*Journal of Infrastructure, Policy and Development* 2024, 8(5), 5072.
https://doi.org/10.24294/jipd.v8i5.5072

Review

# Applying participatory research in solid waste management: A systematic literature review and evaluation reporting

**Yiming He[1,2], Zeinab Zaremohzzabieh[1,3], Haliza Abdul Rahman[1,4,*], Sharifah Norkhadijah Syed Ismail[4], Jing Bin-qiang[5]**

[1] Institute for Social Science Studies, Universiti Putra Malaysia, Serdang 43400, Malaysia
[2] School of Social and Public Administration, Lingnan Normal University, Zhanjiang 524088, China
[3] Women and Family Studies, University of Religions and Denominations, Qom 3749113357, Iran
[4] Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang 43400, Malaysia
[5] Faculty of Human Ecology, Universiti Putra Malaysia, Serdang 43400, Malaysia
*** Corresponding author:** Haliza Abdul Rahman, dr.haliza@upm.edu.my

**CITATION**

He Y, Zaremohzzabieh Z, Rahman HA, et al. (2024). Applying participatory research in solid waste management: A systematic literature review and evaluation reporting. Journal of Infrastructure, Policy and Development. 8(5): 5072. https://doi.org/10.24294/jipd.v8i5.5072

**ARTICLE INFO**

Received: 6 March 2024
Accepted: 23 April 2024
Available online: 27 May 2024



**Abstract:** This study aims to investigate the effectiveness of community involvement in waste management through participatory research. Its objective is to bridge the theoretical underpinnings of participatory research with its practical implementation, particularly within the realm of waste management. The review systematically analyzes global instances where community engagement has been incorporated into waste management initiatives. Its principal aim is to evaluate the efficacy of participatory strategies by scrutinizing methodologies and assessing outcomes. To achieve this, the study identified 74 studies that met rigorous criteria through meticulous search efforts, encompassing various geographical locations, cultural contexts, and waste management challenges. In examining the outcomes of participatory research in waste management, the study explores successful practices, shortcomings, and potential opportunities. Moving beyond theoretical discourse, it provides a detailed analysis of real-world applications across various settings. The evaluation not only highlights successful engagement strategies and indicators but also critically assesses challenges and opportunities. By conducting a comprehensive review of existing research, this study establishes a foundation for future studies, policy development, and the implementation of sustainable waste management practices through community engagement. The overarching goal is to derive meaningful insights that contribute to a more inclusive, effective, and globally sustainable approach to waste management. This study seeks to inform policymaking and guide future research initiatives, emphasizing the importance of community involvement in addressing the complexities of waste management on a global scale.

**Keywords:** participatory research; solid waste management; systematic review; and evaluation report

## 1. Introduction

Solid waste management presents an enduring global challenge, necessitating innovative and sustainable solutions. The insufficient management of solid waste not only presents environmental, health, and social challenges but also emphasizes the crucial role of community participation and stakeholders in tackling this complex issue (Kwakye et al., 2023). Within the framework of addressing the multifaceted challenges linked to solid waste management, participatory research emerges as a powerful tool that not only redefines the conventional approach but also advocates for effective waste management, community empowerment, and stakeholder engagement (Abma et al., 2019).

Participatory research represents a departure from the traditional top-down decision-making paradigm prevalent in solid waste management (Duea et al., 2022). It empowers communities, recognizing their indispensable role in shaping waste management solutions. This approach ensures that strategies are rooted in local contexts and priorities, significantly increasing their likelihood of success. Furthermore, participatory research is deeply committed to inclusivity and equity, allowing marginalized communities to actively shape waste management strategies (Davis and Ramírez-Andreotta, 2021). By providing a platform for previously marginalized voices, it promotes social justice and fair distribution of benefits. Active community engagement fosters ownership and responsibility, contributing to long-term sustainability (Ewnetu and Wondirad, 2019). Additionally, participatory research leverages local knowledge, including waste generation patterns and cultural practices, to tailor effective and culturally sensitive solutions. Collaborative research builds social capital within communities, enhancing cohesion and collective problem-solving (Bretos et al., 2021). It stimulates sustainable behavior change through awareness and empowerment. Beyond community participation, participatory research promotes collaboration among diverse stakeholders. These stakeholders encompass not only community members but also local authorities, businesses, environmental organizations, and governmental bodies. The engagement of diverse stakeholders is essential for holistic and comprehensive waste management approaches. It ensures that the perspectives and interests of all relevant parties are considered, leading to more inclusive, equitable, and effective solutions (Batista et al., 2021). By involving stakeholders and communities as collaborators rather than subjects, participatory research fosters a sense of ownership and shared responsibility.

Participatory research in solid waste management has been recognized as a promising approach, but its actual impact and application have not been comprehensively assessed. While individual studies have looked into the use of participatory methods, there is a need for a systematic review that rigorously evaluates the existing knowledge about participatory research in solid waste management. This study aims to contribute to both academia and practical applications by assessing the effectiveness of engagement strategies, examining existing practices, and evaluating outcomes. The goal is to provide a comprehensive overview of the current status of participatory research in the field of solid waste management, which can inform future research directions, policy development, and practical implementation. Ultimately, the review aims to promote sustainable solid waste management practices and empower communities and stakeholders to shape the future of waste management.

For this study, a systematic review was conducted to track cases of community participatory approaches in solid waste management globally. The main objective of this study is to evaluate the effectiveness of engagement strategies, examine the current practices, and assess the outcomes. The aim of the study is not only to promote solid waste management but also to empower community participation with a focus on achieving sustainable environmental impact. This research can provide a significant contribution to policymakers, practitioners, and community leaders to help them design and implement participatory initiatives that are not just environmentally sound but also socially inclusive and economically viable. Moreover, by highlighting the best

practices and challenges, this research can pave the way for future innovations and improvements in community engagement strategies in solid waste management.

## 2. Materials and methods

In this study, the authors conducted a systematic review to comprehensively identify and analyze primary studies on participatory research in solid waste management. The systematic review is a secondary study that employs a well-defined approach to systematically determine, assess, and interpret scientific evidence related to a specific research question (RQ) or topic area in an unbiased and repeatable manner.

### 2.1. Objective and research questions

To systematically define the research objective, we adopted the Goal-Question-Metric (GQM) (Caldiera and Rombach, 1994) approach. The GQM goal is a measurement goal formalized according to certain dimensions (Althoff et al., 1999), outlined in **Table 1**.

**Table 1.** Research objective.

| | |
|---|---|
| **Analyze** | Participatory research in the realm of solid waste management research. |
| **Assess** | Effectiveness of engagement strategies, examining the practices in place, and evaluating the outcomes. |
| **Promote** | Solid waste management and empowered participation in the community. |

The main goal of this study is to examine how community participation impacts solid waste management research. We aim to evaluate different engagement strategies, analyze existing practices, and assess outcomes to understand how they contribute to effective waste management and empower community involvement. This objective is broken down into three research questions (RQs), each with its rationale, as described in **Table 2**.

**Table 2.** Research questions.

| ID | Question | Rationale |
|---|---|---|
| $RQ_1$ | What is the current status of participatory approach application in solid waste management research, as evidenced by graphical and descriptive analyses? | To establish a baseline for how community participation is applied in solid waste management, enabling the identification of existing trends and gaps |
| $RQ_2$ | How have participatory approaches been implemented in solid waste management research to date, and what is the quality of the research methodologies used in these studies, as indicated by a table of evaluation results? | To evaluate the methodologies of past studies, ensuring the validity and reliability of participatory approaches in this field. |
| $RQ_3$ | What are the best opportunities and main challenges in implementing participatory research in solid waste management research? | To distill effective strategies and recognize common obstacles in community participatory approaches, informing future improvements in practice and research. |

Through $RQ_1$, the authors aim to summarize the current status of community participatory research within solid waste management research. Our analysis includes details such as author, year, country, purpose, types of community participatory

approaches, sampling method, designing interview/survey questions, and main findings. $RQ_2$ assesses the implementation of community participatory approaches up to the present, with a specific focus on evaluating the quality of the research methodology used in previous studies. $RQ_3$ identifies the best practices and main challenges faced in implementing community participatory research in solid waste management research.

## 2.2. Search strategy

In conducting the systematic review, an essential step is identifying relevant studies to address RQs (Berge and Pollock, 2018). Various approaches exist for developing and evaluating search strategies (Legese et al., 2020). Our study adopted an iterative approach, analyzing and refining the search string through multiple iterations in bibliographic databases (October and November 2023). The initial search yielded 7486 articles, revealing potential noise due to broad terms. To validate this, a similar search in Google Scholar's top 100 results was conducted. Two authors independently assessed relevancy. The study then modified the search string, incorporating criteria from the prior systematic reviews. This refinement resulted in two search string combinations (**Table 3**), retrieving a total of 1,618 studies. The revised string reduced noise and improved accuracy. Selected databases (Web of Science, ProQuest, Scopus, Science Direct, and Google Scholar) offer comprehensive coverage of solid waste management literature.

**Table 3.** Search keywords.

| Type | Searching string |
|---|---|
| A | ("Community-Based Participatory Research") OR ("Community-Engaged Research") AND ("Waste Management" OR "waste sorting" OR "waste reduction") |
| B | ("Participatory Action Research" OR "Action research") AND ("Solid Waste Management" OR "Municipal Waste Garbage Management" OR "domestic waste" OR "household refuse") |

## 2.3. Study selection process

The provided information outlines the search methodology employed in this study. The systematic review was conducted by researchers to extract crucial information from existing literature. In the initial phase of the search process, the researchers systematically explored five designated digital databases. The results of these searches were compiled, leading to the creation of a preliminary list of 7486 papers. Subsequently, a thorough selection process was implemented in the second stage, resulting in the removal of duplicate data and reducing the list to 493 papers.

To assess the quality of these papers, researchers applied specific criteria and aligned them with the study's overarching questions. The final step in the search process involved screening the papers, and incorporating an additional validation procedure to ensure adherence to exclusion and inclusion criteria, as detailed in **Table 4**. The outcome of this rigorous process yielded a refined list of 74 papers. **Figure 1** illustrates the step-by-step procedure followed for screening and selecting the studies. To consolidate studies from various databases, a reference management system, RefWorks, was utilized to import all data into a single spreadsheet document.

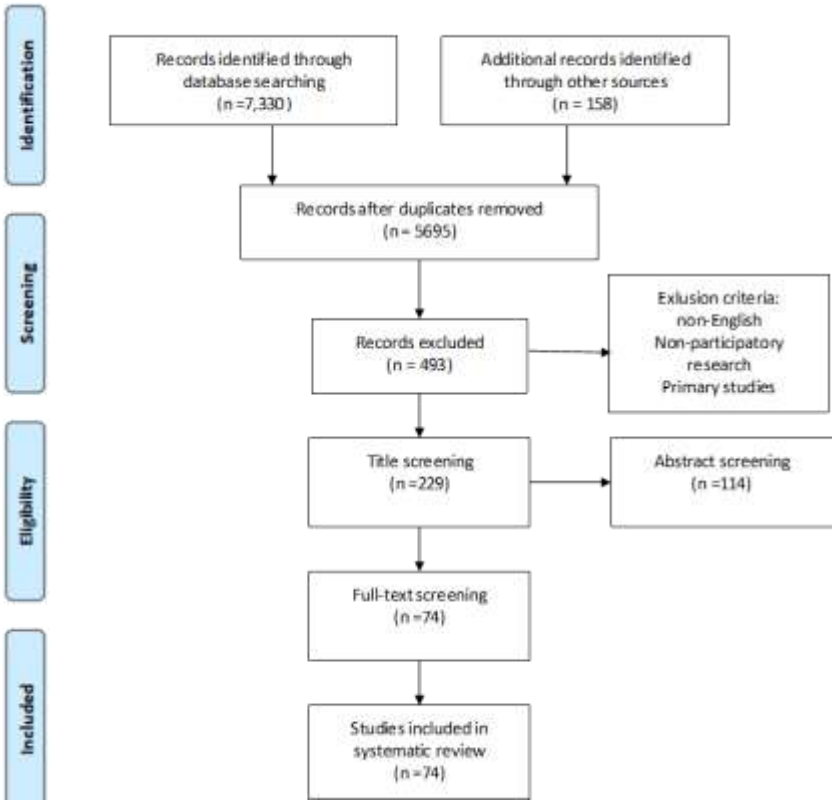


**Figure 1.** Flow chart of literature search.

**Table 4.** Inclusion and exclusion criteria.

| Inclusion criteria | Exclusion criteria |
|---|---|
| The article needs to be written in English | Any studies are written in other languages |
| All papers focus on participatory approaches in solid waste management | Papers that had no connection to the study's questions |
| Articles that may provide insight into at least one RQ | Unfinished studies include grey ones that do not apply to the research's goals |
| Only case studies should be included | Duplicate papers |
| Articles(≥ 3pages) | Short articles (≤ 3 pages) |

## 2.4. Study quality assessment

Kitchenham et al. (2009) proposed that in the quality assessment (QA) process in an SLR, it is necessary to investigate whether differences in study quality could explain differences in the study results, and if this notion can be used as a means of realizing the importance of studies during results synthesis. According to Wohlin (Wohlin et al., 2012), there is no universally agreed-on and applicable definition of study quality, although the most practical means for QAs are checklists. For this purpose, the authors used Kitchenham's (2009) guidelines to define the quality criteria. To increase assessment validity, each primary study was reviewed by two authors. The primary studies included qualitative studies and QA criteria were established based on the following questions proposed by Kitchenham (Kitchenham et al., 2009):

- $QA_1$. Are the study findings credible?
- $QA_2$. How adequately has the research process been documented?

- $QA_3$. How defensible, scientific, and detailed is the design?
- $QA_4$. How well has the design evaluation been conducted?

The authors scored each study as Y = 1 (concrete and reliable information), P = 0.5 (partially available information), and N = 0 or Unknown (no information is specified). The studies were scored as follows: $QA_1$ investigates the credibility of the findings and to what extent the findings are important to the domain. $QA_2$ is related to the scientific reporting of the research process and the results. $QA_3$ evaluates how defensible and scientific the approach is, and the level of detail of the primary study's discussion. The last question ($QA_4$) refers to the evaluation process of the findings.

### 2.5. Data analysis

In the systematic review, descriptive statistics were employed to address the $RQ_1$, focusing on quantitative assessments of publication year, source, research type, contribution type, and study quality. To answer the $RQ_2$ and $RQ_3$, a thematic synthesis approach was adopted (Cruzes and Dyba, 2011). This involved coding primary studies using ATLAS.ti. as a tool for inductive coding, to explore the application of community participatory approaches in solid waste management and assess the outcomes. The coded data were organized into nodes and documents, representing code categories and primary studies, respectively. The use of ATLAS.ti facilitated the import, coding, retrieval, search, and review of textual data, streamlining the qualitative analysis process (Mugambe et al., 2022). ATLAS.ti method-neutral nature and principles for structuring code categories proved effective, saving time and effort compared to manual coding. Previous research has highlighted the software's capability to enhance accuracy and speed in qualitative data analysis while reducing the potential for human error, particularly when conducting electronic searches (Zairul and Zaremohzzabieh, 2023).

## 3. Results

From the initial pool of 7486 studies, this SLR identified 74 papers based on their significant contributions to the subject. In this section, we provide a synthesis of the outcomes and the results derived from the analysis of these primary studies. Section 1 offers a comprehensive overview of the studies, including an examination of publication years, research types, and contribution types within the solid waste management domain (addressing $RQ_1$). Section 2 further expounds on the findings related to elements of solid waste management, evaluation methodologies, quality attributes, and application areas (addressing $RQ_3$). In section 3 we investigate the discoveries about challenges and opportunities associated with the implementation of participatory research in solid waste management (addressing $RQ_2$).

$RQ_1$: What are the intensity and characteristics of research about participatory approach application in the context of solid waste management research?

Our research aims to understand the depth and distinctive features of studies focusing on the application of the participatory approach in solid waste management. The literature review covers primary studies published up to 2023, offering a thorough overview of the evolution of participatory approaches in waste management research. Particularly, there has been a significant increase in scholarly interest in participatory

methods, particularly between 2016 and 2019, as illustrated in **Figure 2**. This temporal pattern indicates heightened attention to integrating participatory methods into solid waste management practices. The surge in publications during this period can be attributed to the growing prevalence of participatory action research and community-based participatory approaches. These methodologies, which emphasize collaboration and engagement with stakeholders and communities, likely influenced the increased focus on participatory approaches in solid waste management research. Particularly, the first instances of these two concepts converging in research titles were documented in the year 2000 (Christensen, 2014), marking a key moment in the scholarly discourse on participatory approaches in waste management (**Figure 2**).

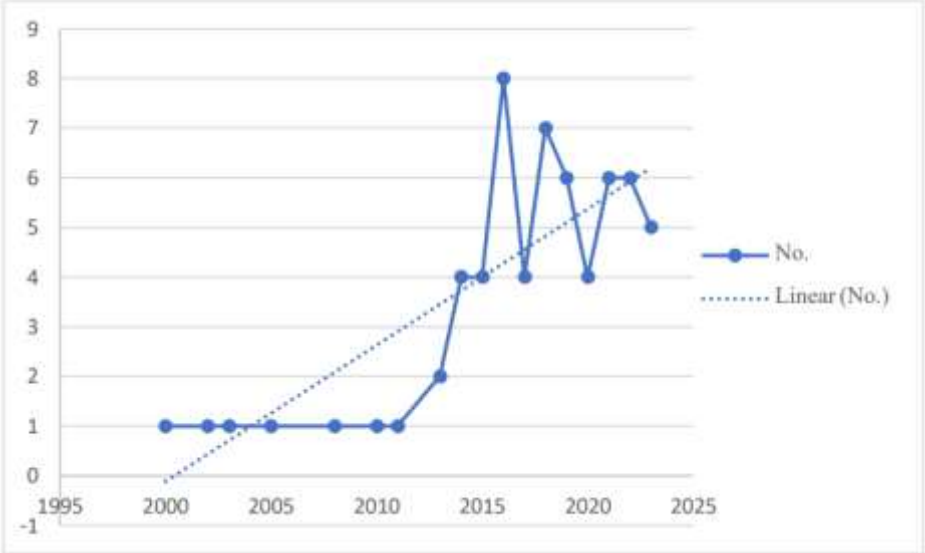


**Figure 2.** Number of publications per year.

The present analysis spans a diverse range of countries, with Brazil leading with 14 reported cases, followed by Ghana with 6 cases, and Hong Kong with 1 case. Notable instances include Indonesia, Uganda, Thailand, Argentina, Iran, Italy, Malaysia, South Africa, New Zealand, Finland, Nepal, Zimbabwe, the United Kingdom, Mexico, and Kenya, each reporting a single case. This diversity underscores the varied prevalence of solid waste management challenges across different regions and emphasizes the importance of employing community participatory research for a comprehensive understanding and effective mitigation of the issues at hand (**Figure 3**).


**Figure 3.** Distribution of papers by country of lead author.

In our investigation of solid waste management, we employed various participatory approaches, including Participatory Action Research (PAR), Art-Based Research (ABR), Action Research (AR), Community-Based Participatory Research (CBPR), Participatory Appraisal (PA), Participatory Research (PR), Participatory Rural Appraisal (PRA), Participatory Rural Community Appraisal (PRCA), and Participatory Video (PV). These approaches were systematically applied and classified, as depicted in **Figure 3**. Particularly, PAR emerged as the most prominently utilized method, encompassing a significant 72% of the publications. CBPR followed closely, accounting for 10%, while AR, PA, and PV comprised 3% and 2%, respectively. These results highlight a pronounced preference for PAR in the literature on solid waste management, indicating its effectiveness and relevance in navigating the intricate challenges within this domain (**Figure 4**).

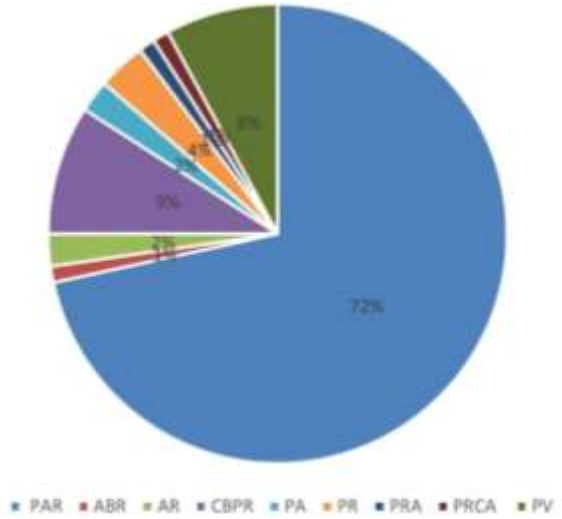


**Figure 4.** Participatory research type.

The findings depicted in **Figure 5** reveal that the literature referenced in our systematic review employed a combination of research methods, with a specific emphasis on triangulation to augment the reliability and validity of the results. The

systematic review, encompassing previous studies that applied participatory research in waste management, revealed a diverse set of research methods employed to thoroughly investigate the application of participatory research in the realm of solid waste management.

The literature drawn upon in our study utilized a blend of these methods, prioritizing triangulation to fortify the robustness of the findings. Triangulation in this context involved the integration of various data sources, such as observation-generated field notes, document analysis, open-ended interviews, and closed-ended survey questions. This methodological approach aimed to capture the dynamic evolution of the solid waste management process and mitigate potential biases linked to relying solely on recall in reported data, particularly during summative evaluation.

The present study underscores the importance of combining both recorded and reported data gathered at multiple junctures throughout the research process. This emphasis on integration is crucial for providing a comprehensive understanding of the contextual conditions and decision-making processes related to solid waste management. **Figure 5** visually represents the diverse sources of data employed in our study, illustrating the comprehensive nature of the research methods used in investigating participatory approaches in solid waste management.

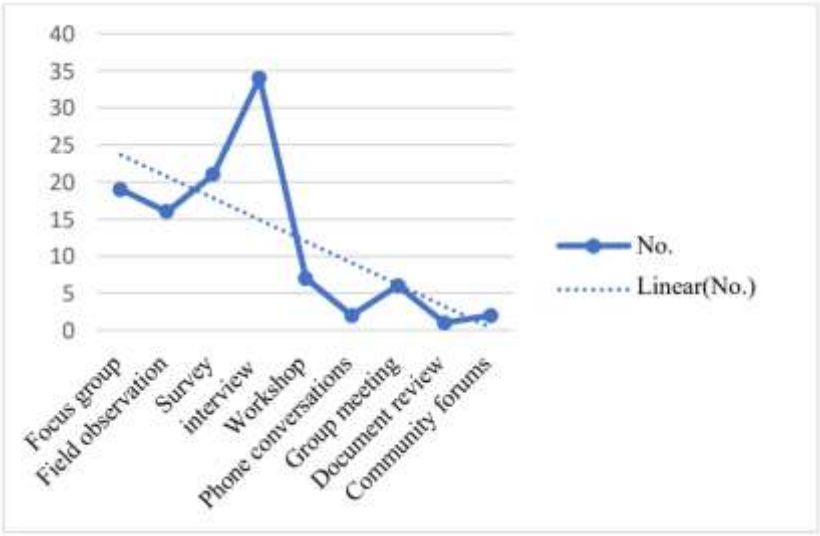


**Figure 5.** Data source.

$RQ_2$: What do the results reveal about how well participatory research works in the field?

The outcomes of this study offer a significant contribution to the efficacy of participatory research in the field. Evaluations, as per Patton (Patton, 1997), require well-defined criteria aligned with the evaluation type and objectives. However, Bellamy (Bellamy et al., 2001) highlights the complexity of selecting criteria due to the multiple goals often associated with participatory processes. Patton (1987) emphasizes the challenge of finding valid quantitative measures for variables in participatory research, particularly in research on solid waste management. The selection of criteria and data for evaluation is acknowledged as a contentious issue (Wulfhorst et al., 2012). Blackstock et al. (2007) provide a summary of potential

criteria for participatory research evaluation based on existing literature, which is employed in this study to assess both process and outcome in 74 participatory research studies related to solid waste management. The analysis of these studies uncovers both strengths and weaknesses in the participatory research process, providing valuable insights into its overall effectiveness. When examining the leadership aspect across 44 studies, a significant inadequacy is revealed, with 60% reporting shortcomings. Specifically, visionary leadership and effective coordination are found to be lacking, and personal agendas frequently compromise coordination roles. Additionally, communication issues exacerbate challenges, with 67 studies identifying problems in this area. Notably, the Community Working Group (CWG) remains unaware of progress post-2002, leading to uncertainties regarding the outcomes of the deliberative sustainable solid waste framework (DSSF).

In addition, 38 studies found that in 51% of cases, conflict resolution was insufficient. Internal power imbalances within groups contribute to decision-making challenges, reflecting broader conflicts and power inequalities in the local political landscape. However, in terms of influencing the process in 70 studies, participants generally feel adequately empowered (95%). Despite this, evidence suggests varying capacities and competencies affecting discussions. In representation and context criteria, representation in 21 studies shows a mixed spread, with 28% reporting inadequacies. The CWG had open access but missed certain voices, while the DSSF lost social/community focus during group mergers. Context evaluation in 26 studies is deemed inappropriate to rank in all instances, signaling challenges in considering the impact of political, social, cultural, historical, and environmental contexts on the process/project (35%).

In outcome criteria, accountability in 26 studies presents a critical problem, with 35% of studies highlighting inadequacies. Participants struggled to update constituents, creating uncertainties about the validity of the process. Conversely, capacity building in 70 studies shows positive outcomes, with 95% adequacy. Participants perceived improved individual capacity to engage in future processes. Emergent knowledge in 57 studies is inconclusive in 77% of cases, revealing difficulties in judging impacts and evaluating this criterion. Recognized impacts in 64 studies are problematic across the board, with no monitoring of implementation, poor communication of achievements, and contested notions of sustainability. Social learning in 57 studies emerges as a positive aspect, with participants acknowledging the exchange of ideas and knowledge. However, evidence suggests a limited transformation of actual practices. Transparency in 54 studies is uniformly inadequate, with 73% citing a lack of clarity in decision-making processes and inconsistent implementation, hindering external observers.

The overall evaluation indicates that there are significant shortcomings in the key process and outcome criteria. Therefore, it is necessary to focus on improving leadership, communication, representation, accountability, and transparency. Although capacity building and social learning have shown positive results, there are still challenges in transforming knowledge into practical actions. The study highlights the multifaceted nature of participatory research in sustainability initiatives and emphasizes the need for nuanced and adaptive approaches to address the identified shortcomings (**Table 5**).

**Table 5.** Evaluative results for participatory research in solid waste management.

| No. | Author(s) | Champion/leadership | Communication | Conflict resolution | Influence on the process | Presentation | Context | Outcome | Capacity building | Emergent knowledge | Recognized Impacts | Social learning | Transparency |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Moreira et al. (2019) | | √ | | √ | √ | | √ | √ | √ | √ | | √ |
| 2 | Oduro-Appiah et al. (2021) | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 3 | Tremblay & Jayme (2015) | √ | √ | | √ | | √ | √ | √ | √ | √ | √ | √ |
| 4 | Siu & Xiao (2020) | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 5 | Yates & Gutberlet (2011) | √ | | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 6 | Bayu et al. (2022) | | √ | √ | | | | √ | √ | | | √ | √ |
| 7 | Becker et al. (2019) | √ | √ | √ | √ | | √ | √ | √ | √ | √ | √ | √ |
| 8 | Bezerra & Iared (2019) | √ | √ | √ | √ | | √ | | √ | √ | √ | √ | √ |
| 9 | Bukirwa et al. (2022) | √ | | √ | √ | | | | | | | √ | √ |
| 10 | Bureecam et al. (2016) | | √ | | √ | | √ | | √ | | √ | √ | |
| 11 | Carreon & Flores (2023) | | √ | | √ | | √ | | √ | √ | √ | √ | √ |
| 12 | Gutberlet et al. (2017) | √ | √ | √ | √ | √ | √ | | √ | √ | √ | √ | √ |
| 13 | Christensen (2014) | √ | | | | | √ | | √ | √ | | | |
| 14 | Adam-Bradford (2006) | | √ | | √ | | | | √ | | √ | | √ |

**Table 5.** (*Continued*).

| No. | Author(s) | Champion/leadership | Communication | Conflict resolution | Influence on the process | Presentation | Context | Outcome | Capacity building | Emergent knowledge | Recognized Impacts | Social learning | Transparency |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | Dias & Ogando (2015) | √ | √ | | √ | √ | √ | | √ | √ | √ | √ | √ |
| 16 | Carenzo & Good (2016) | | √ | √ | √ | | √ | | √ | √ | √ | √ | √ |
| 17 | Dokmaingam & Manomaivibool (2017) | | | | | | | | √ | √ | | | √ |
| 18 | Adenrele (2014) | | √ | | √ | | √ | | √ | √ | √ | | √ |
| 19 | Firmansyah et al. (2022) | √ | √ | | √ | | √ | √ | √ | √ | √ | √ | √ |
| 20 | Gutberlet et al. (2021) | √ | √ | √ | √ | √ | √ | | √ | √ | √ | √ | √ |
| 21 | Gutberlet (2016) | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 22 | Gutberlet et al. (2017) | √ | √ | | √ | | √ | | √ | √ | √ | √ | √ |
| 23 | Gutberlet et al. (2017) | √ | √ | | √ | √ | √ | | √ | √ | √ | √ | √ |
| 24 | Hadi (2022) | √ | √ | | √ | | √ | | √ | | √ | √ | √ |
| 25 | Hamzah et al. (2023) | √ | √ | | √ | | | | √ | | √ | √ | √ |
| 26 | Heydari et al. (2021) | | | | √ | | | | √ | | | | √ |
| 27 | Gutberlet et al. (2013) | √ | √ | √ | √ | √ | √ | | √ | √ | √ | √ | √ |
| 28 | Kittitornkool & Burt (2006) | √ | √ | | √ | | √ | | √ | √ | √ | √ | √ |
| 29 | Inayah et al. (2018) | | √ | | √ | | | | | | | | |

**Table 5.** (*Continued*).

| No. | Author(s) | Champion/leadership | Communication | Conflict resolution | Influence on the process | Presentation | Context | Outcome | Capacity building | Emergent knowledge | Recognized Impacts | Social learning | Transparency |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | Islami & Prihantoro (2023) | | √ | | √ | | √ | | √ | √ | √ | √ | √ |
| 31 | Gutberlet (2015) | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 32 | Lederer et al. (2015) | | √ | | √ | | √ | √ | √ | √ | √ | √ | √ |
| 33 | Hornsby et al. (2017) | | √ | | √ | | √ | √ | √ | √ | √ | √ | √ |
| 34 | Zen et al. (2016) | √ | √ | √ | √ | | √ | | √ | √ | √ | √ | √ |
| 35 | Niyobuhungiro & Schenck (2021) | | | | √ | | √ | | √ | √ | | √ | |
| 36 | Gutberlet (2008) | √ | √ | √ | √ | √ | √ | √ | √ | | | √ | √ |
| 37 | Farrelly & Tucker (2014) | | √ | | √ | | √ | | √ | √ | √ | √ | √ |
| 38 | Manomaivibool et al. (2018) | | √ | | √ | | √ | | √ | √ | √ | √ | √ |
| 39 | Heikkilä et al. (2016) | √ | √ | √ | √ | | √ | | √ | √ | | √ | √ |
| 40 | Linzalone et al. (2017) | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | | √ |
| 41 | Janprasert & Suttawet (2021) | | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 42 | Malekafzali et al. (2022) | | √ | | √ | | √ | | √ | √ | √ | | √ |
| 43 | Oyegunle & Thompson (2018) | √ | √ | √ | √ | | √ | | | √ | √ | | |
| 44 | Krisnanda et al. (2023) | | √ | | √ | | √ | | √ | | √ | | √ |
| 45 | Kristianto & Widya (2021) | | √ | | √ | | √ | | √ | | √ | | √ |

**Table 5.** (*Continued*).

| No. | Author(s) | Champion/leadership | Communication | Conflict resolution | Influence on the process | Presentation | Context | Outcome | Capacity building | Emergent knowledge | Recognized Impacts | Social learning | Transparency |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 46 | Lambert-Pennington et al. (2018) | √ | √ | | √ | | √ | | √ | √ | √ | √ | √ |
| 47 | Little (2020) | √ | √ | | √ | | √ | | √ | √ | √ | | √ |
| 48 | Lotfi et al. (2021) | √ | √ | √ | √ | | √ | | √ | √ | | | √ |
| 49 | Muhajirin & Kusuma (2021) | √ | √ | √ | √ | | √ | | √ | | √ | √ | |
| 50 | Muyassarah et al. (2022) | | √ | √ | √ | | √ | | √ | | √ | √ | √ |
| 51 | Nima et al. (2019) | √ | √ | | √ | | √ | | √ | √ | √ | | √ |
| 52 | Niyobuhungiro & Schenck (2022) | √ | √ | | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 53 | Nugrahini et al. (2023) | | √ | | √ | | √ | | √ | | √ | √ | √ |
| 54 | Oduro-Appiah (2020) | √ | √ | | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 55 | Oduro-Appiah & Scheinberg (2020) | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 56 | Opoku-Asare et al. (2013) | | √ | | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 57 | Pattra et al. (2023) | √ | √ | | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 58 | Praneetham et al. (2016) | | √ | | √ | | √ | | √ | | √ | | √ |
| 59 | Gutberlet et al. (2017) | | √ | | √ | | √ | | √ | √ | | | √ |
| 60 | Oduro-Appiah et al. (2019) | √ | √ | √ | √ | | √ | | √ | √ | √ | √ | √ |
| 61 | Rosyidah (2021) | | √ | | √ | | √ | | √ | √ | √ | √ | √ |

**Table 5.** (*Continued*).

| No. | Author(s) | Champion/leadership | Communication | Conflict resolution | Influence on the process | Presentation | Context | Outcome | Capacity building | Emergent knowledge | Recognized Impacts | Social learning | Transparency |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62 | Johnson & Wilson (2000b) | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 63 | Johnson & Wilson (2000a) | | √ | | √ | | | | | | | | |
| 64 | Sawetrattanakul et al. (2019) | | √ | | √ | | √ | | √ | √ | √ | √ | √ |
| 65 | Schenck et al. (2023) | √ | √ | √ | √ | | √ | | √ | √ | √ | √ | √ |
| 66 | Siriput et al. (2018) | √ | √ | | √ | | | | √ | | √ | √ | √ |
| 67 | Sridan & Surapolchai (2020) | √ | √ | | √ | | | √ | √ | √ | √ | √ | √ |
| 68 | Velenturf et al. (2018) | √ | √ | | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 69 | Jiménez-Martínez & García-Barrios (2020) | √ | √ | √ | √ | | √ | √ | √ | √ | √ | √ | √ |
| 70 | Tantrakarnapa et al. (2018) | | √ | | √ | | √ | √ | √ | √ | √ | √ | √ |
| 71 | Taylor (2008) | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 72 | Tremblay & Peredo (2014) | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 73 | Wanjiru et al. (2019) | | √ | | √ | | √ | | √ | √ | √ | | √ |

$RQ_3$: What are the challenges and opportunities of adoption of the participatory research in solid waste management?

In a systematic exploration of the challenges and opportunities associated with the adoption of participatory research in solid waste management, our comprehensive literature review revealed a multitude of factors influencing the implementation of such approaches. **Table 6** succinctly outlines the identified challenges, providing insights into the intricacies of participatory research in this context. One of the main difficulties faced when using participatory approaches is the presence of engagement barriers. These barriers are caused by socio-cultural factors that prevent full participation and representation. Many studies have confirmed this issue. For example, overcoming socio-cultural barriers to involve all community segments is a significant challenge. In a study conducted by Siu and Xiao (2020), it was observed that certain socio-cultural norms hindered the active participation of specific demographic groups. Another significant obstacle is the lack of resources, both financial and human. Limited financial and human resources often hinder the initiation and sustainability of participatory projects. For example, in the research by Yates and Gutberlet (2011), resource constraints were identified as a major obstacle in implementing waste management initiatives effectively.

**Table 6.** Challenges in implementing community participatory approaches in solid waste management.

| Challenge | Description & Context for Solid Waste Management | References |
|---|---|---|
| Engagement Barriers | Overcoming socio-cultural barriers to engage all community segments can be difficult, affecting inclusivity and representativeness. | (Siu and Xiao, 2020; Becker et al., 2019; Bukirwa et al., 2022; Carreon and Flores, 2023; Gutberlet et al., 2017; Carenzo and Good, 2016; Gutberlet, 2016; Hamzah et al., 2023; Kittitornkool and Burt, 2006; Opoku-Asare et al., 2013; Islami and Prihantoro, 2023; Lederer et al., 2015; Hornsby et al., 2017; Zen et al., 2016; Gutberlet, 2008; Linzalone et al., 2017; Nugrahini et al., 2023; Janprasert and Suttawet, 2021; Lotfi et al., 2021; Rosyidah, 2021; Niyobuhungiro and Schenck, 2022; Gutberlet et al., 2017; Oduro-Appiah et al., 2019; Johnson and Wilson, 2000b) |
| Resource Constraints | Limited financial and human resources can impede the initiation and sustainability of participatory projects. | (Siu and Xiao, 2020; Yates and Gutberlet, 2011; Bukirwa et al., 2022; Carreon and Flores, 2023; Adam-Bradford, 2006; Carenzo and Good, 2016; Dokmaingam and Manomaivibool, 2017; Firmansyah et al., 2022; Gutberlet, 2016; Hadi, 2022; Hamzah et al., 2023; Heydari et al., 2021; Gutberlet et al., 2013; Islami and Prihantoro, 2023; Hornsby et al., 2017; Zen et al., 2016; Niyobuhungiro and Schenck, 2021; Gutberlet, 2008; Manomaivibool et al., 2018; Janprasert and Suttawet, 2021; Malekafzali et al., 2022; Oyegunle and Thompson, 2018; Lambert-Pennington et al., 2018; Lotfi et al., 2021; Muhajirin and Kusuma, 2021; Niyobuhungiro and Schenck, 2022; Nugrahini et al., 2023; Pattra et al., 2023; Oduro-Appiah et al., 2019) |
| Knowledge and Skills Gap | Insufficient community knowledge and skills can hinder effective participation and implementation of solid waste management strategies | (Siu and Xiao, 2020; Yates and Gutberlet, 2011; Becker et al., 2019; Bezerra and Iared, 2019; Bukirwa et al., 2022; Carreon and Flores, 2023; Gutberlet et al., 2017; Dias and Ogando, 2015; Carenzo and Good, 2016; Dokmaingam and Manomaivibool, 2017; Firmansyah et al., 2022; Hadi, 2022; Hamzah et al., 2023; Heydari et al., 2021; Gutberlet et al., 2013; Kittitornkool and Burt, 2006; Islami and Prihantoro, 2023; Lederer et al., 2015; Hornsby et al., 2017; Farrelly and Tucker, 2014; Manomaivibool et al., 2018; Heikkilä et al., 2016; Kristianto and Widya, 2021; Muhajirin and Kusuma, 2021; Nima et al., 2019; Nugrahini et al., 2023; Pattra et al., 2023; Praneetham et al., 2016; Gutberlet et al., 2017; Rosyidah, 2021; Johnson and Wilson, 2000b) |

**Table 6.** (*Continued*).

| Challenge | Description & Context for Solid Waste Management | References |
|---|---|---|
| Resistance to Change | Difficulty in altering established waste management habits and practices among community members. | (Siu and Xiao, 2020; Yates and Gutberlet, 2011; Bukirwa et al., 2022; Hadi, 2022; Heydari et al., 2021; Gutberlet et al., 2013; Kittitornkool and Burt, 2006; Islami and Prihantoro, 2023; Lederer et al., 2015; Zen et al., 2016; Niyobuhungiro and Schenck, 2021; Gutberlet, 2008; Farrelly and Tucker, 2014; Krisnanda et al., 2023; Kristianto and Widya, 2021) |
| Conflict of Interests | Diverse community interests can lead to conflicts, impeding consensus and collaborative efforts. | (Moreira et al., 2019; Siu and Xiao, 2020; Dias and Ogando, 2015; Carenzo and Good, 2016; Gutberlet, 2016; Kittitornkool and Burt, 2006; Hornsby et al., 2017; Zen et al., 2016; Niyobuhungiro and Schenck, 2021; Gutberlet, 2008) |
| Maintenance of Efforts | Sustaining engagement and participation rates over time can be difficult, leading to program fatigue. | (Adam-Bradford, 2006; Niyobuhungiro and Schenck, 2021; Lotfi et al., 2021) |
| Cultural Barriers | Different cultural perceptions of waste can affect participation and the success of waste management programs. | (Moreira et al., 2019; Tremblay and Jayme, 2015; Siu and Xiao, 2020; Yates and Gutberlet, 2011; Bezerra and Iared, 2019; Bukirwa et al., 2022; Dias and Ogando, 2015; Firmansyah et al., 2022; Farrelly and Tucker, 2014; Oyegunle and Thompson, 2018; Krisnanda et al., 2023; Kristianto and Widya, 2021; Lambert-Pennington et al., 2018; Little, 2020; Nima et al., 2019; Niyobuhungiro and Schenck, 2022) |
| Interdepartmental Coordination | Difficulty in aligning various governmental departments and agencies on participatory project goals. | (Zen et al., 2016; Niyobuhungiro and Schenck, 2021; Gutberlet, 2008; Farrelly and Tucker, 2014; Heikkilä et al., 2016) |
| Waste Management Education | Lack of education and awareness about waste management best practices among community members. | (Moreira et al., 2019; Niyobuhungiro and Schenck, 2021; Gutberlet, 2008; Farrelly and Tucker, 2014; Manomaivibool et al., 2018; Heikkilä et al., 2016; Malekafzali et al., 2022; Nima et al., 2019; Niyobuhungiro and Schenck, 2022; Nugrahini et al., 2023; Opoku-Asare et al., 2013; Praneetham et al., 2016) |
| Volunteer Fatigue | Dependence on volunteer efforts can lead to burnout and inconsistency in efforts. | (Niyobuhungiro and Schenck, 2021; Oyegunle and Thompson, 2018) |
| Health Risks | Addressing the health risks associated with waste management, especially in informal sectors, is a concern. | (Moreira et al., 2019; Siu and Xiao, 2020; Yates and Gutberlet, 2011; Becker et al., 2019; Bukirwa et al., 2022; Adam-Bradford, 2006; Dokmaingam and Manomaivibool, 2017; Islami and Prihantoro, 2023; Niyobuhungiro and Schenck, 2021; Gutberlet, 2008; Farrelly and Tucker, 2014; Linzalone et al., 2017; Malekafzali et al., 2022; Oyegunle and Thompson, 2018; Little, 2020; Muyassarah et al., 2022) |
| Integrating Informal Sectors | Formalizing and integrating informal waste collectors into the official waste management system can be challenging. | (Niyobuhungiro and Schenck, 2021; Gutberlet, 2008) |
| Stakeholder Fatigue | Over time, stakeholders may experience fatigue, reducing their active participation and support. | (Gutberlet et al., 2017; Lambert-Pennington et al., 2018) |

Some studies underscored the importance of strategies aimed at securing adequate resources for the success of waste management initiatives. Additionally, a substantial knowledge and skills gap among community members was identified as a pervasive challenge in several studies, hindering the effective implementation of waste management strategies. Bridging this gap through educational initiatives and skill-building efforts was recognized as a crucial avenue for addressing this challenge. Other challenges encompassed resistance to change, conflict of interests, sustaining engagement over time, cultural barriers, interdepartmental coordination difficulties, and the need for waste management education, each requiring tailored interventions

for resolution. For instance, changing established waste management habits and practices among community members poses difficulties. In the study by Bukirwa et al. (2022), it was noted that resistance to change was a key challenge in promoting new waste management practices.

Conversely, **Table 7** outlines the identified opportunities, offering avenues for positive change in solid waste management through participatory approaches. Leveraging local knowledge and practices, as highlighted by several studies, stands out as an opportunity to develop culturally appropriate and effective waste management solutions. For instance, in a study by Bezerra and Iared (2019), it was found that incorporating traditional waste management practices enhanced the effectiveness of community initiatives. Participatory projects were recognized beyond their primary goal, serving as platforms for education and awareness-raising. This potential was emphasized by included studies, contributing to behavioral change within communities. For example, in research conducted by Oduro-Appiah et al. (2021), participatory approaches were found to be effective in educating communities about waste management best practices. Community participation was identified as having the potential to influence policy-making processes, shaping more responsive and effective waste management policies. Collaborative efforts in waste management were recognized as having the potential to strengthen community ties and social cohesion. Participatory research is a powerful tool for building resilience and empowering communities, as previous studies have highlighted. Furthermore, opportunities for partnerships across public, private, and community sectors were identified as means to enhance resource mobilization and foster innovation in solid waste management practices, according to several studies. For instance, in a study by Hornsby et al. (2017), it was found that community involvement led to the development of policies that better-addressed waste management issues. These findings collectively highlight the nuanced landscape of challenges and opportunities associated with the adoption of participatory research in solid waste management.

**Table 7.** Opportunities in implementing community participatory approaches in solid waste management.

| Opportunity | Description & Context for Solid Waste Management | References |
|---|---|---|
| Local Knowledge Utilization | Leveraging local knowledge and practices can lead to more culturally appropriate and effective waste management solutions. | (Siu and Xiao, 2020; Yates and Gutberlet, 2011; Bezerra and Iared, 2019; Bukirwa et al., 2022; Carreon and Flores, 2023; Islami and Prihantoro, 2023; Lederer et al., 2015; Hornsby et al., 2017; Farrelly and Tucker, 2014; Manomaivibool et al., 2018; Heikkilä et al., 2016; Linzalone et al., 2017; Janprasert and Suttawet, 2021; Malekafzali et al., 2022; Oyegunle and Thompson, 2018; Krisnanda et al., 2023; Lotfi et al., 2021; Nima et al., 2019; Niyobuhungiro and Schenck, 2022; Nugrahini et al., 2023; Opoku-Asare et al., 2013) |
| Education and Awareness | Participatory projects provide platforms for education and raising awareness about waste management, contributing to behavior change. | (Moreira et al., 2019; Oduro-Appiah et al., 2021; Siu and Xiao, 2020; Yates and Gutberlet, 2011; Becker et al., 2019; Bukirwa et al., 2022; Gutberlet et al., 2017; Adam-Bradford, 2006; Carenzo and Good, 2016; Dokmaingam and Manomaivibool, 2017; Firmansyah et al., 2022; Gutberlet, 2016; Hadi, 2022; Hamzah et al., 2023; Heydari et al., 2021; Gutberlet et al., 2013; Kittitornkool and Burt, 2006; Islami and Prihantoro, 2023; Hornsby et al., 2017; Zen et al., 2016; Niyobuhungiro and Schenck, 2021; Gutberlet, 2008; Farrelly and Tucker, 2014; Krisnanda et al., 2023; Kristianto and Widya, 2021; Lambert-Pennington et al., 2018; Little, 2020; Lotfi et al., 2021; Muyassarah et al., 2022; Nima et al., 2019; Niyobuhungiro and Schenck, 2022; Nugrahini et al., 2023; Opoku-Asare et al., 2013; Praneetham et al., 2016; Rosyidah, 2021) |

**Table 7.** (*Continued*).

| Opportunity | Description & Context for Solid Waste Management | References |
|---|---|---|
| Policy Influence | Community participation can influence policy-making to be more responsive to local waste management needs. | (Moreira et al., 2019; Oduro-Appiah et al., 2021; Siu and Xiao, 2020; Yates and Gutberlet, 2011; Bukirwa et al., 2022; Carenzo and Good, 2016; Dokmaingam and Manomaivibool, 2017; Firmansyah et al., 2022; Kittitornkool and Burt, 2006; Hornsby et al., 2017; Farrelly and Tucker, 2014; Manomaivibool et al., 2018; Heikkilä et al., 2016; Lambert-Pennington et al., 2018; Nima et al., 2019; Niyobuhungiro and Schenck, 2022; Nugrahini et al., 2023) |
| Strengthened Social Cohesion | Working together on waste management can strengthen community ties and social cohesion. | (Moreira et al., 2019; Bukirwa et al., 2022; Adam-Bradford, 2006; Dias and Ogando, 2015; Kittitornkool and Burt, 2006; Hornsby et al., 2017; Farrelly and Tucker, 2014; Krisnanda et al., 2023) |
| Community Empowerment | Participatory approaches empower communities to take charge of their waste management, building resilience. | (Moreira et al., 2019; Oduro-Appiah et al., 2021; Tremblay and Jayme, 2015; Siu and Xiao, 2020; Yates and Gutberlet, 2011; Becker et al., 2019; Bukirwa et al., 2022; Carreon and Flores, 2023; Gutberlet et al., 2017; Dias and Ogando, 2015; Carenzo and Good, 2016; Dokmaingam and Manomaivibool, 2017; Firmansyah et al., 2022; Gutberlet, 2016; Hadi, 2022; Hamzah et al., 2023; Heydari et al., 2021; Gutberlet et al., 2013; Kittitornkool and Burt, 2006; Islami and Prihantoro, 2023; Lederer et al., 2015) |
| Stakeholders Collaboration | Opportunities for partnerships across public, private, and community sectors can enhance resource mobilization and innovation. | (Becker et al., 2019; Carreon and Flores, 2023; Zen et al., 2016; Niyobuhungiro and Schenck, 2021; Farrelly and Tucker, 2014; Manomaivibool et al., 2018; Heikkilä et al., 2016; Linzalone et al., 2017; Janprasert and Suttawet, 2021; Malekafzali et al., 2022; Lotfi et al., 2021; Muhajirin and Kusuma, 2021; Nima et al., 2019; Niyobuhungiro and Schenck, 2022; Nugrahini et al., 2023; Opoku-Asare et al., 2013; Pattra et al., 2023; Gutberlet et al., 2017; Oduro-Appiah et al., 2019; Johnson and Wilson, 2000b) |
| Environmental Stewardship | Fostering a sense of environmental responsibility and stewardship within the community. | (Siu and Xiao, 2020; Yates and Gutberlet, 2011; Bezerra and Iared, 2019; Gutberlet et al., 2017; Adam-Bradford, 2006; Dias and Ogando, 2015; Carenzo and Good, 2016; Dokmaingam and Manomaivibool, 2017; Firmansyah et al., 2022; Gutberlet, 2016; Hadi, 2022; Hamzah et al., 2023; Heydari et al., 2021; Gutberlet et al., 2013; Kittitornkool and Burt, 2006; Islami and Prihantoro, 2023; Lederer et al., 2015; Farrelly and Tucker, 2014; Manomaivibool et al., 2018; Heikkilä et al., 2016; Oyegunle and Thompson, 2018; Lambert-Pennington et al., 2018; Little, 2020; Muyassarah et al., 2022) |
| Sustainable Practices | Promoting sustainable waste management practices that can be integrated into daily community life. | (Siu and Xiao, 2020; Adam-Bradford, 2006; Islami and Prihantoro, 2023; Zen et al., 2016; Niyobuhungiro and Schenck, 2021; Farrelly and Tucker, 2014; Manomaivibool et al., 2018; Heikkilä et al., 2016; Oyegunle and Thompson, 2018; Muyassarah et al., 2022; Oduro-Appiah et al., 2019) |
| Cultural Exchange | Sharing of best practices and waste management strategies among diverse cultures within a community. | (Tremblay and Jayme, 2015; Farrelly and Tucker, 2014) |
| Health and Sanitation Improvements | Direct community action can lead to improved health outcomes through better waste handling and reduced pollution. | (Moreira et al., 2019; Tremblay and Jayme, 2015; Siu and Xiao, 2020; Niyobuhungiro and Schenck, 2021; Heikkilä et al., 2016) |
| Interdisciplinary Approaches | Collaborations across disciplines can lead to more holistic and sustainable waste management solutions. | (Bezerra and Iared, 2019; Kittitornkool and Burt, 2006; Farrelly and Tucker, 2014) |
| Community Leadership | Development of community leaders who can champion and sustain waste management initiatives. | (Farrelly and Tucker, 2014) |

### 3.1. Success indicators for participatory research in solid waste management

Building upon the identified success indicators for participatory research in solid waste management, it is imperative to leverage these insights to inform future research endeavors and guide improvements in the implementation of participatory initiatives. The comprehensive evaluation framework, encompassing both process and outcome evaluation domains, provides a nuanced understanding of the strengths and weaknesses observed in the 74 studies conducted. By assessing visionary leadership and effective coordination, researchers can pinpoint areas for improvement and develop strategies to enhance leadership qualities and coordination mechanisms within participatory projects. In addressing communication channels, internal power imbalances, and conflict resolution strategies, future research can delve into the specific challenges faced by stakeholders in these aspects. Understanding the intricacies of communication breakdowns or the root causes of power imbalances will enable researchers to propose targeted interventions. Moreover, exploring the dynamics of inclusivity in representing diverse voices and contextual considerations will shed light on specific contexts where improvement is needed, fostering more genuine and representative participatory processes.

The success indicators identified for participatory research in solid waste management are significant for informing future research and improving the implementation of participatory initiatives. A comprehensive evaluation framework that includes both process and outcome evaluation domains offers a nuanced understanding of the strengths and weaknesses observed in the 74 studies conducted. By assessing visionary leadership and effective coordination, researchers can identify areas for improvement and develop strategies to enhance leadership qualities and coordination mechanisms within participatory projects. Future research can delve into specific challenges faced by stakeholders in communication channels, internal power imbalances, and conflict resolution strategies. Understanding the intricacies of communication breakdowns or the root causes of power imbalances will enable researchers to propose targeted interventions. Moreover, exploring the dynamics of inclusivity in representing diverse voices and contextual considerations will shed light on specific contexts where improvement is needed, fostering more genuine and representative participatory processes.

Within the outcome evaluation domain, the success indicators provide a roadmap for future research to focus on refining mechanisms for validating the participatory process. Investigating the factors that contribute to or hinder accountability in providing regular, accurate updates to constituents will offer actionable insights. Similarly, exploring the nuances of capacity-building efforts, the translation of knowledge into transformative actions, and the monitoring of impacts will enable researchers to develop tailored strategies for enhancing these aspects in future participatory initiatives. The emphasis on social learning, recognized impacts, and transparency in decision-making processes provides a foundation for future research to explore the depth of knowledge exchange, the actual transformation of practices, and the barriers to transparency. Understanding these elements in more detail will contribute to the development of effective strategies to overcome challenges and

capitalize on opportunities in participatory research in solid waste management. This forward-looking approach acknowledges the multifaceted nature of participatory initiatives and encourages adaptive, context-specific interventions for continuous improvement (**Table 8**).

**Table 8.** Success indicators for participatory research in solid waste management.

| Domain | Subdomain | Indicators of Success |
|---|---|---|
| Process Evaluation | Leadership | Visionary leadership present. Effective coordination is evident. |
| | Communication | Open and transparent communication channels. Stakeholders informed |
| | Conflict resolution | Mitigation of internal power imbalances. Existence of conflict resolution strategies. |
| | Representation and Context | Inclusivity in representing diverse voices. Consideration of contextual factors. |
| Outcome Evaluation | Accountability | Clear mechanisms for validating the participatory process. Regular and accurate updates are provided to constituents. |
| | Capacity Building | Perceived improvement in individual capacity. Willingness for future engagement. |
| | Emergent Knowledge | Effective judgment of impacts. Successful translation of knowledge into transformative actions. |
| | Recognized impacts | Presence of monitoring mechanisms. Clear communication of achievements. Agreement on sustainability concepts. |
| | Social learning | Active exchange of ideas and knowledge. Evidence of practical transformation. |
| | Transparency | Clarity in decision-making processes. Consistent implementation of decided actions. |

## 4. Conclusions

This systematic review and evaluation of participatory research in solid waste management offer a comprehensive understanding of the current landscape, strengths, and challenges within the field. By aligning the rationales for participatory research and solid waste management with evaluation principles, we have established a conceptually coherent framework for assessing the efficacy of participatory research initiatives. Through the rigorous analysis of 74 studies, we identified critical success indicators, shedding light on both process and outcome dimensions. The findings reveal notable inadequacies in leadership, communication, representation, accountability, and transparency, signaling the need for nuanced and adaptive approaches to address these shortcomings. The systematic exploration of challenges and opportunities associated with the adoption of participatory research in solid waste management provides valuable insights for future research and practice. The identified barriers, including engagement obstacles, resource constraints, knowledge gaps, and cultural barriers, emphasize the importance of tailored interventions for resolution. Simultaneously, the opportunities, such as leveraging local knowledge, influencing policy-making, and fostering collaborations, present avenues for positive change in solid waste management through participatory approaches.

The study has significant importance and contribution to the sustainability field and solid waste management. It has the potential to guide and inform future research

endeavors. The established evaluation framework, along with the identification of success indicators, can serve as a practical roadmap for researchers to assess and improve the implementation of participatory research initiatives. The findings emphasize the multifaceted nature of participatory research and its alignment with the complex stakeholder dynamics inherent in solid waste management. This inclusivity ensures that waste management solutions are not only technically robust but also socially acceptable and sustainable. Moreover, the impact of participatory research on shaping practices, policies, and community development within solid waste management is highlighted. The community-inclusive policy development process ensures that policies are not only theoretically sound but also practically applicable and sustainable in the local context. The findings emphasize the pivotal role of internal leadership within communities, the challenge of limited financial resources, and the need for tailored strategies to address the unique waste management challenges faced by developing countries. This systematic review is a valuable addition to the increasing knowledge base in participatory research and solid waste management. It not only consolidates the existing information, but also provides a foundation for future research, policy development, and sustainable practices in the field. The knowledge gained through this study can help make informed decisions, leading to a more effective and inclusive approach to solid waste management globally.

The synthesized findings from this systematic review underscore the importance of addressing systemic challenges in leadership and communication within participatory research initiatives. Leaders within these initiatives must adopt adaptive strategies, emphasizing transparency, accountability, and effective communication channels. Additionally, there is a pressing need to enhance representation, ensuring that diverse voices are heard, especially those of marginalized communities who often bear the brunt of inadequate waste management practices. The identified success indicators serve as valuable benchmarks for evaluating the impact of participatory research on solid waste management outcomes. Researchers and practitioners can utilize these indicators to tailor interventions and strategies that address the specific needs and challenges of each community. The findings stress the importance of community engagement not only in the planning and implementation stages but also in the ongoing monitoring and evaluation of waste management initiatives.

Moreover, the findings from this review have significant practical implications for policymakers and future research initiatives in the field of solid waste management. The identified challenges and opportunities offer valuable guidance for stakeholders involved in waste management. In particular, barriers such as resource constraints and cultural differences underscore the need for innovative solutions and collaborative efforts. It is crucial to tailor waste management interventions to address these obstacles, taking into account the unique context of each community. Conversely, the opportunities identified, such as leveraging local knowledge and influencing policy-making, present avenues for positive change. Policymakers can utilize insights from participatory research to develop policies that are not only effective but also culturally sensitive to the communities they serve. Collaboration among researchers, policymakers, and local communities can promote a comprehensive approach to waste management, integrating technical expertise with indigenous wisdom. Looking ahead, this systematic review lays a solid foundation for advancing participatory research in

waste management. Researchers can build upon the identified success indicators and evaluation framework to design more robust studies contributing to the evolving knowledge base. Policymakers can leverage these findings to formulate evidence-based policies that prioritize community engagement and sustainability. In conclusion, the synthesis of findings from this systematic review underscores the need for a holistic and adaptive approach to participatory research hin solid waste management. The challenges identified should not be viewed as insurmountable obstacles but as opportunities for innovation and collaboration. By addressing these challenges and leveraging the opportunities, we can move towards a more sustainable and inclusive model of solid waste management, benefiting communities globally.

## 5. Limitations and future directions

One challenge in this study is publication bias, where the availability of published research may affect which studies are included. This bias could make certain types of research or findings more prominent, potentially causing an overrepresentation of specific viewpoints or results. Additionally, the quality and completeness of the studies analyzed may differ, making it harder to rely on the conclusions drawn from the combined evidence. Moreover, another limitation is the difficulty in combining findings from diverse studies. The variety in methods, settings, and participant characteristics among the studies can make it tricky to come to clear conclusions or find consistent patterns in the research. This diversity not only makes it harder to interpret the results but also limits how much we can apply the findings to different situations or groups of people.

To overcome these limitations, future studies could use more rigorous methods to find and combine relevant research, like conducting systematic reviews with broader search strategies. This could help reduce the impact of publication bias and make the review findings more comprehensive and reliable. Additionally, future research could focus on analyzing participatory approaches in waste management more thoroughly, looking at how specific interventions or strategies work in different situations. It would also be beneficial to conduct studies over time to see the long-term effects of participatory projects on waste management and community well-being. By addressing these limitations and exploring new research paths, we can improve our understanding of participatory research in waste management and develop better waste management practices.

**Conflict of interest:** The authors declare no conflict of interest.

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