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

A Special Problem

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Declaration

We, Sheryl Betonio, Kzlyr Shaira Manejo, and Rainer Mayagma, hereby certify that this Special Problem has been written by us and is the record of work carried out by us. Any significant borrowings have been properly acknowledged and referred.

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Dedication

"Hello, world."

Acknowledgment

"Hello, world."

Abstract

Manual service flow and data management remain two of the most common challenges faced by many businesses and institutions, even in today's digital age. One such institution is the University of the Philippines Visayas – Regional Research Center (RRC), which relies on manual and semi-automated processes using Google Apps throughout its service delivery. While functional, this system is inefficient and limits the RRC's potential, creating challenges for both staff and clients. This study aims to develop a centralized system, aptly named TUKIB, to automate the service flow and data management processes of the UPV RRC. It also explores the development and integration of a chatbot using the Rasa framework. The project adopted an Agile methodology, emphasizing iterative development and regular feedback to ensure the system addressed evolving user needs. The resulting system significantly reduced manual tasks, improved data management, enhanced client support, and streamlined operations, ultimately increasing the overall efficiency of the UPV RRC.

Keywords: Workflow Automation, Chatbot, Rasa, Data Management, Service Flow

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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 optimized service workflows are crucial for the success of any business or institution. Perhaps one of the most remarkable and well-known products of technology is the conversion of paper-based or manually-operated systems to automated systems. It is unquestionable 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 strengthened 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. At the time, the institution relies heavily on manual processes, using tools such as Google Apps throughout its entire service delivery process, from handling service requests and tracking to data management. Although this method offers a foundational level of functionality, it fails to address the specific needs of the UPV RRC in its service delivery workflow. This poses challenges not only for the staff but also for the clients of the institution.

Automation, defined as “the application of technology, programs, robotics or processes to achieve outcomes with minimal human input” (IBM, 2024), has been effectively adopted across various industries to enhance quality, productivity, efficiency, timeliness, effectiveness, and operational safety. It also helps in reducing costs and provides greater value to customers (Zayas-Cabán, Haque, & Kemper, 2021).

Over the years, various technologies emerged to address the pressing need for automation. The increase in advanced software solutions offered organizations and institutions an opportunity to enhance their operational efficiency. However, existing systems fell short in addressing the specific needs of some institutions. Adapting these existing systems often guve birth to other problems as integrating and customizing off-the-shelf softwares can be difficult, costly, and limited in scalability (BITCAT, 2023). In such cases, developing new software tailored to the specific needs of an institution is often a better option.

Recognizing this gap, this study explored the design and implementation of a software solution tailored to the unique needs of the UPV RRC, aiming to replace the institution’s current system by automating its service delivery flow and data management. Additionally, this paper included the development and integration of a chatbot using the Rasa framework to enhance and streamline the institution's client support, interaction, and communication. By using modern technologies and best practices in software development, this study sought to add knowledge on building a practical and scalable system, specifically one that could be used by the UPV RRC for their service delivery processes.

1.2 Problem Statement

In today's fast-paced world, success is often associated with efficiency, especially in the business environment. A report by McKinsey & Company (Manyika et al., 2017) reveals that about 60% of occupations involve at least 30% of tasks that were automatable. Despite the growing recognition for the need of automation and even with the rise of different technologies, many businesses and institutions are still dependent on manual or semi-automated workflows. While various workflow automation technologies exist, adapting off-the-shelf softwares is costly and challenging as these softwares often requires extensive customization to fit the institution's unique needs and are difficult to integrate.

The University of the Philippines Visayas Regional Research Center (UPV RRC) is one such institution that is still reliant on manual processes, especially on its service flow delivery and data management. Various tasks including handling of client requests, managing laboratory services, and tracking service-related activities are carried out with the use of semi-automated tools like Google Apps, which is technically still dependent on human intervention. This leads to inefficiencies such as delays, difficulty in tracking, and vulnerability to errors, ultimately compromising the institution's overall productivity.

To address these issues, an integrated workflow automation system tailored to the needs of the UPV RRC was developed to ease the difficulties faced by the institution in its service delivery. This system automated service requests, streamlined data management, enhanced communication between RRC staff and clients, and improved overall operations. With automation, the center improved the efficiency, accuracy, and accessibility of its services, supporting both internal management and the external client experience.

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1.4 Research Objectives

1.4.1 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.

1.4.2 Specific Objectives

Specifically this study aims to:

1. develop a centralized data management system for the RRC to ensure secure, efficient storage, retrieval, and management of information related to service requests, laboratory usage, and client transactions,

2. design and implement an automated chatbot to handle consultations and frequently asked questions, enabling clients to interact with the system for service inquiries and support in real-time,

3. implement an intuitive and user-friendly design that ensures ease of use and accessibility for both staff and clients of UPV RRC, and

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

1.5 Scope and Limitations of the Research

As mentioned, this special problem focuses on developing TUKIB - short for Tracking Utility for Knowledge Integration and Benchmarking, a workflow automation system designed for the UPV Regional Research Center (RRC).

TUKIB covers the full-service management cycle of the UPV RRC, from initial client service requests to the completion and service feedback stage. It has features such as real-time tracking of service requests, facility and equipment availability tracking, and a centralized platform for storing and managing service-related data. Key components such as user interfaces for staff and clients, real-time service status updates, events, service schedule management, transaction records, and a feedback collection mechanism were also added. With this, data accuracy throughout the service flow process is ensured by minimizing manual input and automating repetitive processes, reducing errors and improving the operational efficiency of the UPV RRC. This special problem also involved the development and integration of a chatbot to enhance user support and communication between clients and staff, providing instant responses to inquiries. Additionally, the system was made scalable, allowing it to be flexible for further modification as the needs of UPV RRC evolved.

The system's functionalities were limited to the service-related processes of the UPV RRC and did not cover other internal and external functions. The development was tailored to the specific workflows of UPV RRC, so modifications would be needed for implementation in different institutions or industries. Additionally, this special problem focused on workflow automation but did not delve into advanced analytics or AI beyond using chatbots for customer communication and basic statistics for service feedback reports. The system required a stable internet connection for real-time features like notifications and status tracking; thus, its performance could be compromised in areas with poor connectivity. Moreover, the effectiveness of the system depended on staff and client adaptability to the new system, which required a period of training and adjustment.

1.6 Significance of the Research

This study offers great significance in many domains, benefiting the UPV RRC and its clients, the researchers, other institutions, the computer science community, and future researchers.

- **The Researchers**

  This study provides a great opportunity for the researchers to apply their theoretical knowledge and practical skills to solve real-world problems. This allows them to demonstrate their competency in system design and software development.

- **The UPV RRC and its Clients**

  The development of TUKIB will significantly improve the operational efficiency of the UPV Regional Research Center by automating its service request workflows and data management processes. This will not only benefit the staff but the clients as well.

- **Other Institutions**

  Other institutions facing similar challenges in managing their service flow processes and data can also benefit from this special problem. They can adapt TUKIB to their own workflows or this study can serve as a guide for them in creating their own specialized software solution.

- **The Computer Science Community**

  The Computer Science Community also benefits from this study. This paper contributes to the existing knowledge in developing a tailored workflow automation system by providing perspective into the practical application of various software development tools and methods. Additionally, this special problem also serves as a case study in designing a user-centered software. Other developers can gain valuable insights and inspiration from this for their own projects.

- **Future Researchers**

  The special problem can serve as a reference and guide for future researchers who wish to pursue studies similar or related to this special problem.

Chapter 2

Review of Related Literature

The purpose of this literature review was to provide a comprehensive background on automated systems for workflow automation, especially on service processes, which informed the development of the system for the University of the Philippines Visayas - Regional Research Center (UPV RRC). This review identified existing solutions, highlighted gaps and challenges, and explored technologies that were 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 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 have devastating 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 (Barchard & Pace, 2011). These errors can be subtle and difficult to detect, showing 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 (BITCAT, 2023). 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 or semi-automated workflows often experience extended processing times, directly affecting service delivery. For instance, tasks that could be automated are unnecessarily prolonged when handled manually, impacting customer satisfaction negatively. 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

Workflow automation refers to the utilization of technology systems, usually involving several software and hardware integrations, to efficiently carry out repetitive tasks, thereby reducing the roles of humans in it (Winarko, 2021). It is also defined as "the application of technology, programs, robotics or processes to achieve outcomes with minimal human input" (IBM, 2024). Workflow automation simplifies the sequencing and completion of tasks within a process by minimizing manual input (Astera, 2024). Also known as business process automation (BPA), this approach replaces human intervention with digital technologies to automate workflows (Thomas, 2024).

Several studies indicates that automating business processes through workflow automation can re-engineer operations, increase productivity, and improve decision-making(Abecker, Bernardi, Maus, Sintek, & Wenzel, 2000; Aversano, Canfora, Lucia, & Gallucci, 2002). It can also enhance efficiency, ensure quality data collection, and improve overall output quality (Pakdil et al., 2009). Suitable processes for automation typically exhibit characteristics such as repeatability and predictability (Basu & Kumar, 2002).

A workflow automation software uses rule-based logic or AI to automate tasks that would otherwise require manual effort, such as data entry. While traditionally seen as a tool for IT departments, this software simplifies complex business operations, enhancing efficiency, productivity, and overall customer satisfaction. It is a valuable resource across the entire organization. Connecting various business processes automates critical tasks, sequences, and approvals, allowing workflows to progress automatically without human intervention. This leads to several key advantages for businesses (ServiceNow, n.d.).

Automating workflows offers significant benefits by addressing the limitations and inefficiencies associated with manual processes. While employees are crucial assets, their capacity to handle repetitive tasks is limited, and relying solely on them can lead to bottlenecks, errors, and revenue loss. By automating key steps and processes, workflows proceed more swiftly, reducing the time spent on manual tasks and enabling employees to focus on more strategic initiatives. Furthermore, automated workflows provide transparency and detailed records, which improve accountability by clearly documenting task progress and responsibilities (Awati & Fitzgibbons, 2024). Automation also minimizes errors by adhering to predefined rules and methodologies set by programmers, maintaining consistent results.

2.2.1 Workflow automation in different industries

Automation is used for several workflows across a range of industries. Certain industries, like manufacturing and banking, have a long history of using automation, while others, such as legal consultation, hospitality, and transportation, are newer to automation (Zayas-Cabán et al., 2021). Among these industries various processes have been automated, such as accounting tasks, document routing, resource allocation, quality monitoring and control, report generation, and supply chain and logistics management (Aguirre & Rodriguez, 2017; McQuilken, 2014).

In the education sector, many universities worldwide use automation tools of some form, driven by the need for efficiency and compliance with educational standards. These tools facilitate various processes, including enrollment, grading, and course management, allowing educators to focus more on teaching and student engagement (Choudhary, Tariq, Chaudhry, Maneha, & Awan, 2024). Similarly, automation in healthcare has improved the accuracy and accessibility of patient information, resulting in more informed decision-making (Gupta & Arora, 2020). Even in government offices, the evident use of automation tools for service processes can also be observed to enhance service efficiency and transparency.

2.3 Existing Systems

The development of various digital automation systems and platforms has proliferated over the years. These systems encompass a wide range of functionalities - from automating tasks to facilitating collaboration among staff.

For instance, Enterprise Resource Planning (ERP) Systems are integrated software solutions that manage the core business processes of an organization (Blahušiaková, 2023). ERP systems integrate various business processes, such as Finance, Human Resources, Supply Chain Management, and Customer Relationship Management (CRM), into one complete system to streamline processes and information across the organization (Kimberling, 2024). Examples of existing ERP systems that are used by businesses and organizations are Microsoft Dynamics 365 Business Central, Syspro, QT9, and Acumatica. In addition to these comprehensive systems, a lot businesses and institutions are also utilizing Google apps like Google Drive, Forms, Docs, and Sheets to facilitate easier information storage and sharing, enabling teams to work collaboratively.

Moreover, online automation platforms like Zapier and Integromat (Make) help automate interactions between different apps, enabling businesses to integrate multiple systems and optimize workflows without the need for coding (Wolf, 2020). These systems are examples of how institutions tackle complex tasks, reduce manual data entry, and improve decision-making in today's modern world.

2.4 Gaps in the existing systems and solutions

Despite the availability of various existing automation systems, significant gaps persist that hinder their effectiveness. One major gap is customization limitations which prevent organizations from tailoring solutions to their specific workflows (Aleixo, Freire, Santos, & Kulesza, 2010). These one-size-fits-all solutions can lead to inefficiencies, as standardized systems may not align with different organizations' unique processes or requirements. Employees might adapt their workflows to fit the software rather than the software, enhancing their operational efficiency.

Additionally, the lack of adaptability can render these existing systems ineffective over time. While these existing solutions might be beneficial to some companies, they can be detrimental to organizations that rely on their capacity to meet customer demands(Akkermans, Bogerd, Yücesan, & Van Wassenhove, 2003). As organizations evolve, they often need to adjust their workflows and processes in response to new challenges, regulations, or market demands. Rigid Systems that cannot easily accommodate and such changes can become useless.

Furthermore, many existing software solutions are proprietary, increasing costs for organizations. Proprietary systems often have high licensing fees, maintenance costs, and limited scalability (Goel & Gupta, 2012; Prasad & Reddy, 2013). Organizations may find themselves locked into contracts that are not cost-effective, particularly if the software does not deliver the expected return on investment. On top of that, the difficulty of adapting and getting these automation systems to work effectively is also well documented (Adams, Edmond, & Ter, 2011; Sarker & Lee, 2003; Scott & Vessey, 2000).

2.5 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. Inarguably, chatbots are used daily by some people. Some instances of this are Siri from Apple, Alexa from Amazon, Microsoft Cortana and Bixby from Samsung that have the ability to open apps, play music, set calendar events and, overall, be a virtual assistant for users.

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 (Beattie, Edwards, & 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).

Table 2.1 shows the key differences between an AI chatbot and a non-AI chatbot. As seen, AI chabots are more adaptive in nature and have advanced capabilities than non-AI chatbots.

	Non-AI Chatbots	**AI Chatbots**
Conversation Capabilities	• Linear, rigid chat flow primarily driven by radio button selections • Ignores user free-text input • Context insensitive	• Dynamic, flexible chat flow based on user input • Understands and responds to free-text input • Context-aware interactions
People Insights from Chat	• Only from user explicit choices	• Read between the lines to infer people's insights
Suitable Tasks	• Task-oriented app • Structured, simple tasks that require little user input	• Task-oriented + social chitchat (semi-structured) • Semi-structured tasks with many varied paths • Diverse user actions or questions

Table 2.1: Comparison of Non-AI vs AI Chatbots
From https://juji.io/docs/why-ai-chatbots/

2.5.1 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, Sundström, & Egels-Zandén, 2016; Zarouali, Van den Broeck, Walrave, & Poels, 2018). Internally, chatbots support services, including IT Service Management (ITSM), Human Resource Management (HRM), and learning management systems (Nawaz & Gomes, 2019; Bakouan, Kamagate, Kone, Oumtanaga, & Babri, 2018). Externally, chatbots are increasingly replacing traditional branded websites, offering a more interactive platform for customer relationship management, sales, and marketing (Van den Broeck, Carpini, & Diefendorff[3], 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 are used to enhance patient care and streamline processes such as checking symptoms, reminders, and appointment scheduling (Altamimi, Altamimi, Alhumimidi, Altamimi, & Temsah, 2023). Moreover, a case study by (Fan et al., 2021) 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.

2.5.2 Chatbot Frameworks

Building a chatbot from scratch is not an easy task, that's why chatbot development frameworks have emerged over the years. Chatbot development frameworks are software frameworks that provide built-in functions to simplify the complexities of creating a one (GeeksforGeeks, 2024).

A study by (Hourrane, Ouchra, Eddaoui, Benlahmar, & Zahour, 2020), provides a comprehensive analysis of various frameworks that can be used in developing chatbots. Table 2.2 shows the analysis between different chatbot frameworks. However, the analysis is only limited to the existing frameworks during when the study was conducted. Other popular frameworks that have emerged in recent years include IBM Watson, Botpress, and OpenDialog. Although most of the frameworks are free, they offer limited capabilities, and further access to services most of the time requires a subscription.

Framework	Company	Paid/Free	Ease of Use	Out-of-box integration	Open Source	Popularity	Web-based	Language
QnA Maker	Microsoft	Free	High	Yes	No	Medium	Yes	C#
DialogFlow	Google	Free	High	Yes	No	High	Yes	JavaScript
Rasa	RASA	Free	Low	No	Yes	High	No	Python
Wit.ai	Facebook	Free	High	Yes (Facebook)	No	High	Yes	JavaScript
Luis.ai	Microsoft	Free	High	Yes	No	Medium	Yes	JavaScript
Botkit.ai	Botkit	Free	Low	Yes	No	Medium	No	JavaScript

Table 2.2: Comparative analysis of different chatbot development frameworks.

2.6 Synthesis

As mentioned in Chapter 1, the researchers' aims 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 delivery flow and data management. Currently, the institution is using manual processes employing tools such as Google apps.

Manual processes, especially when involving large amounts of data and interrelated activities, pose a lot of challenges and limitations. This include being prone to error, reliance on human intervention, and delays in processing. Several studies indicate that workflow automation can significantly streamline repetitive tasks, improve data accuracy, and enhance decision-making, ultimately reducing need for human labor.

Over the years, many automation systems have emerged, trying to cater to the demands for automation. Some of these are Enterprise Resource Planning systems and online automation platforms that does not require coding. However, there are gaps that these systems cannot fill, such as customization limitations, cost-effectiveness, adaptability, and integration issues. The proposed system for UPV RRC was designed to address these specific gaps by offering a tailored solution that met the specific needs of the institution. One technology that proved particularly beneficial for this was a chatbot, which could enhance the UPV RRC's client support and interaction.

Many industries had been adapting chatbots for enhanced efficiency. Several studies showed the effectivess of utilizing chatbots, particularly for customer support. However, building a chatbot from scratch is not easy and could sometimes be challenging. Hence, it is easier to use frameworks to simplify the complexities of building one. Some examples of the existing frameworks for developing a chatbot includes Microsoft Dialogflow, Rasa, IBM Watson, and Wit.ai by Facebook.

Chapter 3

Research Methodology

This chapter lists and discusses the specific steps and activities that were performed to accomplish the project. The discussion covers the activities from preproposal to Final SP Writing.

3.1 Research Activities

Research activities include inquiry, survey, research, brainstorming, canvassing, consultation, review, interview, observe, experiment, design, test, document, etc. Be sure that for each method, process, or algorithm used, there is a justification why that method was chosen. The methodology also includes the following information:

- who is responsible for the task
- the resource person to be contacted

- what were done
- when and how long the activity was done
- where it was done
- why should the activity was done

Chapter 4

Results and Discussions

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

Chapter 5

Conclusion

This chapter summarizes your SP and provides conclusions regarding your results and analyses. Provide recommendations on what ought to be done with your SP or provide further directions on the topic you covered.

Chapter 6

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Appendix A

Code Snippets

Appendix B

Resource Persons

Susci Ann Sobrevega

Role1

Affiliation1

emailaddr@domain.com

Mr. Firstname2 Lastname2

Role2

Affiliation2

emailaddr2@domain.com

Ms. Firstname3 Lastname3

Role3

Affiliation3

emailaddr3@domain.net