



# COMP3770 - ASSIGNMENT 3

Group Report

## **MQ Garbage Collection Mapping System**

Prabhleen Kaur - 46420541 | Priya Patel - 46102116  
Zarin Tasnim Isra - 46254927 | Swagat Bhandari - 48182273

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# 1 Project Overview

## 1.1 Executive Summary

In response to the challenges MQ Garbage Collection Mapping System (MQGCMS) is facing regarding increasing costs and declining service quality, Serena joined the team with her project management skills to help introduce better project management practices. MQ Garbage Collection has been facing problems such as escalating costs, declining profitability and customer dissatisfaction due to inefficiencies in routes, fuel usage and driver training. The existing processes lacked project management discipline and technological integration.

Serena has come on board to spearhead the implementation of the GIS Mapping System to optimise routes, enhance driver navigation and streamline operations by introducing formal project management processes. The plan is to develop a comprehensive project plan encompassing system development, outsourcing strategies, internal manual creation and driver training. Serena aims to integrate various IT systems, streamline operations and further enhance customer satisfaction. The Project Plan Report outlines the roadmap for this upgrade, ensuring continued success for MQGC.

## 1.2 Current System

Prior to Serena's appointment as Project Manager, MQ Garbage Collection was operating largely at a manual scale with outdated systems. There were many insufficiencies and largely lacking in the technological integration area. These issues stemmed from the absence of a well-structured approach to route planning and driver management. This led to an increase in operational costs and declined service quality.

- Route Planning: This process was done manually which required printed maps and basic spreadsheets. Drivers heavily relied on their memory and experience to navigate the routes. Which often resulted in missed collections and customer complaints. The lack of route planning resulted in increased kilometres which then increased fuel consumption and vehicle wear and tear.
- Driver Training: Training new drivers is a time-consuming process. New recruits need to be accompanied by experienced drivers which diverts resources and adds extra operational costs. The lack of detailed structured training materials meant that new drivers would take longer to become proficient which resulted in increased inefficiencies.

- Communication: Communication with stakeholders including residents, councils and garbage depots was fragmented and inefficient. There were no streamlined processes for handling complaints, service requests or updates on route changes, which resulted in poor customer satisfaction.
- Operational Visibility: There was minimal real-time visibility in the operations area. Managers had no effective way to track the location of vehicles, monitor route progress, or access the efficiency of collections. The lack of operational insights made it difficult to make data-driven decisions and respond promptly to issues.
- Technology Integration: Technology use in Mq Garbage Collection was very limited. Basic office software is used for administrative tasks but there was no integration between the systems. There was lack of route planning, customer relationship management, and vehicle tracking. The disjointed nature of the business increased inefficiencies.

MQ Garbage Collection was struggling with a system that was not well equipped to handle the growing demands of their expanding service area. The lack of project management practices and technological support showed the need for setting up an integrated formal system.

## 1.3 Upgraded System

Post Serena's appointment as Project Manager, there was a significant transformation in the implementation of the GIS Mapping System and the adoption of formal project management practices. The upgraded system brought many enhancements addressing the inefficiencies and challenges that the company previously struggled with.

- Route Optimisation: The GIS Mapping System enhances route planning. The system dynamically optimised routes based on real-time traffic data, fuel efficiency and time constraints through advanced algorithms. Unnecessary travel time, fuel consumption and vehicle wear and tear were all reduced. Drivers now had access to precise navigation on digital screens, ensuring that no residents were missed.
- Driver Training and Support: the new upgrades include comprehensive training program material and program for new recruits. The interactive modules and simulation tools allow the new drivers to learn the routes quickly and effectively with the use of visuals. Real-time support also allows them the ability to navigate through the GIS System which provides guidance. This method allows a smoother onboarding process and fewer operational disruptions.

- Enhanced Communication: Comms with stakeholders was improved significantly as the GIS System integrated seamlessly with a new Customer Relationship Management (CRM) system. This allowed for efficient handling of service requests, complaints and updates. Further, automated notifications which informed residents of collection schedules and changes, keeping customers happy. Internal communications were also improved as drivers, dispatches and management became more streamlined.
- Operational Visibility: the upgrades introduced by Serena provided real-time visibility into the entire operational environment. Managers could monitor the location and status of the vehicles, track progress, identify issues and escalate them appropriately. This gave a proactive approach to management which solved problems quickly.
- Technology Integration: Serena ensured all IT systems were integrated into the new platform. GIS Mapping System worked in harmony with CRM, route planning software and tracking tools. A holistic integration gives clear visibility of the data and seamless flow of information across the organisation. An integrated system allows for comprehensive reporting and insights to make informed decisions.
- Efficiency and Sustainability: Implementing the GIS Mapping System led to strong growth in improved operational efficiency. There was reduced fuel consumption as the routes were well optimised, saving costs and environmental sustainability. The reduction in vehicle wear and tear also lowered maintenance costs and extended the lifespan of the vehicles.
- Customer Satisfaction: With improved communication and precise route planning there was an increase in customer satisfaction. The number of complaints and missed collections dropped and residents appreciated the timely notifications along with the consistent service.

The upgraded system transformed MQ Garbage Collection into a more efficient and customer-centric operation. Serena's project management skills and the adoption of advanced technology not only addressed the existing problems but also positioned the company for future growth and success.

## 2 Project Scope

The scope of the project to implement the MQ Garbage Collection Management System includes sourcing and implementing the required system components, and making arrangements for the necessary maintenance of the same. A benefits realisation plan is also part of the scope of this project under Serena's management.

## 2.1 System Components

### **Garbage Collector:**

It is one of the core components of the project for the primary task to detect and retrieve memory that is not being used.

### **Memory Manager:**

Memory manager manages the allocation and deallocation. It also interacts closely with the Garbage Collector.

### **Runtime system:**

This system includes libraries and runtime support for the garbage collection algorithms.

### **Compiler/Interpreter Integration:**

The compilation process ensures proper integration of garbage collection mechanisms into the language runtime.

## 2.2 Functionalities

### **Memory Allocation:**

Memory allocation includes the efficient allocation of memory for the objects and data structures.

### **Garbage identification:**

This includes the algorithms to identify unreachable objects and reclaim their memory.

### **Memory reclamation:**

Reclamation process includes strategies for reclaiming of the memory, such as mark and sweep, reference counting or generational collection.

### **Performance Optimization:**

This process includes techniques to minimise pauses and overhead introduced by garbage collection, like incremental or concurrent collection.

### **Memory profiling:**

This includes the tools for monitoring memory usage, identifying memory leaks, and optimising memory allocation patterns.

### **Integration with language feature:**

The process of integration with language features includes support for language-specific features like finalizer, weak references, and custom memory management options.

### **Compatibility and interoperability:**

These features include ensuring compatibility with the existing codebases and interoperability with other systems and libraries.

### **Error Handling:**

Consists of handling memory allocation failures and other errors related to garbage collection.

### **Documentation and Testing:**

Thorough documentation tailored for developers utilising the garbage collection system alongside rigorous testing methods to guarantee reliability and accuracy.

The Summarise block diagram for the scope according to the system components and functionalities is given below:

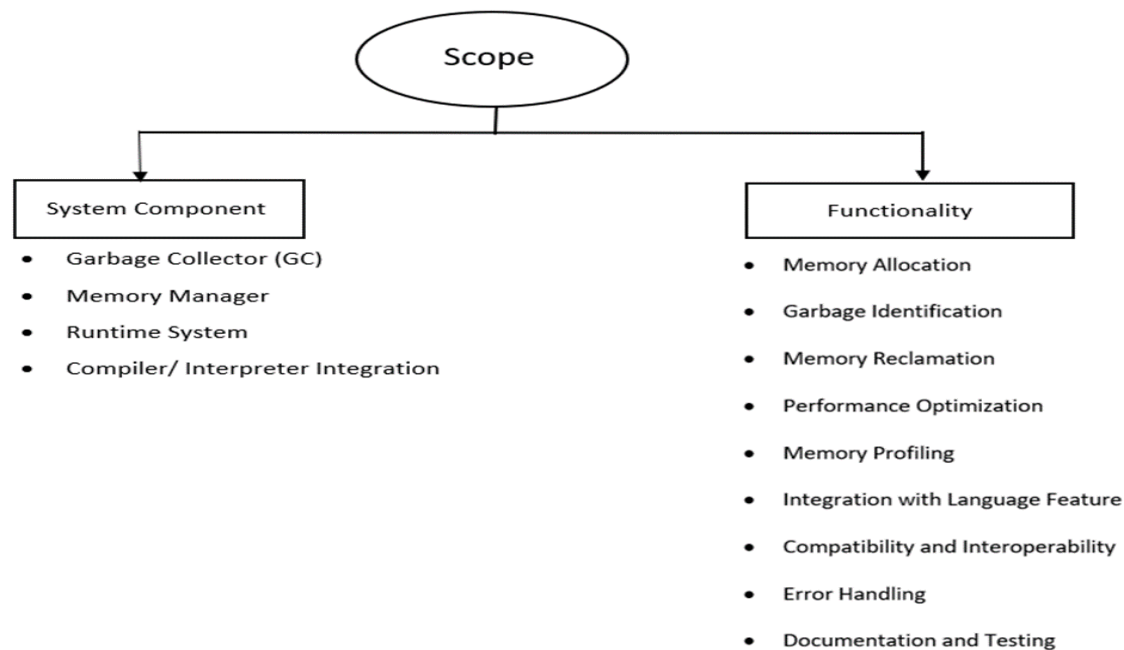


Figure 1: Project Scope

## 2.3 Benefits Realisation Plan

Developing a benefit realisation plan for MQ Garbage Collection entails identifying anticipated benefits and detailing the strategies to achieve and assess them. Here is a structured method for creating such a plan.

### 1. Identify Key Objectives:

This includes defining the primary objectives of implementing the garbage collection project. These may include improving memory management efficiency, reducing memory leaks, enhancing system performance, and simplifying memory management for developers.

### 2. Define Expected Benefits:

#### **Operational benefits:**

This benefit reduces manual memory management efforts, decreased risk of memory-related errors and crashes, improved system stability and reliability.

#### **Technical Benefits:**

Optimal memory utilisation, better responsiveness of applications, scalability to handle larger workloads.

#### **Cost Benefits:**

Lower maintenance costs due to reduced debugging and troubleshooting related to memory issues, potential savings from optimised resource usage.

#### **Strategic Benefits:**

Enhanced competitiveness through faster and more reliable software, better user experience leading to customer satisfaction and loyalty.

### 3. Metrics and KPIs:

Define measurable Key Performance Indicators (KPIs) that align with the identified benefits. Examples includes:

- Percentage reduction in memory leaks
- Performance metrics i.e. reduced garbage collection pause times, improved application response times.
- Cost savings i.e. decreased resource usage leading to lower infrastructure costs.



#### **4. Timeline and Milestones:**

Establish a timeline for the project implementation, including key milestones such as:

- Finishing the implementation of the garbage collection algorithm.
- Incorporating the garbage collection system into the runtime environment or programming language.
- Conducting various testing stages, including unit testing, integration testing, and performance testing.
- Deployment and rollout to production environments.

#### **5. Resource Allocation:**

- List the necessary resources for the project, such as personnel, budget, tools, and infrastructure.
- Assign tasks and roles to team members, including developers, testers, and project managers.

#### **6. Risk Management:**

- Recognize possible risks and challenges that may affect the project's success, such as compatibility issues, performance limitations, or unanticipated shifts in requirements.
- Create plans to mitigate risks and handle contingencies proactively.

#### **7. Implementation and Monitoring:**

- Implement the project based on the established plan, monitoring progress against milestones and Key Performance Indicators (KPIs).
- Establish monitoring and reporting systems to track the achievement of benefits over time.
- Consistently evaluate and analyse the project's performance, making necessary adjustments to enhance the realisation of benefits.

#### **6. Post-Implementation Evaluation:**

- Perform a post-implementation assessment to compare the achieved benefits with the initial objectives.
- Collect input from stakeholders, users, and technical teams to uncover insights and areas for improvement.
- Record the holistic impact of the garbage collection project on operational efficiency, technical performance, cost-effectiveness, and strategic outcomes.

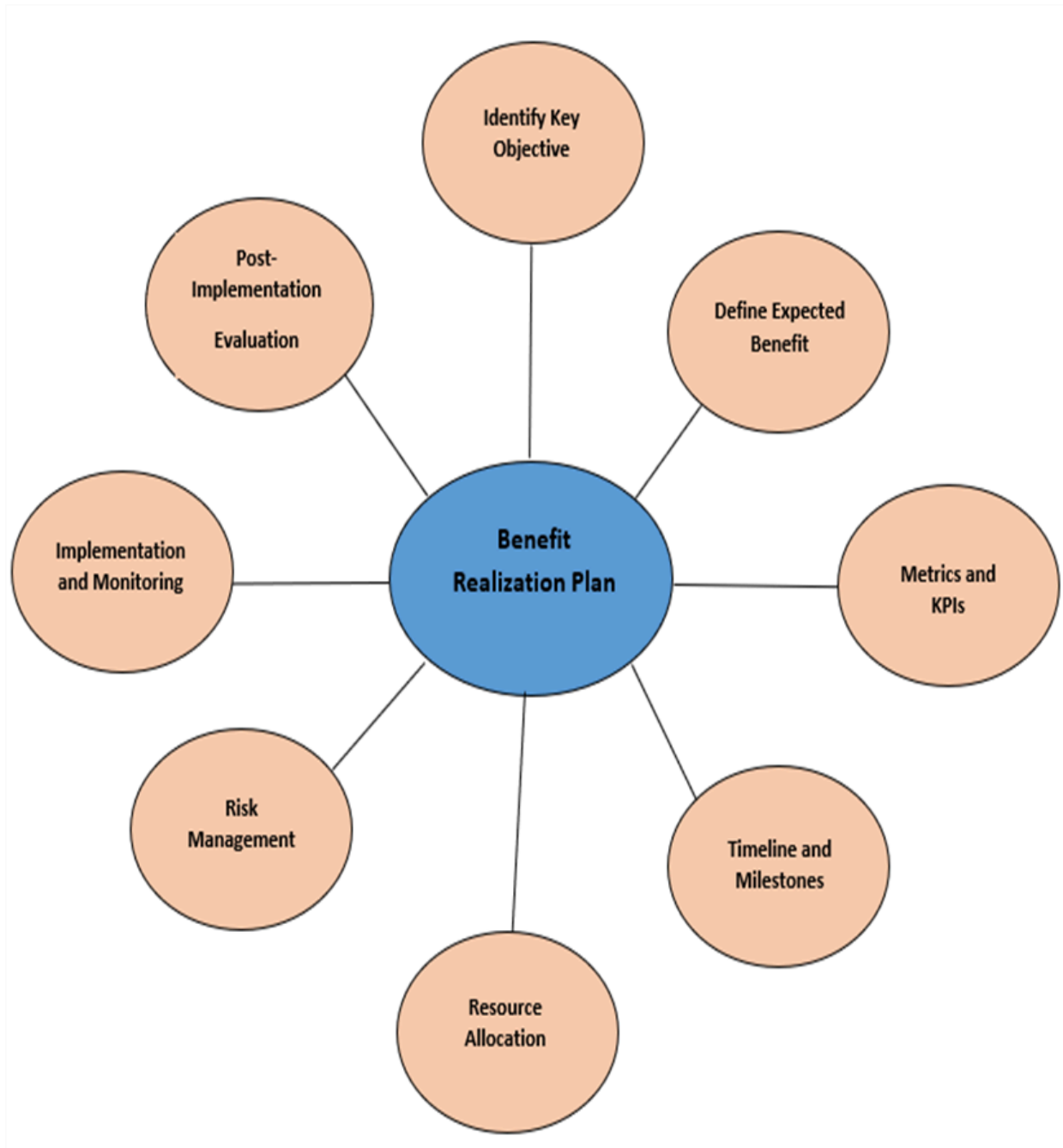


Figure 2: Benefits Realization Plan

## 2.4 Expected Benefits:

Upon executing the aforementioned benefits realisation plan, MQ Garbage Collection aims to achieve:

- 1. Managing complexity:** As software systems and applications become more complex, garbage collection makes memory management efficient, improving the thinking burden on developers and allowing them to concentrate on advanced design and functionality aspects.
- 2. Managing Multitask:** Efficient garbage collectors are specifically engineered to operate effectively in concurrent and parallel programming settings. This ability is crucial for applications that manage multi-core processors and elongate computing, as manual memory management in such environments can be difficult and cause errors.
- 3. Resource Management:** Garbage collection improves resource utilisation dynamically by reclaiming unused memory and resources, a process particularly advantageous in resource-limited settings like mobile devices and cloud computing. Efficient resource management is important for improving performance and cost-effectiveness in such environments.
- 4. Workload Management:** Garbage collection in dynamic and scalable systems adjusts to changing workloads by supporting handling memory allocation and deallocation. This adaptability is beneficial for applications facing changing usage patterns and requiring responsive resource workload management.
- 5. Security Improvement:** Garbage collection helps mitigate security vulnerabilities related to memory management, such as buffer overflows and dangling pointers. By automatically deallocating unused memory, it reduces the risk of memory-related exploits and motivates overall system security.
- 6. Interoperability:** Garbage collection provides cross-platform compatibility by archiving the complications of low-level memory management. This allows developers to develop code that operates effectively across various operating systems and hardware systems, omitting the need for extensive platform-specific adjustments.
- 7. Sustainability Practices:** Effective garbage collection algorithms play a role in promoting energy-efficient computing by optimising how memory is utilised and minimising unnecessary resource usage. This supports sustainability objectives and is becoming more significant in environmentally aware computing strategies.

Hence, with Efficient garbage collection algorithms, MQ Garbage Collection aims to reduce memory utilisation and minimise resource waste. This contributes to sustainability goals and is increasingly important in environmentally conscious computing techniques.

## 3 Resource Management

Resource management is a crucial part of a growing business like MQGC to ensure success. With a successful and efficient business operation in mind, this section outlines an elaborate plan undertaken to solve inefficiency and scalability issues faced by MQGC.

### 3.1 Procurement

All strategies and guidelines in regards to procurement of materials and subcontractors for MQGC's mapping project are contained in this section.

#### 3.1.1 Procurement Strategy

**(a) Needs Assessment**

A comprehensive needs assessment shall be conducted prior to any changes in strategy to identify gaps and areas for improvement. This includes consulting with stakeholders (truck drivers, management, and customers) to understand all parties' needs and expectations.

**(b) Vendor Selection**

Based on the needs assessment, in addition to a revision of existing vendors, potential vendors shall be identified for materials needed to implement new strategies such as GPS, route planner, and training manuals.

**(c) Evaluation Criteria**

Vendors shall be issued formal Requests for Quote (RFQ) and Requests for Proposal (RFP). Criteria shall be established to assess these quotes and proposals, such as vendor's expertise, experience, cost, timeline, compatibility etc.

**(d) Vendor Evaluation**

Upon receipt of quotes and proposals, they shall be assessed based on predetermined evaluation criteria. This step shall involve relevant stakeholders to ensure alignment with business needs and objectives.

**(e) Contract Negotiation**

Once a preferred vendor is selected, Project Manager shall negotiate a contract with the vendor. For material suppliers, this contract shall include timelines and payment terms. For subcontractors, the contract shall include scope of works, deliverables, timelines, milestones, payment terms, inclusions and exclusions etc.

**(f) Budgeting**

The insight gained from the market research conducted through the correspondences with suppliers shall be used to assist in overall budgeting.

**(g) Risk Mitigation**

To mitigate risks such as delays, cost overruns, or vendor performance issues, contracts shall include scopes of penalties for missed deadlines and establishment of a clear communication protocol that works for both parties.

### 3.1.2 Vendor Management

**(a) Up-to-date Database**

Accounting software (Xero) shall be introduced to help track all vendors and payments efficiently.

**(b) Clear Communication Channels**

During contract negotiation, clear communication channels shall be settled with vendors. The contracts shall include the regular communication of updated pricings.

**(c) Regular Progress Review**

Meetings, milestone reviews, and performance evaluation metrics shall be established prior to contract finalisation.

**(d) Issue Resolution**

A clear process for identifying, escalating, and resolving supply and other issues with the vendor shall be established, and communicated among executive stakeholders.

**(e) Relationship Building**

The team shall emphasise on building and maintaining a positive and collaborative relationship with vendors. This shall be done by fostering open communication, demonstrating appreciation for meeting performance benchmarks, and addressing concerns in a constructive manner.

## 3.2 Human Resource Management

This section outlines the strategies and plans for managing the human resources of MQ Garbage Collection. Within the scope of the company, human resources are broadly identified as truck drivers, project managers, IT personnel, administrative staff, and outsourced partners. The HR management plan includes the identification of key roles and responsibilities, training, recruitment and appropriate allocation of personnel, and strategies for ensuring that the project team has the skills and knowledge required to implement and utilise the new system effectively.

### 3.2.1 Employee Management Strategy

#### **(a) Skills Assessment**

A skill assessment of the existing workforce including truck drivers and other garbage collectors shall be conducted. This shall include assessment of technical skills, theoretical knowledge, management capabilities, driving skills etc.

#### **(b) Employee Allocation**

Once skills have been assessed for existing employees, they will be allocated to garbage collection shifts such that each shift contains at least one primary garbage collector and one experienced driver. New employees shall be brought onboard after careful assessment as required.

#### **(c) Outsourcing**

Technical aspects of the GIS project such as setting up GPS screens on trucks, maintaining customer databases, and maintaining the IT infrastructure for the additional technical aspects shall be outsourced appropriately.

#### **(d) Training Plan**

Based on the skills assessment, a comprehensive plan shall be prepared to equip employees with the necessary knowledge to effectively use the newly adapted systems. This shall include workshops, seminars, online courses, and on-the-job training.

### 3.2.2 Key Roles and Responsibilities

Role	Responsibilities
Owners/Board Members (Mick Taylor and Herbert Johnson)	<p>a) Strategic Leadership: Define the long-term vision and strategic goals for MQGC. Make critical business decisions to guide the company's growth and sustainability.</p> <p>b) Financial Oversight: Manage the company's financial health, including budgeting, funding, and investment decisions. Monitor financial performance and profitability.</p> <p>c) Operational Management: Oversee daily operations and ensure efficient resource utilisation. Address any high-level operational issues and implement solutions.</p> <p>d) Stakeholder Engagement: Maintain relationships with key stakeholders, including customers, suppliers, and regulatory bodies. Represent MQGC in public and industry forums.</p>
Project Manager (Serena)	<p>a) Project Planning: Develop project plans outlining the scope, objectives, timelines, and resources required for the GIS mapping project and other initiatives.</p> <p>b) Execution: Coordinate project activities, assign tasks, and ensure timely completion of milestones. Manage cross-functional teams to achieve project goals.</p> <p>c) Risk Management: Identify potential risks and develop mitigation strategies. Monitor and address any issues that arise during the project lifecycle.</p> <p>d) Vendor Management: Select and manage vendors, negotiate contracts, and ensure deliverables meet quality and performance standards.</p> <p>e) Communication: Facilitate communication between project stakeholders, including team members, vendors, and management. Provide regular updates on project status and progress.</p>
Operations Manager	<p>a) Route Planning and Optimization: Design and optimize garbage collection routes to improve efficiency and reduce operational costs. Implement GIS mapping solutions to streamline routes.</p>

	<p>b) Fleet Management: Oversee the maintenance and management of the company's fleet of garbage collection trucks. Ensure vehicles are in good working condition and meet regulatory standards.</p> <p>c) Compliance and Safety: Ensure compliance with local regulations and industry standards. Implement safety protocols to protect employees and the public.</p> <p>d) Customer Service: Address customer complaints and feedback regarding garbage collection services. Implement solutions to improve customer satisfaction and service quality.</p>
Human Resources Manager	<p>a) Recruitment and Staffing: Manage the recruitment, selection, and onboarding of new employees. Ensure that the company has the necessary workforce to meet operational demands.</p> <p>b) Training and Development: Develop and implement training programs to enhance employee skills and knowledge. Focus on training drivers on new technologies and safety protocols.</p> <p>c) Performance Management: Monitor and evaluate employee performance. Provide feedback, conduct performance reviews, and implement improvement plans as needed.</p> <p>d) Employee Relations: Foster a positive work environment and address employee concerns. Ensure compliance with labor laws and company policies.</p>
Procurement Manager	<p>a) Oversee the complete procurement chain, starting with needs assessment, vendor selection and so on.</p> <p>b) Collaborate with project managers and other key stakeholders to establish procurement strategies.</p> <p>c) Maintain relationships with suppliers to ensure an effective communication strategy, contract management, and payment terms.</p>
IT Manager	<p>a) Technology Implementation: Oversee the implementation of the GIS mapping system and other technology projects. Ensure systems are integrated seamlessly with existing infrastructure.</p> <p>b) System Maintenance: Maintain and troubleshoot IT systems, ensuring</p>



	<p>minimal downtime and optimal performance. Address any technical issues that arise.</p> <p>c) Data Management: Manage data related to garbage collection routes, customer information, and operational metrics. Ensure data accuracy and security.</p> <p>d) Support and Training: Provide technical support and training to employees on new systems and technologies. Ensure users are proficient and confident in using new tools.</p>
Truck Drivers	<p>a) Garbage Collection: Execute daily garbage collection routes efficiently and accurately. Ensure all assigned residences and businesses are serviced.</p> <p>b) Route Navigation: Utilize GIS mapping systems to follow optimized routes, avoiding early time slots and peak traffic times. Ensure timely and efficient service delivery.</p> <p>c) Vehicle Maintenance: Conduct routine checks and basic maintenance on garbage collection trucks. Report any issues or needed repairs to the operations manager.</p> <p>d) Customer Interaction: Address any immediate customer concerns during collections. Maintain a professional and courteous demeanor with the public.</p>
Administration Officer	<p>a) Customer Support: Handle customer inquiries, complaints, and service requests. Maintain records of customer interactions and ensure follow-up actions are taken.</p> <p>b) Scheduling and Coordination: Assist in scheduling garbage collection routes and coordinating with drivers. Ensure schedules are communicated clearly and adhered to.</p> <p>c) Documentation and Reporting: Maintain accurate records of operations, including route data, vehicle maintenance logs, and employee attendance. Generate reports for management review.</p> <p>d) Office Management: Oversee general office administration tasks, including supply management, filing, and communication with external partners.</p>

## 4 Risk Management

The Purpose of this Risk Management plan is to help identify, assess and mitigate any risks that are associated with implementing a GIS mapping project at MQ Garbage Collection (MQGC). By understanding and addressing any risks that may be evident it can ensure successful completion of the project in an efficient and effective manner.

### 4.1 Risk Management Plan

#### **1. Resistance to Change:**

This is one risk that can be identified as drivers may resist adopting new systems resulting in decreased productivity. The level of risk can be considered medium as lack of training or fear of the unknown can contribute to resistance to change and minimise impact of the new system.

#### Management Plan:

- Effective communication: Communicating about the benefits of the new systems as well as any concerns that employees may have with the new system in place can help ease transition of the new system.
- Training: Setting up and conducting training sessions that help familiarise drivers with the new systems that are being put in place and how it will work. This can be done by implementing online modules and simulations.
- Ongoing Support: Ensuring that support is available for those who may have concerns or are facing challenges in the transition period.

#### Responsibility:

- Serene leads the training sessions and ensures all information is communicated effectively.
- The HR team will ensure that support is readily available for any issues that may arise during the transition.

#### **2. Increased Fuel Costs:**

The increasing costs of fuel can increase operational expenses for MQ garbage collection (MQGC) impacting the profitability of the project resulting in adjustment to be made to budget allocations. The level of risk can be seen as high as fuel prices can endure fluctuations. These fluctuations can occur due to reasons such as “economic conditions and geopolitical factors” (Ghazanfari, 2022).

#### Management Plan:

- Cost Breakdown and analysis: Conducting regular cost analysis can help understand fuel costs as well as anticipate any future fuel costs.
- Route Enhancement: Implementing strategies such as route optimisations can help ensure fuel efficiency. Implementing softwares that optimises routes and reduces any unnecessary kilometres can be effective to minimise fuel consumptions.
- Vehicle maintenance: Ensuring vehicle maintenance can help reduce fuel consumption. Properly maintaining engines, tires and other components can help reduce fuel consumption.
- Alternative fuel options: Conducting thorough research on different fuels can help determine a suitable option that works better than fuel. Research can be done on biodiesel or electric power and factors such as availability and supply can be considered when making a decision.

#### Responsibility:

- Serene would oversee any budget plans and understand the finances that are available for use for this project. She will also look at any alternative options that can help ensure project costs are within budget.

### **3. Integration of the new system**

The integration of the new system can pose a risk as it can disrupt workflow efficiency as well as increase project costs. The level of risk can be seen high as integration of new technology can have compatibility issues and be a complex process especially when implementing the system with an older system.

#### Management Plan:

- Trials and Testing: Test the system and ensure efficient integration of the system. Identify any issues and gather feedback to ensure effective implementation of software.
- System Analysis: Undertaking an analysis of the old system to understand ways to introduce the new system seamlessly avoiding any challenges.
- Involvement of IT experts: Involving IT experts can help ensure a successful implementation plan and help address any complications that may arise when integrating the systems.

#### Responsibility:

- Serena will oversee the integration process as well as involve the IT department to help with integration.

- The IT department will be invaded to help seamless integration and troubleshooting.

#### **4. Exceeding the Budget:**

Going over the budget is another risk that can disrupt the project and impact the delivery of the project. This can ultimately lead to project delays and extensive financial stress. The level of this risk is high as it can add expenses and cause the project to go over the budget.

#### **Management plan:**

- Approval of Budget: Seeking approvals for expenses with stakeholders to ensure that the budget is on track.
- Monitoring: Tracking the budget and monitoring spendings with the budget regularly to avoid any financial implications. Implement real-time tracking software to monitor project spendings efficiently.
- Setting out objectives: Understanding the important objectives of the project that are required to ensure they are within the budget.

#### **Responsibility:**

- Serene will be able to understand areas for cost saving as well as oversee project expenses
- The Finance Department will also be involved in overseeing the project finances.

## **4.2 Recommendations**

#### **Continuous Training & Support:**

Ensuring adequate training and support is provided to the users of MQ Garbage Collection Mapping System (MQGCMS). This is beneficial as continued training and support can ensure users are confident with using the systems being put in place furthermore maximising the integration and use of the system. Continuous Training can be incorporated in numerous ways such as developing comprehensive training programs and user manuals which allow for users to study and gain an idea of the new systems that are being implemented. Training modules should be regularly monitored and should be refreshed every 4 months allowing users to continuously develop their understanding. Finally implementing user forums that allow users to seek support to ensure all queries and concerns are answered. Thus, the implementation of training programs can provide continuous support, ensure smooth adoption of the upgraded system and help facilitate user transition in an efficient and effective manner.

**Real-Time Tracking and Reporting:**

Implementations of real time tracking helps the company and stakeholders understand how garbage collection operations are progressing, vehicle location and completion service status. This is beneficial as it enhances operation visibility and allows the company to make continuous improvements to the garbage collection process. The implementation of GPS and Geographical Information systems (GIS) technology will allow for real-time tracking and help generate performance metrics. Furthermore, real time tracking and reporting can ensure timely resolutions of service disruptions such as vehicle breakdown and missed pickups if they are to occur. This ultimately helps gain insights and make data driven decisions leading to improved operational efficiency and resource allocation. Overall, the implementation of real time tracking and reporting allows for efficient business operations and an improved customer experience.

**Communication Channels:**

Integrating effective communication channels within the MQGCMS to allow seamless communications between drivers, supervisors, back-end staff and maintenance crews ensuring enhanced customer satisfaction and quality of service. Communication channels can be implemented by including in app messaging and other collaboration tools to ensure efficient communication. By incorporating in-app messaging it can ensure effective communication and help operational efficiency by providing updates on the garbage collection process. Tasks such as route adjustments and inquiries can be communicated and addressed through effective communication channels. Thus, by implementing efficient communication channels it can minimise service disruptions and overall enable optimised garbage collection operations.

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