UDC 004.415.2:332.8

M.O. Hrynchak
O.V. Melnyk

AUTOMATION OF UTILITY PAYMENT ACCOUNTING IN WEB SERVICES FOR RESIDENTIAL COMPLEXES

Vinnytsia National Technical University

Анотація

У тезах розглядається проблема автоматизації обліку комунальних платежів у вебсервісах для житлових комплексів. Проаналізовано сучасний стан управління платежами мешканців, виявлено ключові недоліки ручних та напівавтоматизованих систем. Запропоновано архітектуру уніфікованого інформаційного вебсервісу з модулем автоматичного формування, відстеження та звітності комунальних платежів. Визначено функціональні вимоги до системи та описано основні алгоритми автоматизованого розрахунку.

Ключові слова: комунальні платежі, автоматизація обліку, вебсервіс, житловий комплекс, інформаційна система, розрахунок платежів, особистий кабінет мешканця.

Abstract

The paper addresses the problem of automating utility payment accounting in web services for residential complexes. The current state of resident payment management is analysed, and key shortcomings of manual and semi-automated systems are identified. An architecture of a unified information web service with a module for automatic generation, tracking, and reporting of utility payments is proposed. Functional requirements for the system are defined, and the main algorithms of automated payment calculation are described.

Keywords: utility payments, accounting automation, web service, residential complex, information system, payment calculation, resident personal account.

Introduction

The management of utility payments in modern residential complexes remains one of the most labour-intensive and error-prone processes in property administration. The growing number of residents, the diversity of tariff structures, and the regulatory requirements for transparent reporting create a strong demand for digital solutions that automate the entire billing lifecycle. Traditional paper-based or spreadsheet-driven approaches are insufficiently scalable and frequently lead to billing errors, payment delays, and resident dissatisfaction [1]. The development of a unified web service capable of automating utility payment accounting therefore represents a highly relevant direction in applied software engineering.

System Architecture and Core Functionality

The proposed web service is built on a three-tier client–server architecture comprising a presentation layer, a business-logic layer, and a data-access layer. The backend is implemented as a RESTful API that exposes endpoints for meter reading submission, invoice generation, payment confirmation, and reporting. The frontend provides role-differentiated interfaces for residents, building managers, and administrators [2].

The core module responsible for automated billing applies the following calculation formula for each utility service per billing period:

$$P_i = C_i \times (V_{current} - V_{prev}) + F_i,$$

where P_i is the payment amount for service i; C_i is the unit tariff rate; $V_{current}$ and V_{prev} are the current and previous meter readings respectively; and F_i is the fixed monthly fee component, if applicable [3].

Meter readings can be submitted by residents through the personal account interface or imported automatically from smart metering devices via an MQTT-based integration layer. The system validates submitted values against predefined thresholds and flags anomalies for managerial review, thereby reducing human error and fraudulent submissions [4].

Notification and Payment Workflow

Upon completion of the billing calculation, the system automatically generates personalised invoices in PDF format and dispatches them to residents via email and in-app push notifications. Residents may settle

outstanding balances directly through the web service using integrated payment gateway APIs. All transactions are logged in an immutable audit trail, and payment confirmations are reflected in real time within the resident dashboard [5].

The reporting subsystem provides building managers with aggregated and per-apartment payment analytics, debt tracking, and export capabilities in XLSX and CSV formats. Automated reminder notifications are scheduled for residents with overdue invoices, following a configurable escalation policy. Access control is enforced through JWT-based authentication, ensuring that each actor can access only data within their authorisation scope [2; 4].

Conclusions

The automation of utility payment accounting within a unified web service significantly reduces administrative overhead, minimises billing errors, and improves the transparency of financial operations in residential complexes. The proposed system architecture ensures scalability, maintainability, and a high degree of automation across the full payment lifecycle – from meter reading collection to invoice settlement and reporting. Future development directions include machine-learning-based anomaly detection for consumption patterns and deeper integration with national utility provider APIs [1; 3].

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Гринчак Максим Олегович – студент групи 1ПІ-22б, факультет інформаційних технологій та комп'ютерної інженерії, Вінницький національний технічний університет, м. Вінниця, e–mail:1234567maxgrynchak@gmail.com.

Мельник Олександр Васильович – кандидат технічних наук, доцент, доцент кафедри програмного забезпечення, Вінницький національний технічний університет, м. Вінниця, e–mail: o.melnyk@vntu.edu.ua.

Maksym O. Hrynchak – student of group 1PI-22b, Faculty of Information Technologies and Computer Engineering, Vinnytsia National Technical University, Vinnytsia, e-mail: 1234567maxgrynchak@gmail.com.

Oleksandr V. Melnyk – Candidate of Technical Sciences, Associate Professor, Associate Professor of the Software Engineering Department, Vinnytsia National Technical University, Vinnytsia, e–mail: o.melnyk@vntu.edu.ua.