Isabela State University Linker:
Journal of Engineering, Computing, and Technology
Volume 2, Issue 2
ISSN (Print): 3082-3676 ISSN (Online): 3082-3684
DOI: https://doi.org/10.65141/ject.v2i2.n2

Securing Autonomous Intelligent Automation Through Development, Security, and Operations Framework (DevSecOps) and Cloud-Native Serverless Architecture

Jessa A. Revilla-Dave[1], **Joe G. Lagarteja**[2]
Oaktech Systems LLC, Austin, Texas USA[1]
College of Computing Studies, Information, and Communication Technology, Isabela State University-Main Campus, Echague, Isabela, 3309, Philippines [2]
jessarevilla.16@gmail.com

RESEARCH ARTICLE INFORMATION

Received: September 16, 2025
Reviewed: November 17, 2025
Accepted: December 20, 2025
Published: December 31, 2025

ABSTRACT

With rapidly evolving technology, implementing a secure and efficient way to develop an automation process has become a critical aspect for any organization's success. With the current state of the technology, a traditional development methodology sometimes falls short in addressing the threats and rapidly changing business requirements. This research explored the implementation of Autonomous Intelligent Automation through the development, security, and operations framework and cloud-native serverless architecture. It aimed to improve the efficiency, accuracy, and scalability of an organization by streamlining the business processes that are time-consuming, repetitive, and voluminous, and leveraging and combining cutting-edge technologies and methodologies in software development. This research used one of the processes currently existing in Isabela State University-Main Campus as a pioneer process to implement Autonomous Intelligent Automation and validate its effectiveness in terms of efficiency, accuracy, and scalability. Autonomous Intelligent Automation is a way to eliminate human error in a process. By means of intelligently mimicking what the end user does to accomplish a task, it results in a quality service that is efficient, accurate, and scalable. Implementing DevSecOps is an approach to combine and integrate the Development (Dev),

Security (Sec), and Operations (Ops) to impose security in all phases of development cycle.

Keywords: *Autonomous Intelligent Automation, DevSecOps, cloud-native serverless architecture, efficiency, scalability*

Introduction

All over the world, organizations are undergoing digital transformation. The global priorities that have emerged lately are operational efficiency and cybersecurity. The fastest growing areas in today's world seem to be automation and artificial intelligence (AI), which are said to have the potential to boost the economy hugely (AeoLogic, 2024). These technologies can definitely enhance productivity and service quality and can provide operational excellence at a much lower cost than what is achieving today. Yet while humans are experiencing this potential, these risks are coming along with it, and they are quite significant.

Essentially, automation is probably the biggest risk that most organizations face today because it threatens human existence. Banning people from working at night so that they can get AI to work for humans is not a viable solution, nor is it safe. In response to these challenges, this research aimed to directly contribute to the mission and core values of Higher Education Institutions in the Philippines, particularly Isabela State University (ISU), by developing a solution revolving around the use of Autonomous Intelligent Automation through DevSecOps and cloud-native serverless architecture. Isabela State University, despite being geographically distant from NCR (Metro Manila), which is the technology hub of the Philippines (Teves et al., 2023), is considered as a leading institution in Northern Luzon that implements innovative research for inclusive growth and sustainable development (Glo and Feliciano, 2022), thereby connecting its regional heritage with the global academic and technological sphere to significantly advance societal progress.

Nevertheless, operational challenges, particularly with the processes related to efficiency bottlenecks, human error, and limited scalability continuously persist in any academic community or organization, which then limits operational processes and technological excellence. Moreover, several challenges persist in some digital processes that are time-consuming, repetitive, and voluminous. Such administrative tasks require an effort in making validations and data entry, such as but not limited to invoice processing, student account creation, and document validation of students' requirements. These tasks are prone to human error and data inefficiencies. Having such processes hinders the capability of any workforce in maximizing their potential in addressing much more intricate and value-added processes that need complex decisions.

Consequently, this research aimed to implement an autonomous intelligent automation that serves as a digital workforce driven by integrating artificial intelligence and process automation to revolutionize the traditional operations in a higher education institution. It targets the improvement of the institution's efficiency, accuracy, and scalability by streamlining the tasks that are time-consuming, repetitive, and high in terms of volumes and leveraging cutting-edge technologies using Amazon Web Services (AWS) to implement serverless architecture. Thus, this would eventually drive sustainable development and foster technological innovations in higher education operations.

The primary aim of this research was to evaluate the Autonomous Intelligent Automation that applied a DevSecOps in the software development life cycle, with the use of a cloud-native serverless architecture. Specifically, in this study, an evaluation run was conducted for one of the repetitive, voluminous, and time-consuming administrative tasks in the organization. These include managing Autonomous Intelligent Automation by accessing the AIA Web portal to run automation and performing automation to validate new applicants' requirements by accessing the Sacarias web portal and navigating to each record of the undergraduates under the review category. Moreover, this research applied an intervention rate and a target of ~0% to indicate a fully autonomous execution, captured metrics of accuracy and efficiency to determine a quantifiable time savings as a result of automation, and documented secure implementation and serverless and modular design to explain the technical approach and architecture in developing a secure and cloud-native Autonomous Intelligent Automation through DevSecOps methodology.

With this, the research would support the implementing organization in providing high-quality services for both staff and the institution's clients.

Methods

This research followed and adopted a Development (Dev), Security (Sec) and Operations (Ops) (DevSecOps) methodology framework, a unified, comprehensive, and continuous cycle approach to manage software development and deployment. This primarily emphasizes iterative cycles of development that are anchored to continuous integration and delivery while having a proactive security implementation in all of the identified phases. Vast literature also identifies and promotes the use of DevSecOps to have a secure, efficient, and collaborative software development that aligns with the academic insights and industry standards.

Research Design

The project design that follows the DevSecOps lifecycle consists of phases that ensure a comprehensive coverage of both security, functional, and non-functional requirements. Each phase is designed to provide a coherent value to collectively contribute to delivering a secure and robust solution. A lifecycle model of continuous integration and delivery provides a structured iteration cycle that is aligned with the best practices in terms of software development or software engineering, particularly on continuous integration and deployment (CI/CD) for secure cloud computing (Saleh et al., 2025).

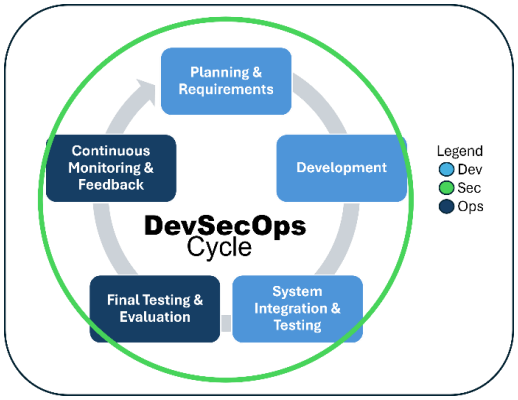

Figure 1. *DevSecOps Development Framework*

Phase 1: Planning and Requirements

This phase is the first part of the Development (Dev) section. This mainly covers the comprehensive discussion of the requirements for both functional and non-functional deliverables. The target action involves a clear objective scope and a requirement documentation that is separated into tasks and serves as the representation of each microservice. This phase also allows for preparation and secure access to the software/applications involved in the process that is undertaken for Autonomous Intelligent Automation.

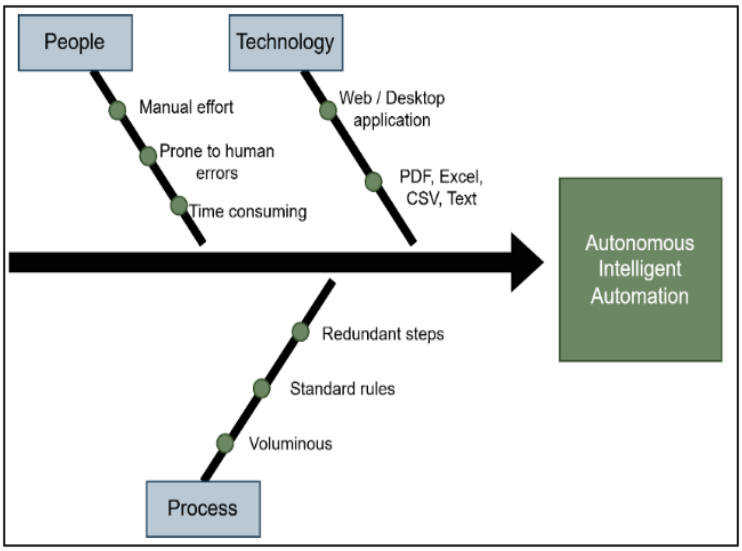

Figure 2. *Fishbone for Autonomous Intelligent Automation Processes*

Phase 2: Secure Development (Backend, Frontend, and AIA)

This phase involves the development of the components for Autonomous Intelligent Automation to leverage modern and secure cloud-native serverless architecture technologies. This research used AWS Lambda (Python 3.7) to implement a secure microservices and AIA functionality for backend, ReactJS (a JavaScript framework) for the frontend and user interface, and Supabase for implementing database functionality to support storing data for configuration and to process automations.

Lastly, to effectively reduce the risks of privilege abuse in serverless architectures, the study adopted the Principle of Least Privilege (POLP) access management. With POLP, every serverless function was assigned only and exactly the minimum set of permissions it needs to perform its tasks. This security measure means forming fine-grained roles and policies that are bespoke to the operational needs of each AWS Lambda function. Such exacting permission set formations do not allow an attacker the leeway to escalate privileges or access resources they should not be able to get to (Cloud Security Alliance, 2022).

Phase 3: System Integration and Testing

This phase involves the integration of the components that were developed separately. Securely validating the interactions between components and data integrity is part of this phase to ensure a smooth transfer of information and commands across

components. Conducting comprehensive development testing and unit testing also eliminates potential risks during final evaluation. Testing the capability of Autonomous Intelligent Automation end-to-end also needs to be secured and thoroughly tested in this phase to ensure time savings, accuracy, efficiency, and reduction of human error which are proven compared to manual execution of the process. To further enhance security and operational visibility during this phase, AWS CloudWatch was utilized for real-time monitoring, logging, and alerting. CloudWatch facilitates immediate detection of performance anomalies, potential security threats, or operational irregularities within the AIA process.

Phase 4: Final Testing, Security Audit, and Evaluation

This phase includes a comprehensive testing and system evaluation, security verification, and readiness for final evaluation. It involves manual testing for the Autonomous Intelligent Automation and extensive security verification in all API endpoints for the microservices. This phase also involves the preparation of user and technical documentation that guides both the admin and users in navigating the automations.

During the evaluation phase of the solution, the following were the documents and environment that were prepared: Amazon Web Service Subscription (1-year Free Tier), Supabase Production Instance, virtual machine/desktop/laptop, User's and Technical Manual and Training, hyper care, and support.

Phase 5: Continuous Monitoring and Feedback

Although this research was not able to deploy the automation into the actual production environment, this phase still holds a role in making an emphasis on the importance of continuous monitoring and feedback. This is the key component to achieve the DevSecOps framework that this research follows in making sure that security is properly implemented and embedded in all phases.

Hardware and Software Requirements

Below is the minimum requirement for software and hardware to smoothly interact with the deployed automation.

Table 1. Software Requirements

Software Specification	Minimum Requirements
Web Browsers	Google Chrome or Mozilla Firefox, or Safari (latest versions)
Web Portal/Frontend	Modern web browser with JavaScript and CSS3 support
API Integration	Internet connection for API calls

Table 2. Hardware Requirements

Hardware Specification	Minimum Requirements
Device Access	Desktop or laptop with 8GB RAM, SSD storage, and a multicore CPU (i5 or above) for faster processing
Operating System	Windows 10 or higher, macOS, or Linux (with modern web browsers)
Internet Connectivity	Stable internet connection of 5 Mbps minimum for system interaction
Screen Resolution	1024x768 or higher resolution display
Security & Authentication	Ability to use secure login (username and password)
Virtual Machine (Optional)	At least 8GB RAM, 4 CPU cores, SSD storage with 50GB+ space for optimal performance

On the other hand, below are the additional software and hardware requirements with minimum specifications needed during the development, testing, and deployment phases.

Table 3. Software Requirements for Development

Software Specification	Minimum Requirements
Development Tools	Visual Studio Code and pip to install various Python libraries to implement OCR and computer vision
Backend	AWS Services (AWS Lambda, IAM, KMS, API Endpoint, S3) with at least a Basic AWS Free Tier account
Frontend	JavaScript Framework (ReactJS)
Testing Tools	Web Postman
Database	PostgreSQL (Supabase)
Storage	Amazon S3 for static asset storage
Source Code Repository	GitHub account

Table 4. Hardware Requirements for Development

Hardware Specification	Minimum Requirements
Development Machine	Laptop/desktop with 8GB RAM, 256GB SSD, quad-core CPU
Operating System	Windows 10 or higher, macOS, or Linux (Ubuntu 20.04)
Internet Connectivity	Stable internet connection of at least 5 Mbps
Virtual Machine (Optional)	Minimum: 4-core CPU, 8GB RAM, 128GB SSD

Data Gathering Procedures

During the evaluation process of executing the automation, AIA should be able to demonstrate that it can operate without human intervention once the AIA starts to

process. AIA should also eliminate manual touchpoints once it decides to start processing and validating information.

To define the measurability of the automation, this research imposed an intervention rate metric to support and describe how gathered data was used to support the autonomy assessment and the analysis procedures to validate truly hands-off operation. In the evaluation process of this research, the data gathered during the AIA run should be captured consistently and accurately to validate against the objectives of the research.

To pilot an execution, the AIA used the first batch of results data using the filtered criteria on the user interface as the total evaluation population to perform end-to-end autonomous automation. After the AIA begins performing its automation, there should be no more human intervention permitted unless otherwise forcefully stopped by the user themselves.

For instrument logging, AIA logged its actions in a JSON file and stored it in an S3 bucket in the AWS cloud platform. This file was encrypted and shown directly on the AIA web portal, thus making sure it cannot be updated or altered in transit and at rest.

Methods of Analysis and Data Validation

To successfully identify the intervention rate, the researchers captured the total number of processed data that is successful over the (N) total number of processed data multiplied by 100 percent. It is illustrated in the following formula:

Intervention Rate = (#{records with InterventionFlag ! = Done} / N) 100%
where N is equal to the number of records

According to Vasu Rao (2023), the human intervention rate can be used to measure how often a human needs to assist or correct the automation. The lower the intervention rate, the higher the autonomy of the automation is, thus making it an intelligent process. For the success criterion, the following description was applied:

Intervention Rate = ~0 % indicates fully autonomous, zero-touch operation.

In measuring the accuracy of AIA, this research used a logical validation cross-checking by monitoring for exceptions in the generated automation logs after the end-to-end evaluation for the pilot process. According to Shin (2020), the accuracy in automation can be based on the successful execution without exceptions, which is an indication of a valid and accurate outcome.

Results and Discussion

This section presents an interpretation of the results during the evaluations performed in the study.

Evaluation Run for One of the ISU Administrative

This subsection presents the evaluation and how AIA works end-to-end.

Managing Autonomous Intelligent Automation

This was done by accessing the AIA Web portal to run automation. Intelligent Autonomous Automation management starts with the AIA Administrator logging in to

the AIA web portal. This module provides a secure and intuitive way to access the AIA and show the list of automations and automation-related data for end users.

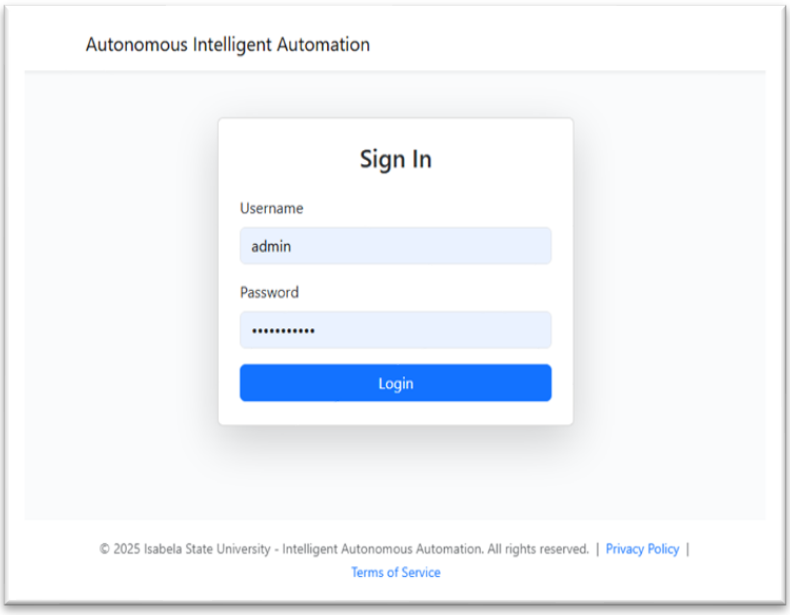

Figure 3. *AIA Login Page*

Once logged in successfully, the dashboard is loaded. This is a page that loads and shows a list of available Autonomous Intelligent Automations enrolled and configured. It allows the user to select which bot needs to run, although for this research, it only has one bot, which is the validation of students' requirements for undergraduate student applicants.

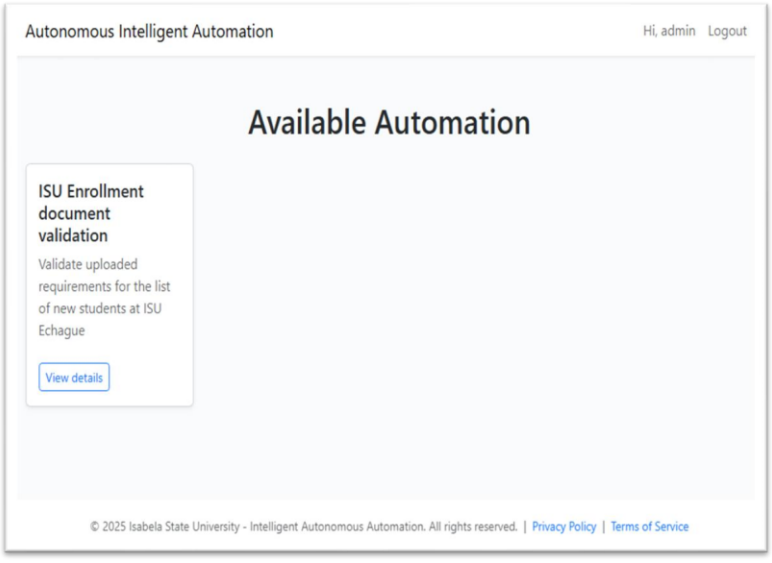

Figure 4. *AIA Web Portal Dashboard*

Once Autonomous Intelligent Automation for ISU enrollment document validation is selected, this provides the bot details and configuration management for the bot's instruction. This research covers the current school year of 2025, the undergraduate level, and the students under the "For review" status. Once the "Run" button is pressed, this triggers an action for the bot to run and validate requirements.

During the execution, AIA launches a bot on users' machines and starts to run autonomously by performing what the administrative staff does, but this time, there was no human intervention needed.

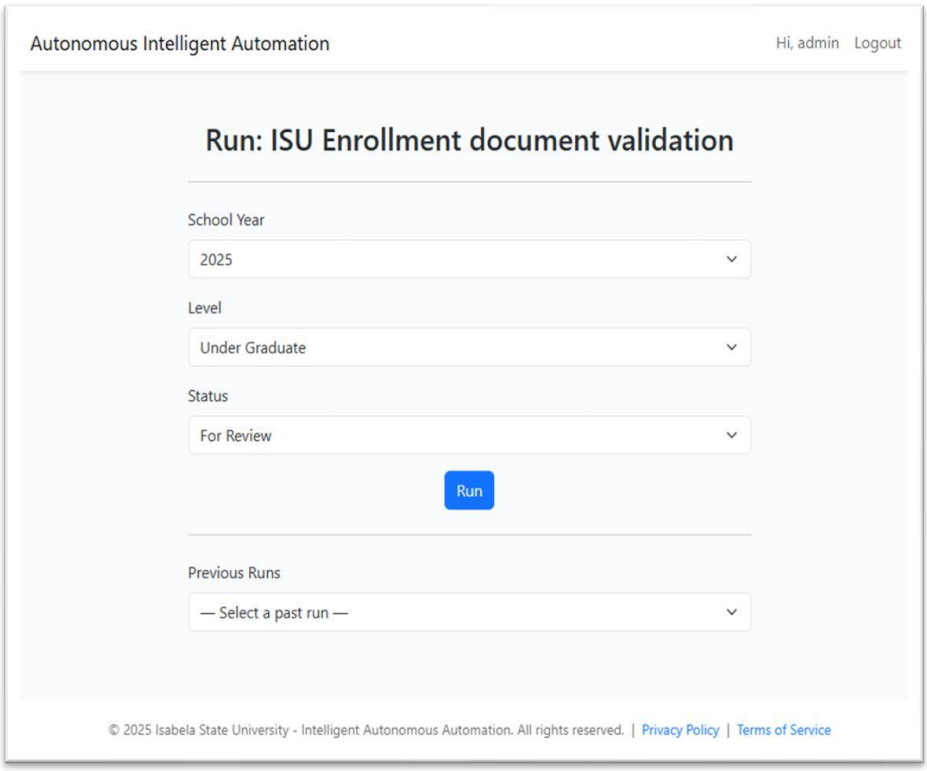

Figure 5. *AIA Run Instruction*

While AIA is running, users can navigate the "Previous Runs" section of the application, which shows the results of the requirements validation. The AIA can be accessed on a separate machine to validate and monitor the status of current and previous runs that AIA performed.

This functionality allows the administrator to flexibly access the AIA web portal and enables real-time monitoring of the current AIA run. AIA ensures that there is continuous visibility into the automation process performance, and quick intervention can be done when needed.

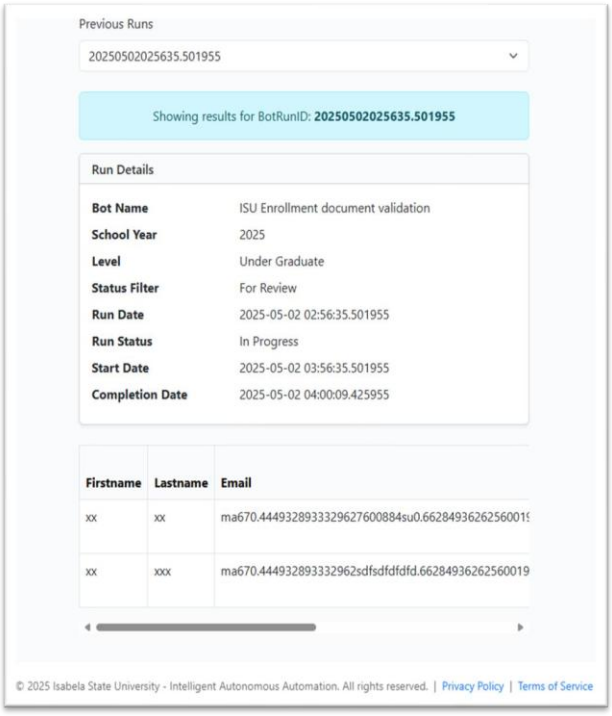

Figure 6. *AIA Run Details*

AIA Performing Automation

This was conducted to validate new applicants' requirements by accessing the Sacarias web portal and navigating to each record of the undergraduates under the review category.

AIA player launches the automation instance on the user's machine. This performs the following tasks without any human intervention, thus calling it Intelligent Autonomous Automation (AIA) as it initiates all applications needed in the automation process. In this case, the Sacarias Web Portal instance is triggered along with the encrypted user credentials used by AIA to log in to the web portal.

Figure 7. *AIA Run Progress*

AIA automatically launches the URL: https://isu-enrolment.online/robot/login. This URL is a separate dedicated instance of the Sacarias Web Portal specifically exposed for AIA to evaluate new applicants' requirements. The dedicated instance where

the evaluation happened exposes encrypted data of the new applicants to ensure that data privacy is strictly followed and ensures compliance with the security standards.

Figure 8. *Sacarias URL Launch*

Based on the selected or configured data in the AIA Web portal, AIA followed those details accordingly. AIA selects "1-2025," which represents the School Year 2025. After AIA selects the appropriate school year, it begins with inputting the user's username and password. The username and password are also dedicated credentials mainly to be used by the AIA bot to access the dedicated instance of the Sacarias Web Portal. Once the username and password are filled out, AIA clicks the "Login" button.

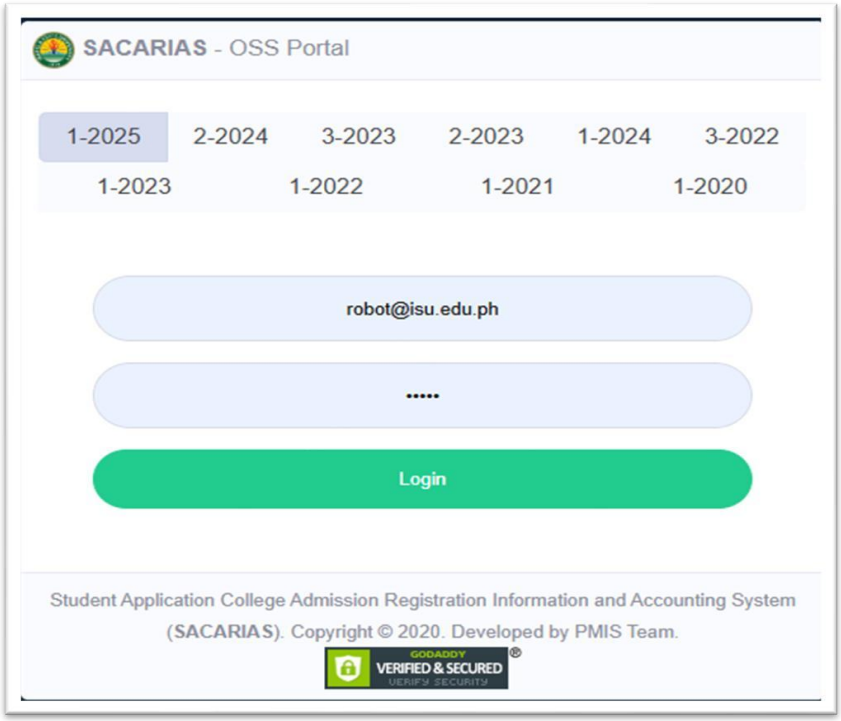

Figure 9. *Sacarias AIA Login*

After AIA performs the Login module, it waits for the Sacarias Web Portal dashboard to fully load before taking any actions. Once loaded, AIA then clicks the "Transaction" menu, then selects the task "College Admission Test (CAT)". This action loads all the new applicants' details, which allows the AIA to start getting records that undergo requirement validations.

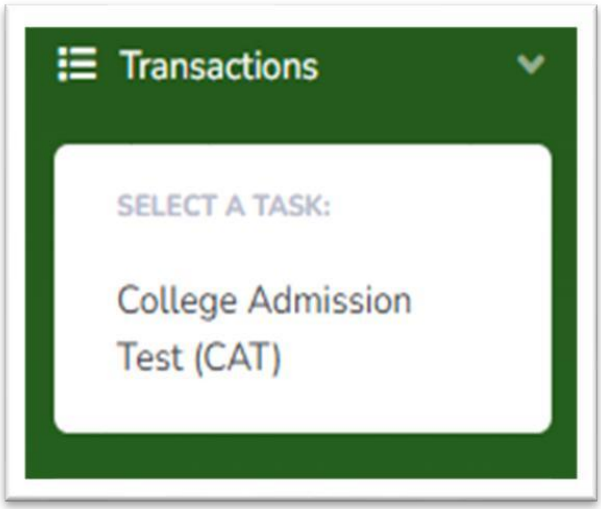

Figure 10. *Navigation to Transaction Tab*

Based on the previously selected configuration on the AIA web portal, the AIA bot selects "Undergraduate" on the dropdown menu. Next, AIA clicks the "For Review" on the list of categories. This action loads all the new applicants that match the selected criteria and is shown in a table format.

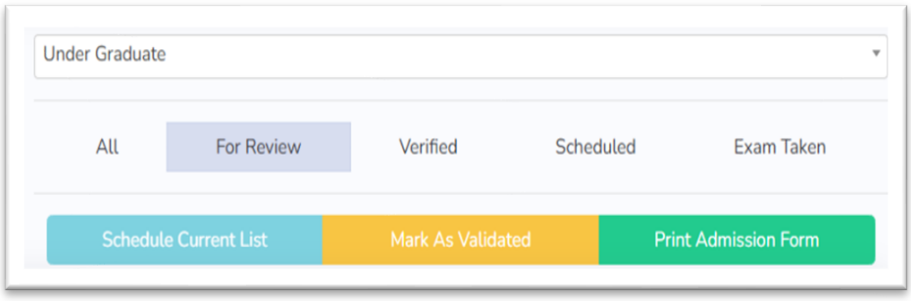

Figure 11. *Selection/ Filter*

Sacarias Web Portal lists all the applicants based on the previous actions; AIA waits for the table to load completely. Once loaded completely, it captures the applicants' list on the table's first page. As part of the evaluation run, AIA only caters the records on the first page of the results. AIA processes the extracted information by getting the unique identifiers and meticulously parses all the data in the table. Once parsed accurately, AIA proceeds in processing records one by one.

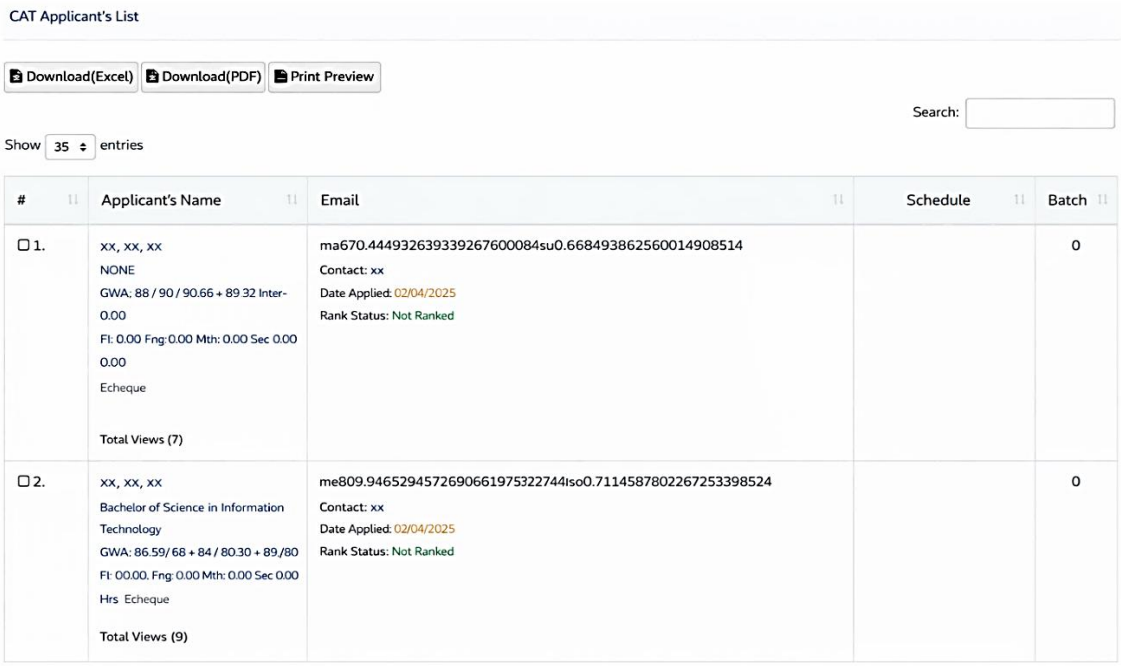

Figure 12. *Capture of All Records*

AIA performs requirement validation in all of the applicants' requirements by opening the online evaluation section one by one. There is a total of 35 records in the first page of the results, thus AIA loads the record, reads all data, downloads the attached requirement, uses OCR to read the data in the downloaded document, captures the GWA in the document, and compares the GWA inputted by the students in the Sacarias Web Portal, logs the action in the AIA database, closes the current page, and then proceeds to the next record. All these actions are performed 35 times as part of the evaluation process. A message box shows "Process completed" once all records have been processed, which means AIA has completely processed all 35 records.

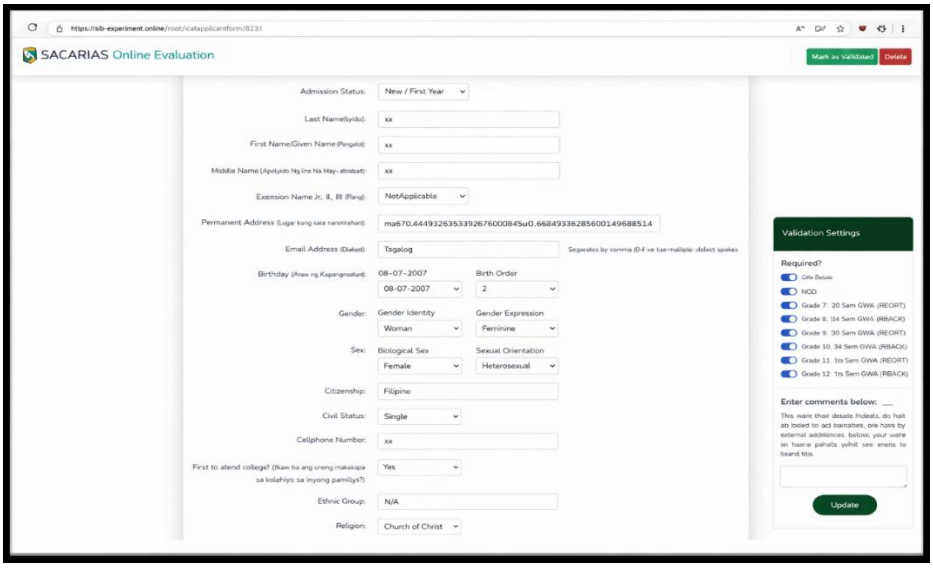

Figure 13. *Validation of Individual Records*

Application of Intervention Rate Evaluation

The research had a target of ~0% to indicate a fully autonomous execution. The AIA performs an end-to-end process in validating 35 records of the new undergraduate applicants for the School Year 2025 under the category of "For Review". After the end-to-end process performed by AIA, Table 5 is the generated result used to evaluate whether the results if target intervention rate has been achieved.

Table 5. Actual Data Processed During Evaluation

First Name	Last Name	Email	Validation Type	GWA Valid	Processed	Status
xx	xx	ma847025920888381615qkilhplebu.6035484183215299 63	GWA Back	True	2025-04-28 02:56:35.501955	Done
xx	xx	ma321129978158321769ubaiecveff.6425978362837140 98	GWA Back	True	2025-04-28T02:57:38.501955	Done
xx	xx	ma902276505162940861lojxtzxukh.1759715217097187 71	GWA Front	False	2025-04-28T02:59:06.501955	Done
xx	xx	ma789294554011196969qqypzmlzmq.255245281663668103	GWA Back	False	2025-04-28T03:00:31.501955	Done
xx	xx	ma100248144947510469kkrzhohgqz.6707322960364330 51	GWA Back	True	2025-04-28T03:00:38.501955	Done
xx	xx	ma915266739981259461uzpwbebuke.621765676265942056	GWA Back	True	2025-04-28T03:02:28.501955	Done
xx	xx	ma837382380101451802aiyltfprdr.145928235301917559	GWA Front	False	2025-04-28T03:02:50.501955	Done
xx	xx	ma287510323434024990fpacrdwozh.373250102590263725	GWA Front	False	2025-04-28T03:04:16.501955	Done
xx	xx	ma865901809901055754lvxluzgnkr.386376193432112705	GWA Front	False	2025-04-28T03:05:23.501955	Done
xx	xx	ma854896688261973517crukrvqibw.1989742163196683 25	GWA Back	True	2025-04-28T03:05:35.501955	Done
xx	xx	ma262916322446340077qqojgxpxht.082834194205934315	GWA Back	True	2025-04-28T03:07:28.501955	Done

xx	xx	ma007529443818452106mncgckykdz.452738899673000813	GWA Front	False	2025-04-28T03:08:25.501955	Done
xx	xx	ma893696098075372764nnsznjyhng.843203960294259229	GWA Back	True	2025-04-28T03:09:07.501955	Done
xx	xx	ma452959056680615349pixwitikjf.224325693431113099	GWA Back	True	2025-04-28T03:09:54.501955	Done
xx	xx	ma414109483061214129rruvustojl.401415504300730464	GWA Back	False	2025-04-28T03:10:55.501955	Done
xx	xx	ma423532883889532497fckujmrjvg.743727975770028612	GWA Front	False	2025-04-28T03:11:49.501955	Done
xx	xx	ma178188735434201027hdaspanqqz.500291556256035841	GWA Front	False	2025-04-28T03:12:46.501955	Done
xx	xx	ma007954084545285916nsjmjvcmko.643175842190692282	GWA Front	False	2025-04-28T03:14:15.501955	Done
xx	xx	ma253049005965205675lkmktpoaly.756318374537795034	GWA Front	True	2025-04-28T03:14:50.501955	Done
xx	xx	ma278051602431674051elwjaiupli.419930287825743779	GWA Back	True	2025-04-28T03:16:18.501955	Done
xx	xx	ma528288417499820277hjneawvagm.832046226718352690	GWA Front	True	2025-04-28T03:17:14.501955	Done
xx	xx	ma861101697084975992vbxfhthdsz.222768398040666189	GWA Back	False	2025-04-28T03:18:06.501955	Done
xx	xx	ma475520812843690070wsecsixuif.327313965525506699	GWA Front	True	2025-04-28T03:18:35.501955	Done
xx	xx	ma879958219677340552inxwtgrsyi.070520053323098975	GWA Front	True	2025-04-28T03:19:44.501955	Done
xx	xx	ma384894145163129816fgdhfzsbqp.426725379124664806	GWA Back	True	2025-04-28T03:21:32.501955	Done
xx	xx	ma399571118136588807ehimajqdtu.721212549146117185	GWA Back	True	2025-04-28T03:21:51.501955	Done

xx	xx	ma039818722103489112mxsfiaozas.613660909327685527	GWA Front	False	2025-04-28T03:22:35.501955	Done
xx	xx	ma264899998543439443bpsvdezknt.371045256162556877	GWA Front	True	2025-04-28T03:24:28.501955	Done
xx	xx	ma178834816760286533cadvkzvuid.468141415338548543	GWA Front	False	2025-04-28T03:25:26.501955	Done
xx	xx	ma786426635209594119tuwlwynzea.771649387972246230	GWA Back	True	2025-04-28T03:26:12.501955	Done
xx	xx	ma264901962320287258rbnbzffwhf.563860283308432570	GWA Back	False	2025-04-28T03:27:17.501955	Done
xx	xx	ma588619545835600126pxoalkgygg.409023316526580826	GWA Back	True	2025-04-28T03:28:28.501955	Done
xx	xx	ma567478028044754455nzfbpztdbk.317631135295299870	GWA Front	True	2025-04-28T03:29:20.501955	Done
xx	xx	ma481937430025205313nvwcnhoetj.913398037148937853	GWA Front	True	2025-04-28T03:29:36.501955	Done
xx	xx	ma042754844131498484tzmjwxdlov.554281650527889730	GWA Front	False	2025-04-28T03:31:05.501955	Done

The number of the intervention rate metric is the number of records where the status is not equal to “Done”. Thus, based on the records shown in Table 5, all statuses are equal to “Done”; therefore, intervention rate is 0.

$$Intervention\ Rate = \frac{0}{35}\ X\ 100\%$$
$$Intervention\ Rate = 0$$

With zero interventions logged, AIA achieved a fully hands-off operation, eliminating opportunities for human mistakes and ensuring consistent, error-free execution across all records. The human intervention rate that was used as a core indicator of automation shows an outcome that is relatively consistent with the previous studies related to intelligent automation. Rao (2024) emphasized that having a minimal to no human touch in the processes drives the difference between the traditional robotics process automation and intelligent and autonomous automation. With this outcome, AIA demonstrated a higher level of operation that is highly autonomous with the academic administrative setup. This confirms that AIA completed all navigations, extractions, and validations without a single manual pause or corrective action.

Metrics of Accuracy and Efficiency

This research was able to determine a quantifiable time savings as a result of automation. During the evaluation, AIA processed all 35 records successfully with a result of 0% intervention rate. This clearly means that there were no deviations or validation errors detected during the AIA evaluation run. Therefore, the accuracy rate of the AIA was inferred to be 100%. Intelligent automation combined with rule-driven processes enhances reliability and reduces error rates during transactional and document processing procedures, based on research on innovative RPA-AI user interfaces. Based on these studies, applying computer intelligence and recognition of patterns when combined with organized automated rationale tends to significantly enhance automation accuracy, especially in data extraction and verification situations (Kitsantas et al., 2024).

Additionally, AIA can easily create a new instance and can scale easily by accessing the AIA web user interface on another machine where automation needs to be performed, as shown during the evaluation. This significantly improves the efficiency of the system by enabling the organization personnel to focus on other tasks that are more valuable to the institution while AIA is running simultaneously as a digital workforce.

Lastly, Table 6 shows the actual runtime performed by AIA during the evaluation. It started at 2025-04-28 02:56:35.501955 and ended at 2025-04-28 03:31:08.501955, having a total of 35 minutes and 33 seconds to process 35 records in a single run. The calculated processing time corresponds with previous research on automation efficiency, which indicates that intelligent automation significantly shortens the time needed to do repetitive administrative tasks (Nielsen et al., 2023). Automation has been demonstrated to reduce staff workload and speed up administrative processes in higher education settings (Benavides et al., 2020). The suggested AIA demonstrated its viability for high-volume university procedures by attaining substantial productivity advantages without requiring human involvement during execution, as opposed to previous implementations.

Table 6. Summary of Processing Time During Evaluation

Start Time	End Time	Overall Processing Time	Individual Processing time (35 Records)
2025-04-28T02:57:29.501955	2025-04-28T03:31:05.501955	33 minutes 36 seconds	~ 1 minute/record

This runtime represents the duration of the actual AIA evaluation that performs an automated process in validating documents, which can be presented as a quantifiable minimum time savings for the university administrative staff, since there was no manual intervention involved during the execution. Moreover, AIA demonstrated its effectiveness in handling repetitive, voluminous, and time-consuming processes.

After AIA Evaluation

The following subsections explain the technical approach and architecture in developing a secure and cloud-native Autonomous Intelligent Automation by implementing a DevSecOps methodology.

Secure Implementation

AIA leverages AWS CodePipeline to implement DevSecOps within the solution, demonstrating that AIA strictly follows the build, security, and deployment pipeline.

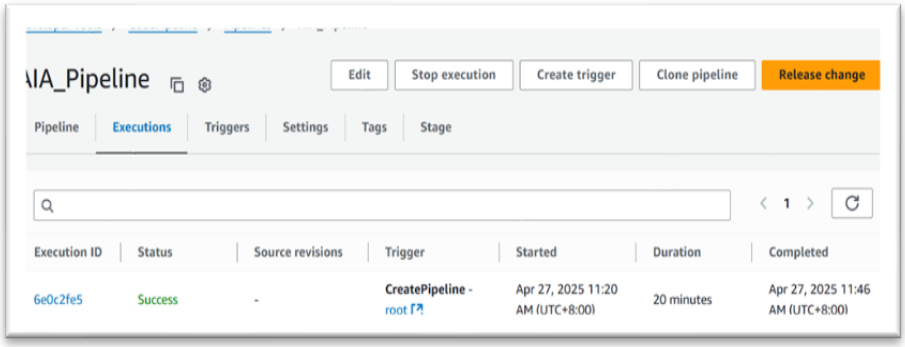

Figure 14. *DevSecOps Pipeline*

AIA leverages custom-managed encryption in the pipeline in all AWS services used for the AWS Lambda functions. Defining custom management keys instead of using the native AWS keys gives the solution control in managing keys used for encrypting and decrypting data.

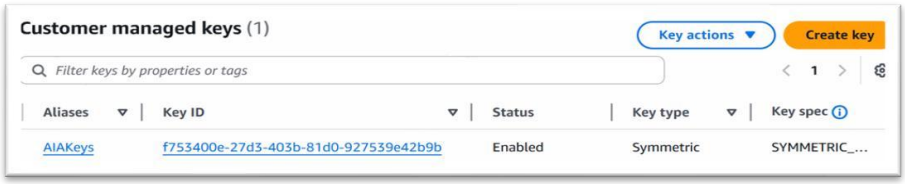

Figure 14. *AWS Custom-manage Keys*

Serverless and Modular Design

AIA uses a serverless architecture by creating microservices inside the AWS Cloud platform. Prior research shows that adopting an architecture without servers improves scalability and cost effectiveness for dynamic operations (Ta et al., 2022; Dutta & J., 2024). This architectural choice is particularly significant as part of the process of university enrollment, when processing demand varies greatly and necessitates quick, on-demand scalability. Each microservice pertains to the backend login that makes the AIA perform its functionality.

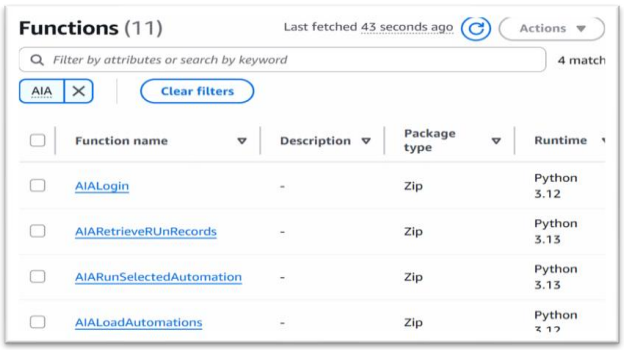

Figure 15. *AIA Microservices*

1. *AIA Login* – A microservice executes to perform login and logout in the AIA web portal.
2. *AIARetriveRUnRecords* – A microservice that executes to perform the retrieval of AIA runs. Below is the payload that this microservice accepts.


```
{
"BotName": "ISU Enrollment document validation",
  "SchoolYear": "2025",
  "Level": "Under Graduate",
  "Status": "For Review",
    "BotRunID": "20250428025033.712352",
}
```


Below is the payload response that this microservice returns and is parsed to show in the AIA Web Portal.


```
{
  "BotName": "ISU Enrollment document validation",
  "SchoolYear": "2025",
  "Level": "Under Graduate",
  "Status": "For Review",
  "RunDate": "2025-04-28T02:56:35.501955",
  "BotRunID": "20250428025033.712352",
  "RunStatus": "Completed",
  "RunStartDate": "2025-04-28T02:56:35.501955",
  "RunCompletionDate": "2025-04-28T03:31:08.501955",
  "Results": [
    {
      "Firstname": "xx",
      "Lastname": "xx",
      "Email":
"ma847025920888381615qkilhplebu.603548418321529963",
      "ValidationSettings": {
        "type": "GWA Back",
        "status": "OK"
      },
      "GWA_Valid": true,
      "processing_date": "2025-05-02T02:57:29.501955",
      "status": "Done"
    },
    {
      "Firstname": "xx",
      "Lastname": "xx",
      "Email":
"ma321129978158321769ubaiecveff.642597836283714098",
      "ValidationSettings": {
        "type": "GWA Back",
        "status": "OK"
      },
      "GWA_Valid": true,
      "processing_date": "2025-05-02T02:57:38.501955",
```

```
      "status": "Done"
    },
  .....
  ]
```


3. *AIARunSelectedAutomation* – This microservice is dedicated to capturing and parsing the AIA instructions of the selected automation that gets performed in the user's local machine. Below is the request payload that this microservice accepts.


```
{
        "BotName": "ISU Enrollment document validation",
}
```


Below is the response payload that this microservice returns.


```
{
  "botName": "ISU Enrollment Automation",
  "steps": [
    {
      "step": "initialize",
      "actions": [
        {"action": "assign", "variable": "url", "value":
"https://isuenrolment.online/robot/online#"},
        {"action": "assign", "variable": "username", "value":
"credential_vault_user"},
        {"action": "assign", "variable": "pw", "value":
"credential_vault_password"},
        {"action": "assign", "variable": "toProcess", "value":
"s3.process"},
        {"action": "open_browser", "url": "$url$"}
      ]
    },
    {
      "step": "Login",
      "actions": [
        {"action": "click", "target": "Login label"},
        {"action": "delay", "duration": 2},
        {"action": "set_text", "target": "Login username textbox",
"value": "$username$"},
        {"action": "delay", "duration": 2},
        {"action": "set_text", "target": "Login password textbox",
"value": "$pw$"},
        {"action": "delay", "duration": 2},
        {"action": "click", "target": "Login button"},
        {"action": "wait_window", "title": "SACARIAS"},
        {"action": "wait_condition", "condition": "LABEL
SACARIAS exists"}
      ]
    },
  .....
}
```

4. **AIALoadAutomations** – This microservice's main function is to provide the list of active AIA Automations registered in the AIA Web portal. Below is the request payload that this microservice accepts.

   {}
   ** Means a request payload is and should be blank

   Below is the response payload that this microservice returns.
   {
   "BotName": "ISU Enrollment document validation",
   }

Conclusion and Future Works

With the figures gathered during the evaluation, AIA's objective was met in terms of processing time, efficiency, accuracy, security, and scalability. This confirms that integrating the DevSecOps framework with the cutting-edge technologies available in the market can truly transform administrative tasks operations in a higher education environment, providing a secure, resilient, and scalable automation foundation that can be readily adapted for other campus processes and institutions seeking to modernize their workflows and maximize staff productivity.

For technical enhancement and future iterations, researchers may extend the OCR capability to support handwritten and multilingual documents. AIA can also be implemented on other processes within the institution with the same qualification of repetitive, time-consuming, and voluminous tasks, such as invoice processing, transcript generation, and faculty workload allocation, which can help maximize productivity across the university. Although AIA performed flawlessly in the pilot, operational risks still merit attention when considering a Sacarias web portal downtime, and may introduce a single point of failure.

References

[1] AeoLogic. (2024). *Reducing operational costs with intelligent process automation.* https://www.aeologic.com/blog/reducing-operational-costs-with-intelligent-process-automation/

[2] Akinnagbe, O. B. (2024). Human–AI collaboration: Enhancing productivity and decision-making. *International Journal of Education, Management, and Technology, 2*(3), 387-417. https://doi.org/10.58578/IJEMT.v2i3.4209

[3] Allen, B., & Edmundson, C. (2023). *SANS 2023 DevSecOps survey*. SANS Institute. https://www.sonatype.com/hubfs/Survey_DevSecOps_2023.pdf

[4] Amazon Web Services. (2025). *What is Amazon CloudWatch?* https://docs.aws.amazon.com/AmazonCloudWatch/latest/monitoring/WhatIsCloudWatch.html

[5] Bell, E., Harley, B., & Bryman, A. (2022). *Business research methods* (6th ed.). Oxford University Press. https://global.oup.com/ukhe/product/business-research-methods-9780198869443

[6] Benavides, L. M. C., Tamayo Arias, J. A., Arango Serna, M. D., Branch Bedoya, J. W., & Burgos, D. (2020). Digital transformation in higher education institutions: A systematic literature review. *Sensors, 20*(11), Article 3291. https://doi.org/10.3390/s20113291

[7] Cloud Security Alliance. (2022). *Top threats to cloud computing: The pandemic eleven report*. https://cloudsecurityalliance.org/artifacts/top-threats-tocloud-computing-pandemic-eleven/

[8] Dutta, A. H., & J, B. (2024). Impact of serverless computing on scalability and cost-effectiveness in cloud-based applications. *International Journal of Research Publication and Reviews, 5*(3), 1824–1830. https://doi.org/10.55248/gengpi.5.0324.0869

[9] Gartner Peer Community. (2023). *DevSecOps: Strategies, organizational benefits, and challenges*. https://www.gartner.com/peer-community/oneminuteinsights/omi-devsecops-strategies-organizational-benefits-challenges-xrd

[10] Humphreys, A. R. (2023). *How AI is driving modern higher education administration*. Van Allen Strategies. https://vanallenstrategies.com/insights/how-ai-is-driving-modern-higher-education-administration/

[11] IBM Security. (2025). *Cost of a data breach report 2025*. https://www.ibm.com/reports/data-breach

[12] Kayanja, W., Kyambade, M., & Kiggundu, T. (2025). Exploring digital transformation in higher education setting: The shift to fully automated and paperless systems. *Information & Communications Technology in Education, 12*(1), 1-15. https://doi.org/10.1080/2331186X.2025.2489800

[13] Kitsantas, T., Georgoulas, P., & Chytis, E. (2024). Integrating robotic process automation with artificial intelligence for business process automation: Analysis, applications, and limitations. *Journal of System and Management Sciences, 14*(7), 217–242. https://DOI:10.33168/JSMS.2024.0712

[14] Microsoft. (2025). *What is DevSecOps?* Microsoft Security. https://www.microsoft.com/en-us/security/business/security-101/what-is-devsecops

[15] Ng, K. K. H., Chen, C.-H., Lee, C. K. M., Jiao, J. R., & Yang, Z. (2021). A systematic literature review on intelligent automation: Aligning concepts from theory, practice, and future perspectives. *Advanced Engineering Informatics, 47*, Article 101246. https://doi.org/10.1016/j.aei.2021.101246

[16] Nielsen, I., Piyatilake, A., Thibbotuwawa, A., De Silva, M. M., Bocewicz, G., & Banaszak, Z. (2023). Benefits realization of robotic process automation (RPA)

initiatives in supply chains. *IEEE Access, 11*, 1–15. https://doi.org/10.1109/ACCESS.2023.3266293

[17] Othman, A. (2025). *The foundations and challenges of AI ethics*. Asia e University. https://doi.org/10.13140/RG.2.2.31556.13444

[18] Pan, M., Wang, J., & Wang, J. (2023). Application of artificial intelligence in education: Opportunities, challenges, and suggestions. In *Proceedings of the International Conference on Information Technology in Medicine and Education* (pp. 623–627). IEEE. https://doi.org/10.1109/ITME60234.2023.00130

[19] Qin, H., & Wang, G. (2022). Benefits, challenges and solutions of artificial intelligence applied in education. In *Proceedings of the 11th International Conference on Educational and Information Technology (ICEIT)* (pp. 62–66). IEEE. https://doi.org/10.1109/iceit54416.2022.9690739

[20] Rao, V. (2024, April 25). *AI will supercharge RPA*. LinkedIn. https://www.linkedin.com/pulse/ai-supercharge-rpa-vasu-rao-zvlic

[21] Saleh, S. M., Madhavji, N., & Steinbacher, J. (2025). A systematic literature review on continuous integration and deployment (CI/CD) for secure cloud computing. *arXiv*. https://doi.org/10.48550/arXiv.2506.08055

[22] Shin, H., Ko, J., & Lee, J. (2020). LogCleaner: Noise-aware log preprocessing to enhance operational log analysis. *IEEE Transactions on Software Engineering, 46*(3), 234–250.

[23] Szeliski, R. (2022). *Computer vision: Algorithms and applications*. Springer Nature Switzerland. https://doi.org/10.1007/978-3-030-34372-9

[24] Ta, P. B., Trần, M.-N., & Kim, Y. (2022). Serverless computing approach for deploying machine learning applications in edge layer. In *Proceedings of the International Conference on Information Networking (ICOIN)* (pp. 396–401). IEEE. https://doi.org/10.1109/ICOIN53446.2022.9687209

[25] Tan, P. A. (2024). *Optical character recognition (OCR) with CNN-LSTM attention seq2seq*. Towards AI. https://towardsai.net/p/artificial-intelligence/optical-character-recognition-ocr-with-cnn-lstm-attention-seq2seq

Acknowledgement

The researchers would like to express their deepest gratitude to those who guided and supported them throughout the completion of this research. First and foremost, they thank Dr. Christine Charmaine G. San Jose, for her invaluable expertise, constructive feedback, and constant encouragement, which helped shape this work into what it is today. Her patience, insight, and unwavering belief in the researchers' abilities had truly inspired them to strive for excellence.

She is equally indebted to the faculty and staff of Isabela State University for providing the resources and nurturing environment that made this research possible. In particular, they extend their appreciation to the committee, Dr. Albert A. Vinluan, Dr. Helena B. Florendo, and Dr. Gloria R. Dela Cruz, for their thoughtful critiques, practical

suggestions, and generosity in sharing their time and knowledge. They also owe special thanks to Ma'am Ma. Corazon M. Verbo for always accommodating any queries and providing guidance for any requirements related to their research.

Lastly, the main author would like to acknowledge the unwavering love and support of her family and friends, especially her husband, John Kelvin V. Dave. Their faith in her, their understanding when she needed long hours to focus, and their words of encouragement pulled her through every challenge. No words can express how deeply grateful she is for all they have done.

Conflict of Interest

The author declares that there is no conflict of interest related to the study. The research was carried out as part of their academic and professional work, and the design, analysis, or interpretation of the results were not influenced by any external funding, commercial organizations, or third-party interests.

Artificial Intelligence (AI) Declaration Statement

Artificial intelligence (AI) tools were used in a limited and supportive capacity during the preparation of this manuscript. These tools were primarily utilized to assist with language refinement, grammar checking, and improving clarity and structure in the writing process. AI tools were not used to generate original research ideas, collect or analyze data, or draw conclusions.