



Smart Waste Collection Based on Vehicle Routing for Municipal Solid Waste Using Genric Algorithms

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Abstract— Waste collection is a important activity for maintaining clean and healthy communities. Traditional waste collection systems generally depend on fixed collection schedules and predetermined routes such an approaches may not always be suitable, when waste generation, collection requirements or available resources change. Recent studies have explored dynamic routing and suitable waste-bin location planning to improve the efficiency of waste collection systems. This review paper focuses on two important areas: dynamic routing for waste collection and optimal planning of waste-bin locations. Dynamic routing help in the modifying collection routes according to changing requirements, while proper waste-bin location planning can make waste collection more accessible and organized. The paper reviewing exists studies related to dynamic routing and web-based approaches. A compare analysis is present to identify difference in objectives, technologies and practical applications of the reviewed studies. The review also identifies research gaps and possible directions for developing the simple and practical waste collection application.

I. INTRODUCTION

Waste management is the important environmental and social activity. The increasing amount of waste generated in residential and public areas. Creates a need for organized collection systems and efficient collection requires proper planning of collection points, vehicles, workers, and routes.

Traditional waste collection systems commonly use fixed routes and schedules. The result in unnecessary traveled when the waste generation and collection requirements vary. A vehicle may visit locations where collection is not required while other locations may require earlier collection. Dynamic routing provides an approach in which collection routes can modify according to changing situation.

Web-based technologies can provide a centralized platform for store and maintain information related to waste bins, collect points, vehicles, workers, and routes and such systems can help organize update collection information to support better planning.



This review paper focuses on dynamic routing. It reviews related literature, compares the approaches used in existing studies, and identify possible research gaps for developing practical and manageable waste collection systems.

II. LITERATURE SURVEY

A. Dynamic Routing Collection

Dynamic routing for efficient waste collection in resource-constrained societies. Their work considers resources such as availability and change waste conditions when we plan to collect routes. This study highlights the importance of flexible routing when collection requirements and available resources are not constant .

Dynamic routing can modify the route of a collection vehicle according to the available information. Factors such as collection requirements, vehicle availability, distance, and operating conditions can influence route planning. This approach can provide greater flexibility compared with completely fixed routes.

B. Location Planning

Web application for determining waste-bin locations. Their study focuses on identifying suitable waste-bin locations and supporting collection-route planning through a web-based approach.

Waste-bin location planning is important because the position of collection points affected by accessibility and the movement of collection vehicles. Factors such as distance, accessibility, existing collection points, and collection requirements can be considered when determining suitable locations.

C. Waste Collection Routing Survey

Hess et al. presented a survey of waste collection routing problems and methods. Their study provides a broader review of different routing problems and approaches used in waste collection. The survey indicates that waste collection routing can involve different operational constraints and requirements depending on the specific collection environment [3].

The survey provides useful background for understanding how waste collection routing has developed and how different routing approaches can be selected according to the requirements of a particular system.

D. Web-Based Waste Collection Planning

Web applications can support waste collection planning by providing a centralized platform for managing collection-related information. Information regarding waste bins, collection points, vehicles, workers, schedules, and routes can be stored and accessed through a web-based system.

The work of Terzi et al. demonstrates how web-based technologies can be used for waste-bin location planning and collection-route determination [2]. Such approaches provide a basis for developing practical digital systems for waste collection organizations.



III. REVIEW METHODOLOGY

This paper follows a review-based methodology. Existing literature related to dynamic waste collection, route planning, waste-bin location planning, and web-based waste management systems was considered to understand the research area.

The methodology consists of identifying relevant studies, examining their objectives and approaches, comparing their major characteristics, identifying common findings and limitations, and determining possible research gaps.

A. Literature Selection

The review focuses on literature related to dynamic waste collection and resource-constrained routing, waste-bin location planning and web-based waste management, and waste collection routing problems and methods .

The selected studies were considered from the perspective of improving the organization, flexibility, and efficiency of waste collection operations.

B. Review Parameters

The selected literature was examined based on the following parameters:

- Collection planning approach
- Routing approach
- Waste-bin location consideration
- Technology used
- Resource requirements
- Practical applicability
- Operational constraints

C. Research Gaps

The review of existing literature shows that dynamic routing and waste-bin location planning have been studied from different perspectives. However, several areas can be explored further for practical and small-scale waste collection systems. These include:

- Integration of collection routes with worker and volunteer availability.
- Development of simple and affordable solutions for small organizations.
- Use of changing collection information during route planning.
- Integration of historical collection records for better planning.
- Improved web-based visualization of collection points and routes.
- Consideration of vehicle capacity during route planning.

These areas provide opportunities for developing practical web-based waste collection systems that can combine route planning, collection-point management, and resource availability.



IV. COMPARATIVE ANALYSIS

The reviewed studies address different but interconnected aspects of waste collection planning. A comparison of the major characteristics of the selected studies is presented below.

Parameter	Priyadarshi et al.	Terzi et al.	Hess et al.
Main Focus	Dynamic waste collection routing	Waste-bin location planning and collection routes	Survey of waste collection routing
Routing Approach	Dynamic routing according to changing conditions	Route determination associated with waste-bin locations	Reviews different routing problems and methods
Waste Bin Location	Not the primary focus	Major focus	Considered as part of waste collection routing problems
Resource Consideration	Resource-constrained collection	Operational and geographic considerations	Different operational constraints
Technology / Approach	Computational routing approach	Web-based GIS/service application	Literature survey and methodological analysis
Primary Objective	Improve routing under changing and limited-resource conditions	Determine suitable waste-bin locations and support collection planning	Classify and review waste collection routing problems and methods
Practical Application	Flexible collection-route planning	Digital planning of collection points and routes	Provides broad understanding of routing approaches

The comparison shows that the studies focus on different aspects of waste collection. Priyadarshi et al. primarily focus on dynamic routing and resource constraints [1]. Terzi et al. focus on waste-bin location planning and a web-based approach for supporting collection planning [2]. Hess et al. provide a broader survey of waste collection routing problems and methods [3].

Together, these studies indicate that effective waste collection planning can benefit from considering both collection-point locations and route organization. The studies also provide a foundation for developing simpler web-based systems that combine collection information and route planning.

V. RESULTS AND DISCUSSION

The reviewed literature indicates that efficient waste collection depends on multiple factors rather than route selection alone. Dynamic routing addresses changing collection requirements and resource constraints, while waste-bin location planning focuses on selecting appropriate collection points.

The literature also indicates that web-based systems can support the centralized management of collection information. Information about waste bins, collection points, vehicles, workers, schedules, and routes can be organized through a digital platform. Such a platform can make information easier to update and access.



A common practical consideration is the availability of resources. Waste collection organizations may operate with limited vehicles, workers, volunteers, or operational resources. Dynamic planning can provide flexibility in such situations by allowing collection routes and assignments to be adjusted according to available information .

Waste-bin location is also connected to route planning. The position and distribution of collection points can influence the movement of collection vehicles. Therefore, considering collection-point planning together with route planning can provide a more organized approach to waste collection .

The reviewed studies also show that advanced routing and GIS-based solutions can involve specialized technologies and data. For smaller organizations, a simpler web-based system may be more practical. Such a system can focus on essential functions such as collection-point management, route planning, vehicle availability, worker assignment, schedules, and collection records.

Based on the reviewed literature, integrating collection-point information with dynamic route planning represents a useful direction for practical waste collection systems. Further development can consider worker availability, vehicle capacity, historical collection records, and changing collection requirements.

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