Tracking Utility for Knowledge Integration and Benchmarking (TUKIB): An Integrated Automation System for the University of the Philippines Visayas Regional Research Center

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Abstract

From 150 to 200 words of short, direct and complete sentences, the abstract should be informative enough to serve as a substitute for reading the entire SP document itself. It states the rationale and the objectives of the research. In the final Special Problem document (i.e., the document you'll submit for your final defense), the abstract should also contain a description of your research results, findings, and contribution(s).

Suggested keywords based on ACM Computing Classification system can be found at `https://dl.acm.org/ccs/ccs_flat.cfm`

Keywords: Keyword 1, keyword 2, keyword 3, keyword 4, etc.

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Chapter 1

Introduction

1.1 Overview of the Current State of Technology

In the era of digital transformation, efficient data management and streamlined service workflows are critical for the success of any business or institution. Perhaps one of the remarkable and known products of technology is converting paper-based or manually-operated systems to automated systems. It is irrefutable that automation greatly impacts people's lives, providing increased efficiency and productivity.

The University of the Philippines Visayas - Regional Research Center (UPV RRC) is a centralized facility that strengthens UP Visayas' research and innovation capabilities by providing researchers access to and training on advanced analytical equipment and method development. It provides several services catering to different fields of natural and physical sciences. Current practices on the service flow of the institution rely heavily on manual processes, using tools such as Google Forms and Google Sheets for service request handling, tracking, and data management. While these methods provide a foundational level of functionality, they fall short in addressing the specific needs of service flow requirements of the RRC, posing challenges not only for the staff but also for the clients. The need for a more sophisticated and integrated system led to the conceptualization of TUKIB.

The proliferation of advanced software solutions presents an opportunity to enhance operational efficiency by automating service flow tasks. However, existing systems fail to provide the specific necessities of some institutions hence, a more sophisticated software is often needed. By developing a specialized software

solution tailored to the unique needs of RRC, it is possible to significantly improve productivity, data accuracy, and overall effectiveness. This project explores the design and implementation of such a software solution, aiming to replace the existing reliance on Google Apps with a more robust, integrated system.

The proposed software seeks to address several key challenges faced by the institution, including the automation of repetitive tasks and the facilitation of seamless communication among team members. By leveraging modern technologies and best practices in software development, this research aims to provide a practical, scalable solution that can be adapted to various research environments.

1.2 Problem Statement

The UPV Regional Research Center (RRC) currently relies on a manual service workflow for handling client requests, managing laboratory services, and tracking research-related activities. This process, which depends on Google Forms and Sheets, lacks automation, leading to inefficiencies such as delays in service requests, difficulty in tracking progress, and limited scalability as the demand for RRC services grows. Furthermore, the absence of a centralized system makes it challenging for staff to manage and monitor multiple services and for clients to access real-time information about their requests.

To address these issues, a comprehensive and integrated workflow automation system, named TUKIB, is necessary. The system aims to automate service requests, improve data management, enhance communication between RRC staff and clients, and streamline overall operations. With automation, the center can improve the efficiency, accuracy, and accessibility of its services, supporting both the internal management and external user experience.

1.3 Research Objectives

1.3.1 General Objective

The general objective of this paper is to develop a system to automate and optimize the service flow and data management at UPV Regional Research Center and evaluate its effectiveness. The system will be called TUKIB, an acronym for Tracking Utility for Knowledge Integration and Benchmarking.

1.3.2 Specific Objectives

Specifically this study aims to:

1. Automate the management of service requests and tracking, enabling real-time monitoring of ongoing tasks and requests for both RRC staff and clients by developing an integrated workflow automation system that streamlines the UPV Regional Research Center's (RRC) service processes, reducing manual intervention and enhancing operational efficiency.

2. Create a centralized data management system for RRC that ensures secure, efficient storage and retrieval of information related to service requests, laboratory usage, and client transactions.

3. Improve communication and feedback mechanisms between RRC staff and clients, enabling the RRC to get the necessary statistics for customer satisfaction, and identify their service strengths and weaknesses.

4. Design and implement a chatbot, allowing the automation of the initial consultation process and for clients to interact with the system for service inquiries and assistance, providing immediate and accurate responses.

5. Evaluate the system's impact on operational efficiency, compare the automated workflow with the previous manual processes in terms of speed, accuracy, and user satisfaction.

6. Ensure the system is scalable and adaptable to future requirements, allowing the RRC to accommodate increased demand and potentially integrate additional features in the long term.

1.4 Scope and Limitations of the Research

This special problem focuses on developing the Tracking Utility for Knowledge Integration and Benchmarking (TUKIB), an integrated workflow automation system designed for the UPV Regional Research Center (RRC). The system aims to automate key service flow and data management aspects within the RRC.

TUKIB will cover the full-service management cycle within the UPV RRC, from initial client service requests to the completion and feedback stage. It will include features such as real-time tracking of service requests, a full inventory list and management of the RRC equipment, automated notifications to clients

and staff, and an integrated platform for storing and managing service data. Key components such as user interfaces for staff and clients, real-time service status updates, events and schedule management, transaction records, and a feedback collection mechanism will be developed. Data accuracy will be ensured by minimizing manual input and automating repetitive processes, reducing errors and improving operational efficiency. The project will also involve the deployment of chatbots to enhance the communication flow between clients and staff, providing instant responses to inquiries and updates on service requests. The system will be scalable, allowing it to be adapted to other similar research institutions in the future.

The system's functionalities will be limited to the services provided by the UPV RRC and may not cover other external functions or services. Customization will be tailored to the specific workflows of UPV RRC, so further modification would be needed for implementation in different institutions or industries. The project will focus on workflow automation but will not delve into advanced analytics or AI beyond using chatbots for customer communication and statistics for service feedback reports. The system requires a stable internet connection for real-time features like notifications and status tracking; thus, its performance may be compromised in areas with poor connectivity. The effectiveness of the system depends on staff and client adaptability to the new system, which may require a period of training and adjustment.

1.5 Significance of the Research

The development of TUKIB offers significant contributions on multiple fronts, benefiting the researchers, the UPV RRC, and other research institutions facing similar challenges in service and data management, the computer science community, and the general society.

- **The Researchers**

  The TUKIB project provides an invaluable opportunity for researchers to apply their theoretical knowledge and practical skills to solve real-world problems. It allows them to demonstrate their competency in system design, workflow automation, and software development, contributing to the completion of their degree requirements.

  Beyond academic fulfillment, the project also equips the researchers with hands-on experience in managing complex systems, collaborating with stakeholders, and implementing scalable technological solutions, which will be

beneficial in their future careers in computer science and related fields.

- **The UPV RRC and Other Research Institutions**

  The TUKIB system will significantly improve the operational efficiency of the UPV Regional Research Center by automating its service request workflows and data management processes. The integration of this system will reduce the time and effort spent on manual tasks such as request processing, service tracking, and data entry. This not only streamlines the internal processes but also enhances the overall user experience for both researchers and external clients, who will benefit from a more transparent and efficient service flow.

  Furthermore, other research institutions facing similar challenges in managing their services and data will be able to adapt TUKIB to their own workflows, allowing them to optimize resource allocation and improve communication between staff and clients. TUKIB's customizable and scalable nature makes it a valuable model for research institutions looking to enhance their operations without investing in entirely new systems.

- **The Computer Science Community**

  For the computer science community, TUKIB represents a meaningful contribution in terms of integrating workflow automation, real-time tracking, and chatbot technology into a research-driven service environment. The project showcases an innovative approach to solving a niche problem, providing a practical application for the latest software development methods and techniques in workflow optimization. Additionally, it demonstrates the importance of developing scalable, customizable solutions that can be adapted to a variety of organizational contexts.

  This research also serves as a case study in designing user-centered automation systems, contributing to the knowledge of software solutions that bridge the gap between operational requirements and technological advancements. The learnings from TUKIB could inspire future research in workflow management, data accuracy, and intelligent user interfaces.

- **The General Society**

  On a broader scale, the TUKIB project has the potential to benefit society by promoting more efficient research processes. By optimizing how research institutions manage their services, TUKIB indirectly supports the advancement of scientific research. With more streamlined workflows and

reduced administrative burdens, research institutions can focus their resources on the core activities of scientific discovery and innovation. This, in turn, may lead to faster advancements in areas like environmental science, technology development, and public health, which could have far-reaching societal impacts.

In summary, TUKIB stands as an important system not only for those immediately involved in its implementation but also for the larger community of researchers, developers, and society as a whole. Its contributions reach across the fields of computer science, research, and institutional management, offering lasting benefits in terms of technological innovation and service improvement.

Chapter 2

Review of Related Literature

The purpose of this literature review is to provide a comprehensive background on automated systems for workflow automation, especially on service processes, which will inform the development of the system for the University of the Philippines Visayas - Regional Research Center (UPV RRC). This review aims to identify existing solutions, highlight gaps and challenges, and explore technologies that can be used to develop the system to improve the UPV RRC's operational efficiency.

2.1 Challenges in Manual Service Handling

Manual handling of service processes and data management can often lead to challenges, including inefficiencies, errors, and delays. One of the most common issues is the risk of data entry errors. Even small data entry errors can devastate outcomes, corrupting important data. A study involving three different data entry methods (double entry, visual checking, and single entry) revealed that manual entry, particularly visual checking, has a significantly higher number of errors-2958% more than double entry methods (Beaty, 1999). These errors can be subtle and difficult to detect, compounding their negative impact on operational efficiency.

Another limitation of manual service handling is its reliance on human intervention, which frequently results in mistakes that are hard to correct. These errors can escalate operational costs, affect service quality, and lead to customer dissatisfaction. For organizations with manual systems, human error compromises not just data integrity but also the scalability and effectiveness of service

operations. Additionally, manual systems lack real-time monitoring capabilities, which are critical for improving service processes. Without automated tracking tools, organizations often miss out on insights that could highlight areas needing improvement.

Current practices in manual service handling also highlight limitations in widely used tools like Google Sheets and Google Docs, which are often insufficient for managing large-scale workflows. These tools lack advanced data retrieval capabilities, and users have reported issues with data not being pulled correctly. According to Okta's documentation on Google Sheets limitations, there are significant challenges when retrieving and integrating data, leading to inefficiencies in data management processes. Moreover, manual entry in Google Forms is prone to errors, which can undermine the accuracy of collected data.

The impact of these manual methods on stakeholders is substantial. Organizations relying on manual workflows often experience extended processing times, directly affecting service delivery. For instance, tasks that could be automated are unnecessarily prolonged when handled manually, delaying customer satisfaction. Furthermore, manual systems offer limited visibility and tracking capabilities. Without real-time performance metrics, organizations cannot effectively monitor their workflows or identify improvement areas. According to research, companies that automate their workflows experience reduced errors and faster processing times, which lead to improved operational efficiency and better customer outcomes. Thus, the inefficiencies inherent in manual service handling are a barrier to organizational growth, and stakeholders across all levels—from employees to customers—are adversely affected (Davis, n.d.).

2.2 Workflow Automation

2.2.1 Workflow automation in different industries

2.3 Client and stakeholder feedback mechanisms

2.4 Existing Systems

2.5 Gaps in the existing systems and solutions

2.6 Chatbot

With the increasing use of the Internet, many businesses and institutions are utilizing online platforms to manage customer inquiries. Consequently, a growing number of them are adopting chatbots to enhance customer service, streamline operations, and boost productivity (Suta et al., 2020). In recent years, chatbots have become an important tool across various industries, particularly in service delivery and automation.

The word "chatbot" is a portmanteau word that is a combination of the words "chatting" and "robot" (Rese, Ganster, & Baier, 2020). A chatbot is an example of technology that is used in computer-mediated communication, where an intelligent system occupies roles once served by humans (Austin Beattie & Edwards, 2020). It is also defined as conversational software that is capable of simulating human conversation with an end user through text or voice interaction (Nuruzzaman & Hussain, 2018).

Chatbots can be broadly categorized into two types; rule-based and AI-based chatbots. Rule-based chatbots function with a set of guidelines through pattern-matching and are limited in their conversation. This means that it can only respond to a limited range of queries and vocabulary. AI-based chatbots leverage artificial intelligence(AI), natural language processing(NLP), and machine learning(ML) technologies and algorithms to understand different keywords that users type in when chatting with them. This integration significantly enhances user experience and operational efficiency as these chatbots learn and adapt over time (Kar & Haldar, 2016).

2.6.1 Chatbots in Service Automation

Chatbots are deployed across different platforms, including websites, social media, and instant messaging applications, making them good tools for both internal and external organizational tasks (Hagberg et al., 2016; Zarouali et al., 2018). Internally, chatbots support services, including IT Service Management (ITSM), Human Resource Management (HRM), and learning management systems (Wolf, 2020; Nawaz& Gomes, 2019; Bakouan, 2018). Externally, chatbots are increasingly replacing traditional branded websites, offering a more interactive platform for customer relationship management, sales, and marketing (Broeck, 2019).

Institutions are utilizing chatbots for various applications. For instance, Pennsylvania State University employs a chatbot called "LionChat" to address frequently asked questions regarding admissions, student aid, and tuition costs (PennState, 2020). In healthcare, AI chatbots can be utilized to enhance patient care and streamline processes such as checking symptoms, reminders, and appointment scheduling(Altamimi et al., 2023). Moreover, a case study by (Fan et al., n.d.) on the utilization of a self-diagnosis chatbot in China highlighted the potential for chatbots to improve user engagement by offering real-time feedback and personalized responses.

2.7 Synthesis

As previously mentioned, the researchers aim to create a workflow automation system specifically for the University of the Philippines Visayas Regional Research Center (UPV RRC) to streamline and optimize their service flow and data management. Currently, the institution is using manual processes employing tools such as Google apps.

The difficulty of manual service handling is discussed in this chapter, as well as the benefits of having an automated system. Several studies mentioned indicate that workflow automation can significantly streamline repetitive tasks, improve data accuracy, and enhance decision-making processes reducing human intervention.

While existing systems for workflow automation are available, there are still gaps that these systems cannot fill, such as limitations with customization, cost-effectiveness, adaptability, and integration issues. The proposed system for UPV RRC aims to address these specific gaps by offering a tailored solution that meets the specific needs of the institution. One technology that can be particularly

beneficial for this is a chatbot, which will enhance the consultation process when availing a service from the institution by providing instant responses to inquiries.

Chapter 3

Research Methodology

This chapter presents the tools, techniques, and methodologies used in the development of the TUKIB system, an integrated workflow automation solution designed for the UPV Regional Research Center (RRC). It specifies the software and hardware requirements, as well as the comprehensive process involved in creating the system.

3.1 Research Activities

3.1.1 Development Framework

Agile Methodology

The software development process that the developers will follow in developing TUKIB is the agile methodology. Agile methodology, or simply agile, is a framework that emphasizes iterative development and features communication and collaboration, adaptive planning, and continuous development (Agile Framework, 2022). The developers chose this framework because of its flexibility and adaptability to change, which is beneficial, especially with evolving user requirements.

- **Data Gathering and Documentation**

  The developers will begin the project by visiting the UPV RRC to conduct interviews with stakeholders. This will help them understand the specific needs of the institution. The data gathered will inform the subsequent

processes of the project.

- **System Design**

  After data gathering, the system's architectural design will be developed. This process will involve creating a context model to outline the system's interactions with external entities, as well as a data flow diagram to illustrate how data moves through the components of the system. Additionally, a process flow diagram will be constructed to detail the specific processes and workflows, while database models will be designed to ensure efficient data storage and retrieval. Together, these diagrams will provide a comprehensive framework that will further guide the development and implementation of the system.

- **Implementation**

  From the design phase, the development of the system will commence. The frontend will be built to ensure a user-friendly interface, while the backend will support functionality through efficient data processing and secure user authentication. Additionally, a chatbot will be integrated to facilitate real-time user interaction with the system.

- **Testing**

  Alpha Testing. During and after the development of each feature, extensive user testing will be conducted to ensure that each feature works as intended. Any bugs or problems will be immediately fixed. For features dependent on other features (i.e. user account creation must function correctly before user can log in), thorough testing will ensure and verify that the integration between these features operates smoothly.

  Automated testing. Automated testing will be implemented to ensure reliability and efficiency in testing the features of the system. This approach will allow for the execution of predefined test cases that can be run repeatedly with minimal manual intervention.

  Beta Testing. Beta testing will be done with a limited group of users composed of available RRC staff and selected potential customers of RRC (e.g. students and faculty). This phase will allow real-world usage feedback and will help in identifying any remaining bugs and usability issues. Users

will test the system in various environments and will be encouraged to provide insights on functionality, performance, and overall experience.

- **Deployment and Maintenance**

  The final product of the study, TUKIB, will made available to the intended users. In this phase, ongoing maintenance and regular performance monitoring- especially of the backend- are essential to ensure stability and reliability. Constant feedback from users during this phase will guide further improvements and updates.

3.2 Development Tools

3.2.1 Hardware

The hardware requirements for the development of the system include a computer or laptop with the following specifications:

- Processor: Intel Core i5, its equivalent on other brands or higher
- RAM: 6GB or higher
- Storage: 200GB SSD or more for faster data access and retrieval Operating System: Windows 10 or higher, macOS, or Linux

These specifications are necessary to ensure smooth development and testing of the system, especially when handling large datasets and concurrent processes.

3.2.2 Software

The TUKIB system will be developed using a range of modern software tools tailored to meet the specific needs of the research center's workflow automation and data management processes.

- **HTML5, CSS, and ReactJS**

  These technologies will be used for front-end development of the system. HTML5 will structure the webpages, CSS will be responsible for the visual

styling, and ReactJS enables dynamic and interactive user interfaces.

- **PostgreSQL**

  For backend development, PostgreSQL is will be used as the database management system, offering robust data storage, querying, and management capabilities.

- **Rasa Framework**

  Rasa will be used for the chatbot development. It allows the creation of a conversational AI system which will handle the service requests, queries, and management capabilities of the system.

- **Figma**

  Figma will be utilized for designing the UI/UX of the system. Figma allows design collaboration, which will ebavle the team to create the system prototype, wireframe, and mock-up interfaces before implementation, ensuring a user-friendly experience for both clients and researchers.

- **VS Code**

  Visual Studio Code (VS Code) is the primary code editor that will be used to develop the system. Its features, such as syntax highlighting, extensions, integrated Git, and debugging tools, make it the most suitable environment for writing and testing front-end and back-end code.

- **Github**

  GitHub will be used to facilitate for version control and collaboration throughout the development of the system. The project code is stored in repositories, allowing the team to manage changes, track progress, and collaborate effectively. It also serves as a backup and source for future development or modification.

Chapter 4

Preliminary Results/System Prototype

This chapter presents the preliminary results or the system prototype of your SP. Include screenhots, tables, or graphs and provide the discussion of results.

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Appendix A

Appendix Title

Appendix B

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