Perceived current and potential role of libraries in citizen science initiatives: Stakeholders' perceptions

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ABSTRACT

Citizen Science (CS) has become an important approach for involving the public in scientific research and facilitating collaboration between professional scientists and citizen volunteers. Libraries, which serve as accessible sources of information and centres for community engagement, are strategically positioned to support CS initiatives. The aim of this study is to explore how researchers, project managers and citizen scientists perceive the current and potential role of libraries in CS initiatives in the Malaysian context. Using a qualitative research design, semi-structured interviews were conducted with 13 individuals who are actively involved in CS projects in Malaysia. The thematic analysis, conducted using ATLAS.ti software, revealed different perceptions of current library services and identified opportunities for libraries to improve their role in CS. The results show that library services play a crucial role in providing access to resources and educational tools, supporting data management and analysis, and providing spaces for public engagement and outreach. In addition, libraries have the potential to become comprehensive resource centres for CS and serve as hubs for collaboration that promote public awareness and engagement. They can also act as centres for training and capacity building, equipping individuals with the necessary skills to contribute effectively to citizen science initiatives. Libraries can support the management and preservation of data and the contribution to achieving the Sustainable Development Goals (SDGs) through CS. These findings emphasise the transformative potential of libraries in promoting scientific literacy, sustainability and strengthening public engagement through CS.

Keywords: *Citizen science; Citizen science initiative; Library; Librarian.*

INTRODUCTION

Citizen Science (CS) is an approach to scientific research in which the public is activelyinvolved in scientific investigation. Citizens contribute to data collection, analysis, interpretation of results and even the formulation of research questions, enabling active

participation in scientific discovery and decision-making processes (Bonney et al., 2016; Waugh et al., 2023). Within this approach, the openness of science lies precisely in the opportunity it offers society to actively participate in the process of knowledge production by promoting ways to integrate citizen contributions directly into scientific research (Macq, Tancoigne & Strasser, 2020). According to the UNESCO Recommendation on Open Science (2023, September 21), CS initiatives are recognised as essential for the democratisation of science by improving transparency, accessibility and collaboration in scientific processes.

CS enables the public to actively participate in scientific endeavours, including collecting and analysing data, interpreting results and formulating research questions to solve specific problems (Rammutloa, 2023; Ekström, 2022; Tang & Prestopnik, 2019). These projects utilise different forms of knowledge, such as the replication of established knowledge, collaborative consensus building and the application of existing knowledge. Recent studies emphasise the increasing involvement of communities in scientific research, indicating a global shift towards participatory methods (Giardullo et al., 2023). The success of CS projects depends on a motivated and engaged participant base. Therefore, it is crucial for citizen scientists, project designers and initiators to understand the factors that encourage user participation (Tang & Prestopnik, 2019). This inclusive approach empowers individuals to contribute to data collection, analysis and dissemination. CS has gained traction in various fields, including healthcare ecosystems (Ciasullo et al., 2022), game and task design (Tang & Prestopnik, 2019), water monitoring (Kinchy, Jalbert & Lyons, 2014), and even library science (Rammutloa, 2023).

Over the years, CS initiatives in libraries have steadily increased. Libraries have also embraced the broader framework of open science, defined by UNESCO (2023, September 21) as transparent, accessible, collaborative and inclusive practises to democratise knowledge. While open science emphasises openness and transparency in all scientific processes, CS places particular emphasis on public participation and community involvement (Bonney et al., 2016; UNESCO, 2023, September 21). These two areas overlap significantly, as CS often embodies the principles of open science through public participation, openness of data and accessibility of knowledge. According to Cozan (2022), libraries have adopted open science practises to improve public engagement, as evidenced by initiatives such as STEM workshops and lifelong learning programmes. European research libraries have introduced CS projects to facilitate community-led research and expanded their role as community hubs (Kaarsted et al., 2023; Cohen et al., 2015). With their wide reach and commitment to public service, libraries are in a unique position to support CS initiatives by providing access to information, fostering community engagement, and offering educational resources (Holland et al., 2021). However, the potential role that libraries can play in supporting these initiatives is still largely unexplored and represents a great opportunity to increase their impact on CS efforts, especially in Malaysia (Che Jaafar et al., 2024). Empirical evidence on the current level of awareness of CS in Malaysia remains limited, suggesting that while CS has long been established in research, its application in libraries is relatively new (Rammutloa, 2023).

LITERATURE REVIEW

As technology advances, libraries and librarians have become indispensable in supporting education and research by providing access to scientific literature, data and essential tools. Embedded in the education system, librarians fulfil an increasing demand for reliable information in the academic environment (Li, Wong & Chiu, 2024; Zulfiqar & Khalid, 2024),

a role that is as important as ever (Khoeini et al., 2025). Jefroy and Sgarbossa (2024) and Khoeini et al. (2025) emphasise that libraries are important pillars in education, promoting collaboration and facilitating group learning. Libraries are moving beyond traditional support for research and adapting to changing information needs, user expectations and technological advances (Khoeini et al., 2025; Rammutloa, 2023). The role of librarians has changed. They now act as key intermediaries, ensuring that library resources are accessible, understandable and meet the needs of users (Liu & Liu, 2023). This shift from developing collections to fostering connections is changing the role of libraries and librarians in digital spaces and community engagement (Khosrowjerdi et al., 2024; Johnston et al., 2022).

Citizen science and open science have emerged as important areas of research that are attracting great interest from researchers and librarians alike. To meet the evolving needs of these fields, librarians are developing specialised skills in areas such as data mining, digital curation and bibliometric analysis. These competencies enhance librarians' ability to support research activities and position them as essential contributors to the open science framework that enables effective management of data, informed decision-making and the promotion of transparent, collaborative research endeavours. The rise of CS research has transformed the role of librarians and libraries in supporting research in educational systems (Rammutloa, 2023). Researchers point out that libraries are increasingly able to integrate open science and CS concepts into their services that benefit both research and society, although documentation of these efforts is still limited (Kaarsted et al., 2023). International organisations, including the Association of Research Libraries (ARL) and the Canadian Association of Research Libraries (CARL), have recognised the essential role of libraries in promoting the open science movement (Liu & Liu, 2023). Citizen science programmes have expanded the functions of libraries and librarians, especially in promoting public engagement, excellent data management, and providing the necessary training for CS projects.

Studies show that these programmes not only strengthen the connection between libraries and their communities but also attract new users and improve the public perception of libraries. Despite librarians' initial concerns about increased workload and user engagement, research shows that CS projects generally yield positive results for libraries (Bridgeman, 2023). Bridgeman's (2023) findings emphasise that librarian-led CS initiatives significantly increase community awareness, which in turn encourages greater user participation and improves the public's image of libraries. Librarians are emerging as innovators and pioneers in this field (Bridgeman, 2023; Kaarsted et al., 2023), acting as knowledge centres that support and promote CS efforts (Rammutloa, 2023). This development emphasises the crucial role of libraries and librarians as facilitators of community-engaged research and as active participants in the CS movement.

In Malaysia, CS plays an important role in the realisation of the SDGs. An example of the focus on SDG 15, "Life on Land"," is a study conducted by Lee et al. (2024) on biodiversity in the flora of Peninsular Malaysia. This SDG focuses on the protection and restoration of terrestrial ecosystems through sustainable practises, with an emphasis on responsible forest management, combating desertification, reversing land degradation and conserving biodiversity (United Nations, 2024, October 29). Another CS initiative is a research project led by Idris et al. (2022), which involves planting trees with Malaysian school children. This project is in line with SDG 11, "Sustainable Cities and Communities"," and SDG 13, "Climate Action", and promotes environmental awareness among the young participants. Numerous CS projects have been conducted, including a recent forest inventory in Royal Belum State Park (Fauzi et al., 2024), a survey on the distribution of the non-native fish species

Hemibagrus wyckioides (Aqmal-Naser et al., 2024) and the Universiti Sains Malaysia Campus Nature Challenge (Che Jaafar et al., 2024).

Despite the minimal involvement of libraries in CS projects in Malaysia, awareness of CS is growing. A recent CS initiative "bridging worlds' initiative on libraries as connectors" organised by the Librarian Association of Malaysia in collaboration with several libraries including Universiti Malaya Library, Universiti Malaysia Kelantan Library, Universiti Teknologi MARA Library and Sarawak State Library (Nurfarawahidah et al., 2024). In addition, the "Citizen Science Boot Camp 2024: Train the Trainer" organised by the Universiti Teknologi Malaysia Library highlights the librarians' commitment to CS. This boot camp aims to empower Malaysian librarians as future trainers by equipping them with the essential knowledge, skills and strategies required to effectively engage and motivate the community in CS activities (SciStarter.org., 2024).

METHODS

The aim of this study is to explore the views of CS stakeholders (researchers, project managers and citizen scientists) on the current role of libraries and how these stakeholders perceive the potential role of libraries in CS initiatives. By exploring these areas, this study aims to shed light on how libraries can improve their participation in CS in the Malaysian context. The research questions guiding this study is:

How do researchers, project managers and citizen scientists perceive the current and potential role of libraries in CS?

This study utilised a qualitative research design based on interpretivism, which is suitable for exploring the subjective perceptions and experiences of individuals (Creswell & Poth, 2016) involved in CS projects in Malaysia. Semi-structured interviews were conducted to allow participants to express their views in their own words while providing sufficient structure to answer the research questions.

A purposive sampling method was used to select participants who could provide rich and relevant information (Palinkas et al., 2015). Thirteen participants were selected based on random sampling and snowballing until the data was saturated to provide diverse yet comprehensive insights into CS projects. For this study, 13 participants were selected based on predefined inclusion criteria, including active involvement in CS initiatives in the Malaysian academic environment, particularly in research universities. Participants were initially selected through purposive sampling. A snowballing process was then used to identify additional participants who met the inclusion criteria and had experience with CS projects in Malaysian research universities. The inclusion criteria for the selection of participants were as follows:

i. Active involvement in CS initiatives in Malaysian academic institutions or non-governmental organisations (NGOs).
ii. Roles as researchers, academics or scientists leading CS projects, project managers actively involved in the implementation of CS initiatives, or citizen scientists from the public who have actively contributed or are contributing to CS projects.
iii. Representation of various CS projects in areas such as environmental monitoring, biodiversity conservation, water quality assessment and other natural sciences.
iv. Willingness to participate and provide insights relevant to the objectives of the study.

Researchers, project managers and citizen scientists were invited by email to take part in the semi-structured interviews of the study. Researchers and project managers were combined into a homogeneous group, labelled "key actors", as both roles involve leadership tasks in CS projects, such as designing frameworks, managing project resources, facilitating community engagement and ensuring the sustainability of the project and the integrity of the research. CS projects were identified using key indicators from established frameworks that emphasise public participation, scientific research components, collaboration between scientists and the public, and openness in sharing results (Bonney et al., 2016; Eitzel et al., 2017; Hecker et al., 2018):

i. Public participation: the project involved non-scientists (volunteers, communities, students) in various stages of the scientific process, including data collection, analysis or problem definition
ii. Scientific research component: the project had a structured research component where the data collected contributed to scientific knowledge or research
iii. Collaboration between scientists and the public: the project not only served to educate the public, but actively involved communities in the research
iv. Open data or shared results: the results of the project should be openly shared with participants or the wider scientific community, which is in line with the principles of Open Science (UNESCO, 2023, September 21)

These criteria are consistent with widely accepted definitions of CS, particularly those of Bonney et al. (2016), who emphasise the role of the public in scientific research, and Hecker et al. (2018), who discuss how civic engagement contributes to the impact of research and the democratisation of knowledge.

The investigator contacted the 13 selected participants to arrange interview dates, considering the availability of each individual. The interviews were conducted from February 2023 to January 2024. Each interview lasted between 45 and 60 minutes. Given the wide geographical spread of participants, secure online platforms such as Zoom and Google Meet were used to conduct the interviews. The interview guide (Appendix 1) was jointly developed by the research team. It was explicitly based on the existing literature and aligned with the research questions and objectives of the study. The participants gave their consent for audio and video recordings, and the interviews were then transcribed word for word. Interviewees were given the option to communicate in either English or Malay, and bilingual researchers checked the accuracy of the translations. The choice of language was based on each participant's preference. After transcription, the validity and accuracy of the data was ensured through a member-checking process, where participants could check and confirm the accuracy of their transcripts.

Participants received an information sheet explaining the purpose of the study, procedures, risks and benefits and gave informed consent before participating. Confidentiality and anonymity were maintained by assigning pseudonyms or codes to participants in all protocols and reports (e.g. "R1"). Specific details that could reveal the identity or affiliation of participants, such as project names and institutional affiliations, were anonymised or generalised. Ethical approval to conduct the study was obtained from the Universiti Malaya Research Ethics Committee (UM.TNC2/UMREC_2399). All digital data, including audio and video recordings, transcripts and ATLAS.ti project files, were stored on encrypted, password-protected devices accessible only to the research team. Regular backups are made to secure, encrypted cloud storage to prevent data loss. Participants were informed of the data management procedures and their rights in relation to data withdrawal and data protection.

The thematic analysis was carried out according to the scheme of Braun and Clarke (2006) and supported by the ATLAS.ti software (version 24.0). Immersion in the data was achieved by reading and re-reading the transcripts several times, noting initial observations throughout the process. Line-by-line coding was conducted to identify meaningful sections that related to participants' perceptions of current library services and their potential role in CS.

The transcribed and selected data were organised in electronic files using the codes-to-theory model for qualitative research in Atlas.ti. This research adhered to the codes-to-theory model for qualitative research developed by Saldaña (2016), which is divided into four phases of data analysis. The stages of data analysis include: a) synthesising the raw data into codes; b) identifying patterns through repetition and cognitive schemas; c) clustering through comparison and contrast (categories); and d) formulating key themes based on extended analysis.

Strategies were used in this study to ensure precision and transferability through detailed descriptions of the research context and participant characteristics so that readers can judge the transferability of the results to other situations. Although the purposive selection of participants provided deep insights, it may not cover all perspectives within the diverse landscape of CS in Malaysia. The findings are context-specific and may not be generalisable to other countries or broader populations. Although this study provides valuable insights, there are certain limitations that need to be considered. The study participants were drawn exclusively from higher education institutions and non-governmental organisations (NGOs), which may not reflect the full spectrum of perspectives within Malaysian CS.

RESULTS

The results are presented on the basis of data collected through semi-structured individual interviews. The original data, which is available in both Malay and English, has been translated where necessary by the researcher, who notes any comments that may have been altered in the translation. Table 1 provides an overview of the study participants. The analysis of the interviews with researchers, project managers and citizen scientists has highlighted the main themes in relation to their perceptions of current library services and the potential role of libraries in CS initiatives. The findings are organised into two main sections corresponding to the research questions.

i. Perceptions of the current role of the library

The analysis of stakeholders' perceptions of the current role of libraries revealed three main points themes: a) access to resources and educational tools, highlights the importance stakeholders place on libraries as repositories of specialised resources, reference works and educational support; b) data management and analysis support, highlights the recognised potential of libraries in providing technical expertise and infrastructures essential for data management, analysis and preservation, particularly for CS projects; c) Public spaces for engagement and outreach, reflects stakeholder views on libraries as accessible spaces that promote interactive community engagement and opportunities for experiential learning. A summary of the themes, sub-themes, codes and supporting verbatim evidence can be found in Appendix 2.

a) Access to resources and educational tools

Nine of the thirteen participants viewed libraries primarily as repositories of resources, particularly books, and placed little value on additional services. Five participants saw

libraries as important hubs for obtaining specialised resources, training materials and as important resources for specific academic research. For example, one participant noted that libraries can facilitate access to information on specific topics, such as water conservation, by providing structured guidance to researchers:

Table 1: Overview of study participants

Participants pseudonym	Gender	Institutions type	Position	Research field	Involvement in CS project (Years)
R1-PM	Male	HEI	PM	Biodiversity / Environmental Sciences	6
R2-PM	Male	HEI	PM	Environmental / Water Conservation	11
R3-R	Female	HEI	R	Environmental / Water Conservation	11
R4-PM	Male	HEI	PM	Environmental / Nature Science	7
R5-RPM	Female	HEI	RPM	Climate Change / Nature Science	2
R6-RPM	Female	HEI	RPM	Biodiversity / Environmental Sciences	7
R7-R	Male	HEI	R	Forestry / Waste Management	5
R8-RPM	Female	NGO	RPM	Wildlife Studies / Environmental	8
R9-CST	Male	NGO	CST	Environmental / Aquatic Ecosystems	10
R10-CST	Male	NGO	CST	Environmental / Nature Science	3
R11-CST	Female	NGO	CST	Nature Science	3
R12-PM	Male	NGO	PM	Nature Science	3
R13-RPM	Female	NGO	RPM	Environmental / Nature Science	15

Note: Citizen Scientist (CST), Higher Education Institution (HEI), Non-Governmental Organization (NGO), Project Manager (PM), Researcher & Project Manager (RPM), Researcher (R)

"If I do not know something, for example, if I want to know about water conservation and see how CS can help me, I can go to the library and get all the information available. Instead of doing research on my own, researchers like me or groups like ours can work with the library to develop the content that is made available to the public and get advice" (R3- R).

This illustrates the function of the library as a reliable repository of knowledge and collaborative space that enables researchers and citizen scientists to directly access curated resources. Another participant emphasised the importance of the resources provided by the library for scientific data work:

"Having access to scientific journals and resources through the library is essential, during my time as student and as staff too" (R3-R).

Similarly, another participant commented on the importance of training resources and access to software provided by the library:

"The library provides access to training materials and software relevant to our work, supporting wider learning needs" (R5-RPM).

Another participant reinforced this positive view, describing libraries as a good resource hub to support researchers and individuals seeking up-to-date information on specific research topics, as well as a reference point:

"They can provide researchers or individuals who want to keep up to date on a particular research topic with full access to their resources on site, like a knowledge centre that allows individuals to carry out their activities on site, subject to certain conditions of course" (R8-RPM).

"The library is still an indispensable reference work… many sources from 1890 are still valuable today" (R9-CST).

In addition, R1-PM emphasised the archiving role of libraries: *"I understand that the main task of the library is to archive all information and data. However, archiving means that the data stays there and is not updated. For CS, the library can archive the data, but it needs to update it regularly, especially for resources, which is where libraries are very good"* (R1-PM).

While several participants praised libraries as reliable sources of scholarly and educational materials, some participants pointed out areas where quality and accessibility could be improved. For example, R10-CST noted: *"Library resources here in Malaysia are a bit poor… the community doesn't put that much emphasis on it","* suggesting a gap between the potential of libraries as resource centres and their actual usage.

R10-CST also noted that libraries tend to attract a limited number of people: *"A library is a place where usually only parents with children come. They bring them for some reason. So the library resources are not utilised as much" (R10-CST).*

Furthermore, R12-PM pointed out that libraries need additional resources. He stated, *"The library could be a central resource for further studies, but I'm not sure it's equipped to do that because there are so many digital resources, you might need to add more resources" (R12-PM)*. These views suggest that while libraries are valued, their current capacity to meet diverse and specialised needs is perceived to be patchy. This feedback contrasts with the generally positive feedback from other participants who see libraries as supportive hubs for academic research.

b) Support for data management and analysis

Participants reported that libraries have valuable expertise and skills in managing and analysing data and are therefore well placed to handle the complex, data-intensive tasks often associated with scientific studies. Libraries have specialised knowledge and skills in data analysis tools that are often lacking in many CS project teams. This view reflects a recognition of the traditional role of libraries in organising and managing information, which can be effectively extended to support scientific data needs.

Participants emphasised the technical expertise available in libraries:

“The library can help provide training on data collection. They have a lot of experience in developing skills, they even offer public courses” (R1-PM).

"Librarians have a lot of expertise in analyses and the like... even with me they have a lot of experts. They teach biostatistics, SPSS, C++ and so on, so they have the necessary knowledge. They even teach it in class" (R4-PM).

This observation underlines the realisation that libraries, particularly in academic institutions, employ professionals who are familiar with specialist analytical tools that can make an important contribution to data-intensive projects such as CS. Participants also pointed to the practical and time-saving benefits of library involvement in data management. As one participant noted, *"they are more skilled and efficient in handling data" (R8-RPM)*, suggesting that library support is seen as a pragmatic solution for researchers who lack the resources or time to organise and analyse data due to other project commitments.

Beyond data analysis, participants recognised the expertise of libraries in data management, particularly in organising and storing data to ensure its accessibility and reliability. One participant commented, *"I think the library can help a lot with data management because they have experience with managing information and data; even though I do research online myself, I know the library can help more in this area" (R2-PM)*. Another participant said: *"The library can provide a server where the metadata is stored so that it is easily accessible to both the organisers and the public because libraries are very closely connected to the community" (R12-PM).*

Nevertheless, some hesitation remains, as R3 expressed: "*We know that the library can help with data management and analysis, but we are still hesitant to include the library in our CS project. I am quite surprised that our library is interested in collaborating and I welcome that" (R3-R)*. These responses reflect the participants' confidence in the libraries' ability to manage information methodically. Similarly, R4-PM commented: *“We didn't have resources or sufficient expertise and had limited time due to other priorities, so when the library invited us we were interested. I never expected the library to be interested in this kind of project" (R4-PM)*. Libraries are considered to be well equipped with the necessary processes and expertise to organise data efficiently. This recognition suggests that libraries' data management and technical skills to improve the efficiency and quality of data processing in CS projects are highly valued.

c) Spaces for public engagement and public relations work

Study participants commented on their perceptions of libraries as places for public engagement and emphasised the value of adapting library services to the diverse needs of the community. Libraries were perceived as valuable institutions that facilitate interaction with the public, particularly through events, exhibitions and community learning environments. However, participants also highlighted challenges related to access and emphasised the need for improved management and outreach strategies.

One participant pointed out the limited accessibility of academic libraries, which are often restricted to campus communities:

"As you know, the academic library tends to be restricted to the campus community and is not freely available to the public. If there is a CS project that involves the public at the university, it would be beneficial if the academic library advertises it and invites everyone" (R6-RPM).

This view suggests that widening access and promoting CS projects could enable libraries to extend their reach to a wider audience and thus strengthen their role as a hub for community engagement. Furthermore, there is a consensus that libraries provide spaces that are inherently conducive to civic engagement, as R1-PM noted: *"Libraries have also been known as friendly places since before gadgets became popular and can easily engage the community".*

Participants emphasised that effective management is crucial to promote public engagement. One participant emphasised this by saying, *"The library could play a bigger role in engaging the public, but it depends a lot on how well the library is managed... better community involvement is needed" (R10-CST)*. This emphasises that good management is essential to create a welcoming and accessible environment that encourages meaningful public participation.

Libraries were also perceived as adaptable platforms for experiential and interactive learning. One participant described how their local library functions as a venue for events and exhibitions beyond traditional book lending:

"We have a library in our clubhouse. The kids used to come a lot, but since COVID that has slowed down... when we have programmes with the kids" (R13-RPM).

This illustrates how libraries are actively engaging communities through events that promote science and nature-based learning. Another participant shared how libraries served as central places of engagement in his hometown, explaining:
"When I was growing up, the library in my small town always offered school holiday programmes... you don't just go to the library and read something, you go out into nature... always a meeting place" (R6-RPM).

These reflections show how a diverse range of programmes, particularly for a young audience, can encourage engagement and strengthen the role of libraries as community hubs. Similarly, another participant noted that libraries are becoming increasingly attractive: *"Because we know that the library is a centre of the community... the library has become more interesting with the new facilities, the colours and everything" (R12-PM)*.

The concept of "living libraries" was introduced by another participant who saw the library as a place of interactive knowledge exchange between community members, such as local fishermen: *"You know, in Europe there are living libraries where people come and talk to people, and these are our fishermen. So, we have them as local knowledge, as community knowledge, and the library should do the same" (R13-RPM)*.

I dream of turning my place into a living laboratory where students can come regularly, but it is not yet time for that. Therefore, the library, which has facilities, can become a living laboratory that also works with the community" (R9-CST).

This suggests that libraries could function as spaces for experiential and interpersonal learning by facilitating access to academic knowledge through community-led initiatives rather than just traditional materials. Similarly, libraries served as central hubs for community information and gatherings, suggesting, *"Like ancient palaces, all information and agendas can be housed there. We can use the concept of a library in a similar way, especially for the community" (R2-PM)*. Participants also described efforts to integrate interactive formats such as exhibitions and digital content to engage the community in novel

ways: *"As well as books, we have an exhibition site in the works... we're putting that together visually... we're creating the samples for the eco museum in Forest City" (R13-RPM)*. By providing multimedia resources and events, libraries can cater to different learning preferences, promoting public interest in CS and other science initiatives, as R2 noted.

ii. Potential role of libraries in CS

The study participants consistently identified libraries as a linchpin in supporting CS. They highlighted five interlinked roles: a) comprehensive resource centres that centralise data and tools; b) public engagement hubs that promote awareness and participation; c) training and capacity building centres that equip communities with the necessary skills; (d) data management and preservation that secure information for future use; and e) supporting the SDGs through CS initiatives. Appendix 3 summarises the themes, subthemes, codes and supporting verbatim evidence.

a) Libraries as comprehensive resource centres for CS

Libraries are increasingly seen as comprehensive resource centres for CS. Participants emphasised the potential of libraries to provide scientific materials, databases and tools such as anecdata and iNaturalist, which are essential for research and data collection in CS projects. Participants noted that libraries could facilitate the work of citizen scientists by centralising these resources. Four participants commented:

"Each ministry has its own data and the community has its own perception or understanding of CS. So I hope the library can be a centre for resources for CS, especially SDG-related CS. The resources can be books and tools. So if the library can be a resource centre for all the information about CS that people need, that would be good" (R6-RPM).

"Also, there are so many online resources on CS such as ANEC data, iNaturalist and apps. People who are interested in biodiversity may not know about the iNaturalist app. I hope the library can make local or global resources accessible to these people" (R3-R).

"We use iNaturalist to collect biodiversity data. iNaturalist is one of the easiest ways to store data, so we don't have to worry too much about backend issues".

"Libraries provide a wealth of educational materials that can help both professionals and volunteers learn more about the scientific aspects of our projects" (R4-PM).

Anecdata is an online platform designed for citizen scientists to collect, manage and share environmental data. By providing access to such platforms, libraries can simplify the process of collecting and analysing data for citizen scientists.

"If there were drones or digital tools for data collection in the field, the library could help with more than just software training" (R10-CST).

"The library can act as a one-stop shop where people interested in a CS project can get basic information and an initial insight into the project they are interested in. This will help to raise public interest in becoming a citizen scientist (R12-PM).

"The library could provide equipment, e.g. suitable free tools or environmental sensors that can be borrowed for data collection" (R5-RPM).

Through these roles, libraries could strengthen their position as a comprehensive resource hub that facilitates access to valuable CS tools and information. By providing support and resources, libraries can empower individuals to make meaningful contributions to scientific research, fostering public engagement and scientific literacy. In addition, centralising resources in libraries fosters a sense of community among citizen scientists.

b) Libraries as a collaborative hub for public engagement and CS awareness

Participants emphasised the important role of libraries as collaborative hubs for promoting public engagement and raising awareness of CS initiatives. This role leverages libraries' extensive networks, resources, and community influence to promote public understanding and participation in CS projects. One participant noted, *"Nowadays, people would rather search for information online than go to the library to find materials. So what the library can do to bring people into the library is to promote and publicise CS projects. I think the library can play a role in CS. Think about how you can get people to visit the library physically and virtually through these projects" (R1-PM)*.

Two participants emphasised the concept of libraries taking an active role in promoting CS initiatives. For example, R12-PM stated: *"The library can be the 'voice' for CS projects by publicising and promoting them so that the public knows about them."* Another participant supported this and suggested: *"The library can be an online hub or platform to share information about CS projects with the public and make them accessible" (R11-CST)*. Furthermore, R6-RPM pointed out that *"the potential role of the library is to engage the public and stimulate their interest in CS projects."* The same participant (R6-RPM) further explained, *"If there is a CS project that also comes from the university library, and they just publicise it and invite everybody… that would be even better because sometimes the university library has... has better management."*

Participants also discussed the value of libraries as platforms for disseminating information about CS through events such as exhibitions, workshops and awareness-raising days. These events can showcase ongoing projects, demonstrate the impact of CS and give community members the opportunity to engage with scientific research. Such initiatives not only serve to educate but also inspire the community and foster a substantive connection to scientific endeavours. As participants said:

"If the library actively promotes CS, it could get more people to participate in these projects" (R4-PM).

"Libraries can promote the project, manage the project with the help of the organisers, train the citizen scientists and share the results with the public" (R12-PM).

R6-RPM continued: *"So the library is very interested and will… develop the materials and posters and a workshop. These are things that the library can also lead on" (R6-RPM)*, reflecting the expectation that librarians can take a proactive role in coordinating events and outreach. Further insights centred on the concept of libraries working with "living libraries'," i.e. those with expertise in areas such as history, architecture and technology, to document and disseminate valuable information. As R7-R explained, *"The library can document all this data and serve as a resource to connect Malaysians."* R12-PM echoed this view: *"The library could be a primary facilitator for spreading awareness of CS by organising events such as exhibitions or awareness days."* R6-RPM also emphasised: *"We are basically organising a campus challenge with iNaturalist… We're going to award the most species, the most*

interesting sightings and the best photo. The library is actively leading this collaboration," demonstrating how librarians help plan and implement interactive CS activities.

c) Libraries as centres for training and capacity building in CS

Participants in this study considered libraries as important centres for training and capacity building and emphasised their role in developing skills related to data collection, analysis and the use of specific tools for CS initiatives. This function is in line with the educational mission of libraries and extends their impact by empowering community members to actively participate in scientific research. As R1-PM stated, *"the library can be a place for capacity building for CS participants by teaching them how to use tools and collect data properly."*

"We have a lot of data and we are trying to open it up and translate this information into a more public-friendly and understandable form. The library can also help us with that" (R6-RPM)

Participants discussed the wide range of capacity building activities that libraries could support. R8-RPM mentioned, *"The library can provide capacity building activities for researchers with different roles,"* suggesting that libraries have the potential to support a diverse group of participants in CS projects. Similarly, R12-PM noted, *"If the library has training materials or tools for CS projects, that would be really helpful,"* emphasising the value of resources that enable effective participation. Ensuring data quality through appropriate training was another important theme. R4-PM emphasised, *"The library can help provide training on data collection or how to use SPSS or any free courses for citizen scientists or volunteers,"* which emphasises the importance of equipping citizen scientists with both basic and advanced analytical skills. Another participant, R9-CST, stated, *"The library does indeed play a role in developing skills, from data collection to using software for analysis,"* highlighting the comprehensive nature of the training that libraries can provide. By providing workshops and training, libraries can equip participants with the necessary skills to use scientific tools and mobile applications and to follow data collection protocols effectively. Three participants emphasised this point, stating,

"The library can help us train citizen scientists to ensure that the data we collect is accurate and of high quality" (R5-RPM).

"It's important to have a specific guide before you send them out into the field. That helps with the understanding and accuracy of the data and the library should help with that because the library is a real place of knowledge" (R9-CST).

"To get high quality and accurate data, the library can train the citizen scientist in the right methodology" (R12-PM).

d) Libraries as data managers and custodians for CS

Libraries have the necessary infrastructure and expertise to support the long-term storage and archiving of CS data. This is crucial to ensure that valuable project information remains accessible for future research and reference. Study participants saw libraries as natural custodians for the preservation of CS data due to their established role in information management and archiving. As two participants noted,

"The library has helped us manage the data and we will run the project with the library's support and provide a platform for participants to upload their observations" (R4-PM).

“If the library can help with data management, I am very happy because as academics we have a lot of work to do. To support the open science initiatives, maybe the academic library can do the data curation or use the data for the future” (R6-RPM).

Another participant emphasised: *"The library can be a long-term data repository for CS and ensure that the data remains secure and accessible" (R10-CST)*. In addition, one participant emphasised the possibilities of the library:

"The library has the capacity and capability to manage data with a skilled team trained to handle metadata and data requests from CS organisers. This includes offering servers or automated tools for the reliable storage and preservation of data in the future" (R12-PM).

This finding emphasises the trust placed in libraries to maintain the integrity and accessibility of data over time. By utilising their existing archiving systems and digital repositories, libraries can provide secure storage solutions that protect data from loss, degradation or obsolescence. Another interviewee explained the importance of data storage for the continuity of the project: *"The library has the potential to become a central hub for the organisation and management of CS data, with a focus on making the information accessible and sustainable for long-term use" (R2-PM)*. Another participant added: *"If the library archives our data, it can be reused in the future. CS projects can have continuity" (R8-RPM)*. R9-CST and R10-CST made similar comments:

"If the library becomes an archive for CS data, it is easy to refer back to it for future studies" (R9-CST).

"Our goal is to create baseline data and process it systematically for long-term monitoring. Data management is an ongoing task and we strive for consistency; hopefully the library can be part of this in the future" (R10-CST).

These comments illustrate how libraries can facilitate the reuse of data so that future researchers and citizen scientists can build on previous work. By archiving CS data, libraries not only safeguard the results of current projects, but also contribute to the sustainability and longevity of CS initiatives.

e) Libraries support the SDGs through CS

Participants emphasised the potential of libraries to align their functions with the SDGs, particularly in areas related to environmental protection and public health. By supporting CS initiatives that address these global goals, libraries can increase their societal impact and contribute to sustainable development efforts.

"The library can align itself with the SDGs, for example in projects that raise environmental awareness” (R6-RPM).

"The library could align its programmes with the SDGs and make CS a way to tackle environmental problems" (R13-RPM).

This emphasises how libraries can integrate SDG-related initiatives into their services by supporting CS projects that focus on issues such as climate change, biodiversity and pollution. In this way, libraries not only provide resources and tools, but also raise awareness and encourage community engagement on critical environmental issues.

Two participants noted:

"For projects that involve clean water, which is an SDG need, the library can help by providing resources or data" (R3-R).

"If the library provides resources and data for the SDGs, it could help the community be more active in sustainability" (R7-R).

This comment emphasises the role that libraries can play in promoting projects that address specific SDGs, such as clean water and sanitation (SDG 6). By providing access to relevant data, educational materials and technical support, libraries empower citizen scientists to help monitor and improve water quality in their communities.

DISCUSSIONS

The results of the study provide valuable insights into the perceptions of researchers, project managers and citizen scientists regarding the current and potential future role of libraries in supporting CS initiatives in Malaysia. Participants referred to both academic libraries in universities and public libraries in communities. Some quotes refer specifically to academic libraries, reflecting the higher education context of the participants, while others emphasise the potential of public libraries as important hubs for engagement in local communities. Figure 1 illustrates the journey from existing perceptions of the role of libraries to their planned contributions, highlighting areas where libraries could become key players in CS initiatives. This section summarises the findings on the key themes, explores the gaps and discusses the implications for libraries seeking to expand their societal impact. Libraries have evolved beyond their traditional role as repositories for books to become comprehensive resource centres for CS initiatives. These facilities now serve as hubs for community engagement, providing access to scientific equipment, data collection tools and educational materials to support CS projects (Cigarini et al., 2021; Kaarsted et al., 2023).

Libraries are widely recognised for their ability to provide access to resources and educational tools. Participants recognised that libraries act as important gateways to scientific literature, databases and educational materials. Nevertheless, study participants noted that the quality and accessibility of these resources is inconsistent, especially across different geographical regions in Malaysia. While some libraries are well-equipped and efficiently managed, others are inadequate, limiting the ability of researchers and the public to access important CS tools. This disparity highlights the need for a more standardised and dynamic approach to curating and distributing resources. Libraries need to expand their offerings and maintain up-to-date content that directly supports CS, thus evolving into comprehensive knowledge centres that respond to diverse research needs (Hansen, 2021; Mumelaš & Martek, 2024).

The themes of data management and support for analysis highlights the strengths and limitations of current library services. Libraries are seen as competent partners for the organisation and analysis of data, often being better in these areas than many IT teams (Wolski, Krahe & Richardson, 2020). Study participants felt that libraries have specialist skills in handling data, such as statistical analysis software, and were confident in their ability to manage complex datasets. This view is particularly underlined by the realisation that libraries are not just passive repositories of information but can proactively help users to navigate complex datasets and use statistical analysis software effectively. As Wheatley and

Hervieux noted, a shift in library strategic planning that incorporates data handling as a core competency is essential (Lai, 2023). Libraries are increasingly recognised as key players in RDM as they are able to address challenges such as data privacy, protection and collaboration while using specialised software for effective data analysis (Goldman et al., 2023; Sheikh, Malik & Adnan, 2023).

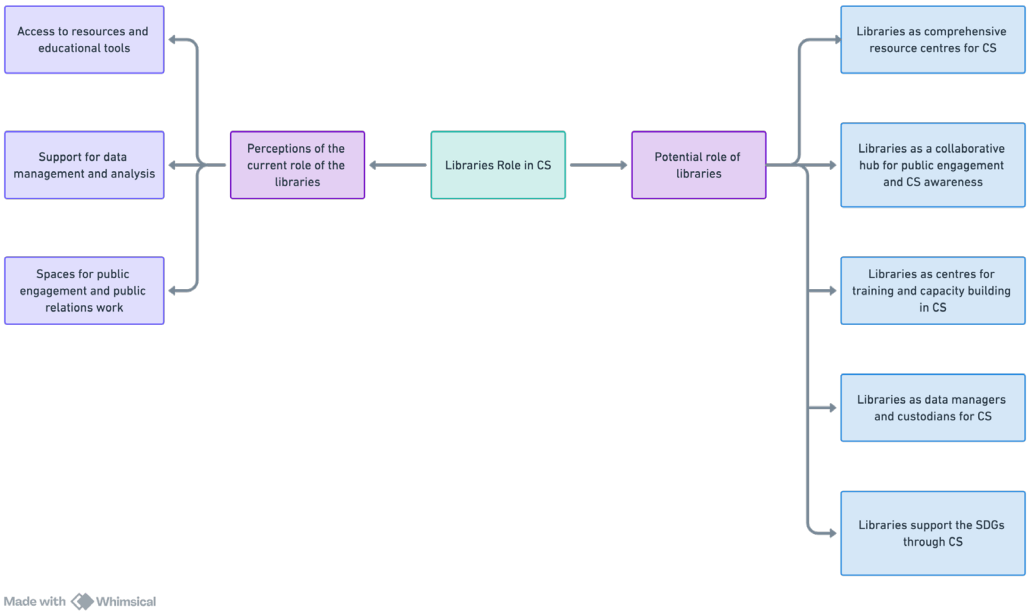

Figure 1: Themes related to the perceived and potential role of the library in CS

Despite this finding, the results show that library services are underutilised, primarily due to a lack of awareness or framework for collaboration. This situation presents an opportunity for libraries to proactively engage with citizen scientists and position themselves as key partners in data management. Through such engagement, libraries can help optimise research processes and ensure data quality, making them an essential factor in the success of CS projects (Herodotou, Scanlon & Sharples, 2021; Katapally, 2019).

Another important theme was public engagement and outreach, reflecting the traditional role of libraries as anchors for the community. Participants emphasised that libraries can serve as important venues for public engagement by providing events, exhibitions and experiential learning activities to promote CS (Cigarini et al., 2021; Bridgeman, 2023). However, challenges such as limited access to academic libraries and public libraries' limited outreach efforts hinder their effectiveness. Participants expressed a desire for libraries to be more welcoming and better equipped to engage diverse audiences. This would require strategic investment in infrastructure and programming, as well as efforts to increase the visibility of libraries as centres for scholarly research and community interaction. By becoming dynamic centres for public engagement, libraries can foster a culture of learning and collaboration, improving the public's access to science (Holland et al., 2021; Martek, Mučnjak & Mumelaš, 2022).

The results also revealed several potential roles for libraries that could significantly increase their impact on CS. One of the most promising roles is that of libraries as centralised resource centres for CS. Participants envisioned that libraries could establish dedicated departments

for CS resources, including educational materials, biodiversity databases, and digital tools. This role would not only facilitate access to important information, but also position libraries as central hubs for scientific engagement (Kalfatovic et al., 2023). Furthermore, the role of collaborative partners in project promotion and outreach was emphasised. Participants suggested that libraries should utilise their extensive community networks to raise public awareness of CS initiatives and facilitate their participation. This active involvement in science communication and outreach would raise the profile of libraries and make them essential to the success of CS projects (Wiggins, Derickson & Simmons-Jenkins, 2020).

Another potential role is for libraries to serve as centres for training and capacity building. Participants emphasised the need for libraries to offer workshops and educational programmes that provide citizen scientists with the necessary skills in data collection, research methodology and data analysis. By investing in capacity building, libraries can empower individuals to contribute meaningfully to scientific research and promote a scientifically literate society (Rammutloa, 2023; Mumelaš & Martek, 2024). In addition, the topic of data storage and long-term archiving options fits well with the traditional role of libraries in preserving information. Participants suggested that libraries could extend this role to archiving CS data to ensure that valuable datasets remain accessible for future research and use. This would provide continuity for CS projects and strengthen the reputation of libraries as reliable stewards of scientific information (Hansen, 2021; Sorensen et al., 2022).

Finally, participants emphasised the role of libraries in supporting the SDGs through CS. By aligning their activities with the SDG goals, libraries could promote environmental protection, public health and other important issues. Participants envisioned that libraries could support CS projects that address global sustainability challenges and thus contribute to broader societal well-being. This alignment with the SDGs would not only increase the impact of library services but also position libraries as important players in the global movement for sustainability (Fraisl et al., 2023; Bangani & Dube, 2023).

To summarise, the results highlight both the current perception of the role of libraries and the potential for growth in supporting CS. While libraries are known for their traditional strengths such as resource access and data management, there is significant untapped potential for them to evolve into roles that actively promote scientific engagement, facilitate capacity building and align with global sustainability efforts. Bridging the gap between perceived and potential roles requires strategic collaboration, greater awareness and a commitment to innovation. By seizing these opportunities, libraries can transform themselves into dynamic centres of CS that have a significant impact on both local communities and broader scientific endeavours.

CONCLUSIONS

This study provides a comprehensive analysis of the current perception of the role of libraries and the potential role of libraries in CS in the Malaysian context. The findings emphasise the need for libraries to expand their services beyond traditional roles and position themselves as active participants in CS initiatives. By acting as resource centres, promoting community engagement, providing training and capacity building programmes, preserving data and aligning with the SDGs, libraries can significantly increase their contribution to CS endeavours. The insights gained from this research contribute to the growing literature on the role of libraries in supporting open science and CS and offer

practical implications for library practitioners and policy makers. Future research could investigate the implementation of these roles in practise and evaluate the effectiveness of library-led CS initiatives and their impact on community engagement and scientific outcomes. In addition, comparative studies across different regions or countries could provide a broader perspective on the global potential of libraries in the CS movement.

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CONFLICT OF INTEREST

The authors have no relevant competing interests to declare in relation to the content of this article.

AUTHOR CONTRIBUTION

Conceptualization: [B. Nurfarawahidah, K. Kiran, A.M.K. Yanti Idaya], Methodology: [M.F. Faizal Hamzah, B. Nurfarawahidah], Formal analysis and investigation: [B. Nurfarawahidah, A.M.K. Yanti Idaya, M.F. Hamzah], Writing - original draft preparation: [K. Kiran, B. Nurfarawahidah]; Writing - review and editing: [all authors]

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Appendix 1: Semi-structured interview questions

General information:

1. Tell me about yourself.
2. What stage is your citizen science project currently at?
3. Who initiated your project?
4. What is your (main) role in the CS project?
5. Can you describe your experience working on CS projects? What kind of research or activities are you involved in?
6. What are the fields of action of your CS project?

Perception of current library services and the potential role of libraries in CS:

7. Can you tell us about your experience with library services?
8. Have you ever worked with a library or used a library for your CS work or other projects? If so, can you tell us what that experience was like?
9. What specific library services have you found helpful or lacking?
10. How do you see the role of libraries in supporting scientific research, especially citizen science? How do you think libraries could better support your work?
11. What kind of resources or support do you think libraries should provide to make your CS projects more effective?
12. Are there any tools, training or facilities that you think libraries should provide?
13. How important do you think libraries are for civic engagement in citizen science?
14. How do you feel about libraries helping to provide data for CS projects?
15. Do you think libraries have the capacity or expertise to help effectively in these areas?
16. How do you envisage libraries playing a more active role in citizen science initiatives in the future?
17. Are there specific ideas or projects that you think libraries could take the lead on or get more involved in?

Appendix 2: Summary of themes, sub-themes and verbatim for the perceived role of the library in CS

Themes	Sub-themes	Codes	Verbatim evidence
Access to resources and educational tools	Provision of specialised resources and training tools	Information access	*"If I want to know about water conservation... I can go to the library to get all the information available." (R3-R).*
			We didn't have resources and sufficient expertise and had limited time due to other priorities" (R4-PM).
		Scientific resources	*"Access to academic journals and resources through the library is essential." (R3-R).*
		Training resources	*"The library provides access to training materials and software relevant to our work, supporting wider learning needs." (R5-RPM).*
	Quality and accessibility of library resources	Need for regular updates and improvement	*"The library can archive, but needs to be updated regularly, especially in terms of resources." (R1-PM).*
			"Library resources are a bit lacking here in Malaysia… the community doesn't put that much emphasis on it." (R10-CST).
		Need for diverse & inclusive resources	*"It's as if a library is a place normally used only by parents with children... not widely used." (R10-CST).*
			"The library could be a central resource for more studies…. you might need to add more resources for diversity." (R12-PM)
Support with data management and analysis	Technical expertise in data management and analysis	Training in analysis tools and data processing	*"The library offers training in data acquisition. They have a lot of experience in developing skills, they even offer public courses" (R1-PM).*
			"The librarians teach biostatistics, SPSS, C++…. they even teach it in class." (R4-PM).
			"They are more skilful and efficient in handling data." (R8-RPM).
		Data processing and archiving	*"The library can be very helpful in managing data... it has experience in managing information and data." (R2-PM).*
			"The library can provide a server for storing metadata that can be accessed by the organisers and the public." (R12-PM).

	Perceived obstacles to Collaboration in data management	Reluctance to collaborate	*"We know that the library can help with data management and analysis, but we are still hesitant to include the library in our CS project. I'm quite surprised that our library is interested in collaborating." (R3-R)* *We didn't have resources or sufficient expertise and had limited time due to other priorities, so when the library invited us, we were interested. I never expected the library to be interested in this kind of project." (R4-PM)*
Spaces for public engagement and outreach	Libraries as hubs for community engagement	Libraries offering programmes for the community	*"When I was growing up… not just… reading something, but really getting involved, going out into nature… always a meeting place" (R6-RPM).* *"We have a library in our clubhouse. The kids used to come a lot, but since COVID it's slowed down… when we have programmes with the kids" (R13-RPM).*
		Libraries as multipurpose spaces	*"The library from the time before gadgets became popular is also known as a friendly place..."(R1-PM).* *"So, because we know that the library is a centre of community... the … library has become more interesting… new facilities..."(R12-PM).* *"Like the palaces used to be… we can utilise the concept of the library in a similar way, especially for the community."(R2-PM).*
	Innovative library models for engagement	Living libraries and living labs	*"You know, in Europe there are living libraries where people come and talk to people… that's our fisherman… local knowledge..." (R13-RPM).* *"I dream of making my place a living laboratory where students can come regularly…. a library that has spaces can become a living lab that also works with the community."(R9-CST).*
		Modernised library spaces and interactive exhibits	*"...the library has become more interesting with the new facilities, the colours and everything that goes with it." (R12-PM).* *"In addition to the books, we have a display area in the works…. we are creating the specimens for the Forest City Ecomuseum and the library should move there as well" (R13-RPM).*
	Obstacles and challenges to public engagement	Inadequate promotion and	*"As you know, the academic library is rather limited to the campus*

	management of the library	*community…. it is not freely accessible to the public..."(R6-RPM).* *"The library could play a bigger role in engaging the public, but it depends… on how well it is managed…. better community involvement is needed" (R10-CST).*
	Decline in library visits over time	*"When I was growing up, the library in my small town always offered school holiday programmes… you don't just go… there... you go out into nature… always a meeting place."(R6-RPM).* *"A lot of kids used to come a lot, but since COVID it's slowed down…when we have programmes with the kids."(R13-RPM).*

Appendix 3: Summary of themes, sub-themes and verbatim for the potential role of libraries in CS

Themes	Sub-themes	Codes	*Verbatim Evidence*
Libraries as comprehensive resource centres	Centralizing CS tools and materials	Provision of online platforms and databases	*"We use iNaturalist to collect biodiversity data. iNaturalist is one of the easiest ways to store data, so we don't have to worry too much about backend issues" (R2-PM).* *"Also, there are so many online resources from CS like ANEC data, iNaturalist as well as apps... i hope the library can make local or global resources accessible to these people." (R3-R).* *"Each ministry has its own data and the community has its own perception... So I hope that the library can be a centre of resources for CS..." (R6-RPM).*
		Educational references and materials	*"Libraries offer a wealth of educational materials that can help both professionals and volunteers learn more about the scientific aspects of our projects." (R4-PM).* *"...if the library can be a resource centre for all the information about CS that people need, that would be good."(R3-R).*
	Specialised equipment and technical support	Loan equipment	*"If there were drones or digital tools for data collection in the field, the library could help with more than just software training." (R10-CST).* *"The library could provide equipment, such as appropriate free tools or environmental sensors that can be borrowed for data collection." (R5-RPM).*
		One-stop centre and technical guidance	*"The library can act as a focal point where people interested in a CS project can obtain basic information and engage with the subject matter at an early stage... stimulate public interest in becoming citizen scientists." (R12-PM).* *"If there were drones or digital tools... the library could not only help with software training." (R10-CST).*
Libraries as collaborative centres for public engagement & awareness	Promotion of CS initiatives and projects	Online/on-site promotion and awareness	*"Nowadays people prefer to look for information online… the library can… engage people by promoting and creating awareness..." (R1-PM).* *"If there's a citizen science project that's also run by the university library and they just publicise it and invite everyone to it,*

			that would be even better, because sometimes the university library… has... better management" (R6-RPM). *"The library can be an online hub or platform to share information… and make it accessible" (R11-CST).*
		Promoting public interest and engagement	*"The potential role of the library is to involve the public and get them interested in CS projects." (R6-RPM).* *"If the library actively promoted citizen science, it could get more people to participate in these projects." (R4-PM).*
	Organising outreach events and exhibitions	Organising and presenting CS activities	*"The library can document all this data and serve as a resource to connect Malaysians." (R7-R).* *"Libraries can promote the project, manage… it... Provide training… and disseminate the results to the public." (R12-PM).* *"So the library is very interested and will… develop the materials and posters and a workshop. These are things that the library can also lead " (R6-RPM).*
		Facilitating collaboration and awareness	*"The library could be a key facilitator for spreading awareness of citizen science by organising events such as exhibitions or awareness days" (R12-PM).* *"We're basically organising a campus competition with iNaturalist… We're going to award the most species, the most interesting sightings and the best photo. The library is actively leading this collaboration" (R6-RPM)*
Libraries as centres for training and capacity building in CS	Training for data collection and analysis	Field methods and basic tools training	*"The library can be a place where citizen science participants can build their skills by learning how to use tools and collect data properly" (R1-PM).* *"If the library had training material or tools for CS projects, that would be really helpful" (R12-PM).*
		Technical skills for software and analysis	*"The library can help provide training on data collection or the use of SPSS, or free courses for citizen scientists or volunteers" (R4-PM).* *"The library does indeed play a role in the development of skills, from data collection to the use of software for analysis" (R9-CST).*
	Data quality and methodological	Guidelines and standard protocols	*"It is important to have a specific lead candidate before sending him into the*

			field… the library should help with this..." (R9-CST).
			"In order to obtain good quality and accurate data, the library can train the citizen scientist in the correct methodology" (R12-PM).
		Quality control and accuracy	*"The library can help us train citizen scientists to ensure the data we collect is accurate and high-quality" (R5-RPM).*
			"We have a lot of data… we are trying to open it up… the library can help us… put this information into a more public-friendly form" (R6-RPM).
Libraries as data managers and custodians for citizen science	Long-term data storage and archiving	Maintenance of digital repositories and archives	*"The library helped to manage the data… it provided a platform for participants to upload their observations" (R4-PM).*
			"The library can be a long-term data repository for citizen science, ensuring that data remains secure and accessible" (R10-CST).
		Metadata Standards & Curation	"If the library can help with data management, I'm very happy…. maybe the academic library can curate the data or use the data for the future" (R6-RPM).
			"The library has the capacity… trained to handle metadata and data requests… provides servers… reliable data storage..." (R12-PM).
	Enabling the reuse and continuity of data	Open data and reusability	*"If the library archives our data, it can be reused in the future. CS projects can have continuity" (R8-RPM).*
			"The library has the potential to become a central hub… making information accessible and maintaining it for long-term use" (R2-PM).
		Continuity of data processing	*"If the library becomes an archive for CS data, it is easy to refer back to it for future studies" (R9-CST).*
			"Data management is an ongoing task… hopefully the library can be part of it in the future" (R10-CST).
Libraries support the SDGs through CS	Alignment with environmental and health goals	Linking local efforts to the SDGs	*"The library can orientate itself towards the SDGs, for example in projects that raise environmental awareness" (R6-RPM).*
			"The library could align its programmes with the SDGs and make citizen science a way to tackle environmental problems" (R13-RPM).

	Targeting resources for sustainability	*"For projects that involve clean water… the library can help by providing resources or data" (R3-R).* *"If the library provides resources and data for the SDGs, it could help the community to be more active in sustainability" (R7-R).*