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Opportunities and Obstacles for Citizen Science

Insights from Finnish Public Libraries

Abstract

The primary aim of this study was to gain understanding on public library perspectives on citizen science in Finland, through examining the conditions of public libraries in three key areas: physical space, digital space, and knowledge resources and infrastructure. Additionally, the study sought to explore how libraries conceptualise an environment supportive for citizen science. In April 2024, an online survey was conducted with 55 public library representatives from Finland, gathering data on their views about public libraries' capability to support citizen science. The survey included a series of questions focusing on the three aforementioned areas. The responses were analysed using thematic analysis. Eleven key concepts supporting citizen science in public libraries were identified: inclusivity and accessibility to diverse communities, meeting and event spaces, study and work areas, role of libraries as connectors, collaboration with educational institutions, national cooperation, community engagement and events, customer service, local collections and research, technology and digital resources, and library staff. Librarians perceived libraries as facilitators rather than leaders of citizen science projects, emphasising the importance of collaboration and accessibility of resources. The results show the potential of Finnish public libraries to facilitate citizen science, simultaneously revealing challenges related to infrastructure, resources, and role delineation. Findings confirm the potential of Finnish public libraries to support citizen science initiatives while highlighting areas for improvement. These insights may be useful in designing effective strategies for integrating citizen science into library services, thus responding to an important research, programmatic, and policy gap.

Keywords: public libraries, citizen science, Finland, thematic analysis, strategy design, library services

Introduction

Citizen science, research conducted partly or entirely by people who are outside the research community, is becoming an increasingly common method in research (Svahn et al., 2022). It involves engaging the general public, for example, in the collection, analysis, and interpretation of the data, thus enabling them to contribute to scientific knowledge and understanding (Requier et al., 2020; McKinley et al., 2017; Pocock et al., 2017; Pandya, 2012).

Research libraries and public libraries play distinct roles in supporting citizen science. Research libraries often engage in citizen science activities in collaboration with research institutions, focusing on specialised research areas and contributing to the advancement of scientific knowledge (Martek et al., 2022; Kim & Lee, 2021). Public libraries serve as community hubs that promote citizen science initiatives to involve the general public in research, emphasising accessibility and inclusivity (Cigarini et al., 2021).

The role of public libraries in the advancement of citizen science is significant, particularly in fostering community involvement, education, and scientific literacy. Public libraries can serve as hubs for engaging the general public in research endeavours, thereby enhancing the accessibility and understanding of science among community members. In contrast, research libraries primarily support the efforts of researchers by providing specialised resources and tools, and facilitating scholarly communication. This distinction underscores the complementary functions of public and academic libraries in promoting citizen science and advancing scientific knowledge.

This study seeks to address a gap in the existing literature by adopting a culturally and socially informed approach to examining librarians' perspectives on the facilitative role of public libraries in citizen science. By understanding the conditions that enable a citizen science friendly environment and exploring the perspectives of library staff and users, it is possible to develop strategies and policies to maximise the impact of libraries in this field. This, in turn, can enhance scientific literacy, community engagement, and the overall contribution of citizen science to society.

Literature Review

The potential of public libraries to act as hubs for citizen science has been a topic of interest in research but has not been fully explored, and has rarely gone beyond literature reviews and case studies (Mumelaš, 2023; Cigarini et al., 2021; League of European Research Universities, 2016). Public libraries, with their extensive reach and resources, are uniquely positioned to support citizen science initiatives by providing access to various resources (Mumelaš, 2023; Ignat et al., 2019). A large-scale U.S. survey of public perceptions and support for public libraries suggests that there is a desire to transform the traditional role of public libraries, i.e. quiet places with books and internet access, into community centres where library professionals take an active role (OCLC, 2018; American Library Association, 2018). Several studies have highlighted the role of public libraries as meeting places for activities related to different aspects of public space, such as writers' evenings or opportunities to learn about various social issues (Cigarini et al., 2021; Aabø et al., 2010).

According to previous literature, citizen science can benefit from the inclusive and accessible nature of libraries (Wu, 2023; Ignat et al., 2019; Phillips et al,. 2019). To fully harness the potential of public libraries in enabling citizen science, it is crucial to understand the perspectives of library staff regarding the necessary conditions for a citizen science friendly environment. Understanding how libraries conceptualise their role in citizen science is essential for developing strategies that leverage their strengths and address any limitations (Cigarini et al., 2021). While libraries may excel in providing access to digital resources, they may require additional support in training staff to facilitate citizen science projects effectively (Cigarini et al., 2021). Exploring the ways in which libraries engage with

their communities can reveal opportunities for fostering a culture of scientific inquiry and participation among diverse populations (Cigarini et al., 2021). Integrating citizen science into public libraries not only promotes scientific literacy and community engagement but also helps bridge the gap between researchers and the public, enhancing the understanding of scientific processes and discoveries (Bonney et al., 2015). Such initiatives can contribute to broader societal goals and foster meaningful interactions between researchers and the public (Bonney et al., 2015).

Literature discussing citizen science in academic libraries tends to highlight the integration of citizen science into scholarly research, emphasising the generation of new knowledge and the research community's involvement (Buyannemekh, 2024; Mumelaš, 2023; Andersdotter & Nauwerck, 2022; Ayris & Ignat, 2018; Ignat et al., 2019). In contrast, literature on citizen science in public libraries emphasises the role of these institutions in fostering community engagement, promoting scientific literacy, and serving as local centres for citizen science activities (Wu, 2023; Cigarini et al., 2022; Cigarini et al., 2021; Rooney-Browne & McMenemy, 2010; Yoshida, 2016).

The participation of citizens in scientific research has facilitated data collection on various topics such as bird abundance (Santangeli et al., 2019), tick distribution (Laaksonen et al., 2017), and tick-borne diseases (Pakanen et al., 2020), while also enhancing public understanding of science (Bonney et al., 2015). Citizen science initiatives have played a crucial role in monitoring population trends of species like the house sparrow and the Eurasian tree sparrow (Jokimäki et al., 2021), highlighting the significance of citizen science projects in biodiversity monitoring.

Citizen science in Finland has garnered significant research interest, with studies showcasing the diverse applications and benefits of involving volunteers in scientific research. Case studies like Järviwiki illustrate successful volunteer engagement in environmental observatories initiatives (Palacin et al., 2020). There is a range of research areas where citizen science has been effectively utilised in Finland, such as tick-borne pathogen prevalence studies (Sormunen et al., 2018), monitoring bat activity (Lundberg et al., 2021) and contributions to ecosystem service measurement (Kaartinen et al., 2013). Studies in Finland have highlighted the collaborative nature of citizen science, emphasising citizen involvement in data collection and decision-making processes (Nieto et al., 2018) as well as presenting numerous case studies. However, the role and the potential of public libraries in facilitating these transactions have been less extensively studied indicating a need for further research in this area. While many citizen science projects tend to focus on STEM subjects (Ignat et al. 2019; Wazny, 2017), where participation in the data collection process has a low threshold, it is important to remember to include crowdsourcing projects in the humanities (Andersdotter & Nauwerck, 2022; Causer et al., 2018; Causer & Terras, 2014) under the citizen science umbrella, as they meet the requirement of people outside the research community participating in the research process.

Analytical Approach
The aim of this study is to examine existing perspectives of librarians on the facilitative role of public libraries in citizen science. The culturally and socially informed approach of the study builds on the Finnish public library law (29.12.2016/1492, Lag om allmänna bibliotek) and the Finnish research community's declaration for open science (Tieteellisten seurain valtuuskunta, 2020). The public library law states that public libraries should provide "information services, guidance and support in the acquisition and use of information and in versatile literacy skills"; provide "premises for learning, recreational activities, working, and civic activities"; and promote "social and cultural dialogue", meaning there is room to explore the role of public libraries in relation to citizen science that is included in the open science mission of the Finnish research community.

Since the study is built from a societal perspective grounded in the public library mission as formulated in the Finnish library legislation, it does not apply a specific library and information science (LIS) theory. Instead it adopts an analytical approach similar to grounded theory which builds theory from the analysis of collected research data (Glaser & Strauss, 2017), except without the explicit aim to build theory. Glaser and Strauss (2017, p. 3) described theory as "a strategy for handling data in research, providing modes of conceptualization for describing and explaining. The theory should provide clear enough categories and hypotheses so that crucial ones can be verified in present and future research." This is similar to what happens in this paper, except that the aim of the study is to address a gap in the existing literature to inform both policy making and future research, making its scope broader than research and less concerned (but not uninterested) in formulating new research questions.

By understanding the practical conditions that enable a citizen science friendly environment and exploring the perspectives of library staff and users, it is possible to develop strategies and policies to maximise the impact of libraries in this field. By focusing on scoping out the role of public libraries in supporting and enabling citizen science activities and a citizen science friendly environment based on the perspectives of library staff and users, this study seeks to provide further insights for policymakers and organisations aiming to increase community participation in research as well as providing a background for further studies that can apply a more theoretical approach to understanding this phenomenon. Concentrating on this relatively unexplored area within the context of Finland, the study contributes to a more comprehensive understanding of the collaborative nature of citizen science and the role that public libraries can play in this domain.

Method

Research Design
This project was conducted in public libraries in Finland employing a qualitative research design to evaluate and describe various aspects of public libraries suitability to support citizen science activities. Based on the role of libraries as community hubs that emphasise inclusivity and accessibility, and their legal mission to provide premises for learning and civic activities we based our inquiry on three primary themes: physical space, digital space, and knowledge resources and infrastructure. The themes are based on space and infrastructure, something all public libraries have to various extent, and therefore they are not forcing a pre-supposed idea of concepts later explored by library staff in their responses or the authors of this paper. This consolidation allows us to focus on the fundamental elements that directly impact the libraries' capacity to support citizen science activities. Physical space, digital space, knowledge resources and infrastructure were evaluated by studying the data collected through a survey designed to gather in-depth qualitative insights from library staff.

Participants
The participants in this study were selected using purposive sampling to ensure a diverse representation of public libraries across different Finnish regions. The sample included librarians, administrative staff, and support staff. A total of 19 regions were invited to participate with responses received from 16 regions. In total, 55 responses were received. 70% of the respondents were librarians and information specialists, 22% library directors and managers, and 8% with other titles. 98% of respondents had an LIS education. 79% of respondents were from a main library and 20% worked in branch libraries.

Participants did not receive a definition of citizen science with the aim of not restricting the participants' views on what entails citizen science. 22% of the respondents were not familiar with the

term citizen science. 34% of the respondents indicated that their libraries had been previously involved in citizen science activities.

Data Collection Methods
Data was collected using an online survey consisting of eight background questions and 15 open ended questions. The survey was designed to bring out detailed qualitative responses and covered the following three main areas:

- *Physical space:* Questions focused on how the layout, accessibility and comfort of the library's physical environment would be suited to support citizen science activity.
- *Digital space:* Questions addressed the availability and suitability of digital resources and online services for citizen science activity.
- *Knowledge resources and infrastructure:* Questions examined the availability of knowledge resources, such as databases, specialised staff, networks and cooperation with external stakeholders that could be used to support citizen science activity.

The survey was developed based on a review of existing literature, and it includes eight background questions and 15 open ended questions (Appendix 1).

Data Analysis
The qualitative data collected from the survey was subjected to a thematic analysis that involves identifying, analysing, and reporting patterns (themes) within qualitative data (Chowdhury et al., n.d.; Nowell et al., 2017). This method allows researchers to systematically interpret the data, ensuring that the findings are both robust and reliable. In our study, thematic analysis was conducted independently by three researchers, which aligns with best practices in qualitative research to enhance the credibility of the findings (Edward, 2024; Jong et al., 2023; Buchan et al., 2022; Knox et al., 2017) The process began with open coding, where initial themes were identified, followed by a more detailed analysis to refine these themes and ensure they accurately represented the data (Eka et al., 2023; Rosairo, 2023).

The literature emphasises the importance of collaborative coding and theme development in qualitative research (Zahra et al., 2021; Alkhawaldeh, 2023). The thematic analysis process followed the phases outlined by Nowell et al. (2017) which include familiarisation with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report (Aoki & Urushibara-Miyachi, 2019; Chauke, 2024) as well as the collaborative coding. The thematic analysis conducted in this study, characterised by independent coding and adherence to established methodological frameworks, provides a solid foundation for understanding the qualitative data collected (Attride-Stirling, 2001; Azmi et al., 2023). The data analysis process involved the following steps:

Step 1. Familiarisation: Each researcher familiarised themselves with the data by reading and re-reading the survey responses in order to gain a deep understanding of the content. Researchers noted initial impressions and potential patterns emerging from the data and discussed the findings in an initial online meeting.

Step 2. Independent coding: Each researcher independently conducted initial coding of the data. Researchers systematically identified and labelled segments of the data that were relevant to the research questions and searched for themes.

Step 3. Discussion: The researchers convened to discuss initial codes and impressions. During this meeting, researchers compared and contrasted their individual coding results, identified common themes, and resolved any discrepancies. This collaborative discussion ensured that diverse perspectives were considered and that the coding was comprehensive and consistent.

Step 4. Conceptual coding: Following the discussion, the researchers engaged in a round of conceptual coding. This involved grouping the initial codes into broader, more abstract categories or themes that encapsulated the core ideas emerging from the data. The researchers refined these themes through iterative discussions, ensuring that they accurately represent the underlying data patterns.

Main themes	Key concepts	Subconcepts
Space and facilities	Inclusivity and accessibility to diverse communities	- Spaces that can be booked free of charge
	Meeting and Event Spaces	- Multipurpose rooms - Spaces for organising lectures - Spaces for exhibitions - Makerspaces
	Study and work areas	- Researcher rooms and conference cubes - Quiet areas
People and partnerships	Role of libraries as connectors	- Library as potential hub or link between various entities involved in citizen science - Library as a facilitator for connections and collaboration
	Collaboration with educational institutions	- Dissemination of surveys for research purposes - Leveraging academic resources and expertise to support citizen science initiatives
	National cooperation	- National cooperation with public libraries and scientific libraries e.g. for interlibrary loans
	Community engagement and events	- Community engagement and events - Nature-themed and other thematic exhibition - Events related to literature, music, recycling and nature - Hosting clubs and groups focused on societal development and inventions - "Libraries could more clearly be gathering place for people and communities"
	Customer service	- Offering digital advice and support - Help with information sources and materials - Librarians existing skills could be targeted better
Knowledge resources and infrastructure	Local collections and research	- Local history and regional literature collections - Exhibitions on local history - Scientific resources
	Technology and digital resources	- Use of customer machines, printers, copiers, scanners and 3D printers - Digital exhibition and information points - Public computers - Information screens
	Library staff	- Understanding in information searching and retrieval - Librarians with IT and scientific knowledge - Enthusiasm of library staff - Effective resource management - Delineation of roles

Table 1. Summary of the concepts supporting citizen science in public libraries

Ethical Considerations

In conducting this survey, several ethical considerations were addressed to ensure the integrity and ethical soundness of the research. Informed consent was obtained from all participants prior to their engagement in the survey. This process involved providing a clear and concise explanation of the study's purpose, the nature of the questions, and the voluntary nature of participation, ensuring that respondents were fully aware of their rights and the scope of their involvement and how the data would be used and made available. Confidentiality and anonymity were maintained throughout the study; participants' responses were anonymised, and any identifying information was removed. The survey design adhered to ethical guidelines by avoiding any questions that could be deemed intrusive or sensitive, thereby respecting the personal and professional boundaries of the participants. The study also complied with relevant institutional and legal ethical standards, including data protection regulations, to safeguard participants' privacy and data security.

Results

In the sections below, results are presented along the three main themes that emerged from the survey data: 1) space and facilities, 2) people and partnerships, and 3) knowledge resources and infrastructure. The three themes deviate slightly from the survey areas (physical space, digital space, knowledge resources) and are a better thematic approach to accurately represent the findings from the survey. The themes serve to identify the public library conditions for supporting citizen science from the librarians' perspective and to explore how librarians conceptualise a citizen science friendly library.

While we have identified several overarching concepts within the data, it is important to acknowledge that the subconcepts exhibit significant areas of overlap and interconnection. Despite this complexity, we have chosen to present the findings within a structured framework to facilitate a coherent and comprehensible narrative. This approach allows us to systematically explain the intricate and intertwined nature of the subconcepts, thereby enhancing the clarity and accessibility of our analysis. By organising the data in this manner, we aim to provide a comprehensive understanding of the key insights while maintaining the integrity and depth of the qualitative findings.

Space and Facilities

Libraries have a wide range of different facilities (Q12, Q13, Q14), such as meeting, reading, group work, researcher and multipurpose rooms, conference cubes, quiet workspaces, project rooms, open study spaces, bookable rooms, exhibition spaces, info displays and, more recently, makerspaces and 3D printers. It is noteworthy that although the respondents did not indicate that the facilities were specifically designed to take into account the needs of citizen science, 31 respondents (Q12) nevertheless considered library facilities reasonably good for organising citizen science activities. Several respondents felt that it would be difficult to improve the premises without significant input, such as expansion, but smaller suggestions for improvement were also made (Q14), such as increasing the number of quiet workspaces, developing interactive research markets, space versatility, presentation technology and equipment, and providing sufficient storage space for various loanable devices. According to the responses, it was clear that a versatile selection of quiet and noisy spaces were needed.

Also according to our survey, some respondents thought that libraries could play a more active role in promoting citizen science and one respondent (Q14) noted that "it would be important to be able to disseminate information about citizen science projects also in the library premises".

The majority of respondents (Q14) presume that public libraries have the potential to act as hubs for citizen science, as they have a wide range of physical spaces that are reasonably suitable for organising citizen science activities, and the digital infrastructure of libraries generally supports the

promotion of citizen science projects well. However, there are also challenges (Q12, Q13), as library facilities are limited and there is often little quiet working space. One respondent (Q14) even saw the current situation quite desolate: "Not in these spaces, maybe in the next ones".

User involvement in public libraries can also raise critical questions. Libraries often have limited resources and budgets are rather being reduced, as some of the responses to our survey pointed out. On the other hand, participation can also collide with traditional use in a physical library, where activities such as reading may be disrupted due to noisier activities. (Rasmussen, 2016)

People and Partnerships
In the survey (Q22), most respondents think that public libraries should not take a leading role in citizen science activities; they rather view the libraries as a vehicle for citizen science projects initiated by other actors. Some respondents see the potential for public libraries to fill both of these roles, but highlight some difficulties for this to come to fruition. One respondent wrote: "In many ways, the university lives in its own bubble, and the public library operates outside of it", highlighting the gap between the two knowledge institutions. Another respondent underlined the issue with public libraries receiving new responsibilities and tasks, but no additional funding to undertake them. Indeed, resources for public libraries are rather being reduced, and the respondent compares this dilemma with the role public libraries "have been forced to play as digital guardians". The reluctance to leadership in citizen science projects seems to be based on the general conditions of libraries rather than a specific opposition to citizen science.

When asked about the type of partnerships (Q21) that would be beneficial for citizen science initiatives in the library, 19 of 34 respondents mention partnerships with universities, research libraries, or educational institutions, while researchers or scientists are mentioned in five responses. It is interesting to see that partnerships are viewed on an organisational level rather than a personal level, considering that citizen science projects are often initiated by a researcher in the context of a research project, rather than by an institution. Here is a gap between organisation and practice that needs to be considered.

As for the roles library staff can play in citizen science projects, focus often fell on certain skills needed to support them. Interestingly, many responses noted that librarians already have good skill sets that could be marketed, better valued, and better targeted in potential citizen science projects. A prime example is the information literacy skills librarians teach users, that help the users to access and use information and digital tools.

Throughout the survey, respondents call for more resources to be able to develop this area in public libraries, and a central message seems to be that these resources should be spent on library staff; on developing their skills and on freeing up more time to spend on citizen science activities.

Knowledge Resources and Infrastructure
Knowledge resources encompass access to various databases, digital tools, specialised staff, and comprehensive collections. Respondents consistently highlighted the importance of having access to scientific databases, statistical programs, and reference management software to support citizen science initiatives (Q15, Q16, Q17, Q19, Q20). Specialised staff or librarians with IT and scientific knowledge were also deemed essential for guiding and assisting patrons (Q19 and Q20). While some respondents emphasised the need for specialised personnel, others suggested that enthusiastic and well-informed staff could suffice. The integration of digital platforms and mobile applications was seen as vital for modernising the library's knowledge resources, making them more accessible and engaging for patrons. Two respondents noted that "access to scientific databases and professional

staff would significantly enhance our ability to support citizen science projects." The necessity for up-to-date digital collections (Q15, Q16, Q17), as well as improved promotion of existing resources and staff expertise to the public, was also emphasised. On the other hand, several respondents pointed out that the provision of access to scientific content should be the responsibility of scientific libraries. This perspective introduces an interesting discussion regarding the roles of various stakeholders in citizen science and the specific responsibilities each party should assume. Based on the survey responses, it appears that the delineation of these roles still requires further clarification.

Knowledge infrastructure included essential equipment, reliable internet connections, and interactive digital platforms. Respondents frequently mentioned the necessity of having computers, tablets, microfilm readers, and a stable internet connection to facilitate seamless access to digital resources. The importance of interactive digital platforms and teamwork environments like Teams was highlighted as a means to optimise the library's infrastructure for citizen science activities. Collaboration with universities and other scientific organisations was also seen as crucial for enriching the library's infrastructure and resources. Effective budget allocation and resource management were deemed vital to ensure the library can support these initiatives without compromising other services. One respondent highlighted the significance of integrating digital tools and collaborating with scientific organisations to enhance the library infrastructure for citizen science. The need for better integration and collaboration was emphasised to ensure that the library's infrastructure could support citizen science effectively.

Discussion

This study aimed to clarify the potential of public libraries to serve as actors in citizen science initiatives. While previous studies (Mumelaš & Martek, 2024; Cigarini et al., 2021; Ignat et al., 2019; Ayris & Ignat, 2018 Aabø et al., 2010) have explored the role of citizen science within the context of public libraries, previous studies have not explicitly sought the perspectives of librarians and library staff regarding how they perceive the potential of public libraries to act as enablers of citizen science. This gap in the literature underscores the need for a more nuanced understanding of the views and experiences of those who are directly involved in the day-to-day operations of public libraries.

The findings from this study reveal a nuanced perspective among librarians regarding the potential for libraries to assume a role in citizen science initiatives. While there is evident enthusiasm for the educational and community engagement opportunities that citizen science could offer, significant concerns persist about the practical challenges involved. Survey respondents highlighted the potential benefits of leveraging existing library resources and infrastructure to support scientific literacy and hands-on learning. However, they also pointed to substantial barriers, including space constraints, limited staff capacity, and inadequate funding. These findings suggest that while libraries are well-positioned to contribute to citizen science, successful implementation would necessitate strategic partnerships with research organisations, additional training for library staff, and enhanced institutional support. Addressing these challenges is crucial to ensure that libraries can expand their role in citizen science without compromising their core functions and services.

The concept map (Figure 1) illustrates the understanding of public library staff on the operating environment that promotes citizen science. This study identified for the first time several new concepts or concepts related to the three main themes (Table 1) that were conceptualised in a new way. The concept map also highlights the key concepts identified in previous studies, which are correspondingly divided into all three main thematic areas.
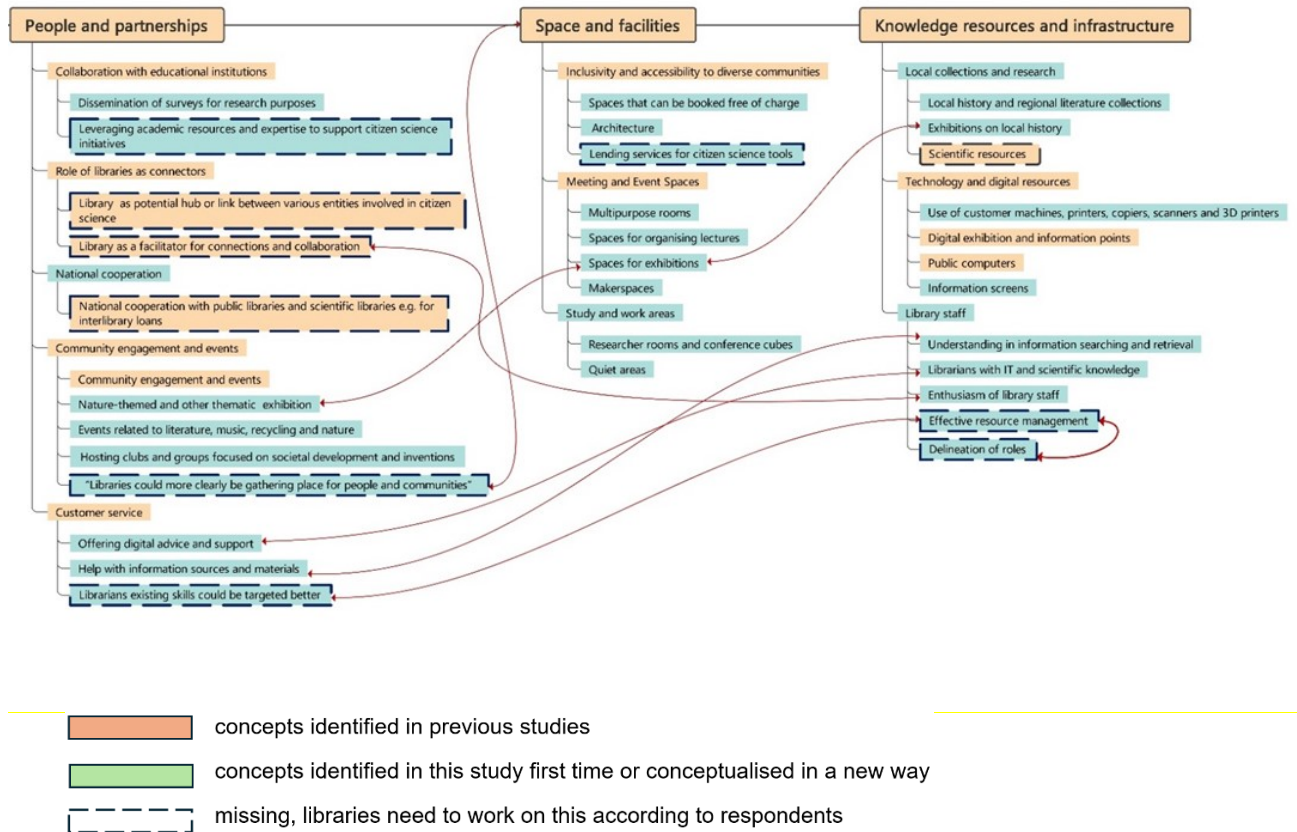
Figure 1. Concept map illustrating public libraries' comprehension of an environment conducive to citizen science

Our results indicate that in the case of physical space, almost every library can take the first step towards becoming a centre of citizen science activities in their community. As our survey also pointed out, the current facilities of libraries can mainly be considered suitable for carrying out citizen science activities. The usability of the facilities is promoted by the fact that they are open and safe learning environments for all members of the community (Mumelaš & Martek, 2024).

The current infrastructure of public libraries is not always adequate and needs to be upgraded to successfully implement citizen science projects (Cigarini et al., 2021b). Citizen science projects can also lead to the creation of new services and making libraries communal spaces for building knowledge (Mumelaš &; Martek, 2024). For example, makerspaces in public libraries can take advantage of flexibility where there is not just a "one size fits all" model for learning and doing, but purpose and materials can change depending on facilitators and participants (Willett, 2018). Improving the infrastructure of public libraries would sometimes be necessary to better support these projects, but in most cases existing facilities allow citizen science activities to be launched to some extent. According to the results, the current digital infrastructure of libraries also enables the promotion of citizen science projects reasonably well, although there is room for improvement.

A toolkit for citizen science (Cigarini et al., 2021b, 2021a; Ignat et al., 2018) has been seen as a useful instrument that libraries could utilise. Our survey did not specifically ask about the use of toolkits, but some responses brought up the idea that libraries could have a lending service for citizen science

tools. In the United States, the "Libraries as Community Hubs for Citizen Science" project developed and evaluated CS toolkits for public libraries and created related resources to train and support librarians and citizen scientists (Libraries as Community Hubs for Citizen Science Final Summative Evaluation Report (IMLS) Phase 1 and Phase 2 (Supplement), 2017). Also this project showed that citizen science can be integrated into library activities.

The survey responses underscore a critical discussion on the adequacy and allocation of knowledge resources and infrastructure in supporting citizen science initiatives. Respondents highlighted the importance of access to scientific databases and the expertise of professional staff, which are seen as pivotal in enhancing the effectiveness of such projects. The access to scientific databases is sometimes hindered by subscription costs that the public library cannot afford. This underlines the necessity of open science, specifically open access research publications, because these are openly accessible for everyone, including public library users. Considering citizen science is a method often brought up in the open science context, it seemingly rhymes well with the principle of open access publication. Additionally, there was a strong call for the maintenance of up-to-date digital collections and the need for better promotion of existing resources and staff capabilities to the public. However, a notable divergence in opinion emerged, with some respondents arguing that the responsibility for providing access to scientific content should rest with research libraries. This divergence brings to light the broader issue of role delineation among stakeholders involved in citizen science. It suggests that while there is consensus on the need for robust knowledge resources and infrastructure, there is ambiguity regarding which parties should be accountable for these provisions. This ambiguity indicates a need for clearer definitions and agreements on the roles and responsibilities of different stakeholders to ensure the effective support and advancement of citizen science projects.

The expressed need for access to scientific databases and tools is supported by Cigarini et al., (2022) where libraries were found to serve as venues for citizen science activities, providing digital platforms for data sharing and collaboration, as well as access to literature and resources that support citizen science projects.

While the infrastructure is deemed as mainly sufficient, the largest obstacle to successfully working with citizen science activities seems to be time. In the results, we can see many mentions of how library staff do not have the time to develop this area, or do not have the time to develop the skills needed to support this area. At the same time there is a clear indication that library staff are deemed as well suited to take on this area in terms of competencies and interest. In short, if more resources were allocated to public libraries it would allow them to explore this area further. However, one might consider whether these resources should be part of the public library budget (and if so: why should citizen science activities be prioritised over other public library activities) or whether joint citizen science projects should start already in funding applications. The latter brings to mind the notion of partnerships, where the results indicate the respondents mainly think about organisations as partners, rather than individual researchers or citizen scientists. This makes sense in the way that it might seem intuitively easier for organisations to build sustainable partnerships, but at the same time citizen science methods are often employed by individual research projects, and some successful citizen science projects highlight personal partnerships as key success factors (Andersdotter & Nauwerck, 2022; Peet, 2018). There is a gap between organisational partnerships and person level partnerships that brings to light whether citizen science collaborations should be built from top-down (universities and libraries providing infrastructure and opportunities for citizen science so that researchers can be encouraged to use the method) or bottom-up (researchers and library staff collaborating on research projects and getting support from their respective organisations).

Addressing these challenges is crucial to ensure that libraries can expand their role in citizen science without compromising their core functions and services. While public libraries are well positioned to become hubs for citizen science activities, several critical factors need to be addressed. These include improving infrastructure, clarifying the roles and responsibilities of various stakeholders, and ensuring adequate time and resources for library staff. Additionally, strategic partnerships with scientific organisations, targeted training for staff, and enhanced institutional support are essential.

Conclusion

This study provides regional and cultural insights into the potential role of public libraries in supporting citizen science initiatives. By highlighting both the opportunities and challenges, it responds to the growing interest in leveraging public library resources to enhance scientific literacy and community engagement through citizen science.

The findings underscore the need for versatile physical library space, strategic partnerships with organisations and people, targeted staff training, clear role delineation, and enhanced institutional support to successfully integrate citizen science activities into public libraries. This research contributes to the broader discourse on expanding the functions of public libraries and offers practical recommendations for enhancing their role in community-based scientific endeavours.

This study confirms existing findings on the potential of public libraries to serve as hubs for citizen science, while highlighting new perspectives on the practical challenges and opportunities involved. By capturing the nuanced opinions of library staff, this study addresses a gap in understanding the practicalities of implementing citizen science initiatives within public libraries on a grassroot level, providing a more comprehensive view of the necessary resources and support.

Findings from this study contribute to identifying pathways for policymakers, public libraries, national and regional development libraries (VAKE[1] & AKE[2]) to effectively support citizen science initiatives in Finland and internationally. The study underscores the importance of leveraging existing library resources and infrastructure to promote scientific literacy and community engagement through citizen science, while also addressing space constraints, role delineation, limited staff capacity, and inadequate funding. By clarifying the roles and responsibilities of various stakeholders, libraries can better position themselves to expand their role in citizen science without compromising their core functions and services.

While the findings of this study provide valuable insights into the operations and challenges of Finnish public libraries, it is important to acknowledge certain limitations that may affect the applicability of the results. Primarily, the data collected pertains exclusively to public libraries in Finland, which may limit the generalisability of the conclusions to public libraries in other countries or regions with different cultural, economic, and institutional contexts. Additionally, despite the survey being distributed to all public libraries in Finland, assessing the representativeness of the sample remains challenging. Variations in response rates and potential non-response bias could mean that the sample may not accurately reflect the entire population of Finnish public libraries. These limitations should be considered when interpreting the results and applying them to broader contexts.

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[1] The National Development Task (VAKE) is a set of responsibilities defined by the Library Act. It is managed by the Helsinki City Library and funded by the Ministry of Education and Culture. According to the 2016 Library Act, the purpose of VAKE is to support public libraries equally by implementing shared services and promoting cooperation among them.

[2] There are nine libraries responsible for regional development tasks (AKE). The national and regional development tasks replace the previous central and provincial library system. The regional development task aims to strengthen the operations of public libraries within their areas, support their development and staff expertise, and promote cooperation among libraries. Libraries with this task work together with other regional development libraries, the national development library, and other libraries.

Future research could benefit from a more diverse and representative sample, as well as comparative studies across different countries to enhance the generalisability of the findings. Additionally, longitudinal studies could provide deeper insights into the evolving trends and long-term impacts on public libraries perspectives on acting as hubs for citizen science. Exploring qualitative methods, such as in-depth interviews and case studies (either by following a citizen science project in a library or by being part of one with the dedicated mission to study the citizen science process), could also enrich the understanding of specific challenges and best practices within the library sector. By addressing these areas, future research can build on the current study's findings and contribute to a more comprehensive understanding of public library operations and their role in society.

Declaration of Interest: The authors have declared no competing interests.
Data Accessibility Statement: An anonymised full dataset is available under a CC-BY compatible licence after publication at the Finnish Social Science Data Archive.

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Appendix 1. Survey questions

Background questions	Open ended questions
Q1) Informed consent question	Q7) How do you understand the term "citizen science"
Q2) Library Municipality	Q9) Describe collaboration
Q3) Number of librarians working at your library?	Q11) Describe other activity, that could be classified as citizen science
Q4) Is the library a main library or a branch library?	Q12) How do you perceive the current physical spaces of the library in terms of its suitability for hosting citizen science activities?
Q5) What is your role in the library?	Q13) What physical resources or facilities within the library do you believe could be utilised to support citizen science initiatives?
Q6) Do you have LIS education?	Q14) In what ways do you think the physical spaces of the library could be optimised to encourage citizen science participation and engagement?
Q8) Does your library collaborate with universities or researchers?	Q15) To what extent do you perceive the library's digital infrastructure supports the integration of citizen science projects?
Q10) Does your library take part in another activity that could be classified as citizen science?	Q16) What digital tools or platforms do you think would enhance the digital infrastructure for citizen science engagement within the library?
	Q17) In what ways do you think the digital spaces (infrastructure and platforms) of the library could be optimised to encourage citizen science participation and engagement?
	Q18) How do you perceive the availability of scientific resources and materials within the library to support citizen science projects?
	Q19) What types of knowledge resources (e.g. databases, specialised staff) do you think are essential for promoting citizen science initiatives within the library?
	Q20) In what ways do you believe the library's knowledge resource infrastructure could be enhanced to better facilitate citizen science engagement?
	Q21) What type of partnerships do you think would be beneficial for citizen science initiatives within the library?
	Q22) Do you think the library should take a leading role in citizen science initiatives/partnerships or should libraries act as a vehicle for citizen science projects initiated by other actors?
	Q23) Please add any further thoughts on citizen science in public libraries