



(RESEARCH ARTICLE)



PREDICTING AND MANAGING CUSTOMER RETURN TIME UNCERTAINTY IN CAR RENTAL FIRMS: THE ROLE OF DIGITAL COMMUNICATION AND OPERATIONAL FLEXIBILITY

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World Journal of Advanced Research and Reviews, 2026, 32(01), 053–059

Publication history: Received on 26 July 2026; revised on 05 September 2026; accepted on 07 September 2026

Article DOI: <https://doi.org/10.30574/wjarr.2026.32.1.2289>

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ABSTRACT

Objective: This study investigates how customer return time uncertainty affects operational efficiency in car rental firms and examines the role of digital communication and operational flexibility as predictive and managerial strategies for addressing this uncertainty. Customer return time uncertainty, defined as the deviation of actual vehicle return times from agreed schedules due to traffic congestion, recreational activities, oversleeping, changes in travel plans, or unexpected personal events, generates overtime costs, workflow disruptions, and reduced fleet utilization that collectively impair operational efficiency.

Methodology: A sequential explanatory mixed-methods design is proposed. Phase 1 employs a structured survey administered to a minimum of 200 customers of car rental firms, analyzed using descriptive statistics, multiple regression, and Structural Equation Modeling. Phase 2 conducts semi-structured qualitative interviews with 12 to 20 operations managers and vehicle collection officers, analyzed using thematic analysis. Theoretical grounding draws on the Theory of Planned Behavior, Contingency Theory, and Dynamic Capability Theory.

Anticipated Results: The study expects to confirm that return time uncertainty is negatively associated with operational efficiency and that digital communication tools, including mobile app notifications, GPS tracking, and automated reminders, and operational flexibility measures, including flexible staffing and dynamic scheduling, each independently and interactively moderate this negative relationship.

Conclusion: The study will produce the first empirically validated framework for predicting and managing customer return time uncertainty in car rental firms, contributing to service operations management theory and generating practical tools for industry practitioners.

Keywords: Car Rental Operations; Customer Return Time Uncertainty; Digital Communication; Operational Flexibility; Service Operations Management; Vehicle Return Management

1 INTRODUCTION

The car rental industry is an important component of the transportation and tourism sectors, providing customers with temporary access to vehicles for business, leisure, and personal purposes. The efficiency of car rental operations depends heavily on customers adhering to agreed vehicle return schedules. However, customers frequently return rented vehicles either earlier or later than expected, creating uncertainty for car rental firms [1].

Delayed returns may occur because customers encounter traffic congestion, participate in recreational activities such as hiking or sightseeing, oversleep, extend their trips, or experience unexpected personal events. On the other hand, customers may also return vehicles earlier than scheduled due to changes in their travel plans. These unpredictable return behaviors create operational challenges, disrupt staff schedules, increase overtime costs, and reduce overall service efficiency [2, 3].

Recent advances in digital communication technologies, such as mobile applications, GPS tracking, automated reminders, and real-time messaging, offer opportunities for firms to predict and manage customer return time uncertainty more effectively. Likewise, operational flexibility, including flexible staffing, dynamic scheduling, and adaptive resource allocation, may help firms cope with unpredictable return patterns [4, 5].

Nevertheless, limited empirical evidence exists regarding how these strategies influence operational efficiency in car rental firms. Most prior research has concentrated on fleet management, pricing, reservation systems, and customer satisfaction, leaving a gap regarding the prediction and management of return time variability [6, 7]. This study seeks to investigate how customer return time uncertainty affects operational efficiency and examine the moderating roles of digital communication and operational flexibility in managing such uncertainty.

1.1 Background of the Study

Car rental firms rely on predictable customer behavior to ensure efficient vehicle utilization and smooth business operations. Vehicle return schedules determine employee work plans, fleet availability, customer service delivery, and revenue generation. However, customer return times are often uncertain, and this uncertainty has measurable operational consequences [8].

The problem becomes particularly significant when managers or collection officers must extend their working hours beyond official closing times to receive late returns. Similarly, early returns may interrupt planned activities and force employees to alter their schedules unexpectedly. Khwaja and Yang [9] demonstrated that service disruptions in car rental operations, including vehicle unavailability resulting from return scheduling failures, directly reduce customer retention even when compensation is provided.

Although service operations literature has extensively explored demand uncertainty, queue management, and customer satisfaction, limited research has examined customer return time uncertainty as a distinct operational construct in car rental firms. Existing studies have primarily focused on fleet management, pricing, reservation systems, and customer satisfaction, leaving a gap regarding how firms can predict and manage variability in customer return behavior [6, 10].

This research aims to bridge this gap by investigating the determinants of return time uncertainty and exploring the effectiveness of digital communication and operational flexibility as managerial strategies. Mohammed [11] and Mohammed [12] documented analytics adoption and fleet management performance gaps across U.S. car rental operator types, establishing that operational coordination challenges are particularly acute at firms with limited digital infrastructure. This study extends that line of inquiry to customer behavior prediction and return schedule management.

1.2 Problem Statement

Operational efficiency is essential to the success of car rental firms. However, firms frequently encounter uncertainty regarding vehicle return times because customers often return rented vehicles earlier or later than agreed. These deviations from scheduled return times create operational disruptions that manifest as overtime costs, reduced employee productivity, lower job satisfaction, and impaired fleet utilization [2, 3].

Although digital technologies and flexible operational practices have the potential to reduce uncertainty and improve scheduling, there is limited empirical evidence on their effectiveness in the car rental industry. Most previous studies have concentrated on customer satisfaction, fleet optimization, and pricing strategies, with little attention given to customer return time uncertainty and its implications for operational performance [6, 10].

Consequently, car rental firms lack evidence-based strategies for predicting and managing return time uncertainty. This study addresses this gap by investigating the determinants of customer return time uncertainty and examining the moderating roles of digital communication and operational flexibility in improving operational efficiency under uncertain return conditions.

Research Objectives

- General Objective

To examine how customer return time uncertainty affects operational efficiency in car rental firms and investigate the roles of digital communication and operational flexibility in predicting and managing this uncertainty.

- Specific Objectives
- To identify the factors influencing customer return time uncertainty in car rental firms.
- To examine the effect of customer return time uncertainty on operational efficiency.
- To investigate the role of digital communication in predicting and managing customer return time uncertainty.
- To examine the effect of operational flexibility on operational efficiency under conditions of return time uncertainty.
- To develop and empirically validate a framework for managing customer return time uncertainty in car rental firms.

1.3 Research Questions

- What factors influence customer return time uncertainty in car rental firms?
- How does customer return time uncertainty affect operational efficiency?
- What role does digital communication play in predicting and managing customer return time uncertainty?
- How does operational flexibility influence operational efficiency under uncertain return conditions?
- What strategies can car rental firms adopt to manage customer return time uncertainty effectively?

1.4 Research Hypotheses

Table 1 presents the five research hypotheses derived from the theoretical framework and prior literature.

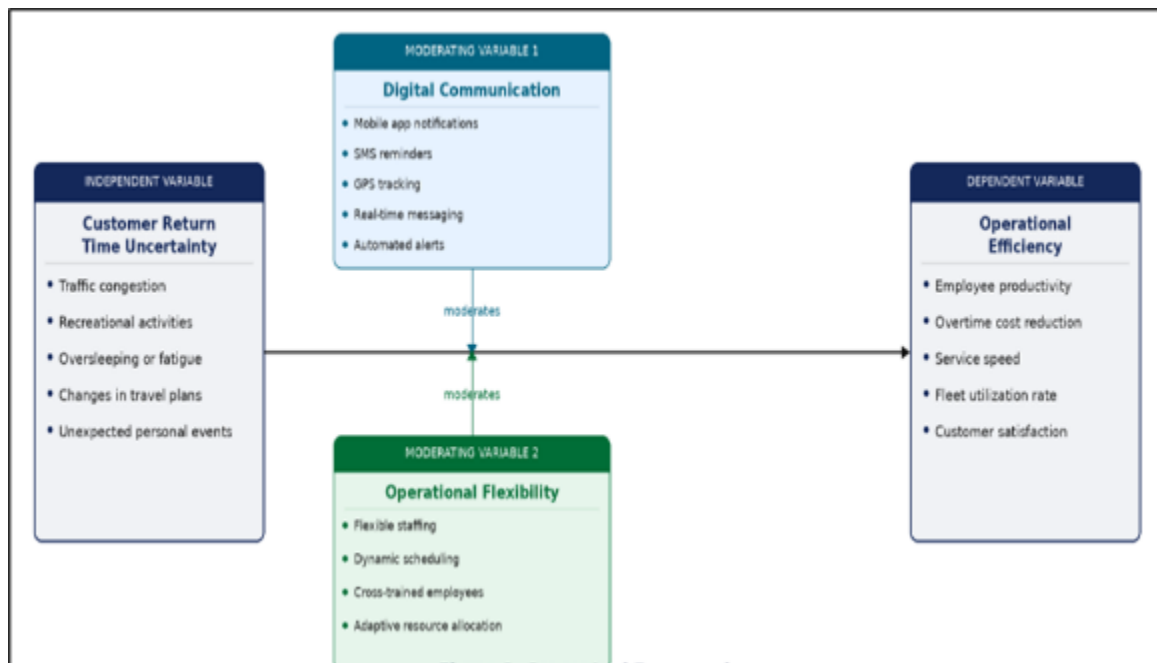
Table 1: Research Hypotheses

Hypothesis	Statement
H1	Customer return time uncertainty is negatively associated with operational efficiency in car rental firms.
H2	Digital communication is positively associated with improved prediction and management of customer return time uncertainty.
H3	Operational flexibility is positively associated with operational efficiency under conditions of customer return time uncertainty.
H4	Digital communication moderates the relationship between customer return time uncertainty and operational efficiency, such that the negative effect of uncertainty is weaker when digital communication capability is higher.
H5	Operational flexibility moderates the relationship between customer return time uncertainty and operational efficiency, such that the negative effect of uncertainty is weaker when operational flexibility is higher.

Note: H4 and H5 test moderation effects.

2 CONCEPTUAL FRAMEWORK

Figure 1 presents the conceptual framework for this study. Customer return time uncertainty is the independent variable, with digital communication and operational flexibility serving as moderating variables and operational efficiency as the dependent variable.



Note: Arrows from the independent variable (Customer Return Time Uncertainty) to the dependent variable (Operational Efficiency) represent direct and moderated relationships. Digital Communication and Operational Flexibility each moderate the main relationship.

Figure 1: Conceptual Framework for Predicting and Managing Customer Return Time Uncertainty

3 THEORETICAL FRAMEWORK

3.1 Theory of Planned Behavior (TPB)

The Theory of Planned Behavior [13] explains how individuals' attitudes, perceived behavioral control, and subjective norms influence their behavioral intentions and actions. Applied to this study, the TPB provides a framework for understanding why customers deviate from agreed return schedules. Customers who perceive low behavioral control over their circumstances, such as unexpected traffic congestion or changes in travel plans, are more likely to return vehicles outside the agreed window. This theoretical lens informs the identification of customer-level factors contributing to return time uncertainty.

3.2 Contingency Theory

Contingency Theory [14] argues that organizational effectiveness depends on the ability of firms to adapt their structures, processes, and resources to the demands of their operating environment. In the context of car rental operations, this theory predicts that firms with more flexible organizational structures, including dynamic staffing and adaptive resource allocation, will be better positioned to maintain operational efficiency when customer return behavior is uncertain. This framework underpins the operational flexibility hypotheses in this study.

3.3 Dynamic Capability Theory

Dynamic Capability Theory [15] explains how organizations develop and reconfigure their capabilities in response to changing environments. Applied to digital communication in car rental operations, the theory predicts that firms that actively develop capabilities in GPS tracking, mobile communication, and real-time customer engagement will be more effective at predicting and managing return time uncertainty. Mohammed [12] documented that analytics capability development in car rental operations is associated with measurable improvements in fleet coordination and error reduction, consistent with the Dynamic Capability framework.

4 MATERIALS AND METHODS

Table 2 presents the research design components across the two phases of this sequential explanatory mixed-methods study.

Table 2: Research Design Overview

Component	Phase 1: Quantitative	Phase 2: Qualitative
Research Design	Sequential explanatory mixed-methods design	Sequential explanatory mixed-methods design
Population	Customers of U.S. car rental firms	Operations managers and vehicle collection officers
Sampling	Stratified random sampling	Purposive sampling
Data Collection	Structured questionnaire (Likert scale items)	Semi-structured interview guide
Analysis	Descriptive statistics; multiple regression; Structural Equation Modeling (SEM)	Thematic analysis
Sample Size Target	Minimum 200 respondents	12–20 key informants

Note: Phase 2 qualitative interviews are conducted after Phase 1 quantitative results to explain and elaborate on quantitative findings.

4.1 Research Philosophy and Approach

This study adopts a pragmatic research philosophy that acknowledges both objective and subjective dimensions of reality and prioritizes the use of methods best suited to answering the research questions. A mixed-methods approach is adopted because neither quantitative nor qualitative methods alone are sufficient to fully capture the complexity of customer return time uncertainty and its operational consequences [16].

4.2 Quantitative Phase

Phase 1 employs a structured questionnaire to collect data from a minimum of 200 customers of car rental firms using stratified random sampling. The questionnaire will measure return time uncertainty, digital communication usage, operational flexibility, and operational efficiency using validated Likert scale instruments adapted from prior service operations and customer behavior research. Descriptive statistics will be used to characterize the sample and variable distributions. Multiple regression analysis will test H1 through H3. Structural Equation Modeling will test the full moderated model including H4 and H5, using the PROCESS macro [17] with bootstrapped confidence intervals.

4.3 Qualitative Phase

Phase 2 conducts semi-structured interviews with 12 to 20 operations managers and vehicle collection officers at car rental firms, selected using purposive sampling to ensure representation across firm sizes and geographic locations. Interview questions will explore the operational consequences of return time uncertainty, current digital communication practices, staffing flexibility approaches, and perceived effectiveness of existing management strategies. Data will be analyzed using thematic analysis [18], with themes validated through member checking and peer debriefing to strengthen credibility.

4.4 Ethical Considerations

Informed consent will be obtained from all participants. Participation will be voluntary and participants will be free to withdraw at any time without consequence. All data will be anonymized prior to analysis. Institutional Review Board approval will be secured before data collection commences.

5 RESULTS AND DISCUSSION

As this is a research proposal, empirical results are not yet available. The following section describes the anticipated results based on the theoretical framework and prior literature, which will be tested and reported in the full study.

Based on the Theory of Planned Behavior and prior service operations research, it is expected that customer return time uncertainty will be negatively associated with operational efficiency (H1), with late returns generating the most significant efficiency costs through overtime labor, fleet readiness failures, and downstream customer service

disruptions [2, 9]. The analysis of factors contributing to return time uncertainty is expected to identify traffic congestion and unexpected personal events as the primary customer-level drivers, consistent with the behavioral control dimension of the TPB [13].

Regarding the moderating effects, digital communication tools are expected to reduce the negative impact of return time uncertainty on operational efficiency (H4) by providing real-time information that allows firms to adjust staffing and fleet preparation proactively. Mohammed [11] documented that firms with more developed digital communication and analytics capabilities show stronger operational performance outcomes, suggesting that the moderating effect of digital communication will be strongest at firms with higher baseline analytics infrastructure. Operational flexibility is similarly expected to moderate the uncertainty-efficiency relationship (H5) by enabling adaptive staffing responses to real-time return information.

These findings, when confirmed, will extend Contingency Theory and Dynamic Capability Theory to the car rental context and provide the first empirically validated evidence on the joint moderating effects of digital communication and operational flexibility on return time uncertainty management.

6 CONCLUSION

This study investigates the relationship between customer return time uncertainty and operational efficiency in car rental firms, with digital communication and operational flexibility proposed as moderating variables. The research addresses a significant gap in the service operations management literature: while demand uncertainty, queue management, and customer satisfaction have been extensively studied, customer return time uncertainty as a distinct construct with measurable operational consequences has not been empirically examined.

The proposed sequential explanatory mixed-methods design will generate both quantitative evidence on the magnitude and direction of the hypothesized relationships and qualitative depth on the operational mechanisms through which return time uncertainty disrupts car rental operations. The study will contribute theoretically by extending the Theory of Planned Behavior, Contingency Theory, and Dynamic Capability Theory to the return time uncertainty context, and practically by providing car rental firms with an evidence-based framework for predicting and managing customer return behavior.

Future work will develop and test a Customer Return Time Prediction Model integrating customer behavioral history, GPS tracking data, real-time traffic conditions, and digital reminder responsiveness to generate predictive classifications of customer return likelihood as early, on-time, or late. This tool will represent both an academic contribution to behavioral prediction methodology and a deployable operational management instrument for the car rental industry.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Acknowledgments

The author acknowledges the publicly available software tools and computational resources used to support the data analysis and preparation of this manuscript.

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