Intelligent Systems and Process Automation CA

Yixuan Wang
M.Sc. - Artificial Intelligence
National College of Ireland,
Dublin, Ireland
x23162767@student.ncirl.ie

Context

The graduate employment rate is a crucial indicator for assessing effectiveness of colleges and universities in China. The Department of Personnel and Social Security (DPSS) is responsible for tracking and reporting these employment statistics for each academic year. The initial employment statistics are published in mid-June and the final edition is released at the beginning of the next academic year. Meanwhile, the DPSS prepares the "National Employment Agreement for Graduates of General College and Universities", known as the tripartite agreement, which is signed between graduates, employers and schools, aiming to clarify the rights and obligations of all parties to ensure the smooth graduate employment.

However, the handover between the DPSS and colleges, and the procedures for performing these tasks in institutions remain manual and inefficient in many cities. This project assesses the current workflow in Lanzhou Institute of Technology and proposes potential automation solutions to optimize the entire process. It includes As-Is and To-be BPMN diagrams and outlines the potential benefits. The proposal could not only improve the current institution but may also be applicable to other institutions in the city of Lanzhou.

As-Is
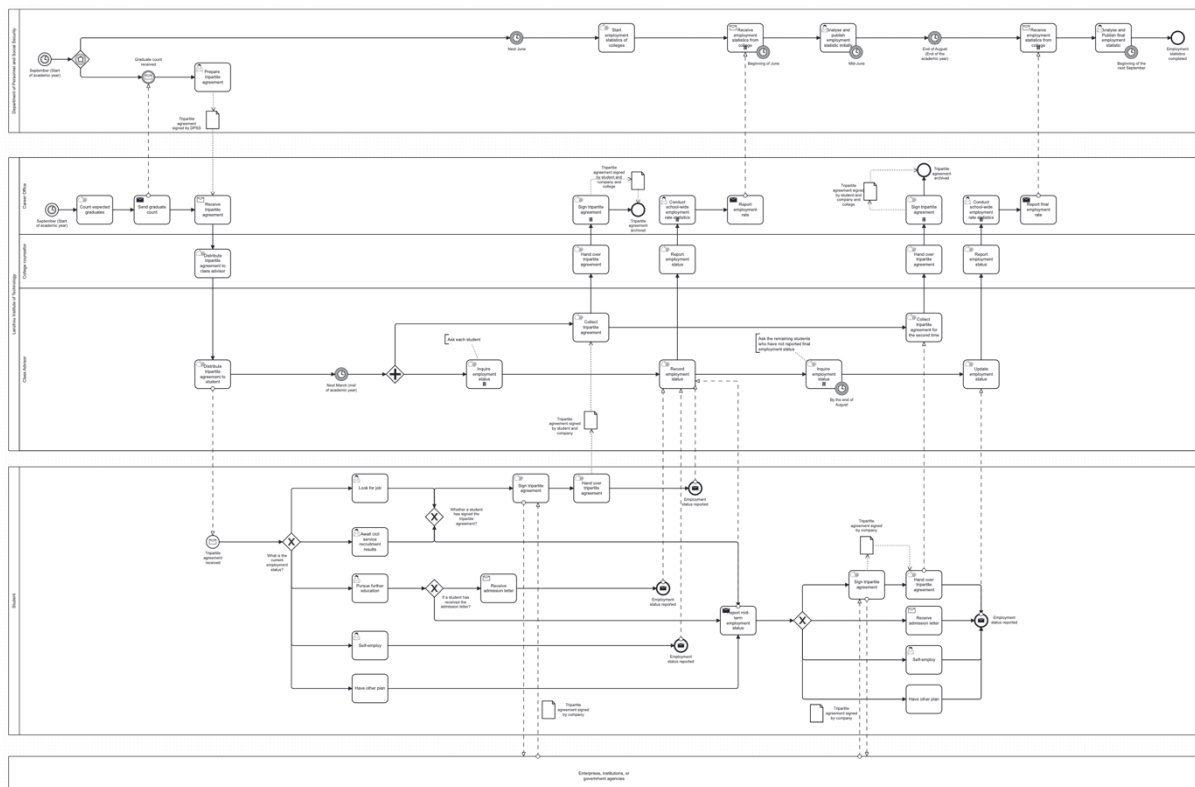
Analysis

The Department of Personnel and Social Security (DPSS) prepares the tripartite agreements according to the number of expected graduates and distributes them to each student through their institution at the beginning of the academic year. This task is performed manually. The university career office receives the tripartite agreements and distributes to the college counsellor of each school, who then passes them down to class advisors of each major. Finally, the class advisors hand them over to the students.

If a student is going to work in enterprises, institutions or government agencies, the tripartite agreements should be signed; in other cases, such as pursing further education, self-employment, the agreements will be discarded. After securing their first job, the graduate needs to sign the tripartite agreements with their employer. Before the start of the first employment statistics, the signed agreements will be collected by the class advisor, passed to the college counsellors, and handed back to the career office to sign the documents. One copy is archived in the university, and two are returned to the students; the student keeps one copy and sends the other back to their future workplace.

The DPSS starts the first employment statistics in June. The university begins preparation in March. Class advisors may send emails, make phone calls, text the student, or inquire orally to collect the student's current employment status. Once the post-graduation destination is clear, for instance, receiving job offer and signing tripartite documents, or receiving the admission letter from a university, the graduate reports the employment status to the class advisor by the end of May. If the future plan is not finalized, the mid-term employment status is reported. Then, the class advisor reports the information to the college counsellors, and finally the career office conducts the employment statistics for the entire university and reports the employment status to the DPSS at the beginning of June. The DPSS collects and analyses the employment status from all universities and publish the initial employment statistics in the mid-June. The report is valuable for students to select universities.

The final employment statistics of the academic year by DPSS begins at the end of August, with the focus to collect information from the previous unsettled students. The procedure is the same as the previous one. The final report is released at the beginning of the following September.

Overall, the entire procedure involves an extensive amount of repetitive and routine tasks. The manual processes, their cost impacts, error rates and lost productivity will be assessed in next sections.

Manual Processes

The delivery, collection and signature of the tripartite agreements, are primarily performed manually. Firstly, the DPSS prepares and distributes the tripartite agreements to universities, where the documents are passed through various departments until they reach the students. The signing of the documents is also manually handled. Students contact their employer to sign the agreements and hand them over through various parties inside the university to finally be signed by the career office. They then receive the signed documents and return a copy to their employers. The process is extremely cumbersome, inconvenient and time-consuming. Potential automations can be identified in the document delivery and signature procedure.

As for the employment statistics, the majority of tasks are handled manually. Within the university, the initial inquiry from class advisors to students is realized manually. Each student is asked individually, and the information may need to be updated over time. The process extends for months and involves a substantial amount of work. The delivery of the statistical results is also manual. The class advisor passes the records to colleges counsellors, and finally, the career office collects and analyzes the overall statistics. Reporting the results to DPSS involves human contact and the delivery of official documents, therefore is also a manual task. The second round of statistics follows a similar procedure, but mainly focusing on collecting information from the previously unsettled students.

Cost Impacts

The costs impact analysis focuses on the expenses incurred by the Lanzhou Institute of Technology, excluding costs at the DPSS.

The assessment starts by analyzing employee payroll expenses. The average monthly rate of college administrators is approximately1300 euros before tax. Assuming a 40-hour workweek, the estimated hourly rate is around 8 euros.

The expected number of graduates for each academic year is around 3000. For employment statistics inquiries, staffs may face delay from some students and need to contact them multiple times. Based on the experiences of previous staff, the average time for each inquiry and employment status registration is at 20 minutes. For the first round of statistics, all 3000 students contacted. The total estimated time is 1000 hours ($3000 \times 20 \div 60$). For the second round, only previously unsettled students are contacted, around 50% of the total. So, the estimated time is 500 hours ($3000 \div 2 \times 20 \div 60$). Therefore, the minimal cost of staff salaries for employment status inquires is approximately around 12,000 euros ($8 \times (1000 + 500)$).

For the management of the tripartite agreements, it is estimated that 50% students will sign the agreements. A time spent by college administrators for each student is estimated is about 25 minutes. Thus, the total payroll expense is estimated to be 5,000 euros ($8 \times 3000 \times 50\% \times 25 \div 60$).

Besides the direct payroll costs arising from the inquires, at least one staff in the career office must oversee the entire process throughout the academic year, to manage records and communicate with different parties. The annual salary for this role is estimated to be 15,600 euros (1300×12).

Other costs include phone fees, paper, seal, office supplies costs, and the cost of maintaining archived tripartite agreements. These are estimated to be 15,000 euros per year based on the experience of previous employee.

In conclusion, expected costs of performing graduate employment statistics and the managing the tripartite agreements at the institution are summarized in the table below. However, this estimation is solely focuses on direct costs. There may also be hidden costs, such as administration expenses, frictions between departments, and additional costs resulting from human errors or delays in information delivery. These factors are not included in this estimation, so the figures shown below present the minimal expected costs.

Graduate Employment Statistics and Tripartite Agreements Management Costs

Type of costs	Costs per year (€)
Direct payroll expenses of conducting employment status inquiry	12,000
Direct payroll expenses of managing tripartite agreements	5,000
Payroll expenses of administrative staff	15,600
Overhead costs	15,000
Total estimated costs	**47,600**

Error Rates

This section assesses potential errors in the graduate employment statistics and tripartite agreements management procedures at the Lanzhou Institute of Technology.

The employment status inquiries are manually conducted, which may cause errors due to inefficient communication or documentation typos. Additionally, as the employment status of expected graduates is constantly changing, information may need to be updated over time. Each statistics routine spans several months, and errors from any stage can cascade. Therefore, it may be challenging to maintain consistent and accurate records among all the participants.

Errors can also occur during the delivery processes. Information passes through multiple departments, from class advisors to college counsellors and finally to the career office. With thirteen schools, each having at least three majors, at least 39 class advisors and 13 college counsellors are involved. Errors from any part can impact overall statistics accuracy. Moreover, currently there is no third-party verification mechanism. It may be hard to detect the existing errors, leading to inaccuracies in the final statistical reports.

In managing graduate tripartite agreements, errors can arise at each stage. Documents are counted and passed to students through the career office, college counsellors, and class advisories, making them susceptible to miscounts or loss. So, the process may require repeated work. Additionally, graduate tripartite agreements are distributed at the beginning of the academic year and collected in next June or August. Keeping paper documents properly during such an extended period may be challenging for students. They may lose the papers or signed them improperly, thus requiring more copies and additional work for college administrators.

Lost Productivity

Inquiring about employment status from over 3000 students is time-consuming and inefficient. Each round of the statistics involves substantial amount of work, increasing management costs. Staff needs to dedicate significant effort to fulfil these routine tasks, distracting from more import responsibilities, such as improving teaching quality, enhancing student learning experiences, offering career counselling, and employer outreach, which is a loss of productivity for the university.

The current method for managing the graduate tripartite agreements is also inefficient. Documents distribution starts at the beginning of the academic year and collection occurs by the end. Students may request more copies due to errors or losses, therefore staff is required to manage continuously over the entire academic year. Moreover, managing and maintaining physical documents requires additional institutional resources and can also slow down

decision-making processes. Therefore, the current system not only wastes time and resources but also limits the potential growth and development of the institution.

To-Be
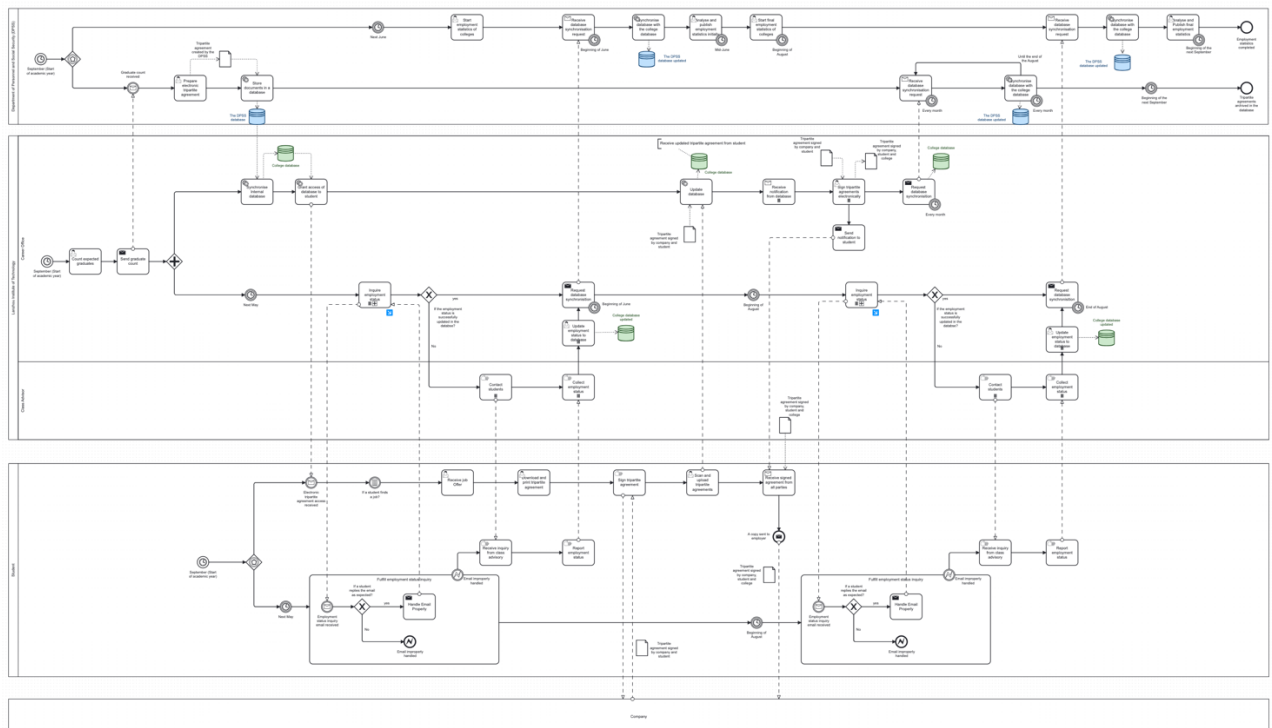
Analysis

To address the redundancy of the original procedure, a more automated and efficient process has been designed. The new process replaces physical documents with digitized ones using databases. The information collection is also automated, with emails sent, information extracted, and data registered automatically. This automatic and electronic transformation reduces human contact and requires fewer stuff members. Therefore, the role of the college counsellor in this task is eliminated. The career office oversees the entire process, intervening only when exceptions occur. Detailed processes are discussed further below.

For tripartite agreements management, after receiving expected graduate counts from the career office in the university, the DPSS prepares electronic tripartite agreements in their database. The university then synchronises its internal database with these documents, and grants students access to the document through a software application. This eliminates paper delivery and avoids passing documents through multiple parties.

After gaining access to the digital tripartite agreements, students can download and print them as needed. This avoids paper waste and allows redownload in cases of loss and errors. The self-service approach improves the problem resolving efficiency, thus enhancing student experiences. After signing the agreements with their employer, students simply need to scan and upload the documents to the university system for electronic approval. The career office receives notifications of updates and approves the agreements electronically. Once signed, students are notified and receive the signed digital agreements. Then, the student can send a copy of the fully signed tripartite agreements to their employer. Finally, the fully signed tripartite document is also backed up in the DPSS database through synchronisation, which

facilitates future reviews and statistics. This automated process can reduce human interaction and save expenses, such as staff payroll, office supplies and communication fees. It also brings more convenience for students who do not live in campus, since many of them may be on internships. The system allows them to complete the process online and potentially save travelling costs.

The graduate employment statistics process is also automated, which limits required human communications. In the As-Is version, employment status enquiries begin in March and need manual updates. The new design completes the entire process within a month. Inquiries are sent through emails, with replies automated processed and updated in the database. The detailed steps are illustrated in the automation recommendation section. Students are contacted only when errors occur. For instance, if a student's reply does not meet requirements after a notification email, the class advisory will contact them individually, report the records to the career office to update the database manually. With two rounds of statistics, the designed system can overwrite old responses and update records automatically. This process significantly improves efficiency and reduces error rates. During the statistics date for the DPSS, the career office simply needs to request database synchronization, allowing the DPSS to access the records and extract information for performing statistics. The streamlined process reduces human interaction, clarifies data origins, and simplifies data updates.

Manual Processes

Most manual processes from the As-Is system have been automated. The remaining tasks either necessitate human intervention, do not involve extensive human labour, or are difficult to automate.

As for the inquiries about employment status, the main procedure is automated. Very little manual work remains, primarily focused on resolving issues when students face difficulties providing required information. In case a student does not reply, or reply in an unrecognizable format by the software, the class advisory will contact the student individually, to obtain their employment status.

Another remaining manual task in the redesigned system in the signing of the tripartite agreement between students and their employers. This process is not automated, as it does not affect the overall efficiency of the institution and it would be impossible to integrate the university's database with all employer systems. Even if the university were to develop a feature for employers to sign the agreements electronically, employers might be unwilling to learn to use an unfamiliar software system.

Cost Improvement

This section will evaluate the development and maintenance costs required to realise this system. The university needs to develop software which can send emails, extract information from replies, and automatically update the database. Moreover, the software should have a feature to share the electronic tripartite agreement with students, allowing to access to the documents through an interface. The system enables students to download and upload documents and allows university staff to sign the documents electronically. The university also needs to integrate their database with the database of the DPSS, enabling document delivery and information transfer.

To implement this software system or integrate these functions with the existing system in the university, an IT team consists of various professionals is required. There should be at least

one project manager, who will coordinate with college staff and ensure the expected software functionalities are fully understood. Additionally, we require one database engineer, two backend engineers, one front end engineer, one integration engineer, one automation and infrastructure engineer. The entire software development process is expected to be completed within three months, and the expected costs can be calculated based on the average annual salary based on the local job market for each involved role. The detailed salary for each each is presented in the table below

The yearly maintenance cost for the developed software is around 6% of the development cost. In addition to that, there are cloud infrastructure costs, which are estimated to be 5000 euros per year.

In the redesigned system, most manual tasks are eliminated. However, a few staff members are still required to resolve issues when students face difficulties providing the required information. Assuming that the automated system encounters issues processing information for around 5% of the students, human intervention is required in such cases. If resolving issues for each student requires 20 minutes, the total payroll expenses for this process would be 4,000 euros ($8 \times 3000 \times 5\% \times 20 \div 60$). Signing tripartite agreements electronically does not require much time. Assuming that signing the agreement for each student requires 5 minutes, the payroll expenses for this process would be 1,000 euros ($8 \times 3000 \times 50\% \times 5 \div 60$). Similar to the As-Is process, one staff member needs to oversee the process. Instead of working throughout the academic year, the person only needs to work for around one month before each round of statistics. The payroll costs for this roll should be included in the total costs, which is 2600 euros (1300×2).

The costs for the initial year and subsequent years are summarized within the tables below:

Costs of Implementing the Automated System in the Initial Year

	Annual salary (€)	Number	Time (months)	Costs (€)
Project manager	25,000	1	3	6,250
Database engineer	20,000	1	3	5,000
Backend engineer	20,000	2	3	10,000
Front end engineer	15,000	1	3	3,750
Integration engineer	18,000	1	3	4,500
Automation and infrastructure engineer	25,000	1	3	6,250
Total development costs				**35,750**
Cloud infrastructure				6,000
Software maintenance				2,145
Payroll expenses				7,600
Total costs in the first year				**51,495**

Maintenance and Cloud Infrastructure Costs in Subsequent Years

	Costs per year (€)
Software maintenance	2,145
Cloud infrastructure	6,000
Payroll expenses	7,600
Total annual costs	**15,745**

The break-even analysis is presented in the following table. In summary, in the initial year, additional 8% in costs will be incurred due to the implementation of the new system. In the subsequent years, the annual cost saving reaches 67%, which is highly profitable. The cost recovery period is 2 years. Therefore, it is strongly recommended that the university proceeds with the project based on this cost analysis.

Break-Even Analysis

	Euro (€)	Percentage	Time
As-Is annual costs	47,600		
To-Be Implementation costs	35,750		
To-Be annual costs after development	15,745		
Total costs in the initial year	51,495		
Costs change in the first year		108%	
Costs change in the subsequent years		33%	
Annual costs saving after development		**67%**	
Cost recovery period			**2 years**

Error Rates Reduction

The new system is able to address the following potential errors:

- Lost files and distribution errors: The digitalized system eliminates the issues of file losses, misdistribution and collection errors.

- Improper documents storage: Delays in delivery or loss of important documents may occur when maintaining physical documents. The digital transformation eliminates these risks.

- Manual data entry errors: The redesigned system automates data collection and registration processes, therefore the likelihood of human errors in data entry is reduced significantly.

- Inconsistent format: In the As-Is procedure, student employment status is documented by more than a hundred class advisors, and these records then need to be consolidated by various college counsellors. It may be difficult to maintain a consistent format. The automated system eliminates this error and reduces the needs for post-adjustments.

- Mismatched data errors: Students employment status needs to be updated, which poses a risk of overlooking some updates. Automatic data updates reduce this error, ensure data consistency over time, and keeps information up to date.

- Untimely issue resolution: The new design can handle errors automatically. If a student information cannot be processed, the system raises notifications to request human intervention. This setting reduces the risk of staff overlooking issues, as they are recorded in the system and the red flag must be removed by staff after resolution.

Overall, by addressing all these errors, the new system offers more accurate and reliable employment statistics, and a more efficient information and documents management system with fewer errors.

Productivity Gains

Besides significant cost saves, the digital and automatic transformation could increase productivity in various aspects.

The new system significantly reduces the workload of staff by minimizing redundant and repetitive manual tasks. This will increase efficiency and effectiveness of the processes and enhance task fulfilment.

Reducing these routine tasks also results in fewer required staff members, the organization can relocate them to other departments. Therefore, they can focus on more import tasks or resolve other issues, which improves the overall performance and productivity of the institution.

The automation of inquiries and the digital handling of tripartite agreements reduce the required time to complete these tasks. In the As-is version, initial enquires start in March, in the middle of academic year. The updates of students' employment status need to be continuously monitored until the second round of statistics, at the end of August. The inquiry process spans over 6 months. In contract, the inquiries in the new design can be completed within a month for each round of statistics. This greatly saves time, frees up resources for other tasks, and reduces the risk of delays.

Staff only needs to intervene in exceptional cases, which can increase problem resolution efficiency as their workload is lighter than before. Minimised human interaction can also reduce potential friction between different departments, potentially leading to a more harmonious working environment.

Finally, the new system is more convenient for students. The unnecessary amount of time to fulfil the task, to be contacted, and the burden of document custody are eliminated. This will free them up to focus on studies or career development, potentially leading to better academic results and professional development. Additionally, they are not required to be present on campus to complete these tasks. For those who are on internships, it will greatly save time and travelling costs. Overall, this will increase student satisfaction and improve the university's reputation.

Automation Recommendation
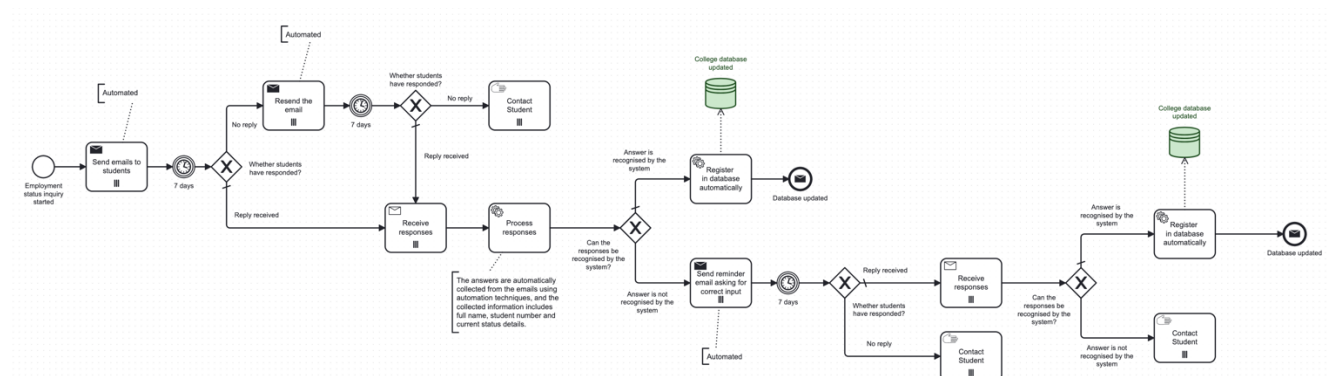
Firstly, the new process implements the digitized transformation of the delivery and singing of the tripartite agreements. Secondly, graduate employment status inquiries are automated via automatic email sending, information extraction, and data registration, involving human

intervention only in exceptional cases. This section will mainly illustrate the design of the second automation. The diagram above shows the process flow, which is a subprocess named "Inquire employment status" within the To-be BPMN graph.

The system in the career office will automatically send the enquiry emails to all students, requesting their responses following specific format within a week. It will then process the email responses automatically and update them in the database. If a student's response is not received, the email is resent after a week. If reply is still not received after another week, a staff member will directly reach out to the student. If the student's response is received, but does meet the requirements and cannot be processed by the system, another template email will be sent to request a proper response. The answer will be processed and updated, if received as expected. The student will be contacted if the reply is not received within a week, or still does not meet the requirements. Assuming issues can be resolved within one week through direct contact, the longest span during the process would be a month. Moreover, the system also features automatic update functionality. If the information received in la atter email is different from the previous one, the database will register the new record. This setting facilitates updates and the second round of statistics.

The automation pipeline and demo are introduced in the presentation, where GitLab automation pipeline is used to streamline the process. The GitLab pipeline schedules are set to send email at assigned times and collect and process replies periodically. Regular expressions in Golang programming are used to extract the required information, and the results are stored in a MySQL database. This demo outlines the basic logic design flow, real-world implementation requires more sophisticated and robust design and technology.

Conclusion

In conclusion, digital transformation and automatic information collection will greatly enhance the work of graduate employment status statistics and tripartite agreements management at Lanzhou Institute of Technology. It can save the annual costs of performing these tasks by 67% and achieve a break-even period of less than 2 years. The new design minimizes manual tasks, reduces error rates, and improves efficiency and productivity. Finally, an automation plan for the employment inquiry system is presented.