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# Fostering Smart Citizens: The Role of Public Libraries in Smart City Development

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**Abstract:** With rapid urbanization, cities worldwide have sought innovative, sustainable solutions such as smart city initiatives to leverage technology and data to better manage this growth and the challenges it brings. Developing smart cities requires multi-stakeholder collaboration, including citizens who, as smart citizens, are aware and capable of using technologies to improve their quality of life and actively and equally contribute to making their cities smarter. This study examines how smart citizens are developed by focusing on the underexplored role of public libraries as community organizations in such efforts. To this end, we use comparative case studies of four U.S. public libraries informed by thirty-seven in-depth interviews with representatives from these libraries, local governments, and external partners. Our findings indicate that by providing inclusive access to advanced technology and training, facilitating civic engagement, and promoting innovation, public libraries can develop citizens who, as smart citizens, have the digital skills, agency, and creativity to actively contribute to smart city development. In doing so, public libraries can bridge digital and social divides and thereby develop smart citizens in a way that furthers inclusive and representative participation of their communities in smart city initiatives.

**Keywords:** smart citizens; smart city; smart city development; public libraries



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## 1. Introduction

Cities worldwide are experiencing unprecedented urbanization and seeking innovative, sustainable solutions to better manage this change and tackle problems associated with increasing pressures on the environment, as well as their resources, infrastructure, and services. Smart city initiatives are considered one such innovative solution, and they leverage technology and data to address pressing challenges and enhance living standards through participatory means [1–6]. As smart cities encompass a range of domains, interdisciplinary research offers various definitions of smart cities. One detailed definition theorizes smart cities as cities that, through technological and human development, seek to increase the efficiency of urban operations, enhance the quality of life, and foster economic growth while maintaining environmental sustainability [7].

The significance of smart cities lies in their use of digital technologies to boost city responsiveness, optimize urban functions and resources, improve service delivery, and minimize environmental impact while elevating residents' socio-economic well-being [3,8–10]. The short-term outputs of smart cities have been thus far observed in terms of a reduction in pollution, greenhouse gasses, water consumption, and energy use, whereas medium-term outcomes have also been realized, for example, in a higher degree of citizen engagement and transformation of governance [11].

As the understanding of what constitutes a smart city evolves, smart cities are increasingly recognized as not just technical but a socio-technical phenomenon that integrates

stakeholders, technology, and the environment to create and add value for society [12–17]. This perspective perceives technology in smart cities as a means rather than an end, emphasizing the role of citizens not just as consumers or data providers but as important social actors contributing information and different perspectives to decisions on developing smart cities [18–24]. As such, the research underscores that there are no smart cities without their citizens, as their needs, perspectives, and participation are essential to making cities smarter [7,25–27]. The importance of citizens is reflected in another definition of a smart city, as a "city well performing in a forward-looking way in [various] characteristics, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens" [28]. Given our research focus, this is the definition of a smart city we adopt for this article.

Prior studies indicate that smart cities are developed and governed through collaboration among diverse stakeholders including citizens who, as co-creators, actively determine how their cities become smart by collectively charting the smart city vision and designing specific initiatives [7,17,29–36]. However, the most commonly recognized collaborators are more traditional actors such as technology companies, governments, and knowledge institutions [4,23,29,31,37–39]. In several more comprehensive studies, citizens are also acknowledged as salient collaborators who, instead of playing passive roles, become active actors in realizing smart cities [1,7,9,19,36,40–45]. Yet, some scholars posit that citizen engagement and power have been limited in technocratic, top-down agendas driving smart cities and advocate for a more citizen-centric, context-aware, and bottom-up focus, in which smart cities are built for and with citizens [24,25,38,40,42,46–54].

Against this backdrop, there is a growing body of research discussing the role of citizens in smart cities. This discourse centers around the concept of a "smart citizen", which is considered the benchmark for citizen agency in the smart city agenda [20,49,55–57]. Smart citizens are generally defined as individuals empowered by technology and information to have a say in and evaluate decisions directly related to making their cities smart and sustainable [7,17,21,35,40,58–62]. Smart citizens can be integral to the success of smart cities as their active participation can ensure that smart city initiatives are designed and implemented in alignment with real needs and aspirations, which can foster more inclusive and responsive urban development and governance [9,24,51,63–66]. Being a smart citizen also means interacting and engaging with other stakeholders to ideate and co-create innovative solutions that improve individual and collective outcomes, which can contribute to collaborative forms of smart city development [17,20,57,62,67–71]. In this regard, empirical studies in cities around the world show that smart citizens' active participation varies and can range from contributing ideas and opinions on smart city initiatives to co-creating those initiatives on par with other stakeholders [25,51,64,72,73].

Given the importance of smart citizens, research has identified the following three roles for citizens in smart cities: (1) citizens as democratic participants who can voice and apply their views amicably, (2) citizens as co-creators capable of innovating, and (3) citizens as information and communication technology (ICT) users becoming 'consumers' of smart city initiatives [74]. These roles are contextual and usually reflect local specificities [24,25,43,44,57,75–77].

Despite the increasing recognition of the importance of smart citizens, current knowledge about how smart citizens are developed is limited. The smart city literature touches on smart citizens peripherally as one of the dimensions of smart cities and actors in its governance without in-depth coverage [1,28,33,78,79]. Extant studies on smart citizens are mostly informed by ad hoc or pilot projects often led by more traditional smart city actors [60,70,80,81]. Research also suggests that community-rooted organizations such as public libraries (in the U.S. context, a public library is defined as an entity "established under state enabling laws or regulations to serve a community, district, or region, and provides at least the following: (1) an organized collection of printed or other library materials, or a combination thereof; (2) paid staff; (3) an established schedule in which services of the staff are available to the public; (4) the facilities necessary to support such a collection,

staff, and schedule, and (5) is supported in whole or in part with public funds" [82]) can contribute to the development of smart citizens in a sustained manner [9,83–89]. In this respect, nascent research posits that public libraries can develop smart citizens threefold, serving as community-level spaces for: (1) training (with citizens as ICT users), (2) participation (with citizens as democratic participants), and (3) innovation (with citizens as co-creators) [83–89].

First, public libraries develop smart citizens by serving as hubs for different community members to learn, engage, and experiment with technology and data that underpin smart cities, providing them with awareness and training on how to use these technologies to improve their lives [90–95]. Second, public libraries expand opportunities for diverse citizens to actively and democratically participate in smart city development, ensuring that smart city goals and objectives are aligned with actual community interests and priorities [83–86,96,97]. Third, public libraries support innovation through resources, experimental spaces, and interactions that enable citizens and other community stakeholders to co-create technology- and data-based solutions that meet various needs [83,98–101]. However, further research is still needed to better understand the details of these three roles.

This paper aims to contribute to this area by answering the following research questions: (1) How do public libraries develop smart citizens? (2) What specific characteristics, functions, programs, and services of public libraries contribute to the development of smart citizens? We use a comparative case study of four U.S. public libraries in Chattanooga, Tennessee; Chicago, Illinois; Ignacio, Colorado; and Saratoga Springs, New York. We systematically compare these four public libraries and highlight their various roles in developing smart citizens within local contexts. Therefore, the main purpose of this paper is to understand how public libraries contribute to the development of smart citizens.

This paper is organized into seven sections, including the foregoing introduction. Section two presents a literature review on understanding smart citizens and how they are developed. Section three explains the research design and methods used in this study. Section four provides brief descriptions of the cases. Section five shows the main findings, which are organized based on public libraries' contributions to developing smart citizens. Section six discusses these findings and compares them with previous research, highlighting the implications for research. Finally, section seven answers our research questions, presents practical implications and ideas for future research, reflects on the limitations, and closes with a brief conclusion.

## 2. Literature Review

The literature review comprises two subsections. First, we review previous studies to gain a comprehensive understanding of the concept of smart citizens and their importance. Second, we explore how the current literature discusses how smart citizens are developed. In the latter subsection, we also discuss the roles of different actors, including public libraries, in contributing to the development of smart citizens. The literature review is summarized in Table 1 and is discussed in detail in the following paragraphs.

**Table 1.** Synopsis of the literature review.

| Topical Area | Research Streams | References | Emphases | Implications |
| --- | --- | --- | --- | --- |
| Understanding smart citizens | Smart people | [1,8,28,33,45,65,78,79,102–114] | Individual attributes and capabilities, less on technology | Signifies diverse, informed, and engaged citizenry in smart cities |
| | Smart citizens: action potential | [7,10,20,40,44,49,63,67–70,74,115–122] | Citizens' use of a range of technologies to enhance civic engagement and co-create socially oriented innovations | Underlines the need for citizen involvement in smart city policy- and decision-making and potential contributions as innovators |

**Table 1.** *Cont.*

| Topical Area | Research Streams | References | Emphases | Implications |
| --- | --- | --- | --- | --- |
| Understanding smart citizens | Smart citizens: role in data | [20,37,46,48,57–59,115,123–125] | Sensor technologies, data collection, and smart city services | Highlights citizens' role as key data contributors and decision-makers in smart cities |
| | Smart citizens: critical perspectives | [20,23,25,27,30,33,38,42,46,51,53,54,58,65,66,71,76,107,126–139] | Focus on limitations and challenges as related to smart citizens and their participation | Calls for a more inclusive approach to developing smart citizens and their empowerment and critical engagement |
| Developing smart citizens | Role of actors in developing smart citizens: governments (+non-profits) | [19,20,38,42,57,70,80,117,118,120,121,130,131,140,141] | Developing digital skills and engaging citizens in technology and data projects | Highlights training, socializing new technology, and conducive policies for citizens' participation in smart city decision-making |
| | Role of actors in developing smart citizens: knowledge institutions (+governments and non-profits) | [38,39,41–43,47,49,76,116–118,120,142,143] | Building digital skills among different generations and offering expert support for innovation | Underlines mediation of design workshops and co-creation engagements among diverse community stakeholders for inclusive smart city development |

### *2.1. Understanding Smart Citizens*

Research has yet to agree on a definition, and different authors describe smart citizens by highlighting some specific features. Early studies approach this topic from a social and human capital lens by discussing the term "smart people" as a significant dimension of smart cities and characterizing smart people as comprising "various factors like affinity to lifelong learning, social and ethnic plurality, flexibility, creativity, cosmopolitanism or open-mindedness, and participation in public life" [28,112,113]. Further, smart people use technology and data to make informed choices related to resource and service consumption towards greater sustainability and interact with others about public affairs [65,102–107]. Smart people are also skilled individuals who contribute to socio-economic development [33,45,79,108–111], for example, as innovators [114] and problem-solvers for urban issues [1,8,78]. These attributes are reiterated in perspectives on smart citizens, a term often used interchangeably with smart people [76,89,105,144].

Views on smart citizens also underscore different aspects but coincide with a shift in the government's approach towards placing citizens as smart citizens at the center of a smart city so that its development is citizen-driven and bottom-up, which contrasts but can complement expert-led, top-down models [6,20,25,40,41,57,76,89,134,143]. Studies thus often discuss the importance of smart citizens for the community, government, and society.

In general, the literature on smart citizens presents three major research streams. The first stream is descriptive and broadly discusses smart citizens, their action potential, and the implications of such agency. An influential work defines smart citizens as "citizens using social media and related technologies to organise and act" [145]. One more significant publication based on a series of essays by thought leaders posits that smart citizens are individuals who take responsibility for their community and use technology to participate in public affairs and collectively create better solutions to urban problems [118]. Such participation and agency are often realized through new ways of connecting, interacting, and learning with other stakeholders to prioritize, design, and implement smart city initiatives, ensuring their value for money, effectiveness, and wide adoption [7,10,40,63,74,115–117] as well as the co-creation of socially oriented innovations [20,67–69,118–120]. This co-creation includes innovations conceived, tested, or fabricated by smart citizens using various ad-

vanced tools and resources, often in dedicated experimental spaces such as makerspaces, fablabs, or living labs [20,40,44,49,70,74,121,122].

The second research stream is technology-specific and discusses how smart citizens not only provide data that feeds smart city services but also actively participate in how that data transforms their cities. This is unsurprising as cities are expected to be the "world's most copious creators of data" owing to the volumes of data generated by their residents [39]. As such, citizens could collect and share data unconsciously or consciously to improve their quality of life. On the one hand, studies relate unconscious sharing to citizens acting as sensors using technology (e.g., sensor kits, smartphones, and other devices) to provide data and information that support smart city services; these contributions are perceived to be less associated with being smart citizens due their limited participation nature [25,48,125]. On the other hand, existing research considers conscious sharing to be more reflective of smart citizens as it relates to citizens explicitly allowing the data collection as well as their active, direct engagement with smart city services and technology to generate or input data that not only could inform citizens to act differently (e.g., make more sustainable choices) but also develop partnerships with local governments to better plan urban infrastructure, monitor the environment, and manage mobility [20,37,57–59,115,123,124].

Studies also show that smart citizens use or tinker with technology (e.g., low-cost sensor kits) and leverage data to better understand their built and natural environments, self-organize around a common issue (e.g., air and noise pollution, damp housing), and advocate for government action [41,43,49,57,70,121,126,140,146]. Moreover, smart citizens are increasingly becoming decision-makers who, on an equal footing with other stakeholders, can determine how data are (re)used, analyzed, governed, and protected to achieve smart city goals [21,51,66,147]. In this light, scholars postulate that smart citizens value open access to data and user-centered systems so that data use is transparent, responsible, participatory, and collaborative; in some way, smart citizens are making strides in opening the black box of data collection, processing, and transmission [52,126,148,149].

The third research stream is critical and comprises three sub-streams focused on: (1) reconceptualization of smart citizens, (2) limitations of smart citizens' participation, and (3) depoliticization of urban issues. The first sub-stream examines the notion of smart citizens, recognizing its significance but suggesting that it needs further refinement. In this way, studies acknowledge that, at the core, smart citizens have access to technology and knowledge, are digitally skilled and informed, and can actively and meaningfully participate in complex, technology-oriented smart city decisions [20,33,132,133]. Yet, this perception of smart citizens can exclude those unaware of the use and impact of technology in their cities, which limits participation [58,71,107,127]. This research sub-stream thus posits that the assumption of smart citizens as tech-savvy populations able to participate could be unrepresentative and exacerbate inequalities, especially given the multidimensional social and digital divides [23,42,51,65,76,126–131].

The second sub-stream questions the participation of smart citizens. In particular, studies imply that such participation can be somewhat symbolic and not afford citizens (particularly from marginalized groups) real power or influence over decision-making processes in smart cities [25,51,66,76,126,129]. This is evident in the case of the growing data generated by citizens, which are often controlled and mobilized by private companies and government agencies [23,27,113,114,134,135]; this grip on data has tightened during the pandemic, raising feelings of powerlessness and surveillance [129]. Even when smart citizens participate, their involvement in some smart city initiatives could be pre-defined or diminished in expert-led projects, thus effectively excluding them from the actual development of smart cities [38,51,54,136,137], much to some citizens' discontent [127]. Further, practices of such participation can be process, not outcome-oriented, focusing on citizens' preferences and opinions and not tapping into their potential knowledge or expertise [42,59]. Another challenge lies in sustaining citizen participation, which can wane over time [70,140].

The third sub-stream argues that the narrative on smart citizens depoliticizes urban issues. Such detachment frames pressing issues as engineering or mathematical challenges to be solved using the right technology or data rather than broader socio-political or structural problems [23,30,51,53,128,132,138,139]. This proclivity positions the smart city as a fated and accepted present or future, leaving less room for smart citizens to resist or question it politically, prompting calls to re-politicize smart city discussions and decisions [127,128]. Such re-politicization can enable smart city debates that critically engage citizens as smart citizens to ensure that local stakeholders with different interests and knowledge shape smart cities and their technological solutions [42,150].

Overall, smart citizens are citizens who are skilled in using technologies and data underpinning smart cities for their individual and collective benefits. Further, smart citizens are described as change agents who leverage technologies to make informed decisions and co-create novel solutions to improve the quality of life and collectively shape smart cities. The literature shows that fulfilling the role of smart citizens requires technological agency, active participation in smart city discussions, and innovation. In this light, developing smart citizens is paramount for building smart cities.

### *2.2. Developing Smart Citizens*

Research shows that multiple actors can contribute to the development of smart citizens but usually emphasize more traditional actors such as governments, non-profits, and knowledge institutions as frequent contributors [42,51,57,76,80,121,126,130,143,151]. These actors play different but complementary roles and contribute to smart city development through strategies focusing on training, innovation, and participation. At the same time, these strategies could have an interrelated impact as training could lead to innovation, participation, or both in smart city initiatives.

Previous studies indicate that training and development of proficiencies necessary for smart citizens have been the major contributions made by a variety of stakeholders. Governments, sometimes in partnership with non-profits, can fill the gaps in technology access and digital skills to advance awareness and offer spaces and resources such as onboarding to support smart citizens and their transformative use of smart city technologies and data [42,121,131,140]. Such training offered by multiple actors can help citizens become ICT users and, in turn, make them co-creators through innovation as well as democratic participants. This is evident in the case of Waag Society, a Dutch non-profit founded in 1994 and a government partner known for socializing low-cost sensor kits (i.e., Smart Citizen Kit), an initiative aimed at creating more engaged and informed communities by empowering citizens with the tools to measure and understand their environment [152]. In this regard, Waag Society helps citizens master sensor kits so that they can collect and share key environmental data (e.g., air quality, noise, temperature, humidity) and then potentially mobilize around an urban issue and meaningfully interact with other stakeholders to challenge the status quo [38,57,70,140]. Further, Waag Society offers a fablab, an experimental space for citizens to prototype and create socially oriented innovations by using digital technology (e.g., laser and vinyl cutters, 3D printers), which research poses as an instance of active participation by smart citizens [20,39,42,120].

Driven by research and development interests, knowledge institutions also contribute to developing smart citizens through training. In partnership with governments and non-profits, research organizations can provide the expertise and support (e.g., programming, calibration, digital skills training, tool kits) needed to ensure that smart citizen-led projects (e.g., those involving sensor kits) are inclusive and generate reliable, real-time data and location-specific insights for community action [39,42,70,143]. Such interventions can enhance smart citizens' socio-technical competencies [153], reveal the needs of different social groups [81], and address concerns such as those related to privacy and security of data collection, sharing, and usage in smart cities [21]. Moreover, universities and schools can help prepare not only the current but also the next generation of smart citizens by offering educational courses, programs, and sessions for different age groups that impart knowledge

about technology, public affairs, and the environment (natural and built) in addition to developing digital skills and connections necessary for present and future participation in making their cities smart [17,81,117]. Regarding the youth, schools are advised to take new, carefully planned approaches, such as using serious game elements and mechanics in urban innovation tasks, which are part of smart city development processes [154,155].

Further, knowledge institutions can contribute to the training and participation of smart citizens. For example, universities can mediate and design workshops and consultative or co-creation engagements. In such engagements, citizens, alongside other stakeholders, can not only learn and discuss smart city plans and initiatives but also experience and experiment with smart city solutions to become active, informed contributors to smart city development [41,43,49,76,116,117,142]. Some government-backed research institutes, such as the European Research Council, can be influential in promoting multi-stakeholder approaches to developing smart cities and citizen-centric processes in urban innovation projects, interventions, and experiments [38]. Yet, the impact of knowledge institution-led projects could be incremental or limited given their ad hoc or pilot nature, especially if not fully reflective of the realities of end-users [81,126,137].

Multiple actors have been encouraging citizens to be democratic participants in smart cities, contributing to their development as smart citizens. To make cities smart, governments initially engaged citizens in an ex post consultative manner to better understand diverse needs and preferences and align planned smart city initiatives with these insights to enhance implementation [19,25,80,117,130,141]. With changing citizens' expectations, public management realities, and technology, resource-strapped governments are reaching out ex ante to tap into citizens' ideas and expertise to maximize technology's value and collaboratively improve the quality of life in cities [20,39,118,121,140]. Some governments have legislated policies or adopted strategies to mandate smart citizens' active participation in such collaborations [89,117]. For example, the United Kingdom has adopted eight 'citizen-centric' smart city national standards, which explicitly refer to the active participation of smart citizens in decision-making processes [36]. To promote citizen participation, governments—often partnering with non-profits and knowledge institutions—can also initiate smart citizen-led technology and data projects (e.g., urban sensing efforts) and events such as prototyping experiments and hackathons [41,43,47,118,143]. Such partnerships are also important because non-profits operate at the grassroots and can facilitate smart citizens–government–business interactions on smart city initiatives [40,70].

In sum, there is a growing awareness of the critical role of smart citizens in making cities smarter. Although research increasingly recognizes developing smart cities and smart citizens as a collaborative effort strengthened by different actors with complementary roles, such knowledge is limited in scope and focuses on more traditional actors, paying less attention to community-rooted organizations such as public libraries that have been neutral, inclusive spaces where diverse stakeholders can access and use various technologies with the purpose of increasing their action potential and creativity as smart citizens contributing to smart city development [9,83–89]. In particular, libraries can provide training for citizens to learn, use, and experiment with the technologies and data essential to bettering their lives in smart cities [90–95]. Further, public libraries can be community-level spaces where citizens and other stakeholders can interact and democratically and equitably participate in smart city development [83–86,96,97], and develop innovative solutions to shared urban challenges [20,40,55,71,143]. As enduring community organizations, libraries can persistently contribute to developing smart citizens [9,83–89], and such contributions can be complex and interrelated [83,86,156]. However, more evidence-based insights are needed on how public libraries actually develop smart citizens.

## 3. Research Design and Methods

In the following paragraphs, we describe our research design and process, as illustrated in Figure 1.

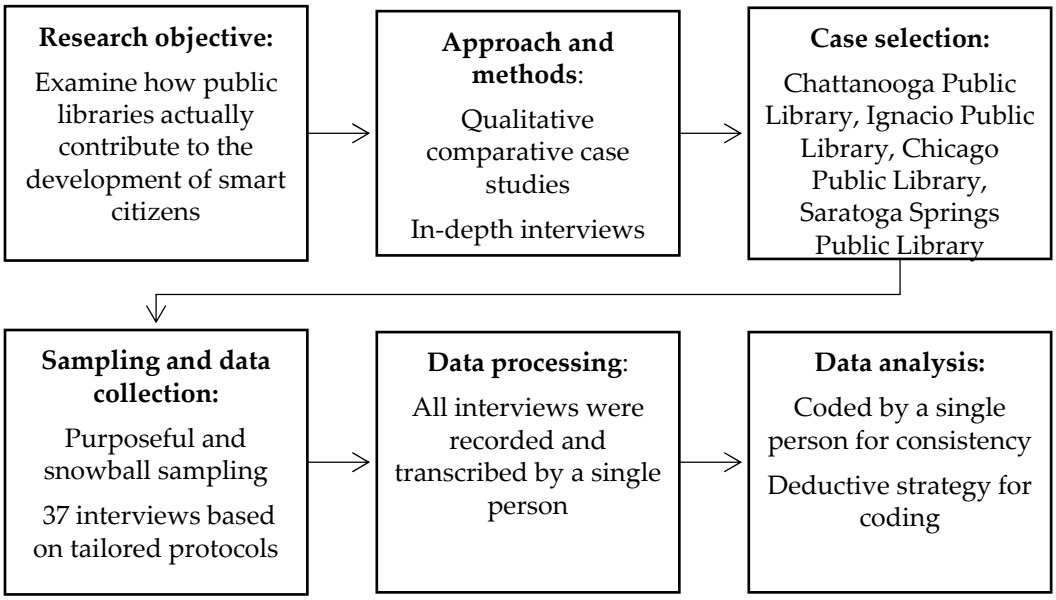


**Figure 1.** Research design and process.

As the research objective is to examine how public libraries actually contribute to the development of smart citizens, this study adopts qualitative methods, particularly a comparative case study approach. Qualitative studies can help understand how practices, processes, or activities are formed in a specific context, which is useful for building or refining theories [157–159]. A case study allows for an in-depth analysis of an un(der)explored phenomenon of interest in its natural setting and can help answer why and how questions [160,161].

We used a comparative case study approach to answer our research questions. This strategy is recommended for studying questions across various scenarios or cases [162], especially when comparison within and across contexts is sought [163]. Further, comparative case studies consider broad, intermediate, and specific factors of the phenomenon of interest and can adapt to changes in conceptual paradigms [164]. As such, we use comparative case studies to better understand the ways libraries contribute to the development of smart citizens.

We selected four public libraries in the United States: the Chattanooga Public Library in Tennessee, the Ignacio Public Library in Colorado, the Chicago Public Library in Illinois, and the Saratoga Springs Public Library in New York. We selected these libraries based on the following three criteria: (1) engagement in smart city initiatives, (2) innovative programs and services, and (3) diversity. For the first criterion, we chose libraries that are participating in smart city initiatives while acknowledging that their levels of participation and resources may significantly differ. For the second criterion, we targeted public libraries with varying degrees of innovation in terms of not only technology but also other programs and services so that our findings would be relevant to a wide range of libraries. For the last criterion, understanding that context matters, we selected libraries across various towns and cities, including both rural and urban locations, to gather a broader range of perspectives on how public libraries contribute to the development of smart citizens. The geographical focus in the United States is because these case studies are components of a larger research project funded by the Institute of Museum and Library Services in the U.S.

We conducted thirty-seven in-depth interviews on-site for all cases between November 2018 and February 2019 with individuals representing public libraries, local governments, and community partners. Interviews allow researchers to delve into interviewees' perspectives on a subject of interest and gather rich data on the outcomes of specific activities [165,166]. Our recruitment strategy consists of purposeful and snowball sampling as we sought to reach a specific group of people with characteristics relevant to our research,

who, once interviewed, were requested to suggest other potential individuals pertinent to the subject of this study [160,165,167]. Specifically, we interviewed fifteen representatives from public libraries (four senior executives, seven managers, two staff, and two board members), six local government managers/officials (five senior executives and one elected official), and sixteen external partners (two community leaders, seven local development organizations' senior executives, five knowledge institutions' leaders, and two non-profits' senior executives).

Each interview followed a similar protocol tailored to the interviewee's affiliation: the public library, the local government, or an external partner. To answer our research questions, we draw upon works that explore programs, services, and spaces to discuss public libraries' contributions to developing smart cities and, in doing so, to smart citizens [74,83,86,88]. We began the interviews by exploring the missions and visions of public libraries and then progressed to the interviewees' understanding of smart cities and their awareness of local smart city initiatives. We then delved into the involvement of libraries in these initiatives, discussing current and future programs, services, and spaces in relation to smart city initiatives. In this regard, we asked questions such as "What specific programs/services is your library currently providing as a result of your participation in the local smart city strategy?" and "What are the future plans of your library to enhance the library's role in the local smart community strategy?" Discussions around these general questions revealed how public libraries specifically contribute to both making their cities and citizens smarter, which provided us with evidence to answer our research questions. Subsequently, we focused on the benefits of these library offerings for various stakeholders and the challenges associated with implementing such programs and services. In this part of the interview, we asked questions such as "What benefits do you think the public library has obtained by offering these programs/services?" and "What have been some of the challenges you have had when implementing the programs/services and what have you done to face them?". These general discussions were also informative for understanding how libraries had to reinvent themselves to contribute to developing smart cities and smart citizens. The interviews concluded with the interviewees sharing their views on the public libraries' role in smart cities, key success factors, and potential future actions.

Interviews lasted one to two hours and were recorded, transcribed, and coded by a single person to maintain consistency and uniformity of interpretation [168]. In qualitative research, coding is a process of labeling and categorizing textual data to identify themes, patterns, and relationships [158]. Given that we identified three main roles for smart citizens in the literature [74], we employed a deductive strategy to use existing concepts and themes as codes to analyze the interview data [165,169]. As such, we started with a pre-defined set of codes and then systematically applied them to categorize interview data and analyzed the coded data to identify patterns and relationships that respond to the research questions [161]. Then, we synthesized the identified relationships to inform our understanding of how public libraries contribute to the development of smart citizens. The last step encompassed presenting the findings in a structured format, in which direct quotes from the interview transcripts support a detailed analysis of themes.

## 4. Brief Descriptions of the Cases

### *4.1. Chattanooga Public Library*

Established in 1905, the Chattanooga Public Library (CPL) spans 108,500 square feet and is nestled in downtown Chattanooga, Tennessee. In 2012, the CPL initiated a strategic planning process to revitalize the library and foster a culture of change and innovation, expanding its service area beyond the City of Chattanooga to include Hamilton County. As such, the CPL transformed itself to create a welcoming environment that fosters collaboration and creativity. Capitalizing on the deployment of a citywide gigabit fiber network (i.e., the Gig), the CPL enhanced its technology-oriented spaces, programs, and services. In 2013, the CPL converted the entire fourth floor into an innovation space, an initiative that was funded by selling a third of their print collection.

The CPL continues investing in programs and services that meet the community's evolving needs. To do so, the CPL is transitioning from its traditional role as a keeper of knowledge stored in physical format to becoming a community-level space contributing to Chattanooga's smart city development. The CPL is also one of the partners in the Innovation District of Chattanooga, a local cluster for innovation and entrepreneurship.

### *4.2. Ignacio Community Library*

The Ignacio Community Library (ICL) was founded in 1990 and is an 11,000-square-foot rural public library in Ignacio, Colorado, a small town with 800 residents located in the Southern Ute Indian Tribe Reservation. The library serves a larger community of over 5000 residents living in a 240-square-mile area within the Ignacio Community Library District. The library's building is relatively new; it was constructed in 2006 and financed by a USD 2 million voter-approved bond. The library provides its multi-ethnic community with access to broadband (not widely available), various technologies, and skills to use it with a purpose. Additionally, the library supports the Ignacio Public School District students, making it an essential resource for education and digital skills. In an increasingly digital and interconnected world, the ICL is committed to ensuring that no members of the Ignacio community are left behind.

The ICL is laying the foundation for smart city development through digital inclusion. The library seeks to collaborate with other community stakeholders and strengthen partnerships to offer more programs and services to help Ignacio and its residents advance toward a smart city.

### *4.3. Chicago Public Library*

Since 1873, the Chicago Public Library (ChiPL) has been an inclusive community hub for learning, interaction, and development. The ChiPL serves nearly three million residents across 77 diverse communities through its 81 strategically located branches. The library collaborates on numerous initiatives outlined in the City of Chicago Technology Plan, a local smart city strategy emphasizing advanced infrastructure, good governance, innovation, open data, and community engagement. This strategy places the library as one of the key partners in smart city development. The ChiPL provides access to various technologies and related training in addition to opportunities to participate in community affairs and ideate and innovate to improve outcomes.

The ChiPL is well-positioned to contribute to smart city development in various ways. Such contributions are projected to expand in general and in collaboration with the local government to realize the smart city strategy.

### *4.4. Saratoga Springs Public Library*

The Saratoga Springs Public Library (SSPL) is a 58,626-square-foot public library in the center of Saratoga Springs, New York, a city with approximately 49,070 residents. The SSPL has served urban, suburban, and rural residents since 1995. In 2016, the city leaders formed the Smart City Commission, comprising diverse stakeholders, to guide Saratoga Springs toward a smarter city. This vision is outlined in the Smart City Roadmap, which recognizes the SSPL as a community hub for information, inspiration, and digital skills. As such, the SSPL is expected to be an important contributor to developing smarter communities.

The SSPL plans to continue investing in its technology-oriented services and programs. This includes updating existing technology, introducing new technologies, and expanding training offerings to meet diverse needs and promote innovation.

## 5. Main Findings

This section presents and discusses the main findings. In doing so, we highlight the differences and similarities across the cases. Our research shows that libraries contribute to developing smart citizens differently based on specific local demands and needs, the context, and the available resources.

Overall, we find that public libraries may contribute to developing smart citizens threefold by serving as community-level spaces for: (1) training (with citizens as ICT users), (2) participation (with citizens as democratic participants), and (3) innovation (with citizens as co-creators). The key findings are summarized in Table 2 and discussed in the following subsections.

**Table 2.** Summary of key findings.

| Library | Training (w/Citizens as ICT Users) | Participation (w/Citizens as Democratic Participants) | Innovation (w/Citizens as Co-Creators) |
|---|---|---|---|
| CPL | • Provides inclusive access to (advanced) technology and training; fosters digital inclusion<br>• Trains citizens to leverage open data for their benefit | • Promotes civic engagement in public affairs<br>• Furthers democratic participation in specific projects such as local smart city initiatives | • Offers spaces and resources for prototyping and creative projects<br>• Helps advance library-conceived innovation projects |
| ICL | • Serves as a sole provider of public computers and the Internet; focuses on digital literacy and (advanced) technology training<br>• Expands access to broadband and technology via lending | • Facilitates policy discussions on various civic topics and political events<br>• Acts as an open community forum for engaging with current and future elected officials | • Offers spaces and resources for 3D printing and launch of multimedia projects; focuses on youth and peer-to-peer learning<br>• Supports project development and e-commerce activities |
| ChiPL | • Provides access to and training (in-person and online) for tech tools and software; offers one-on-one tech assistance<br>• Trains citizens to design and test smart city initiatives | • Foster stakeholder interactions on pressing local issues<br>• Engages citizens and facilitates discussion on smart technology projects and their governance | • Offers spaces and resources for hands-on experimentation and teen creative projects<br>• Links library makers with other local innovators to advance projects |
| SSPL | • Provides access to and training on (advanced) technology; offers one-on-one tech assistance<br>• Trains citizens to be creators | • Serves as a neutral space for informed community engagement<br>• Hosts workshops on local governments' activities and goals | • Supports creative production and business development<br>• Provides various resources and training for entrepreneurs |

### *5.1. Spaces for Training (with Citizens as ICT Users)*

The emphasis on technology in smart cities entails training citizens in using technologies and data in ways that could benefit them. Concomitantly, citizens need to be able to understand and use the technological infrastructure and open data underpinning smart cities—that is, become ICT users. To this end, public libraries seem to offer inclusive access to (advanced) technology and a range of training programs and services designed to help citizens understand and purposefully use different technology tools.

The public libraries we studied perceive access to technology as a foundation for developing smart citizens. At a minimum, all libraries appear to be committed to offering inclusive access to broadband and public computers, which could be particularly important in settings where the digital divide persists. For instance, we learned that the CPL not only offers wired and wireless Internet powered by the Gig but also has a Wi-Fi hotspot lending for un(der)served residents to take home, a program made possible through collaboration with various providers. Interviewees said that these efforts support local smart city initiatives and advance digital equity. Another example is the ICL, a library considered the sole public computer and Internet provider in town, serving as a lifeline and a "place of endless possibilities" for the community. In relation to this, an interviewee

said: "... for some of the people in the rural areas where they might not have any Internet, people go [to ICL] every day, check their emails, and access the Internet from the library". In a place where "20 or 25 percent of students do not have Internet at home", such access also benefits digitally divided youth, particularly public school students who use the ICL's broadband and borrow Chromebooks for learning, accessing databases, assignments, or tutoring. An interviewee said:

> "Every student has some sort of online program to meet their weaknesses; whether it's math, English, or science. It's all web-based, so you need the technology, Internet, bandwidth to provide those programs to them [...] so they're pretty dependent on the Internet and the cloud".

In the words of an interviewee, libraries also "democratize" access to advanced technology such as 3D printers, laser cutters, vinyl plotters, CNC routers (i.e., computer-controlled cutting machines), virtual reality, and other tools. Some technologies, like 3D printers, are more common across libraries, whereas other creation tools are less common. For instance, an interviewee shared that the SSPL "had a 3D printer for a long time [...] it was initially for the computer class, people could learn to use the software and print something". At the ChiPL, patrons can access electronic circuitry, multimedia production equipment, or editing software. In some libraries, these advanced technologies are often found in designated experimental spaces such as makerspaces. In its makerspace on the fourth floor, known as Maker Lab, the CPL offers a 3D printer, button maker, and virtual reality booth to foster the imagination of various patrons. In addition to Tinkercard for 3D modeling, the ICL's makerspace on the second floor, known as Idea Lab, provides "Arduino, Raspberry Pi, and sensor kits so that [patrons] can practice coding; the Internet of Things; so we have that available for folks". We were told that mastering advanced digital skills for programming and operating diverse devices such as 3D printers and cutters is essential for workforce development since contemporary manufacturing increasingly depends on similar technologies.

Beyond access to technology, public libraries seem to offer various training and services to help diverse groups of patrons interact with and use different technologies for specific purposes. This echoes the following reflection of one interviewee on the role of the library: "[...] simply providing access to the digital world is probably not enough without providing some direction for it as well; technology is not the end goal; it's harnessing it and using it in a useful way". Indeed, public libraries appear to have been doing exactly that by providing classes and courses that teach core (e.g., how to use computers and devices or create emails) and advanced digital skills (e.g., 3D printing, multimedia content editing, and programming), often complemented with personal assistance. The ChiPL offers the Cyber Navigators program, where trainers provide one-on-one help with various technology-related needs as well as the DigitalLearn program for those who prefer to learn online. Further, the CPL has a unique program that combines access and training, in which youth and their guardians can purchase technology at low cost upon course completion. Speaking about this program, an interviewee shared:

> "...you go through 15 h of class, and if you're a preschool-K-12, you have a responsible adult in your life go through the program with you because a lot of these kids are learning stuff in schools in a little bit, and they are getting exposed to it, but it's the parents or the guardians are the responsible adults in their lives or part of it [...] so you go through 15 h a curriculum you then get the ability to buy a brand new computer [...] it's a Chromebook, you can buy that for 50 bucks".

The ICL and the SSPL also offer one-on-one consultations on topics ranging from learning how to set up personal devices (e.g., smartphones, tablets, laptops) and apply for jobs online (including resume preparation) to sessions on cybersecurity (e.g., how to create secure passwords, Internet safety), information quality (e.g., how to spot fake news), and productivity software (e.g., Microsoft Office Suite, Google Apps). In addition, the ICL runs

a tablet lending service for seniors "to get them comfortable with using that technology" and a STEM youth summer program. The ICL seems to broadly understand inclusivity as the library extends its computer training to people in local homeless shelters.

There are several notable library initiatives where users may apply their advanced digital skills to transform their communities. The CPL, for instance, plays a significant role in the local open data initiative by building awareness among the patrons and offering them access and training to compile and analyze the available data for informed problem-solving. Multiple interviewees indicated that the local government had entrusted the CPL with housing municipal open data. This initiative is supported by the specialists working out of the Mayor's Office and Open Chattanooga Brigade, a citizen group dedicated to using technology and data to solve community issues. This setup appears to capitalize on the library's core competencies in "organizing data and making it accessible and understandable" so that citizens can leverage the data to address pressing issues. Such an arrangement was intentional, as expressed by an interviewee: "...[the local government] wanted [open data] to be on the library [website] because it is part of doing research about the city right".

Another initiative where libraries seem to serve as spaces for citizen training as ICT users is the City of Chicago's partnership with the ChiPL to improve its 311 systems and their uptake. The 311 system serves as a dedicated, non-emergency hotline for information on city services and a channel for reporting issues. The library hosted focus groups and design workshops in communities with low usage rates, actively involving citizens in the 311 system redesign process. In these sessions, citizens could experiment with and test the system and "actually see the service being delivered", which helped better align the 311 system with the actual community needs. We were told these efforts align with the civic user testing model that the local government created to engage citizens in planning technology-enabled smart services and programs. An interviewee stated that "[the City] is approaching 311 as a sort of technology smart platform [...] and they are very much trying to [hold] focus groups in user testing" and emphasized that "technology is only a good tool if people understand it and [are] willing to be part of it".

In summary, our findings suggest that public libraries are more than just knowledge repositories and have emerged as critical enablers of digital literacy and participation. They may offer inclusive technology access and core and advanced digital skills training, and expand opportunities for smart citizens to apply these skills and maximize the value of technology to improve their well-being.

### *5.2. Spaces for Participation (with Citizens as Democratic Participants)*

Public libraries may foster the participation of smart citizens as democratic participants who express and apply their opinions amicably in various ways. Most of this engagement is realized in partnership with local governments and other partners; it focuses on supporting group processes and developing aware and informed citizens who represent the community and participate in public affairs and specific projects that make their cities smarter. For the CPL, one interviewee said that it has been "a space for informed decisions" in the community. Another interviewee reaffirmed this and provided the following example that directly relates to exercising democracy:

> "...the Mayor's office [asked the CPL] to [make] a really big push for voter registration, early voting. [The CPL] was like, yes, that helps a more informed city; people are going to go out and learn about their local politics and actively vote on them, today's voting day. That helps make a smarter city".

We heard similar views about the ICL as a trusted space to engage the community in policy discussions and local politics. We were told that the ICL thus far held policy discussions on general topics such as immigration, taxes, education, or city branding. Further, the ICL has been a forum for current and future state or local elected officials to engage with the community. In this regard, an interviewee shared that: "[the library] got a call from the regional director for Senator who wants to hold office hours here next Monday". Another interviewee said:

> "[The library] does a lot of political outreach. They allow political events to be held. They allow forums between the candidates. Candidates for county commissioner. Candidates for whatever position are held in the library, which is a huge benefit to the community. To be educated, to be able to hear from the people running for offices, to have groups moderating and asking questions that actually matter to the people".

For the ChiPL, we heard that: "[. . .] the library is the place [where] they ask people to meet there together and to address a specific issue happening in the community". Further, we learned about more specific library-facilitated citizen participation in the City of Chicago's deployment of smart technology, particularly urban sensors that capture environmental data (e.g., air quality, climate, traffic, etc.) as part of the Array of Things initiative to improve quality of life. This also seems to reflect the belief expressed by an interviewee that "[. . .] a lot of problems are solved when you not only looking at the dataset or map [. . .] but then you also [. . .] have these conversations around it to really understand what it is". As such, the library acted as a neutral facilitator for a citizen-oriented engagement that could inform and educate citizens about smart city technologies and seek their input on the goals and associated privacy issues. In this respect, we were told:

> "We found it's not an accident that leveraging the library as a space is just a simple and powerful way to reach people and make them feel welcome. Actually, if the topic is unfamiliar, and so that is again when [the City] decided to use the library as a space for the Array of Things and [hold] those public meetings in libraries; [the City] got [to] inform the community about the project, and then get feedback on the privacy and governance policies both online and in-person".

Similar to other libraries, the SSPL appears to have been offering inclusive, neutral spaces for citizens and community stakeholders, including non-profit organizations, to gather and discuss shared interests or exchange information amicably. On this subject, an interviewee said that: "[the library] as a neutral institution [. . .] to provide a place where [groups] can come together and talk to each other in a way where it can be a conversation and not an argument". Further, the SSPL is one of the places where local governments connect with citizens and socialize city activities and goals. An interviewee offered an example of this, speaking about a workshop the library co-organized with the local government:

> "The City is putting together a natural resources inventory, and so you know collecting all this data, much of it from data sources that are online and publicly available [. . .] And [the City] is said to be able to go [into the library] and have the community there providing feedback to make better products that serve the community and all of the angles and as opposed to just a narrow group . . . this is what's best for the developer or best for the zoning board to make the decision, but having that really wide perspective".

Therefore, public libraries seem to have become integral to developing smart citizens by providing versatile and safe spaces for informed community engagement and decision-making in smart city development. In this light, our results suggest that libraries can serve as salient platforms for democratic participation, where the intersection of technology, information, and civic discourse informs smarter city initiatives and policies.

### *5.3. Spaces for Innovation (with Citizens as Co-Creators)*

Innovation is central to smart cities and their development as it involves harnessing technology to meet evolving community needs and expectations. Smart citizens actively participate in innovation processes as critical stakeholders and co-creators who contribute innovative ideas and turn them into products, services, or models that meet social needs. Our findings show that the public libraries we studied have been serving as spaces for decentralizing innovation through citizen-centric programs and services. These programs and services build on unique local resources and capacities to unleash creativity and

improve individual and collective outcomes. In some cases, such co-creation of innovations in libraries occurs in designated experimental spaces (e.g., makerspaces). As such, some libraries are perceived as stepping stones for community members, supporting initial creation phases and project launches, which can then be scaled up elsewhere with other collaborators or partners.

For example, the CPL has two designated innovation spaces, the Maker Lab and The Studio, providing patrons with resources to ideate and create. We were told that the library is an entry point for individuals to explore, prototype, and test their initial innovative ideas or concepts, and then "when [they] are ready for manufacturing, [they] go somewhere else". Innovations originating from the Maker Lab showcase diverse applications: a local small business owner made signage using a vinyl cutter, a patron took advantage of the Gig connection to develop software, and a father utilized a 3D printer and a Raspberry Pi to create an assistive, sensor-based device for his mobility-impaired daughter. Another space is The Studio, which serves as a launchpad for aspiring content producers who can create music offline or online without delay (thanks to the Gig) and then move on to record an album. The interviewees perceive such innovations as contributing to the local innovation strategy and economic growth that align with bottom-up smart city development.

At the ICL's makerspace based out of the Idea Lab, we learned that 3D printers and multimedia recording equipment and software are especially popular with the youth, who use these advanced technologies to design and create projects by themselves or with the help of staff or volunteers (e.g., professional DJ). Interviewees shared that this is a collaborative learning environment, where the emphasis is on hands-on learning and knowledge sharing among patrons. Further, the ICL has an e-commerce station where "people can go and sell their stuff online, and [the library] will help them get it online and make it available to sell".

Like the CPL, the ChiPL sees itself as a welcoming space for hands-on experimentation and a springboard for innovation. In the words of one interviewee: "[The] library is the ramp for people to get familiar [and] explore in a safe environment; we can help guide them through that experience and then when they are ready to take that deep diving—go really deep into something, we can try to help them if we can [. . .] to make that connection for the next [step] up [so] that they can go explore further". In this regard, we learned that the ChiPL nurtures innovation in its well-resourced Maker Lab and, if appropriate, connects library makers, who are mostly women, to the broader maker or innovation community in Chicago to take their prototypes to the next level. Similar to the CPL, the ChiPL also caters to the youth and offers a YOUmedia, a space for teens to engage in projects encompassing graphic design, video, music, photography, 2D/3D design, STEM, and hands-on making. We were told these library services and programs complement the city's focus on inclusive entrepreneurship so that there is "a direct correlation [between] adopting skills and technology and the economic benefits it can result in that".

Similar to the ICL and the ChiPL, the SSPL focuses on creative production and supports business development. Although the library has no makerspace, it has a 3D printer and offers various do-it-yourself programs for learning 3D design and printing. Additionally, the SSPL provides aspiring entrepreneurs with resources and training designed to assist in searching for and securing grant funding. Contributing to the city's sustainability goals, the SSPL hosts Repair Café, where patrons can bring broken items including electronic devices and computers, and repair them with the help and technology training from a coach or volunteer and thereby extend the useful life of items and "keep stuff out of the landfills". Speaking about the impact of this program, an interviewee said: "You are coming to get it fixed [at the Repair Café], but you leave with a deeper understanding of sustainability".

Overall, our results suggest that public libraries are emerging as spaces where technology, creativity, and community needs intersect to advance bottom-up innovation and smart city development. With citizens as co-creators, libraries facilitate the ideation and prototyping of novel inventions and, in some cases, contribute to the local economy and

other smart city goals. Taking advantage of its resources and connections, libraries can help springboard those prototypes into scalable projects.

## 6. Discussion

This paper examines how public libraries contribute to the development of smart citizens through case studies of four libraries. To do so, we used a framework for citizen participation in smart cities [74] to better understand the relationships between community organizations and other stakeholders for developing smart citizens. Overall, we find that public libraries and their programs and services could play a multifaceted, interrelated role in developing smart citizens.

Table 3 summarizes the key findings of previous studies compared to this study. It is also important to note that our research stands out in the following ways. First, it provides empirical evidence to the research area that has been more conceptual and thereby adds to a deeper understanding of how public libraries as community organizations actually contribute to the development of smart citizens. Second, in contrast to prior studies that often concentrate on a single aspect of smart citizens, we simultaneously explore three roles of smart citizens and their connectedness. Third, our research shows the pivotal transformation of public libraries from repositories of books and non-digital knowledge to inclusive community spaces resourced to develop smart citizens in line with local needs.

**Table 3.** Key findings of previous studies vs. this study.

| Developing Smart Citizens | Findings of Prior Studies | Findings of This Study |
| --- | --- | --- |
| Training (w/citizens as ICT users) | • Community organizations are understudied as contributors to developing smart citizens<br>• Public libraries offer inclusive access to technology and training to use it with a purpose<br>• Smart citizens are skilled to ideate and co-create innovative solutions | • Public libraries can be strategic community partners for developing smart citizens<br>• Beyond access and training, libraries build advanced digital skills essential for smart citizens<br>• Libraries can empower citizens to influence how technology and related policies make cities smart |
| Participation (w/citizens as democratic participants) | • Participation in libraries can help align smart city initiatives with community needs and priorities<br>• In libraries, citizens can participate in the design and governance of smart city initiatives | • Libraries partner with other stakeholders to advance inclusive, equitable citizen participation by bridging social and digital gaps and thereby may improve policy- and decision-making and strengthen democracy |
| Innovation (w/citizens as co-creators) | • Libraries provide innovation spaces resourced with technologies and support for developing ideas and prototyping<br>• Demand exists for inclusive community-level innovation spaces or intermediaries | • Libraries meet diverse needs and can enable citizens to be co-creators of specific initiatives or in the broader innovation ecosystem<br>• Libraries can be the community innovation spaces abstractly mentioned in the literature |

In the subsequent paragraphs, we briefly discuss our main findings (organized by three roles of smart citizens), compare them in detail with previous studies, and provide some implications for research and practice.

First, public libraries notably contribute to developing smart citizens as ICT users. Prior research has indicated that libraries play an important role in offering inclusive access to various technologies and training to use them with a purpose [90,94,95,170]. Although such access and training build core digital skills for citizens, we observed that public

libraries take a step further and help citizens develop advanced digital skills needed for them to actively contribute to realizing smart cities as smart citizens. Previous studies have also shown that being smart citizens not only means being able to understand and evaluate decisions that make cities smarter [17,62,64,74] but also interacting and engaging with other stakeholders to ideate and co-create innovative solutions [91–93,155]. Our cases indicate that this can take place at the community level, with libraries serving as spaces for diverse community groups as smart citizens to learn and apply their advanced digital skills toward experimenting with technology and data that underpin smart cities. Examples of open data initiatives and the 311 system redesign empirically show that libraries can be neutral intermediaries that bridge citizens, technology, data, and other stakeholders so that citizens can be aware and contribute to how exactly technology and related policies make their cities smart. Such collaborations may further new ways of working among various stakeholders and innovative uses of technology, which adds to knowledge on multi-stakeholder interactions and collaborative models for smart city development and governance frequently advocated for in the literature [7,9,29–36]. In parallel, our case studies contribute to the emerging research indicating that community organizations such as public libraries can develop smart citizens [9,66,83–89] and thus add to the studies on the roles of different actors in developing smart citizens [51,57,65,76,80,121,143,151].

Second, libraries are emerging as safe spaces for citizens to actively and inclusively participate in smart city development. Consistent with prior research, such participation in libraries can align the aims and objectives of smart cities with the genuine needs and priorities of the community as a whole [83–86,96]. To enact this, the libraries we studied partner with local governments and other stakeholders, capitalizing on their reputation as trusted places for sharing and discussing community affairs amicably and supporting group processes. These collaborations have transformed public libraries into fora for citizens as smart citizens to learn and participate in the design and governance of the smart city and its technologies (e.g., urban sensors) on par with other stakeholders and offer perspectives on other projects that impact city life [19,21,97]. Our research suggests that such participation and agency can also lead to better policies that regulate the use of smart technologies and the stewardship of public data and result in participation, which is more representative of the community due to libraries' locations and wide reach. In turn, these contributions may strengthen the democratic fabric of a smart city as public libraries can help address the concerns about the digital and social divides voiced by scholars [23,42,51,76,126–130] as through libraries, more citizens can become aware of the use and impact of technology and thus as smart citizens participate in related decisions. Such a higher degree of citizen participation has the potential to transform governance in smart cities [11].

Third, libraries play an important role in promoting innovation and developing citizens to become co-creators. Consistent with prior studies, libraries offer experimental spaces such as makerspaces and labs, which serve as incubators for creative ideas and practical learning for citizens, allowing individuals to develop ideas and prototype projects [83,98–101]. These spaces have advanced technologies and tools, such as 3D printers, multimedia recording equipment, and e-commerce stations, in addition to the assistance of experts or peers [83]. We observe that public libraries, in line with their inclusivity ideals, design these innovative spaces and services in response to the various needs of diverse groups. Remarkably, these library offerings can help citizens as smart citizens become co-creators of not only specific initiatives but also co-creators in the broader innovation ecosystem. To this end, public libraries can help citizens kick off projects and scale up by connecting creators and makers with wider innovation networks, which can amplify the economic and social impact of the projects. In some cases, these library contributions are seen as directly contributing to local smart city strategies for decentralizing innovation. With this, public libraries can become catalysts for innovation in smart cities, providing well-resourced spaces where citizens become co-creators and leverage technology to attend to their needs and aspirations. This paper also demonstrates that public libraries can be those inclusive spaces or neutral mediums often underscored but referenced abstractly

in the literature on developing smart citizens, where communities can learn, engage, and innovate to improve individual and collective outcomes [20,40,55,71,143].

Moreover, libraries' contributions to developing smart citizens mentioned above can be multifaceted and interrelated as well as contextual. In particular, one contribution of the library to developing smart citizens can lay the foundation for another, which is consistent with previous research [83,86,156]. We find that library programs and services, which build advanced digital skills and offer supportive interactions, can concurrently inform and empower citizens to engage more deeply with smart city technologies or innovate. Concomitantly, proficiency in digital skills could lead to a more informed understanding of their surroundings and enable citizens to actively participate in public affairs. Yet, we contribute to the literature that often focuses on the characteristics and perceptions of smart citizens [7,21,26,35,40,58–61] by showing that context matters as it can inform how public libraries develop smart citizens. For instance, libraries in places where the digital divide persists focus on access and core digital skills, while other libraries that are recognized as partners in smart city development concentrate on advanced digital skills and innovation. At the same time, what constitutes a smart citizen can also vary. In some libraries, this could be related to broad participation in community affairs, whereas in other libraries, this participation could be specific to citywide technology-related initiatives. In essence, libraries can simultaneously play multiple roles that contribute to developing smart citizens, which can be interdependent and contingent on the needs of their respective communities.

## 7. Conclusions

In this paper, we examined how public libraries contribute to the development of smart citizens. Through qualitative comparative case studies of four public libraries, the research finds that public libraries contribute to developing smart citizens by playing salient, interrelated roles in fostering digital skills, democratic participation, and innovation among citizens. In particular, public library spaces, services, and programs democratize access to advanced technology, nurture participatory governance, and encourage innovation through makerspaces and other experimental environments. These offerings create knowledge and enable participation in smart city initiatives, and thus position libraries as salient actors alongside more traditional actors (e.g., technology companies, governments, and knowledge institutions) in developing smart citizens. Some of these impacts are realized through collaborations with other community stakeholders, which libraries can support and facilitate as neutral, trusted, and welcoming spaces where different smart city stakeholders can interact and collaborate on an equal footing to make their cities smarter. As such, public libraries have transitioned from being knowledge repositories to active community hubs where technology, civic engagement, and creativity intersect.

Our study has several important practical implications. This paper shows a need for wider acknowledgment and support for the public libraries' roles in developing smart citizens. Local governments could leverage libraries' enduring position as safe community hubs for technology access and training, civic engagement, and innovation to further citizen agency and advance their participation in smart city initiatives. However, this may require government interventions in the form of additional funding and policies encouraging the formation of conducive collaborations among the community stakeholders. Moreover, libraries can serve as grounds for socializing and testing smart city initiatives so that the community can be involved in the pilots and insights can be gained to improve the transparency and adoption of smart technologies. Citizen feedback and participation in these library-facilitated engagements can also advance collaborative smart city governance models, which are often sought. Local governments can then harness libraries' contributions to developing smart citizens to evolve into smart cities with a strong community orientation and where technological advancements are grounded in real-world needs and democratic values.

For public libraries, their contributions to developing smart citizens can help them establish themselves as strategic partners in such efforts in an increasingly digitized world.

With the pace of technological innovation, public libraries could build on their current experiences and best practices in developing smart citizens to continue to play a key role in fostering critical and inclusive civic engagement in emerging technologies such as artificial intelligence and the value these technologies produce for the community as a whole. Further, public library spaces, services, and programs that contribute to digital literacy, innovation, and democratic participation could present beneficial opportunities as these are some areas in which local governments, knowledge institutions, and non-profits are constantly trying to find new ways of having an impact. Moreover, libraries can foster more inclusive smart cities as equalizers in technology access and its use for socially oriented innovation and informed civic participation in smart city development, which can bridge both digital and social divides that persist. These contributions can deepen the role of libraries as community organizations that remain truly public, not just in terms of space but also in terms of the activities that are community-centric.

There are several opportunities for future research. Future studies could examine the contributions of public libraries in different countries and delve into specific contextual factors that shape these. Also, future research could explore the perspectives of library users and other potential contributors (e.g., other community organizations) to developing smart citizens. As our findings reflect the perceptions related to library operations before the coronavirus pandemic, there is a research opportunity to re-examine these findings in the post-pandemic world. Methodologically, the results could be strengthened through participant observation and ethnographic studies. Quantitative research could also, for example, measure the impact of public libraries' programs and services on developing smart citizens. A quantitative analysis of different library types could also provide more insights into how resources (including available smart technologies) and context impact libraries' contributions to developing smart citizens. Moreover, longitudinal studies could be conducted to assess changes in digital literacy, civic engagement, and innovation skills among library users over time. Future conceptual studies could also investigate the theoretical link between smart citizens and smart communities. Finally, libraries' contributions to developing smart citizens could be approached from collaborative innovation, civic technology, or public value frameworks.

We acknowledge the following limitations of our study. Our case studies comprise libraries in the U.S., which means that the external validity is limited, and caution should be exercised in generalizing beyond this setting. Further, our study primarily draws on interviews with representatives from public libraries, local governments, and external partners and, therefore, does not include other important perspectives. Some interviewees could have also been reserved in their opinions despite the guarantees of confidentiality and the research focus on findings. Moreover, the interpretation of the concept of a smart citizen can vary among different groups and people, albeit our interviews indicate that our interviewees considered similar characteristics related to this concept.

From our study, it is evident that public libraries, through their programs, services, and spaces, play a salient role in making the citizens of their communities smarter. Such contributions are multifaceted, interrelated, and contextual but aimed at helping citizens become highly skillful, engaged, and innovative smart citizens who are able to leverage technology and data to benefit themselves and their communities. In the end, it is widely accepted that truly smart cities are built for and with smart citizens, which underscores the present and future role of public libraries in advancing this participatory approach as cities are increasingly investing in technologies to improve the quality of life and address pressing challenges.

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