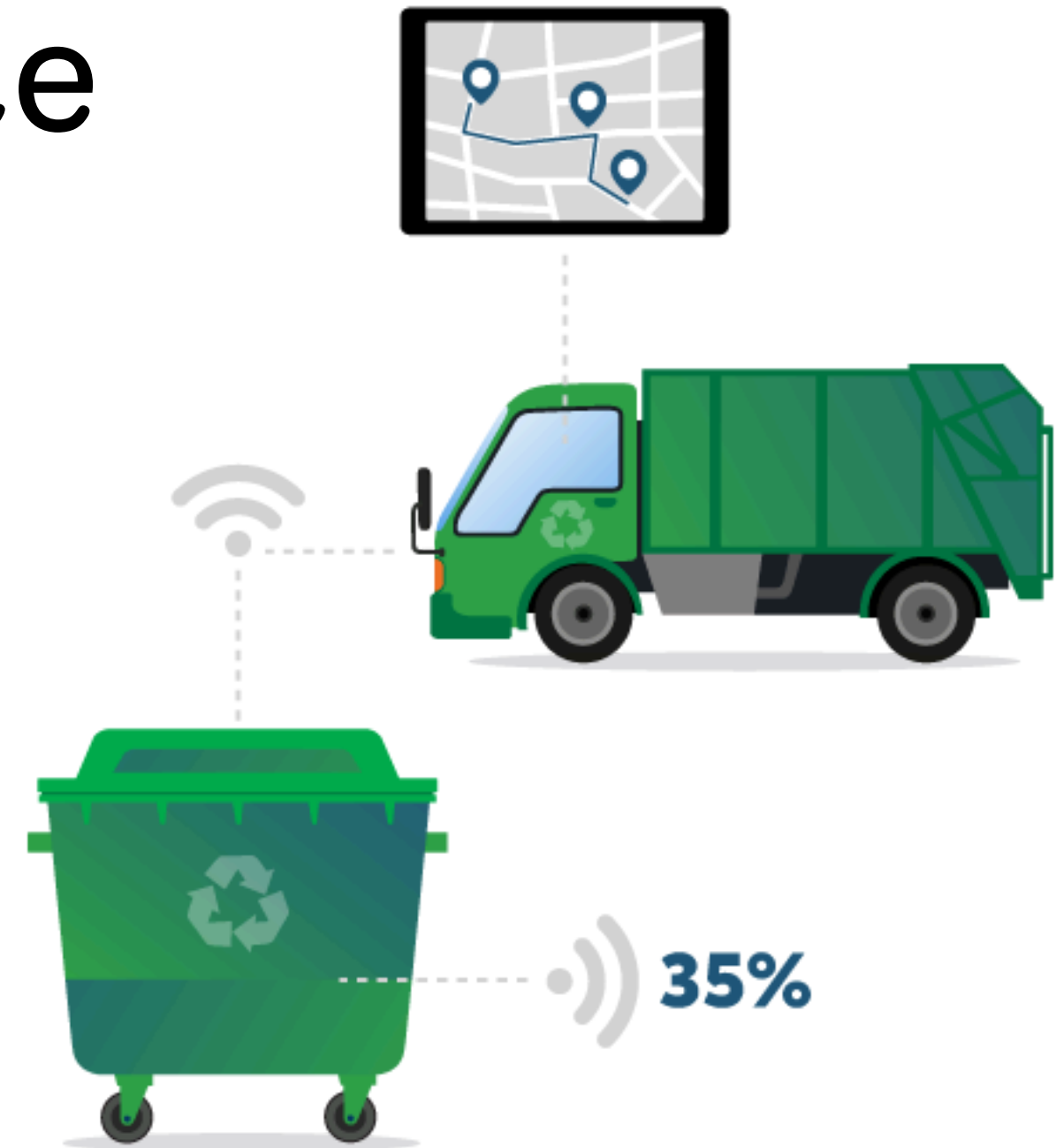# An Investigation into the use of IoTs to automate the operations of the NSWMA

Major Project

35%

Presented By: Steve Anderson |Kemar Christie |Tyriece Parkinson | Austin Peck |Aviel Reid

Chapter One

Introduction

Background Information

- NSWMA oversees waste management, vital for community health and sustainable progress.
- Efficient practice enhances living standards and preserves resources.
- In Jamaica, waste collection follows a set schedule, managed by supervisors allocating trucks based on a paper-based system
- IoT can enhance NSWMA's operation by providing real-time data, enabling remote monitoring, and improving resource allocation in waste management.
- Smart waste bin with ultrasonic sensors monitors waste levels, aid efficient resource allocation, and mobile and app-based monitoring.
- It also communicates data to relevant authorities, leveraging cloud servers for usability, accessibility, and disaster recovery.
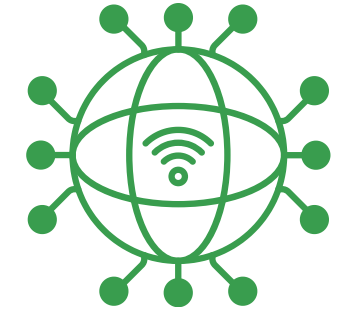
Problem Statement
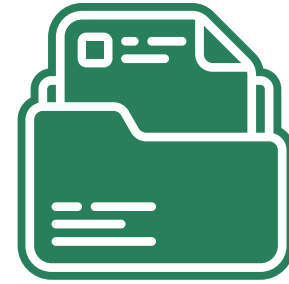
The problem of the study is the persistent use of a paper-based filing system by NSWMA in Jamaica for garbage management, leading to operational inefficiencies.

Purpose Statement

The objective of this research is to explore how IoT can optimize garbage collection processes, reduce operational inefficiencies caused by traditional filing systems, and ultimately improve the overall waste management operation of NSWMA.

Research Questions

To what extent are employees of the NSWMA knowledgeable about the application of IoTs for waste collection and monitoring?

How can the Implementation of IoT technologies enhance the operations of NSWMA?

Study's Significance

- The study explores IoT's potential to enhance garbage collection and monitoring.

- Contributes to effective waste management practices with positive impacts on the environment and public health in Jamaica.

Study's
Limitations

- Restricted access to participants may affect reliability.
- NSWMA employees mandated for questionnaires and interview, but work shifts pose engagement challenges.

Study's
Delimitations

- Avoids technical intricacies of IoT development.
- Ignores broader socioeconomic implications of IoT adoption.

Chapter Two

Literature Review

Relevant Literature

- Research focuses on using IoT to digitize file systems, addressing rising global waste by promoting efficient smart city solutions.

- Chaudhari et al. (2018) emphasize solid waste as a crucial environmental issue and propose an IoT-based system for efficient smart city waste management.

- NSWMA employs a mobile app for waste management, aiding environmental reporting, yet limited accessibility across operating systems and lack of awareness hinder its effectiveness, (NSWMA - Jamaica, 2020).

- Addressing waste output requires rethinking waste management, behavioral changes and overcoming smart technology challenges.

- In Ghana solid waste management includes inadequate legislation, corruption and hindering sustainable solutions but IoT offers improvement (Oteng-Ababio et al., 2020)

# Literature Review Specific to the Technical Area being Researched

- The conventional method of waste monitoring, collection, management.

- The advantages of utilizing Internet of Things (IoT) for garbage collection and monitoring

- The difficulties of utilizing Internet of Things (IoT) for garbage collection and monitoring
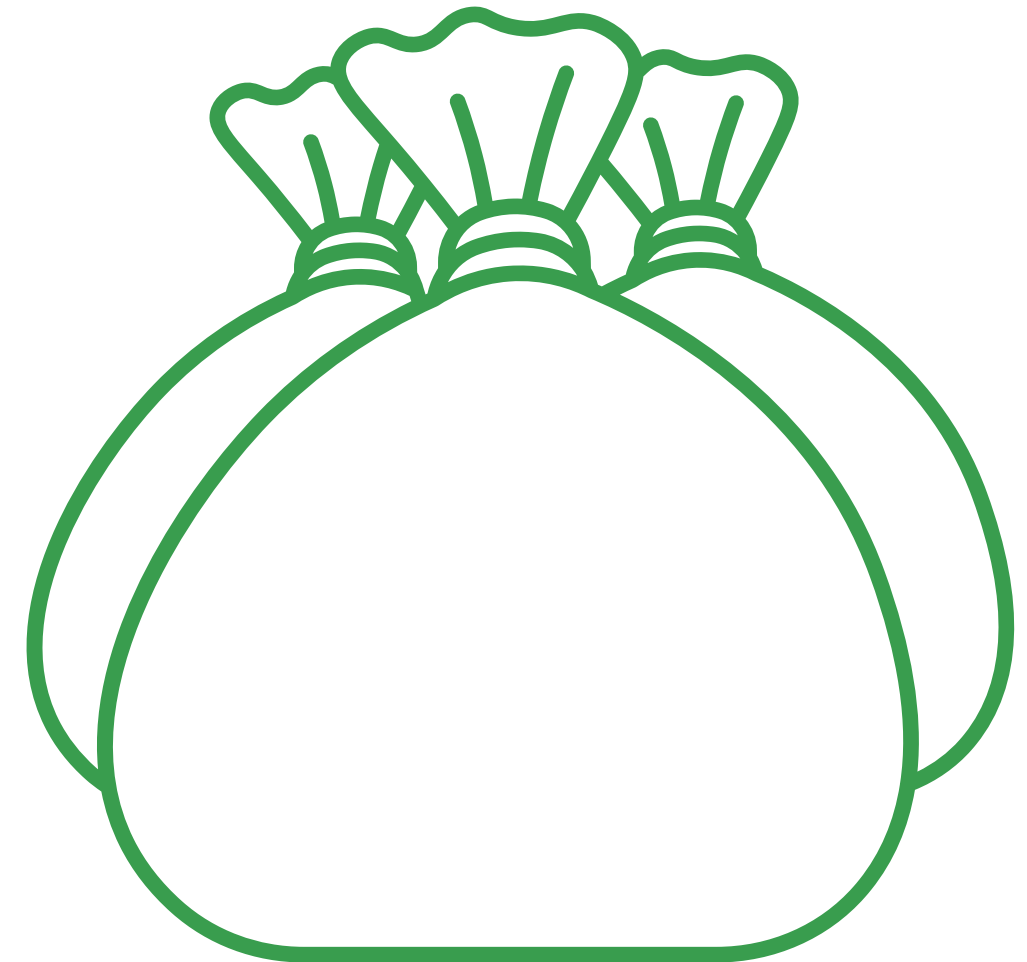
Contribution of Reviewed Literature to Current Research

- Abuga et al. (2021) proposed the Smart Garbage Bin Mechanism (SGBM) for smart cities, featuring subsystems like smart garbage bins, collecting vehicles, and a centralized database, utilizing NetLogo and fuzzy logic for enhanced data accessibility and throughput.

- Sohag et al. (2020) introduced an IoT-based waste management system using Arduino Uno, incorporating an identification system, automated lid, display, and communication system for efficient garbage collection.

- Haque et al. (2020) proposed a similar system with added navigation, optimizing waste collection routes to reduce collection time and fuel costs for trucks.

- Jajoo et al. (2018) suggested a waste management system notifying authorities when bins are full, with the added feature of escalating notifications to higher authorities if ignored.
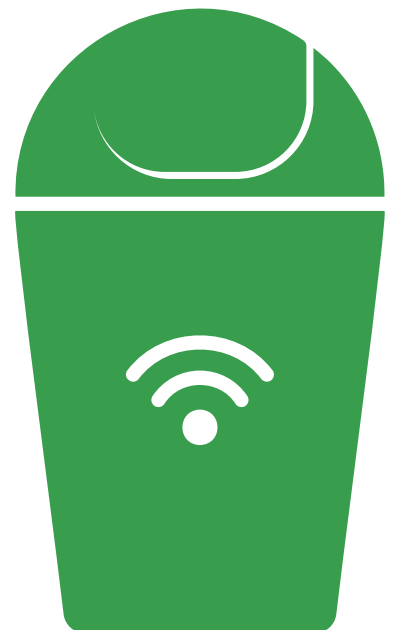
Specific Gaps in the Literature

- Data security and privacy implications need further exploration, and measures such as encryption, access control, software upgrades, secure communication protocols, device security, and user education are crucial to address these gaps.

- User adoption and involvement are also another gap that need to be address which in turn could improve efficiency, cost reduction, and sustainability.

- Long-term maintenance and reliability are additional challenges for using IoT in waste management.

Concluding Remarks

The literature underscores IoT's pivotal role in waste management. It highlights benefits like real-time monitoring and cost savings, while acknowledging challenges in data security and user adoption. Proposed solutions, including integrated systems and advanced notifications, aim to enhance waste collection efficiency, reduce health risks, and improve communication with authorities.

Chapter Three

Methodology

Research Design

- The study explores replacing paper-based systems at the NSWMA with IoT integration for enhanced efficiency
- It employs survey, interviews, and document analysis, gathering both quantitative and qualitative data for a thorough analysis

Population Sample

- The study employs purposive sampling, selecting individuals directly linked to the research objectives at NSWMA.

- 30 employees were selected for the survey to ensure statistical significance and the director of operations at NSWMA was asked to participate in an interview.

Data Analysis

- A hybrid approach, combining content analysis and statistical techniques was used to analyze data and address research questions.

- Content analysis was used to detect bias in interview language, while descriptive statistics was used convey survey findings concisely for decision-making.

Chapter Four

Findings

- **Questionnaire (5 Questions)**

- **Interview Session (5 Questions)**

How garbage collection locations are determined?

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According to Questionnaire Responses

NSWMA's garbage collection approach highlights potential IoT benefits. Heavy reliance on citizen requests underscores community engagement importance, but manual feedback may cause delays. Real-time data absence hinders route optimization. IoT integration could enhance efficiency.
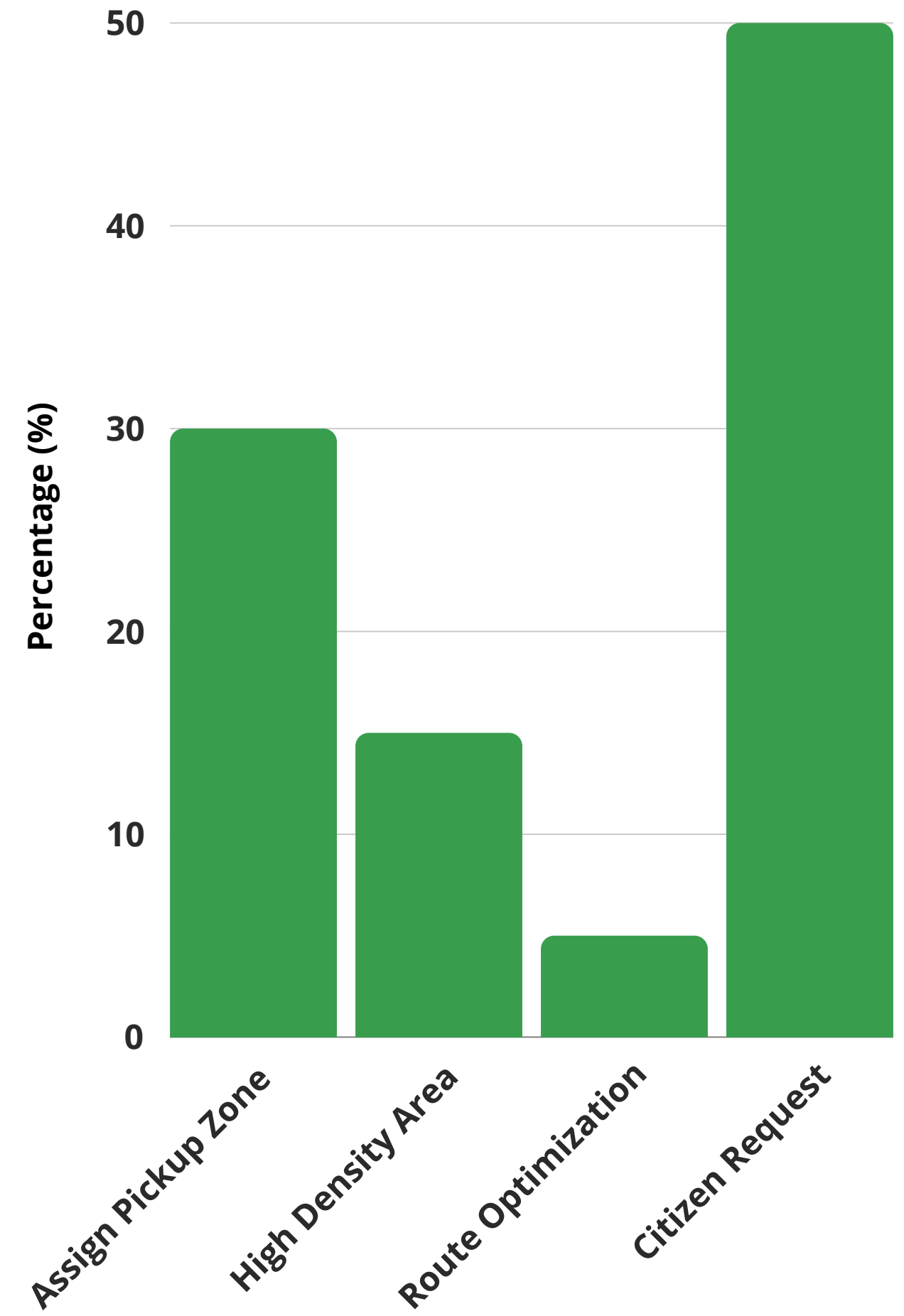
Does the NSWMA utilize any software system to aid garbage collection?

_____

According to Questionnaire Responses

While a smaller percentage of respondents agree that Nswma has a software system, and some are unsure, the majority of respondents are unaware of any system in place to help with the garbage collection process. This highlight the lack of communication between workers about such systems.
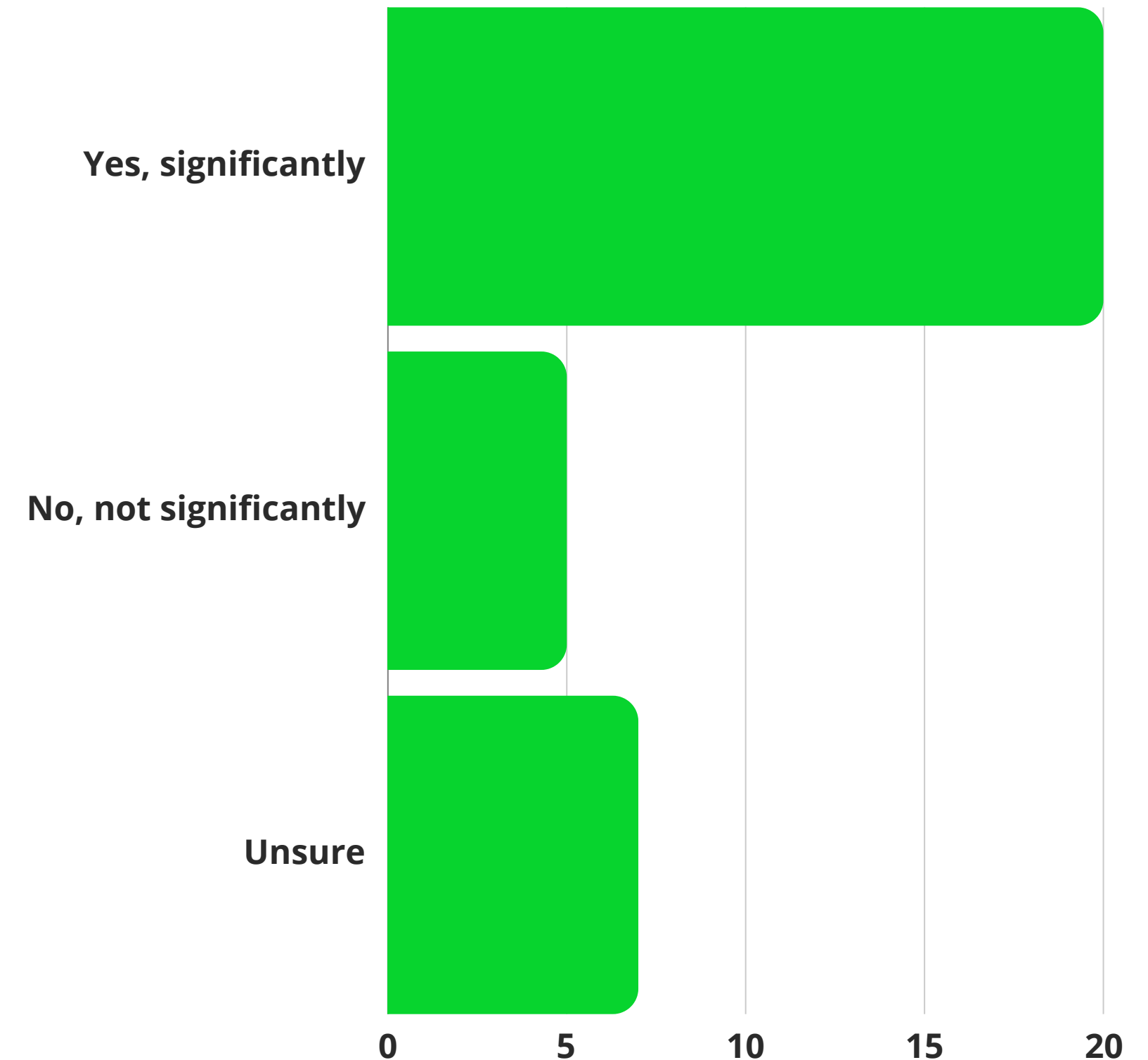
Yes
25%

I am not sure
31.3%

No
43.8%
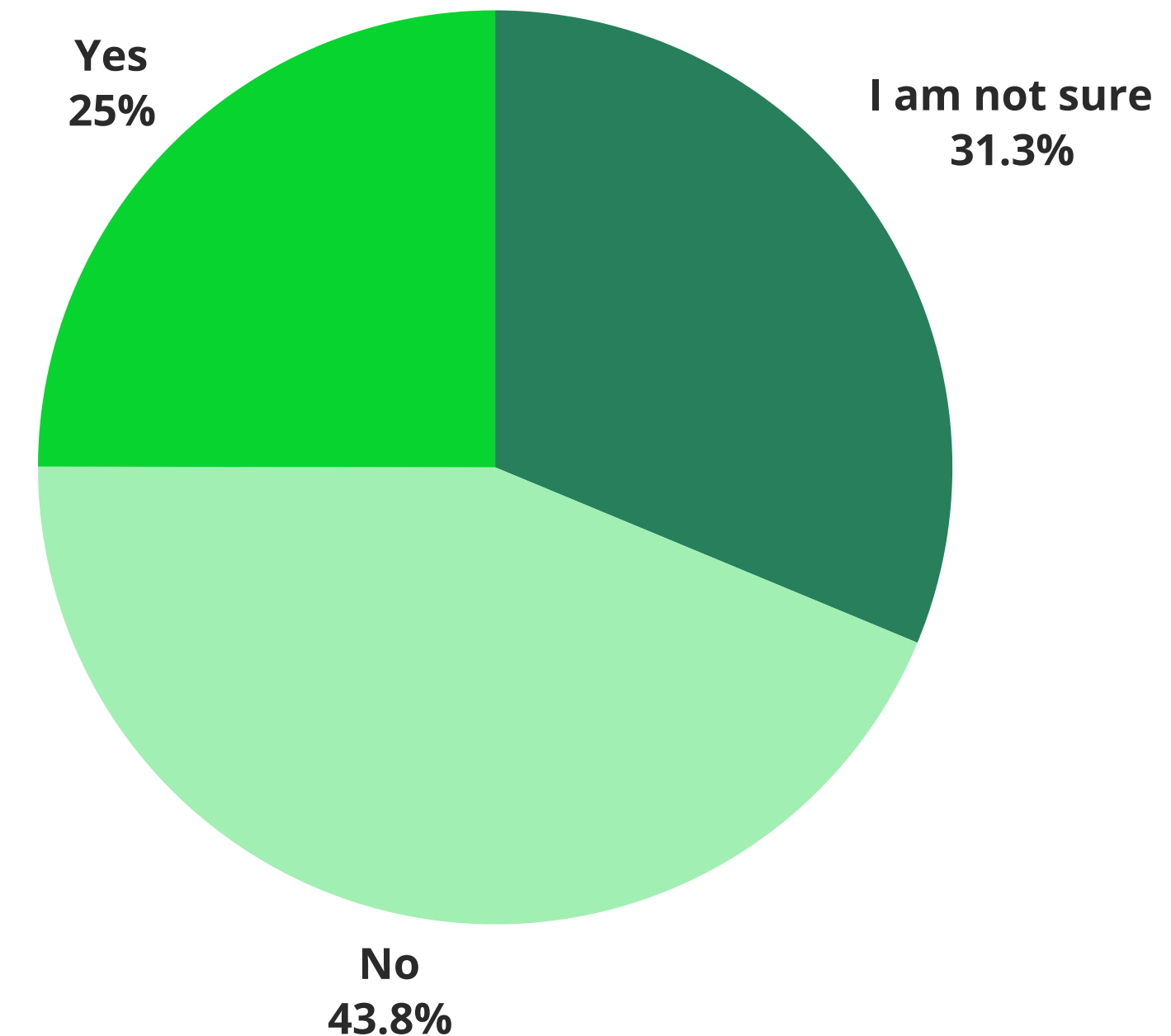
Can IoT implementation improve resource allocation?

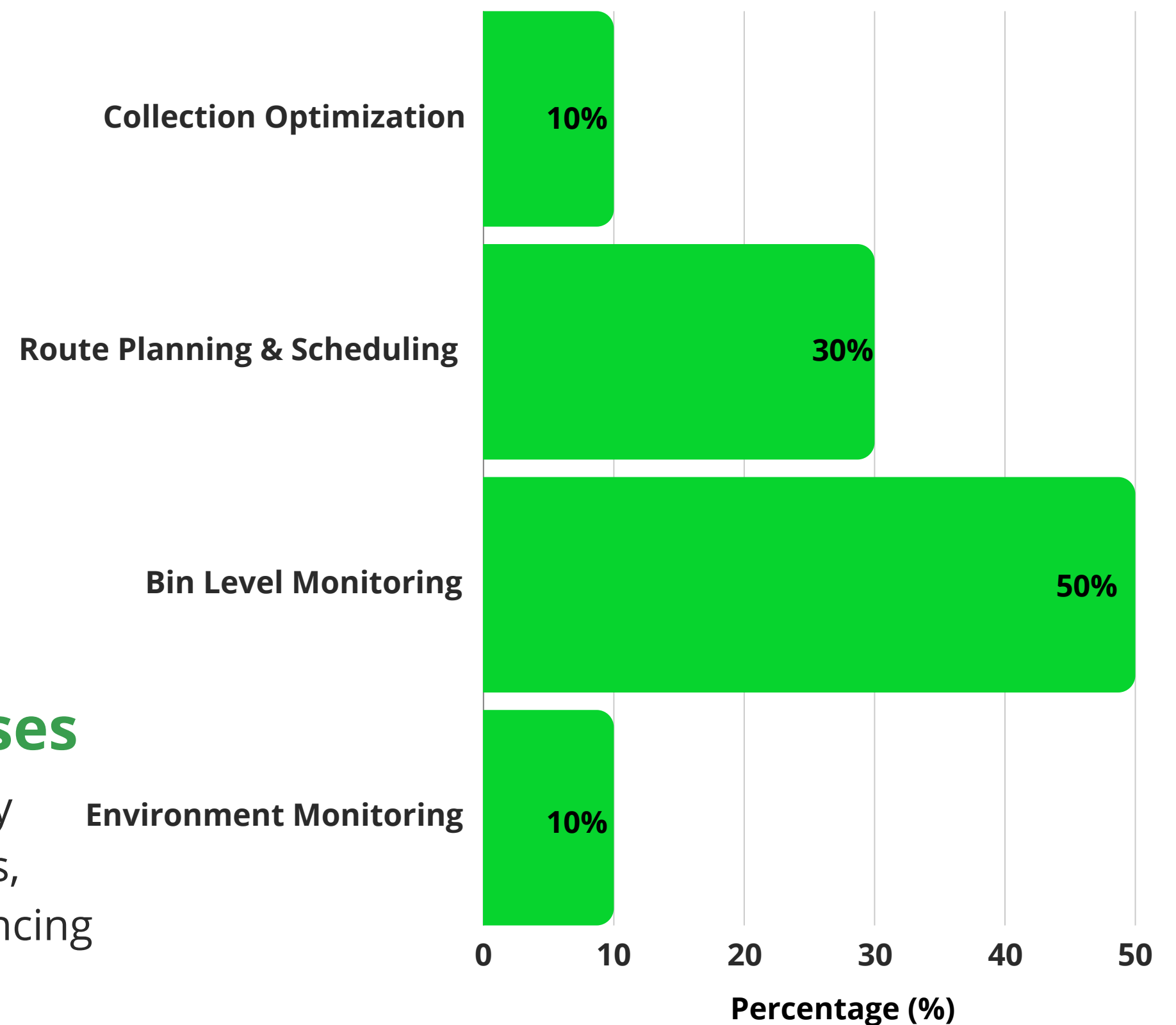**According to Questionnaire Responses**

Most respondents agreed that IoTs would improve resource allocation as it currently exists, while a smaller percentage expressed doubt about the use of IoT technology to improve resource allocation at NSWMA. To ease fears and uncertainties, this suggests that further research and discussion are necessary.

Areas of waste management collection that could benefit from IoT implementation

According to Questionnaire Responses

The study showed that IoT technology can significantly improve waste management by moynitoring bin levels, optimizing collection routes and schedules, and enhancing resource allocation and operational efficiency.

Collection Optimization — 10%

Route Planning & Scheduling — 30%

Bin Level Monitoring — 50%

Environment Monitoring — 10%

Percentage (%)

# How can automating NSWMA's system improve waste collection delays?

————

According to Questionnaire Responses

Implementation of an automating system within the NSWMA could significantly improve resource allocation decisions, streamline operations, reduce costs, enable real-time monitoring capabilities, and improve the overall effectiveness of waste collection operations according to responses from the survey.
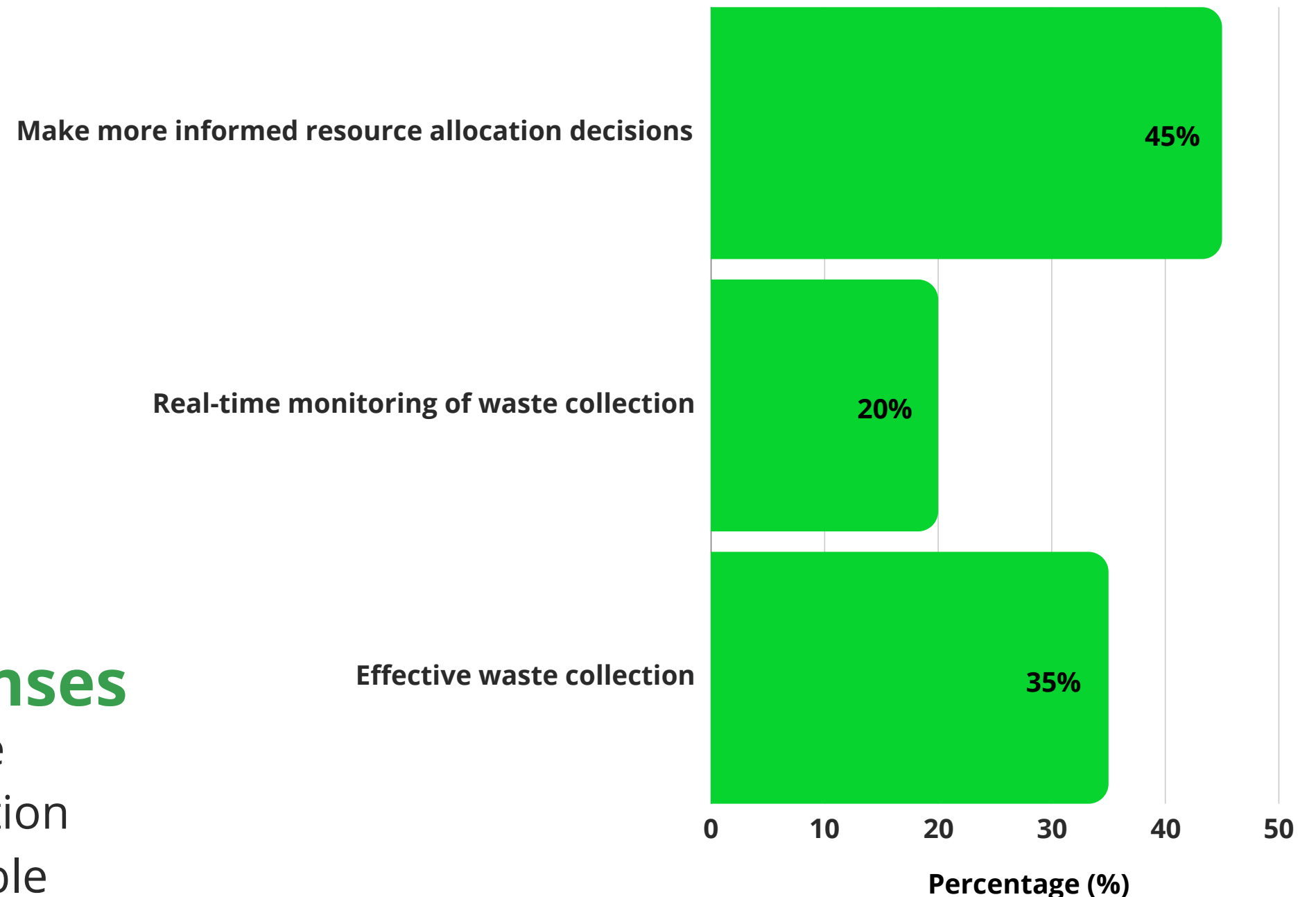
Interview Responses

How can you ensure that waste collection workers complete their assigned tasks?

Regional Operation Managers supervise waste operations in designated areas called Metropolitan Parks and Markets. Each region has a team, including managers, inspectors, monitors, crews, and workers. Zonal monitors report if collection was done, but lack alerts for saturated areas or pickup times due to resource constraints and scheduling challenges.

How effective is the mobile application that is used to monitor waste collection by the NSWMA?

The mobile app isn't used for monitoring waste collection but for reporting dumpsites or areas lacking collection. Users capture images, pinpoint locations, and once cleared, it's marked complete. Despite its intended purpose for scheduling and reporting, it is perceived as a monitoring tool, even though it was inactive up until the time of the interview.

What current challenges or inefficiencies does the NSWMA face in its operations that could potentially be addressed by IoT technologies?

Garbage collection frequency varies weekly or bi-weekly based on area and topography, hindered by limited truck access, causing waste buildup. IoT can counter pests and bacteria proliferation. Urban zones, with large skip bins, benefit most from IoT automation, improving efficiency.

How would the implementation of IoTs impact the workforce and job roles within the NSWMA? What steps should be taken to ensure a smooth transition and maximize the benefits for employees?

Implementation would enhance collection supervision. Job losses are unlikely as regional staff remain, with a zonal monitor's role changing. Their reporting redundancy allows for reallocating responsibilities during IoT integration.

In what ways do you see technological advancement being incorporated into the current systems and infrastructure at NSWMA, and are there any obstacles or potential problems that should be of concern?

Interviewee highlights: Mobile app streamlines tasks, and offers access to collection areas. Analytical tools optimize resource allocation for NSWMA. Challenges include internet access and IT infrastructure limitations, staff training costs, and investment considerations.

SIMULATION OF PROTOTYPE
&
ANIMATED VIDEO

Chapter Five

Summary, Conclusions & Recommendations

Summary

The study examined how IoT's can improve waste management operations at the National Solid Waste Management Authority (NSWMA) in Jamaica, which currently uses a paper-based filing system. Through surveys and interviews, the research explored employees' knowledge of IoT and the benefits of implementing IoT technologies for waste collection. The findings highlighted potential improvements in garbage collection processes and operational efficiencies, suggesting that adopting IoT could lead to more effective waste management practices at NSWMA.

Conclusions for the Findings

Citizens mainly complain about uncollected garbage, revealing management gaps in adhering to NSWMA website data. Addressing this, clarifying information can improve trust and pave the way for technological advancements in garbage collection. With 75% unaware of NSWMA's software use, operational transparency issues arise. IoT's widely acknowledged benefits promise effective solutions, particularly for bin-level monitoring, where garbage often accumulates unnoticed for weeks.

Conclusions for the Project

NSWMA's reliance on manual feedback and limited software use suggests communication inefficiencies, urging better tech adoption like IoT for real-time monitoring. Overcoming challenges such as high costs and resistance to change is vital. The project aims to enhance efficiency and public health through improved waste management. Continuous improvement ensures adaptability.

Recommendations

1. Given the identified potential benefits of IoT integration in waste management operations, NSWMA should prioritize investment in IoT technology.

2. Alongside investment in technology, there should be provisions for comprehensive training programs aimed at familiarizing staff with IoT devices and software.

3. Furthermore, given the complexity and potential risks of IoT integration, consider testing IoT solutions in specific areas or pilot projects before implementing them on a larger scale.

4. IoT technology could be incorporated in organizations looking to streamline waste management processes, offering real-time monitoring and data analytics to optimize collection schedules, reduce costs, and enhance environmental sustainability.

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