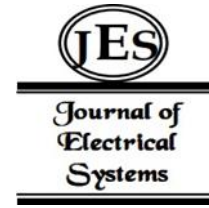


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Intelligent Data Integration: A Case Study of NOVOI in a Higher Education Institution in China



Abstract: - Massive data of different sectors inheres in different sites, which requires integration of those data in various types and formats when dealing with system development and integration of an organization. Intelligent data integration is crucial for system development and management to enhance the effective governance of organizations at all levels. It alleviates the lagging service and meets users' needs in higher educational institutions (HEIs). From the holistic perspective, the “No More than One Visit for One Item” (NOVOI) is a paradigm emphasizing the integration of system information, which is utilized in integrated services all in one, namely, the synergy and collaboration of all offices in an HEI. By a case study of the status quo of NONOI in an HEI in China, the NOVOI framework was constructed and its outcomes were analyzed by a comparison of data in past years. It's found that users of NOVOI vary among different service items. The most frequently used service items are academic-related, instead of teaching affairs or administrative affairs. Service items for faculty and staff have more nodes than those for students. As a result, NOVOI can improve the efficiency of the service, enhance the overall management level, promote information disclosure in HEIs, and help the HEI system develop towards diversification of services and improve a more efficient informatization process through intelligent and effective data integration.

Keywords: Data Integration, System Development, “No More than One Visit for One Item”, Higher Educational Institution, Holistic Governance

I. INTRODUCTION

Intelligent data integration has widely researched and applied and many trades and fields. However, the ever-growing heterogenous properties of data processing call for a more intensified degrees of automation in order to decrease the work load of human beings [1]. An efficient data integration can handle issues in systems development and management when dealing with massive data in different organizational sectors [2]. Intellectual data incorporation and integration is the most fundamental stage in all processes of system development and management [3].

In the information processing, data collection requires intelligent detection and command implemented at the very beginning of system planning stage for an organizational sector. Therefore, the development and research team intend to meet and collect data or inputs from all the stakeholders of the organization and make them seamlessly work together to obtain an integration and requirement of the system [4-6]. The developer of the system will have to set the goals as of the requirement of all stakeholders and include necessary iterative cycles to achieve a better work outcome. In system development and planning, usually, four stages are included: coding, testing, listening, and debugging stage [7]. During the organizational system development and management, it's important to observe protocols in each stage, which is based on a solid application of design processing planning, and crucial to enhance the competitiveness of an organization, and manifest its ability to echo to the external changes [8]. Likewise, in Alfred's work, he also defined the system programming process into designing, coding, testing, and listening stages [9]. In the designing stage, the system design team will share the responsibilities and they are responsible for the design of a certain part of the code to be collaboratively work together for each part of the system. Therefore, system developers encode all necessary factors minimize errors, and make sure that the code is compatible with each and everyone's codes. In the testing, there will be a demonstration of the system to all stakeholders to find out whether the stakeholders are satisfied with the performance of the product or not. In the listening stage, there will be feedback on the new system to be collected which can lead to new adjustments and changes and inclusion of the additional requirement from the stakeholders.

In recent years, to achieve better service delivery and outcomes, promote better regional development, and improve greater efficiencies in the management of public costs and resources, there have been improvements in coordination under the framework of e-governance with the development of the Internet. The framework involves issuing data governance plans, introducing data protection and network security protection systems to standardize data governance, and setting up decision-making supervising departments such as data management, evaluation,

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and supervision institutions, etc [10-12]. As governance technology condition is often associated with the governance role, information system is of great importance in implementing holistic governance. In the case of a government, its information technology is the center of modern public management and public service systems [13-15].

Electronic governance is the improvement of inside processes of organizations by providing e-services to help be adapted more accurately and efficiently and establish a higher public value towards holistic governance [16]. It's vital for Chinese organizations at all levels, including profit or non-profit, government or non-government, to connect the promotion of informatization under the framework of governmental systems reform and focus on transforming the functions of the government.

To assess the problems and challenges, strategies, and outcomes of implementing “No More than One Visit for One Item” (NOVOI) in the higher education institutions (HEIs) in China, a case study will be made to analyze both foreground and background during the process of data-driven system development and integration. This will evaluate the impact of NOVOI on its efficiency and effectiveness to provide practical insights and recommendations regarding system development and integration processes from the perspective of holistic governance in China and beyond.

II. LITERATURE REVIEW

“No More than One Visit for One Item” was abbreviated as NOVOI [17]. The NOVOI reform in Zhejiang was highly acknowledged by the Chinese government and was commented as a “crystallization of wisdom” of innovation and well worth popularizing nationwide because it's the first to officially give a guideline for NOVOI for HEIs. Fudan University in Shanghai and Zhejiang University in Zhejiang were the first two universities to start student online service websites although there were limited choices of businesses users could do at that time [18].

Therefore, Government guideline is the important guideline at the beginning stage of NOVOI in HEIs. The NOVOI reform has established a full coverage and all-around administrative service system. To build holistic service-oriented governance in HEIs, it's required to establish a working pattern for the whole process and long-term service for those in need on and off-campus, especially resources in the fields of essentials, which can comprehensively enhance the sense of gain and happiness of users. Shang et al. (2021) define the integrity of holistic governance elements in public cultural services by governance environment, governance subject, governance object, and governance tools of governance [19]. Her case study shows that the number of populations in a region as a governance object has a significant impact on the number of people who benefit from public cultural services with a positive correlation, which shows that the construction of the regional public cultural service system should always implement the concept of people-oriented and consider the characteristics and factors of the population.

Most research is done in coastal provinces or cities in China, such as Zhejiang, and Shanghai, as they were the first tier to have NOVOI reform. Based on the characteristics of the relationship between political and administrative leadership, governance is divided into hierarchical governance and consultative governance, which means the former advocates a top-down administration and the latter cooperation instead of hierarchical mandates [20]. Holistic governance in HEIs is more consultative and cooperation-based as it needs a joint-up work of offices in universities. However, in the early days, it was not rare to see different offices in HEIs develop different apps according to their specific needs, which means users needed to download and register on different apps. Some apps might have not been used once, but they needed to be kept for emergencies. The divisions of competition of governance within an HEI have a serious impact on information and technology sharing. It is seldom seen that the office that can handle affairs does not have access to other data, but the offices with rich data resources are unwilling to share, which hinders information and technology sharing and synergy for users [21].

To alleviate the lagging service and meet the needs of users in HEIs, the “No More than One Visit for One Item” (NOVOI) reform was launched in China to allow the Internet to connect all information islands to develop a seamless and efficient system. As NOVOI reform in HEIs of China came along with the government reform and innovations. Recent years have seen a spike of increasing holistic reforms in HEIs which are integrating more functions in one app or one interface. As a result, e-governance has been encouraged in most HEIs, and many new terminologies which can characterize their features are frequently seen in HEIs in China in recent years with different names, such as “No More than One visit for One Item”, “One-website Office”, “Smart Office”, “Mobile Office”, “No Visit at All”, “One Integrated Window”, “Joint-up Office”, “Inter-provincial Office” and “One

Smart Card”, which have become the result of the e-governance reform without going to the scene when users want to solve certain items. More research is beginning to focus on how well NOVOI works in different offices in HEIs, such as the finance and auditing office [22], archive office [23], and labor union office [24].

III. PLANNING AND CODING OF NOVOI MODEL

The planning and coding of the NOVOI Model aims to explore how the whole NOVOI system collaborated by multi-layer informatization so that users can handle affairs by mere operations by mobile devices or computers through intelligent data integration. All service items of HEIs can be combined and processed with logical processing and service portals so that it can provide flexibility through all comprehensive and integrated support to NOVOI.

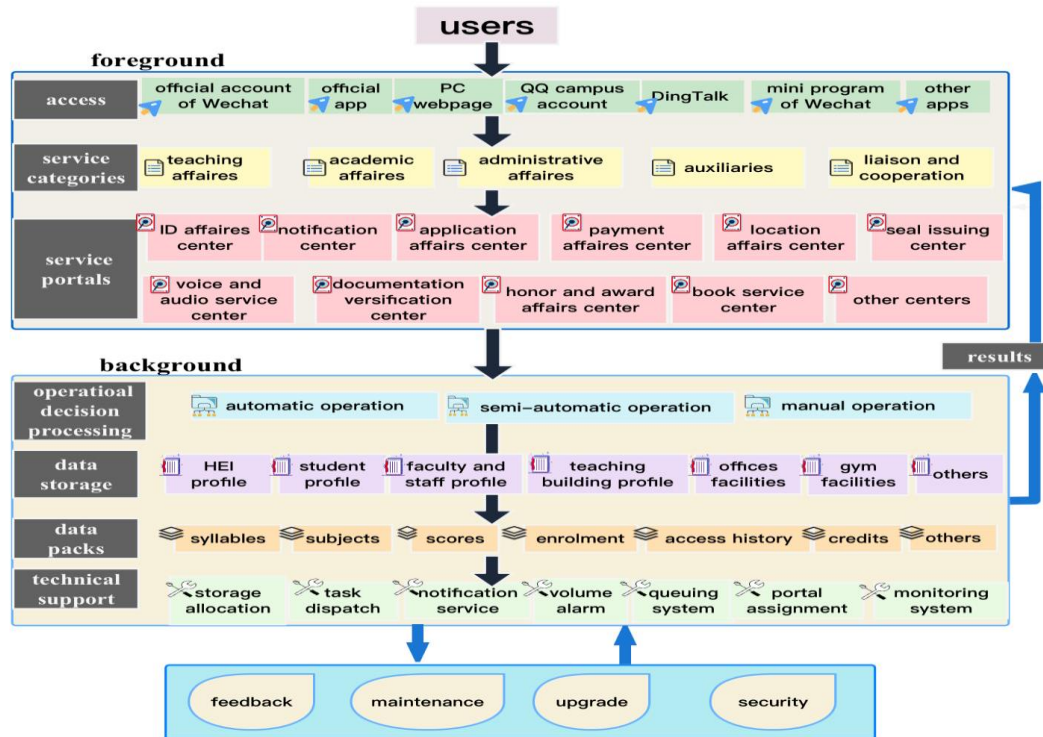


Figure 1. The framework of NOVOI in HEIs with intelligent data integration

As illustrated in Figure 1, the framework of NOVOI in HEIs with intelligent data integration shows how the system works in different sections. The foreground is what is visible and operatable for users and the background is how different offices process the launched service items by users. A user will just check into the interface through a different platform, such as official apps, webpages, or mini-programs of HEIs, and go to the categories and sub-categories to launch service items and then the processing section will be left for the synergy and collaboration of all offices of HEIs and finally will be integrated to a processing result to the users. The background of NOVOI first will make the operation decision processing to check whether the service item needs to be processed manually or not. Data packs and data storage will provide the necessary data. With technique support, the whole process can be accomplished. Besides, to make NOVOI work more efficiently, there will be a rear technical section such as maintenance and upgrading.

IV. TESTING AND LISTENING OF THE NOVOI MODEL

Every HEI possibly has a different flow chat of NOVOI upon its requirements and needs. To take a closer exam of the current status of the NOVOI, this paper will take one university, in Zhejiang, China (hereinafter referred to as ZJHEI) as an example to investigate how users, service categories, processing center, service nodes, processing decisions, and technical support work. ZJHEI is an HEI located in a coastal province of China—Zhejiang. It started the NOVOI reform in 2019 with 17 service items. In 2020, the number of service items expanded to 107, and at the end of 2021, it had 128 service items.

A. Users of NOVOI

Users of the NOVOI in HEIs can be generally categorized into three types: students, faculty and staff, and other off-campus users. Off-campus users include other individuals and organizations that are linked with or have a partnership with HEIs, such as the guardians of students, alumni, business partners, and other visitors from different social contexts. Take job fairs on campus as an example. Those companies that want to recruit promising candidates for the vacancy in their job posts from the HEI graduates need to apply from a portal in the NOVOI for a reservation for a spot before a job fair starts first, and graduate employment offices of HEIs will examine the documents submitted by the companies to check if the job post will attract graduates. If a job post is legitimately legal, but salaries or other benefits don't seem inviting at all, graduate employment offices will decline the application. If there is a lecture by an off-campus guest to the on-campus students, invited keynote speakers need to use a portal in the NOVOI to make an appointment to visit the campus first, and then the academic lecture offices in HEIs will examine and approve the visit if everything submitted and uploaded in NONOI by the speaker is correct. Therefore, every user has a designated role when logging onto the NOVOI. The NOVOI system of ZJHEI has 128 items on its services list. The following table shows the targeted users of all users.

To make the tables easier to understand, "category" in the paper means the five main divisions of all services in the NOVOI. "Item" here means different services offered by offices of HEIs. "Cases" means service items launched and processed by different users.

Table 1. Targeted users of NOVOI in ZJHEI

targeted users	number (service items)	examples of service items	number (cases)
students	24	make-up test application	8552
		units/credits verification	2583
		tuition fees e-invoice printing	179
faculties and staff	73	employment and income certificate	520
		sabbatical leave application	682
		office equipment supplement application	8163
students, faculties and staff	28	public use of gym facilities application	966
		on-campus automobile parking permit	2856
		renting electronic banners on campus	108
off-campus users	2	visitor's permit application;	76047
		one-time parking permit	6683
students and off-campus users	1	application of visiting university history museum	159

Source: data collected from January 1, 2021, to December 31, 2021. Data accessed March 2, 2022

As is shown in Table 1, although the targeted users can be categorized into three, all items of NOVOI of ZJHEI are divided into five types as shown in the first column. Part of the 128 service items can serve combined category users, but some items serve only one category. Among all items, 73 items (57.0%) of the items are targeted at both faculties and staff, which constitutes the largest part of all items. Items for off-campus users are relatively limited.

Several examples of service items are provided for a single category of users. For the make-up test application, there are 8552 cases, which is higher than the number for the whole year in 2019 (475 cases) and half of the number in 2020 (8325 cases). The reason for that climbing number is the Covid-19 pandemic. Since its outbreak in January 2020, some students were in quarantine during the final tests and they had to take the make-up test in the next semester. Tuition fees e-voice printing is a new service that has been online since January 2021. Therefore, there is no number in 2020 and most students don't need the e-invoice. That's the reason why the cases are relatively few. Sabbatical leave applications for faculties and staff are more than 2020 (275 cases), and office equipment supplement application is relatively equal to last year among faculty and staff.

Three examples of service items targeted for both students and faculty and staff are relatively stable. For example, on-campus automobile parking permit application was 2757 in 2020 compared to 2856 in 2021.

For off-campus users, visitor's permit application is on a steep rise in 2021 because in May 2020, the ZJHEI campus will close because of the pandemic, and therefore, the university will just be in virtual operation for eight months. But in 2021, there is no lockdown in Zhejiang province and people on and off campus are on normal mobility.

The application of visiting the university history museum for students and off-campus users decreased sharply from 385 in 2020 to 159 in 2021.

B. Services categories of NOVOI

According to Figure 1, service items of the NOVOI can be divided into five categories and more sub-categories. The NOVOI in HEIs is a system on the move and upgrading, which means there will be more service items to be included in the future. Necessary changes are to be made to adapt to the changing circumstances so that it can be exemplified as amending problems and meeting the needs of all users. Generally speaking, all service items of the five categories are teaching affairs, academic affairs, administrative affairs, auxiliaries, and liaison and cooperation. All 128 service items of ZJHEI are included in the five categories and its subcategories are shown as follows.

Table 2. Service categories of NOVOI in ZJHEI

Service categories	Number (service items)	sub-categories	number (service items)
teaching affairs	22	teaching affaires	22
academic affairs	54	academic research	11
		students' affairs	43
administrative affaires	24	committees and organization	6
		propaganda service	3
		financial service	4
		property and asset service	11
auxiliaries	25	information technology	4
		library service	7
		recreational service	5
		pandemic related	9
liaison and cooperation	3	off-campus affaires	3

Source: data collected from January 1, 2021, to December 31, 2021. Data accessed March 2, 2022

Table 2 shows how the service items are sorted by the content of subjects to fall into their categories and sub-categories. Academic Affairs (54 service items) are the ones with the most service items, followed by auxiliaries (25 service items). Auxiliary service used to be less than teaching affairs in 2020 but increased in 2021 and now it has more service items than teaching affairs because of the Covid-19 pandemic-related situation. For example, students need to report their body temperature twice a day (5672624 cases in 2020 and 2059305 cases in 2021) and have to report their departure from campus regularly (183640 cases in 2020 and 156793 cases in 2021).

Sub-categories can be easily accessed from different “affairs centers” in Figure 2. For example, if a user wants to apply for or replace a new ID card, he/ she will first go to the interface of the category “administrative affairs”, and then go to “ID affairs center” which is visible to the user. And then the rest will be left for the NONOI to finish.

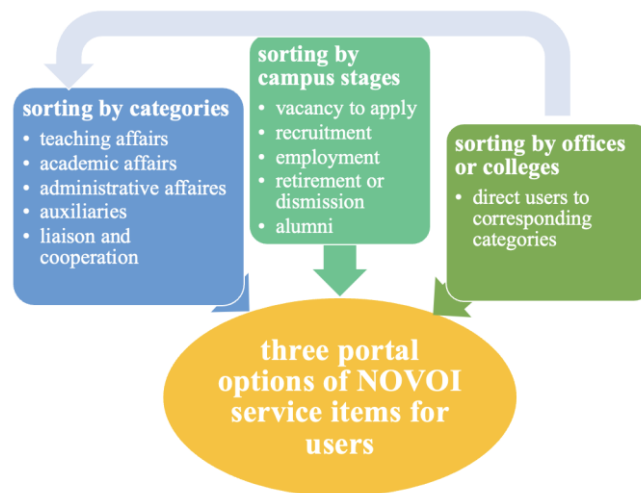


Figure 2. Portal options of NOVOI service items for users in ZJHEI

Figure 2 shows three portal options for service items in ZJHEI. In case the users are not aware of the portals of the service items, the NOVOI of ZJHEI provides two extra kinds of portals for users to sort: by campus stages (faculty and staff only) or by offices or colleges. Campus stages can be divided into six stages: vacancy to apply, recruitment, employment, dismissal, retirement, and alumni. In the “vacancy to fill” section, applicants can look up the advertisement for hiring in different offices or colleges; “recruitment” shows some forms to fill in once get the job; the “employment” section shows all services of faculty and staff on campus; “retirement or dismissal” section contains all procedure and forms to submit on leaving the job; “alumni” section provides services for all

students and employees who used to stay in the university. Another option is to sort the service items by offices or colleges. For example, a user who wants to verify the credits/ units can either go to the “academic affairs” section if sorting by subjects or go to “academic affairs office” users affiliated online.

C. Background

The background of the NOVIO includes operation decision processing, data packs, data storage, and technique support. Decision processing embedded in the NOVOI central system is based on the pre-fabricated-subject method. A decision is made according to the attributes of service items. Those items that can be processed automatically will be taken care of by operations by the NOVOI system without interference from humans, such as students’ daily temperature reports and alarming unusual reports. For those who need a hybrid of automatic and manual processing, it will be categorized into semi-automatic, for example, verification of units/credits for make-up tests needs a manual verification of staff in the teaching affairs office again for reasonability sometimes and then the credits can be issued to the students. For those manual operations, the submitted affairs will need to be processed manually, such as issuing graduation diplomas for graduation.

Data packs and data storage need cloud computing, big data, and information other technologies to allocate. Different profiles and data packs of HEIs will be connected to targeted for different service times and will synchronically echo when a service item is launched by a user.

Technique support involves a series of pre-cut algorithms dealing with different aspects of items. For example, storage allocation determines where the data will be stored and the access code to activate that storage. Volume alarm will warn the system if there is an abnormal amount of browsing of the service items in case there is a hack attaching or a monitoring system can check if all parameters are correct. The queuing system will determine how the different items can be handled by one user after another during different time slots. The monitoring system will technically guarantee NOVOI system operates promptly and regularly. Notification services will notice the processing results of service items in the desired ways, such as text messages, emails, or system notifications. A volume alarm will set a safeguard for the NOVOI. If the normal processing volume of a service item is 30 cases per day and there is a sharp increase in the number of cases, technicians will check up on the reasons for that increase and see if there is a glitch in the NOVOI.

Feedback, maintenance, upgrade, and security of the NOVOI also need technique support. Feedback can get the reviews and ratings of service items they have finished, and then different offices can decide how to improve their work in the future. As is mentioned in Table 1, more items will be added to the NOVOI because more services are needed as time goes by. Besides, data storage and data packs will need refreshing constantly and that’s why maintenance and upgrade are important. As the NOVOI incorporates much information in one system, it’s critical to protect the safety of all data.

V.CONCLUSION

In the case study of this paper, intelligent data integration allows users of the NOVOI in the HEI to log onto the system through various accesses for the purposive service categories and service portals in the foreground interface. In the background, both operational decision processing and data processing work collaboratively to guarantee the presentation of results to the users. The feedback, maintenance, upgrade, and security are also important parts of the whole NOVOI system for data integration. This has brought about a drastic increase in the number of service items and cases and more user-friendly service categories in the past few years, which is the exemplification of system development and integration. Although different user types utilize different service items with different numbers of service nodes, the NOVOI system can improve the effectiveness and efficiency of holistic governance in HEIs in China.

The NOVOI in HEIs in China is the result of intelligent data integration under the background of “Internet Plus”. Both of its beginning and developing stages were by the guidelines and practices of the Chinese governments at all levels. Information Integration and data intelligence are the most distinctive attributes of NOVOI in HEIs, especially in the big data era and e-governance platform. Holistic governance, no matter in terms of overall planning, intelligent algorithm, technique support, platform design, operation processing, and foreground and background maintenance, is targeted to promote the application and integration of all recourses within one HEI. NOVOI supports the application of innovation and integration and lays its support to realizing overall intelligent governance and efficient coordination to meet the characteristic needs of users and provide an integrated platform to avoid chaos and redundancy. With the help of intelligent data integration, comprehensive coordination and systematical transformation of the service items can be more accessible, which can expand and

improve scientific management, working efficiency, and administration integrity from the perspective of holistic governance in HEIs.

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