI are driving major process innovations in the back-office, whether in library operations or in administrative management. For example, the introduction of AI has enabled

significant productivity gains and quality improvements in a number of processes, including: automated resource acquisition services (predictive analytics for resource allocation and optimizing collection development); book cataloging via the augmented cataloging process (expert systems for reference assistance); automated circulation follow up services for books (and other resources) and automated (or smart) book shelving based on AI and RFID (and sometimes robots). Other process innovations include automated (AI-assisted) metadata generation; AI-assisted restoration of damaged or fragile old books and documents (in order to preserve cultural heritage), using AIs such as Optical Character Recognition (OCR). AI has also had a positive impact on the automation of certain general administrative processes, such as membership management or online information about the availability of seating in the library.

Thus, the idea of a RPC (shifting from the domination of process innovations to the domination of product innovations), while not called into question, is in need of being qualified to some extent. We might even hypothesize that the AI wave began by aiming to automate routine back-office operations (process innovation), before offering new services (product innovation). AI can also be seen as blurring the boundary between product and process innovation. However, this blurring is nothing new. In services, "the product is a process", and the distinction between the two is questioned, regardless of the enabling technology envisaged (Gallouj, 1998). Barras (1990, p. 226) himself acknowledges this difficulty. He addresses this by suggesting that "the more radical the services innovations become, the more reasonable it is to identify the resultant improvements in services delivery as 'new services'".

4.3. A fifth wave of enabling technologies: Industry 5.0 and the sustainability issue

The manifestations of Industry 4.0 have become part and parcel of everyday life. However, it appears that a new paradigm is already at work: Industry 5.0 (European Commission, 2021). It rests on three key principles (European Commission, 2021; Noble et al., 2022):

1. Human-machine collaboration. This principle focuses on people, emphasizing their safety, their well-being at work, and the personalization of services. It moves away from the idea of machines replacing humans or offering mass-produced services. Instead, it advocates for a balanced collaboration between humans (both librarians and users) and machines. This "human-centric approach to technology" illustrates a concern for balance in the innovation dynamics between technology-push and demand-pull logics.
2. A renewed focus on sustainability in general and environmental sustainability in particular. Industry 5.0 places a central emphasis on corporate social responsibility (CSR), decarbonization and the circular economy.
3. Adaptability, and resilience to the unexpected.

In libraries, the technologies of Industry 5.0 are based on those of Industry 4.0 that have been widely adopted within less than a decade (cf. Section 4.2). These technologies are then enhanced, to align with the three principles set out above. Examples of Industry 5.0 technologies include (Carrión, 2023; Noble et al., 2022): quantum computing, cloud computing, edge computing, collaborative robots (cobots), digital twins and augmented reality, the metaverse, machine learning systems, the internet of everything and cognitive artificial intelligence. This strong overlap between Industry 4. 0 technologies and those of the emerging Industry 5.0 raises the question of whether Industry 5.0 represents a new paradigm that truly breaks with its predecessor, or whether it is merely an evolution and enrichment of it.

Libraries have embraced the new opportunities offered by the emerging technologies of Industry 5.0, using these smart technologies (which are still at the start of their cycle) to offer new services to users. Examples include Virtual Reality (VR) and Augmented Reality (AR)-based immersive learning experiences and collaborative spaces, VR and AR-based virtual library tours, advanced accessibility technologies for disabled people, etc. (Ashiq, 2025; Adigun et al., 2024).

This phase of the cycle may seem dominated by user-focused product innovations, yet like its predecessors, the Industry 5.0 paradigm also drives innovations aimed at enhancing library efficiency, sustainability, job security and quality, as well as the confidentiality of user data. As a result, it fosters a range of process innovations, including the use of IoT and AI to monitor temperature, air quality, lighting and security in libraries; the use of data analytics and big data to optimize library operations and resource management; the use of cobots for shelving and retrieving and the strengthening of libraries global digital connectivity (that is, ensuring unlimited geographical access to information and knowledge for users).

Interest in environmental issues in libraries predates the onset of the 5th industrial revolution (currently underway). Even during the Industry 3.0 and Industry 4.0 eras, libraries were already addressing these concerns in two different ways: first, by expanding numerous outreach programs for users, and second, by implementing various environment-friendly measures within their own organizations. These included the construction of new "green" libraries, the "greening" of existing facilities, and the adoption of energy-saving and recycling initiatives. One illustration of ecological concerns during this time is the "green library movement" – which was created in the United States in the early 1990s, but only really took off in 2003 (Antonelli, 2008). Another example is the Sustainable Libraries Initiative (SLI), which promotes the exchange of ecological best practice among libraries worldwide.

Ecological considerations are now central to innovation in libraries, though it is important to recognize that the modern library, as it has evolved since the eighteenth century, was an inherent part of a "sharing economy" long before the term became popular. The modern library emphasizes the collective use of books over private ownership, and in a sense, (even though it was never on the agenda of the founders of modern libraries), ecological sustainability can be seen as the positive externality of the quest for social sustainability (mass education, democracy). In contemporary libraries, this sharing economy has expanded well beyond books and now includes a wide range of more or less unconventional items that are available for loan (the "library of things", followed by the "library of everything"), alongside a range of collaborative activities that contribute to a circular economy (Repair Cafés, maker spaces, etc.). Thus, the ecological challenge encompasses not only the innovation dynamics within ICT-based trajectories that are discussed here, but also extends to a broad range of other innovation trajectories that are book-based, object-based, individual-based or space-based (cf. following sections).

4.4. From the original to the extended (or updated) RPC: an interactive innovation model

In Section 3 of this article, we discussed the validity of the *"original" RPC model* (based on the technologies of the Third Industrial Revolution) when applied to libraries. In the first two parts of Section 4, we attempted to generalize this model and its application to libraries, extending it to include technologies (those of the Fourth Industrial Revolution) that were either in their infancy, or non-existent (those of the Fifth Industrial Revolution) when Barras was conducting his analysis. This generalization has led to what we have called the *"extended" or "updated" RPC model* (see Table 1 and Fig. 1).

All in all, the extension of the Barras model, in this article, is achieved in three distinct ways:

1. By incorporating technologies, some of which are now considered outdated, but not explicitly mentioned by Barras. These include: photocopiers, fax machines, barcodes, microforms, radios, tape recorders and audio tapes, VCRs and videocassettes, televisions, cinemas, printers, DVDs, CDs, CD-ROMs and their corresponding

players. A few of these technologies are specific to libraries (and therefore understandably absent from a model aimed at providing a general theory of innovation in services); many others are universal technologies used across various service activities and functions (e.g. photocopiers, printers, etc.).
2. By introducing Industry 4.0 technologies (which began emerging in the 2010s – although their roots reach further back). It is important to recognize here that Barras (1990) made a particularly insightful and forward-looking reference to certain aspects of Industry 4.0 (still in its early stages at the time he was writing) and their potential implications. For example, he mentioned the precursor to AI – expert systems.
3. By adding the emerging new paradigm of Industry 5.0 and sustainability.

Focusing on a specific moment or issue can lead to overemphasis on either a technology-push or a demand-pull logic, but in reality (and in line with Barras' 1990 analysis), it is true that in libraries (as in other sectors such as financial services), the RPC represents an interactive innovation model. At its various stages, this model involves three dynamics interacting with one another as the cycle evolves: technological dynamics, representing technological opportunities offered by the capital goods sector (technology-push logic), market dynamics (demand-pull logic), and organizational and institutional dynamics characterizing libraries as adopting industries.

Fig. 1 illustrates these interactive dynamics. To do so, it uses the concept of innovation trajectory in the sense of evolutionary theory, i.e. a technological potential which, starting from a technological paradigm, evolves in a direction conditioned by a market or non-market "selection environment" (Nelson and Winter, 1982). This theoretical framework considers the various technological, market and institutional conditions that guide innovation dynamics in libraries. In Fig. 1, the row variable (technological trajectories) aligns with what Barras refers to as the "technological possibilities" (provided by the technology supplier industry), while the column variable (service categories) corresponds to what Barras calls the "product demand (market)".

Barras model considers ICTs solely as enabling technologies, while a general theory of innovation in services should encompass a broader range of technologies (Gallouj, 1998). The proposed mapping of innovation trajectories in libraries (Fig. 1) highlights four innovation trajectories that are either not influenced by ICTs, or only partially shaped by them. These trajectories are book-based, object-based, individual-based and space-based; they may be determined by social or institutional factors, or by technologies other than ICTs (e.g. architectural, construction and design technologies for the space-based trajectory, a variety of technologies for the object-based trajectory).

4.5. A book (and written document)-based trajectory

Faced with the existential challenge posed by certain ICT developments, libraries have sought to explore new innovation trajectories (independent of ICTs) within the framework of their main object: the book (and the written document more generally).

The new services discussed here fall outside of the Barras RPC model, insofar as they are not based on an enabling technology. These services seek instead to mitigate the negative effects of certain enabling technologies (the internet and digitization in particular) by approaching the library's historical object (the book) in a different (and highly original) way. Innovations within the book-based trajectory are primarily driven by social needs and institutional developments (such as literacy, education, environmental conservation, leisure, health, etc.). As a result, these innovations play a significant role in promoting social sustainability.

And even though some overlap is inevitable – given that some new services fall into more than one generic category – it is possible to illustrate the fact that many new services do fall within the scope of this (book or collection-based) innovation trajectory, using some of the six generic service categories identified in the literature as a frame of reference.

Thus, in this book-based innovation trajectory (see Fig. 1), examples of new services in the "Education services" category include the implementation of multiple programs and collections aimed at specific audiences (early literacy programs using adapted books, STEM programs/collections, teen programs/collections, summer reading programs/collections, etc.) and the development of collections in foreign languages. This book-or-document-based innovation trajectory is also illustrated by new services such as book-reading and discussion clubs, sending human readers to users' homes and user-driven acquisitions.

Examples of new "Government services" include services (programs, collections) aimed at ethnocultural minority groups, or the provision of community services on the shelf (road safety, various events, etc.), the provision of relevant (local) government information on the shelf, the provision of local newspapers and magazines or the provision of local history or genealogy programs/collections.

The provision of new "Social services (for vulnerable people)", based on the book medium (i.e., as part of the book-based innovation trajectory), can be illustrated by homework help and school failure prevention programs (particularly in socially disadvantaged areas), programs/collections to combat adult illiteracy, collections and services for LGBT people, etc.

4.6. An object-based innovation trajectory

The struggle for the survival of libraries (whose continued existence had been called into question by the third wave of computerization) has also resulted in new trajectories of innovation, from which (paper) books are totally excluded.

One such new trajectory ignored by the original RPC model encompasses the provision of new types of collections, which are grouped together under the term "Library of Things". Regardless of the category of service concerned, the objects in question can be offered for use inside the library, or on loan. Training in the use of these objects may also be made available.

The list of objects made available to users by libraries is long, with varying degrees of unusualness, and subject to constant additions as dictated by librarians' imagination and their perception of the needs of their community. For example, the tool lending library at the University of California, Berkeley, offers over 3000 objects for loan (Cole and Stenström, 2021). The objects offered by libraries, and the uses made of them, fall into one or more of the six categories of services provided by public libraries (cf. Fig. 1). Generally speaking, they can be said to contribute to the education/training of citizens, to their well-being, and to their inclusion in discussion groups. Examples of objects provided for in-situ use or on loan (for each "service category", respectively) include: 1. Various types of reading equipment: e-readers, laptops, tablets, digital audio-services; 2. Audio or video cassettes, CDs or DVDs providing community information; 3. Talking books for visually impaired users or cellphones for homeless people; 4. Various materials for health preservation (bicycles) and leisure (toys, board games, musical instruments, seeds); 5. Creativity devices: Arduino kits, robotic kits, Makey Makey kits and 3D printers; 6. Objects relating to professional integration and employment: photo studio for professional photography, camera for recording and job interview training.

This object-based innovation trajectory gives rise to several comments:

1. The provision of objects by libraries is a long-standing phenomenon. As early as the 18th century, libraries offered users collections of prints, medals, works of art, various plans, etc. (Beudon, 2017).
2. The significant development of this innovation trajectory, particularly in the United States, can be explained by the fact that it falls within the scope of a broader paradigm that is gaining great success

in contemporary economies, namely the "sharing economy" (Botsman and Rogers, 2010). Innovations in the object-based trajectory thus explicitly contribute to the sharing economy, to collaborative consumption and to the circular economy. Additionally, some of these innovations aim to bridge the digital divide (via, for example, the loan of computer hardware) and reduce exclusion from accessing various objects. These initiatives make a significant contribution to both ecological and social sustainability.

3. Electronic devices (e.g. CDs, DVDs, e-readers, 3D printers, laptops, iPads) are also included in the objects considered. Thus, they fall within the scope of both the ICT-based and object-based trajectories.

4.7. An individual-based innovation trajectory

The user-based innovation trajectory encompasses four different scenarios: 1. Situations in which the individual is, in a way, the book (the content); 2. Situations in which he or she shares personal content with other users; 3. Situations in which he or she participates in content creation, and 4. Situations in which he or she contributes to its correction.

The (Scenario 1) concepts of the "Human Library", "Human Book", "Living Library" and even "Storytelling Cafés" describe arrangements in which users take the place of books, or behave like living books (by coming to talk about themselves) when they have a distinctive experience to share (Calenge, 2015), or discuss a book that has made a particular impression on them. Book discussions can take the form of speed-reading (inspired by speed-dating). It should be noted that this "Human Library" concept can be applied to any generic service offered by a library. Thus, whether it is a question of sharing a social vulnerability, health, creativity or professional experience, all are expressions of the "Human Library". It should also be noted that the "products" of Human Libraries" can be recorded (podcasts) and thus become part of the digital library. In Scenario 2, users share their own personal collections (e.g. rare documents, family papers, photos, etc.) with others, either by temporarily displaying the originals in libraries, or by digitizing them. In Scenario 3, users create content in various forms (paper works, digital works, artistic works, etc.) and become authors (writing workshops, collective creation of a theater piece, etc.). These diverse productions are integrated into library collections. Lastly, one example of Scenario 4 is when users contribute to the collaborative proofreading of OCRized texts (Calenge, 2015).

The individual-based innovation trajectory (centered on individuals other than users, such as librarians, authors, volunteers or other people) can be illustrated by the following examples: the sending of readers (often volunteers) or librarians to users' homes, meetings with authors, inviting speakers (such as entrepreneurs and business managers, public managers, health workers, association leaders, etc.), the "Borrow a Librarian" service (Calenge, 2015), in which a librarian is made available to a user for a given period of time.

4.8. A space-based innovation trajectory

The physical organization of spaces constitutes a powerful innovation trajectory in public libraries, which is partly determined by advances in architectural, construction and design sciences and technologies. It can be approached from one of two different modalities: *an internal space-based innovation trajectory or an external space-based innovation trajectory*.

4.8.1. An internal space-based trajectory

The internal space-based innovation trajectory describes the implementation of different types of new, well-identified, specialized subspaces within the library itself. These new subspaces are designed to accommodate one or other of the six generic service functions offered by libraries (see Fig. 1). These spaces may be dedicated to the "*Education*" function. This is the case, for example, with the creation in many libraries of areas dedicated to a multitude of specialized collections (children's sections, environmental issues, science fiction, bicycles and cycling, etc.), the provision of "spaces" where users can temporarily deposit and share works, the establishment of a bookshop in the library or even the "Artificial Intelligence Lab" (AI learning space for students, researchers and other visitors) (Kim, 2019).

These subspaces can also be well-identified spaces organized to host a new modality of any other generic service.

Regarding *"Community and Government services"*, examples of new spaces include "Memory Labs" (which provide space and tools for the digitization of various types of documents, such as photos, to enable users to preserve local and personal history), the setting up in libraries of branches of other public services (which can take on multiple missions: passport or identity card applications or renewals, tax returns, naturalization procedures, driver's licenses, referrals to social services, etc.) (Dauphin, 2011).

In terms of spaces dedicated to *"Social services for vulnerable people"*, examples include: the library (or certain spaces within it) as a safe haven for the homeless (Garner, 2023); the provision of gender-neutral inclusive bathrooms (Pun et al., 2017) and the setting up of social services antennae inside libraries (Dauphin, 2011), with social workers available to refer vulnerable people to the relevant social services (Hines, 2017).

Many examples can be found of specific spaces dedicated to *"Health, well-being, relaxation, and leisure"*. These spaces embody the idea of the library as a "third place" in the original sense of the term (Oldenburg, 1989), that is: a furnished space for socializing, conviviality and relaxation. These include, for example, catering spaces, bike desks (Hoppenfeld et al., 2019), meditation or prayer rooms (Ramsey and Aagard, 2018), breastfeeding rooms and family-friendly spaces (Godfrey et al., 2017), etc.

Spaces that support user innovation and creativity illustrate the idea of the library as a "third place" in the modern sense. From this point of view, libraries can host the following types of spaces: makerspaces and fablabs, digital labs, living labs (Nichols et al., 2017), innovation hubs (Leebaw and Tomlinson, 2020), digital media labs, technology petting zoos, etc. Other spaces involving human creativity are dedicated to cultural services. They include exhibition, conference and recording spaces, theater stages, auditoriums, museums in the library. It should be noted that, given their architectural quality, their originality or their historical value, some libraries serve as tourist destinations (Leorke and Wyatt, 2019).

Finally, with regard to employment and business support spaces, examples include: coworking spaces, "career centers" (which support jobseekers), "business centers", which provide economic information to local companies (macroeconomic data, patent information), incubation spaces, etc.

4.8.2. An external space-based trajectory

The external space-based innovation trajectory encompasses two types of spatial dynamics: on the one hand, the relocation of (some or all) library services to other spaces, and, on the other, the co-location of libraries with other (generally cultural) organizations. The first set of strategies (delocalization) are essentially motivated by the desire to bring the library as close as possible to users by placing it in high-traffic locations, while the second set are also aimed at economies of scale and cost reductions (Nicholson, 2017).

Examples of the relocation of library spaces, irrespective of generic service category, include bookmobiles, mobile makerspaces (such as San Jose Public Library Maker[Space]Ship), libraries at the beach, libraries in shopping malls, libraries in railway stations or airports, leisure parks, markets and public squares, public gardens, and, in contrast to museums in libraries (as mentioned above), libraries in museums, such as the specialist Humor Library in the Museum of Humor and Satire in Gabrovo (Bulgaria), etc.

Co-location (joint location) of libraries is most often with cultural organizations. There are many examples of libraries sharing space with

museums or art galleries. Bruijnzeels (2015) offers the example of an integrated arrangement (The Chocolade Fabriek Gouda) in the town of Gouda (Netherlands). A building that formerly housed a chocolate factory is now home to four organizations: The Gouda Library, the Mid-Holland Regional Archive, the Gouda Fine Printing Society and a restaurant.

Our analysis of the space-based innovation trajectory has resulted in a number of observations:

1. We have envisaged innovation subspaces inside and outside libraries. However, the design of a new library model as a whole (e.g., the implementation of "Learning Centers") is also part of this space-based trajectory, albeit at a different analytical level.
2. In conjunction with the previous point, either the library as a whole, or just some of its dedicated subspaces, can be considered a "third place".
3. The dynamics of spatial innovation are often accompanied by (innovation) dynamics that are linked to the design of spaces, furniture, atmospheric technologies (lighting, heating) and so on.
4. The new spaces in question may be permanent (e.g., a maker space) or transitory (e.g., ephemeral pop-up libraries in particular locations or events (Nicholson, 2017)).
5. The use of certain spaces and the implementation of corresponding services can be totally incidental. This is the case of the example, in which the parking lot of a public library is being used to access Wi-Fi and watch YouTube videos on people's own laptops (Ginger, 2015).
6. Whatever their purpose, those new spaces that fall within the scope of this space-based trajectory have one thing in common: they constitute spaces for discussion and socialization. In other words, they host discussion groups – or to use the terminology of Desmarchelier et al. (2024), "output networks". Thus, the space-based innovation trajectory positively influences social sustainability.
7. Many space-based innovations have a clear ecological dimension. As a result, this trajectory also has a positive influence on ecological sustainability.
8. ICTs, and AI in particular, have led to the emergence of virtual spaces (for example, virtual tours of the library are now possible). These innovation dynamics, which have already been addressed in the ICT-based trajectory discussed above, are not included here. The space-based innovation trajectory is, therefore, limited to physical space.
9. Even if they do constitute a new service in themselves, these new spaces, falling within the scope of the space-based innovation trajectory, are designed (both architecturally and in terms of furniture) to accommodate implementation of the various categories of services offered by libraries, drawing on other targets (ICTs, books, objects, individuals) that come under other innovation trajectories at work in libraries. Thus, an innovation from the space-based trajectory is always associated (hybridized) with innovations from other trajectories.

To conclude this exploration of the new innovation trajectories, beyond those highlighted by Barras, we put forward the following two observations:

1. Only the new ICT-based trajectories (those associated with Industry 4.0 and Industry 5.0 technologies) can be viewed as extensions or evolutions of Barras's framework (see Fig. 1). In contrast, the other innovation trajectories – those based on books, objects, humans, and spaces – do not seem to fall within the scope of the RPC where process innovations precede product innovations. These four innovation trajectories are dominated by product-service innovations, although in the case of human and space-based trajectories, product-service innovations are inextricably intertwined with process and organizational innovations (as individuals or spaces themselves deliver services). These product-service innovations fall within the scope of a normal product cycle. The absence of enabling technologies, in Barras's sense – specifically ICTs – likely accounts for the divergent dynamics observed between these trajectories and the others.
2. The traditional, book-based historical trajectory is not necessarily the most powerful today nor the most resilient or diversified. The resilience of libraries, and the continuation and renewal of this historical path, now depend on other trajectories that offer alternative platforms or means for preserving and transmitting knowledge – such as ICTs, objects, individuals, and physical spaces.

5. Conclusion

Our aim in this article was to draw on the Barras RPC model (which was one of the first efforts to construct a theory of innovation in services) in an attempt to account for the dynamics of innovation in library services.

As we have stated above, the Barras RPC model highlights a cycle in which product innovations follow on from process innovations, first incremental then radical, under the enabling effect of waves of different ICTs (mainframes, then mini- and micro-computers, and finally networks). A priori, the model seems applicable to library activities. We have shown that the various stages of the RPC can easily be illustrated, using examples of process and then product innovations implemented in public libraries around the world.

However, the Barras model does not fully capture the complex dynamics of innovation within libraries. Grounded in the information paradigm, it offers a particularly insightful perspective for understanding ICT-driven innovation trajectories. In this model, ICTs play a dual role in the innovation process: they function both upstream, as enabling technologies that initiate innovation, and downstream, as essential elements of subsequent developments. Indeed, both early-stage process innovations and later-stage product innovations within the RPC are characterized by their ICT content. It should be noted first of all that the relationship between ICTs and libraries differs from the relationship between these same technologies and other service activities. Indeed, ICTs certainly can be enabling technologies and sources of product-service innovations in line with the Barras model – and sometimes even beyond what he could have foreseen, especially if we consider certain forgotten technologies (television, radio, CDs, DVDs, etc.) as well as (and above all) the most recent developments in ICTs, namely digitization and artificial intelligence. However, these ICTs undoubtedly also represent a real existential risk for libraries. Indeed, the internet and networks, coupled with the digitization of paper documents (books, journals, etc.), are helping reduce both numbers of library visits and use of physical documents.

Faced with this existential challenge, in a Schumpeterian logic, the survival of libraries depends on exploring other innovation trajectories. On the basis of a survey of the literature and our own empirical investigations carried out as part of the European LibrarIN project, we have highlighted these. Libraries have continued to explore ICT-based innovation trajectories, themselves becoming providers of internet access and internet-related services, transforming existential risk into service opportunity. Within the ICT-based innovation trajectory, further opportunities are offered by new (fourth and fifth) waves of enabling ICTs – namely those based on Industry 4.0 and 5.0 (Generative Artificial Intelligence, Internet of everything, Big Data, Cobots, Quantum Computing, etc.). Other innovation trajectories are also at work, however, beyond the informational paradigm, and these can explain the survival and reinvention of libraries. We have drawn up a general map of these innovation trajectories, and provided some illustrations. They are based on books, objects, individuals and physical spaces. In contrast to the ICT-based innovation trajectories at the heart of the Barras model (which are essentially trajectories of library dematerialization) it is now possible for us to say that these other trajectories are of re-materialization (Beudon, 2017) and re-humanization (in the sense that they re-focus on individuals).

Even in an updated reading that takes account of the most recent manifestations of ICTs (what we have called the *extended RPC model*), the innovation mapping of libraries thus goes beyond what is captured by the Barras RPC model. These innovation dynamics encompass various library models (automated, electronic, digital, smart), the most comprehensive and all-encompassing of which can be described as a multi-service or multi-channel library (cf. Fig. 1).

It is possible for the various innovation trajectories highlighted to overlap, leading to hybrid trajectories. The ICT-based trajectory in particular is often concomitant, or hybridized, with other trajectories, owing to the 'pervasive' nature of ICTs.

One limitation of our work lies in the fact that we have considered the library as a standard, undifferentiated object, without explicitly considering either the different types of existing libraries (municipal, academic, national, etc.) or their geographical location. In the future, it would be useful to map out the various trajectories of innovation (their existence, if any, and their power, if any) according to these various categories of libraries – including by country. This raises the question of whether certain libraries tend to prioritize one trajectory over another, and, if so, for what reasons and based on which trade-offs. It is likely, for example, that the effect of the Fourth and Fifth Industrial Revolutions (AI, cobots, etc.) has thus far been felt most strongly in national libraries (even though it is likely to spread to every category), while social innovations are seen mainly in municipal libraries. The notion of "vanguard libraries" that we suggested is linked to these questions. However, it lacks the conceptual rigor of Barras's "vanguard services". Developing a more robust conceptual framework for "vanguard libraries" (beyond its current metaphorical use) would be a valuable avenue for future research. It is also essential to consider differences between countries. Indeed, the dynamics of innovation in public libraries are strongly influenced by public policy, whether this pertains to general technological policies (in support of the ongoing technological revolution) or policies specifically targeting public libraries (such as those setting their budgets).

This article is based on a specific field of application (libraries) and may be criticized for its narrow focus. However, it is using the example of library services to revisit (validate and update) a general analytical model of innovation in services (the Barras reverse product cycle model). The results presented thus enrich our understanding of innovation not just in libraries, but across services in general, both market and non-market.

CRediT authorship contribution statement

Benoît Desmarchelier: Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Faridah Djellal:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Faïz Gallouj:** Writing – review & editing, Writing – original draft, Project administration, Investigation, Funding acquisition, Conceptualization. **Nassim Gallouj:** Investigation, Data curation.

Declaration of competing interest

No conflict of interest.

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Data availability

No data was used for the research described in the article.

References

Abernathy, W., Utterback, J., 1978. Patterns of industrial innovation. Technol. Rev. 80 (7), 41–47.
Adigun, G.O., Ajani, Y.A., Enakrire, R.T., 2024. The intelligent libraries: innovation for a sustainable knowledge system in the fifth (5th) industrial revolution. Libri 74 (3), 211–223.
Antonelli, M., 2008. The Green library movement: An overview of green library literature and actions from 1979 to the future of green libraries. Electron. Green J. 1 (27), 1–11.
Ashiq, M., 2025. Industry 5.0 – the human centric solution and personalization: challenges and opportunities for libraries. Library Hi Tech News. https://doi.org/10.1108/LHTN-10-2024-0176.
Barras, R., 1986. Towards a theory of innovation in services. Res. Policy 15 (4), 161–173.
Barras, R., 1990. Interactive innovation in financial and business services: the vanguard of the service revolution. Res. Policy 19 (3), 215–237.
Beudon, N., 2017. Le prêt d'objets : chant du cygne ou renouveau des bibliothèques publiques ? Nectart 2 (5), 87–97.
Blackburn, H., 2011. Millennials and the Adoption of New Technologies in Libraries Through the Diffusion of Innovations Process. Criss Library Faculty Publications, p. 8. https://digitalcommons.unomaha.edu/crisslibfacpub/8.
Borgman, C.L., 1997. From acting locally to thinking globally: a brief history of library automation. Libr. Q. 67 (3), 215–249.
Botsman, R., Rogers, R., 2010. What's Mine is Yours: How Collaborative Consumption is Changing the Way we Live. Harper Business.
Bourne, C.P., Hahn, T.B., 2003. A History of Online Information Service, 1963–1976. MIT Press, Cambridge, Mass.
British Library and Carnegie, 2019. Digital Transformation for UK Public Libraries: Five Approaches to a Single Digital Presence, a Report by the British. Library for Arts Council England and Carnegie UK Trust, June.
Bruijnzeels, R., 2015. Die bibliothek: Aussterben, überleben oder erneuern? Bibliothek Forschung und Praxis 39 (2), 225–234.
Calenge, B., 2015. Les bibliothèques et la médiation des connaissances. Editions du cercle de la librairie, Paris.
Campbell, J.D., 2006. Changing a cultural icon:The academic library as a virtual destination. EDUCAUSE Rev. 41, 16–30.
Carlson, S., 2001. The deserted library. In: The Chronicle of Higher Education, 16 November.
Carrión, C., 2023. Research streams and open challenges in the Metaverse. J. Supercomput. 80 (2), 1–42.
Churchman, C.W., 1967. Wicked problems. Manag. Sci. 14 (4), 141–146.
Cole, N., Stenström, C., 2021. The value of California's, public libraries. Public Libr. Q. 40 (6), 481–503.
Cox, A., Mazumdar, S., 2024. Defining artificial intelligence for librarians. J. Librariansh. Inf. Sci. 56 (2), 330–340.
Dauphin, E., 2011. Construire et évaluer les services avec les usagers. In: Jacquinet, M.-C. (Ed.), Créer des services innovants : stratégies et répertoires d'actions pour les bibliothèques. Presses de l'Enssib, Villeurbanne, pp. 56–61.
Denning, S., 2015. "Do we need libraries?", *Forbes*, 28 April.
Desmarchelier, B., Djellal, F., Gallouj, F., 2024. Public libraries as social innovators. Public Library Q. 1–20.
Desmarchelier, B., Djellal, F., Gallouj, F., 2025. Innovation in libraries: a service-oriented perspective. Res. Policy 54 (1), 105110. January.
Djellal, F., 2023. The reverse product cycle model (Barras). In: Gallouj, F., Gallouj, C., Monnoyer, M.-C., Rubalcaba, L. (Eds.), The Elgar Encyclopedia of Services. Edward Elgar, Cheltenham (UK), Northampton (USA), pp. 408–409.
Dow Schull, D., 2013. 50+ Library Services: Innovation in Action. American Library Association, Chicago.
European Commission, 2021. Industry 5.0: Towards a Sustainable, Human-centric and Resilient European Industry. R&I Paper series,. Policy Brief, European Commission.
Flood, A., 2019. Britain Has Closed Almost 800 Libraries Since 2010, Figures Show, 6 December.
Gallouj, F., 1998. Innovating in reverse: services and the reverse product cycle. Eur. J. Innov. Manag. 1 (3), 123–138.
Gallouj, F., 2002. Innovation in the Service Economy: The New Wealth of Nations. UK, Northampton, USA, Edward Elgar Publishing, Cheltenham.
Garner, J., 2023. Public libraries and people experiencing homelessness: the experiences and attitudes of library workers. J. Libr. Adm. 62 (5), 662–681.
Gegenhuber, T., Mair, J., 2024. Open social innovation: taking stock and moving forward. Ind. Innov. 31 (1), 130–157.
Gilbert, R., 2010. *Services innovants en bibliothèque: construire de nouvelles relations avec les usagers*, Mémoire d'étude, Diplôme de conservateur de bibliothèque. Ecole nationale supérieure des sciences de l'information et des bibliothèques, ENSSIB, Janvier.
Ginger, J., 2015. Capturing the Context of Digital Literacy: A Case Study of Illinois Public Libraries in Underserved Communities, PhD in Library and Information Science. University of Illinois at Urbana-Champaign.
Godfrey, I., Rutledge, L., Mowdood, A., Reed, J., Bigler, S., Soehner, C., 2017. Supporting student retention and success: including family areas in an academic library. Portal Libr. Acad. 17 (2), 375–388.

Hines, S., 2017. Connecting individuals with social services: the academic library's role. Coll. Undergrad. Lib. 9 (2), 109–116.
Holley, R.P., 2013. Library space and technology. In: Matthews, G., Walton, G. (Eds.), University Libraries and Space in the Digital World. Routledge, New York, pp. 51–69.
Hoppenfeld, J., Graves, S.J., Sewell, R.R., Halling, T.D., 2019. Biking to academic success: a study on a bike desk implementation at an academic library. Public Serv. Q. 15 (2), 85–103.
IFLA, UNESCO, 2022. Public Library Manifesto 2022. UNESCO, IFLA.
Jaeger, P.T., Bertot, J.C., McClure, C.R., Rodriguez, M., 2007. Public libraries and internet access across the United States: a comparison by state from 2004 to 2006. Inf. Technol. Libr. 26 (2), 4–14.
Khan, A., 2013. Dispensing books in hospital. CILIP Update 12 (7), 44–45.
Kim, B., 2019. AI and creating the first multidisciplinary AI lab. Libr. Technol. Rep. 55 (1), 16–20.
Knight, H., 1921. Risk, Uncertainty and Profit, Hart, Schaffner & Marx; Boston: Houghton Mifflin Company. The Riverside Press, Cambridge.
Leebaw, D., Tomlinson, C., 2020. What do you get when you mix libraries and entrepreneurship? The case of an innovation hub at a large research library. Libr. Leadersh. Manag. 34 (4), 1–15.
Leorke, D., Wyatt, D., 2019. Public Libraries in the Smart City. Palgrave Macmillan.
Line, M.B., 1997. The public library in the future: a British reaction. Libr. Trends 46 (1), 68–82.
Lynch, C.A., 2000. From automation to transformation: forty years of libraries and information technology in higher education. Educ. Rev. 35 (1), 60–68.
MacDonald, K.I., vanDuinkerken, W., 2015. Libraries surviving as entrepreneurial organizations: a creative destruction perspective. New Libr. World 116 (7/8), 406–419.
Maness, J.M., 2006. Library 2.0 theory: web 2.0 and its implications for libraries. Webology 3 (2). http://www.webology.ir/2006/v3n2/a25.html.
Martorana, M.F., Rizzo, I., 2024. The Economics of Libraries. Routledge.
McClure, C.R., Jaeger, P.T., 2009. Public Libraries and Internet Service Roles: Measuring and Maximizing Internet Services. American Library Association, Chicago.
Mcternan, J., 2016. Don't mourn the loss of libraries – the internet has made them obsolete. In: The Telegraph, 29 March.
Nelson, R., Winter, S., 1982. An Evolutionary Theory of Economic Change. Belknap Harvard, Cambridge, Ma. and London.
Nicholson, K., 2017. Innovation in Public Libraries: Learning from International Library Practice. Elsevier, Chandos Information Professional Series, CP Chandos Publishing.
Nichols, J., Melo, M.M., Dewland, J., 2017. Unifying Space and Service for Makers, Entrepreneurs, and Digital Scholars. Portal Libr. Acad. 17 (2), 363–374.
Noble, S.M., Mende, M., Grewal, D., Parasuraman, A., 2022. The fifth industrial revolution: how harmonious human–machine collaboration is triggering a retail and service [R]evolution. J. Retail. 98 (2), 198–208.
Oldenburg, R., 1989. The Great Good Place: Cafés, Coffee Shops, Community Centers, Beauty Parlors, General Stores, Bars, Hangouts, and how They Get You Through the Day. Paragon House, Social Science, New York.
Pellack, L., 2022. Academic library innovation: a selective review. Libr. Leadersh. Manag. 36 (3), 1–19.
Potnis, D.D., Winberry, J., Finn, B., Hunt, C., 2020. What is innovative to public libraries in the United States? A perspective of library administrators for classifying innovations. J. Librariansh. Inf. Sci. 52 (3), 792–805.
Pun, R., Flash, K.S., Nangle, N., Hernandez Perez, J., 2017. Libraries and gender neutral/inclusive bathrooms: case studies on promoting information, inclusivity and access in open spaces. In: IFLA WLIC 2017 Conference "Libraries, Solidarity, Society". IFLA/WLIC, Wroclaw, Poland.
Pungitore, V.L., 1995. Innovation and the Library: The Adoption of New Ideas in Public Libraries. Greenwood Press, Westport.
Ramsey, E., Aagard, M.C., 2018. Academic libraries as active contributors to student wellness. Coll. Undergrad. Lib. 25 (4), 328–334.
Rogers, E.M., 1962. Diffusion of Innovations. The Free Press of Gleneoe, New York.
Saffady, W., 1989. Library automation: an overview. Libr. Trends 37 (3), 269–281.
Schumpeter, J., 1911. The Theory of Economic Development. Routledge Classics, New York, p. 2021.
Shaw, D., 1989. Libraries and mainframe computers, or when do you need a 747?. In: Clinic on Library Applications of Data Processing (26th). University of Illinois at Urbana-Champaign.
Smith, C., 2019. Top ten challenges facing public libraries. Public Libr. Q. 38 (3), 241–247.
Touitou, C. (Ed.), 2020. Bibliothèques publiques britanniques contemporaines : autopsie des années de crise. Presses de l'Enssib, Lyon.
von Hippel, E., 1986. Lead users: a source of novel product concepts. Manag. Sci. 32 (7), 791–805.
Whitmore, M.P., 1983. An innovative approach to user acceptance of microforms. J. Acad. Librariansh. 9 (2), 75.
Williamson, M., 2000. Social exclusion and the public library: a Habermasian insight. J. Librariansh. Inf. Sci. 32 (4), 178–186.