Utilizing website for analytical and inorganic Chemistry laboratory services

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Abstract. Improving the quality of laboratory services in the Industrial Revolution 4.0 era, one of which is by utilizing information and communication technology or in this study it is called digitization. Digitization is the process of converting information available on paper to a digital format, digitization can be in the form of a website. Utilization of this website will make it easier for students to access the information needed quickly and easily. So far, inventories in analytical and inorganic chemistry laboratories have only been carried out by entering data in a book, and only some of the data has been entered into a simple Excel so it is too complicated and the risk of losing files is very large. Therefore, the use of a centralized website system needs to be done. This study intends to identify the stages involved in creating a website dedicated to the Laboratory of Analytical and Inorganic Chemistry within the Chemistry Department, Faculty of Mathematics and Natural Science at Universitas Negeri Surabaya. Additionally, it aims to assess user reactions to the website. The research methodology employed is the 4D approach, encompassing the Define, Design, Develop, and Disseminate phases. The initiation of the website design process entails the incorporation of various features to enhance its visual appeal. These elements are then used as a basis for coding both the website's menu and content.

1 Introduction

In today's Fourth Industrial Revolution, technology, communication, and information are becoming more advanced and widespread. This shift is closely tied to the process of digitization, where data is turned into digital form. Scholars like Brennen & Kreiss explain that digitization means making digital data more accessible due to improvements in how we create, send, store, and analyze this kind of information. This change has a big impact on how our modern world is shaped [1]. Think about it like converting things we used to see in print, hear in audio, or watch in videos into digital versions [2].

At the same time, according to the definitions from Gartner.com, digitization means using digital technology to really change how businesses work. It's like transforming a business model to find new ways to make money and add value. This whole process is what we call digitization. It involves moving from older analogue methods to newer digital ones, and it's

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aimed at saving money by making things work better inside a company. This includes things like automating tasks and using less paper. But here's the catch: you can't do digitization without first digitizing things. This means that before we can use digital technology, we need data to be in digital form. For example, papers that were written a long time ago need to become electronic documents like PDFs or DOCs to be useful in today's digital world.

The education world, especially universities, is benefiting a lot from technology, particularly digitization. Chemistry labs are super important in universities because they help students learn and use chemistry in a sustainable way [3]. These labs are like special rooms where students do experiments and learn, and they're managed based on scientific methods [4]. Making these labs work better involves having enough staff and making sure students are happy with the services [5].

Using technology, like digitization, in labs brings several good things: (1) it makes services faster and easier, (2) helps keep track of things quickly, (3) saves time, (4) saves energy, (5) encourages students to use lab equipment well, and (6) reduces the use of paper. Usually, lab inventories are managed using books and sometimes Excel sheets, which can be complicated and risky. So, having a website to manage everything is a smart move. In this research, we're figuring out how to make a website for the Analytical and Inorganic Chemistry lab at FMIPA Unesa's Chemistry Department. We also want to see how students like using the website. We're using a method called Research and Development. In a previous study, using technology in labs got positive feedback, so we're making it even better by adding a part to track stuff in the labs. This research is important because it helps improve how our Chemistry Department works and solves problems.

2 Methods

The study is grounded in the systematic application of research methods, encompassing a structured set of strategic approaches, methodologies, or techniques. These methods are instrumental in acquiring pertinent data or empirical substantiation, which subsequently undergoes rigorous analysis, engendering novel epistemic revelations or an enriched cognitive apprehension of the subject of inquiry. The primary focus of this investigation resides in effectuating the digitization of services offered by analytical and inorganic laboratories, a transformative initiative aimed at amplifying the accessibility and user experience of these services for the student cohort. In pursuit of this objective, the chosen methodological framework is characterized by the 4D approach, distinguished by its sequential articulation of four cardinal phases: Definition, Design, Development, and Dissemination [7,8].

2.1 Define

The first step in the 4D framework involves defining development prerequisites. In the realm of product development, developers must consult these prerequisites, scrutinize, and gather data regarding the necessary extent of development. During this phase, a questionnaire is disseminated among laboratory users to ascertain the specific data to be incorporated into the website.

2.2 Design

Moving forward in the progression of 4D educational media development, the subsequent phase is centered on design. This stage aims to outline the blueprint for the forthcoming site. Integral components of the design phase encompass the selection of media, formatting for

materials, and prototyping. The insights garnered during the previous stage are synthesized, serving as a foundation for designing the supplementary features to be incorporated into the website.

2.3 Develop

The primary objective of the development phase is to bring the pre-established design to fruition, which can alternatively involve finalizing a previously constructed prototype. The implementation of supplementary website features takes place, followed by the validation of the completed website by experts. This stage entails a trial-and-error process, during which coding errors are addressed and rectified.

2.4 Disseminate

The concluding phase of the 4D educational media development process is dissemination. The point at which the product can be deemed to have completed its journey from inception to production (development) is when the testing carried out during the development phase yields a functional product. Subsequent to successful trial outcomes and the resolution of any issues, the subsequent step is the distribution of the website to students utilizing analytical and inorganic laboratory services.

3 Results and Discussion

The website's anticipated user-oriented features encompass research permits, records for borrowed materials and equipment, laboratory discharge letters, equipment logbooks, Material Safety Data Sheets (MSDS), and an inventory system for tools and materials. The designed laboratory services website is accessible via the following URL: https://lab.kimia.fmipa.unesa.ac.id/. It has been tailored to ensure smooth access via mobile phones, tablets, and laptops. The website offers several accessible menus, including:

1) The management of the laboratory includes functionalities such as securing research permits, issuing laboratory discharge letters, managing equipment and materials, and specifying entry requisites for the laboratory.
2) Menu linked with other laboratories This section encompasses an equipment logbook, accessible for students intending to utilize resources from the two laboratories. Additionally, a Material Safety Data Sheet (MSDS) is available, serving as a crucial resource for laboratory-related tasks. Elaboration on these aspects will be presented through the subsequent illustrations.
3) Inventory application that contains an inventory of laboratory tools and materials for analytical chemistry and inorganic chemistry. Apart from that, in this application, there is also a menu for borrowing equipment and purchasing materials.

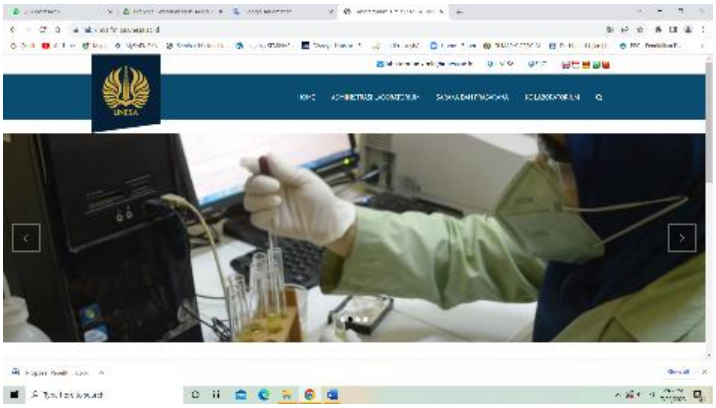

Fig. 1. Homepage/Start page website.

Figure 1 displays the website's initial page featuring various menus, encompassing announcements, laboratory management, and infrastructure.

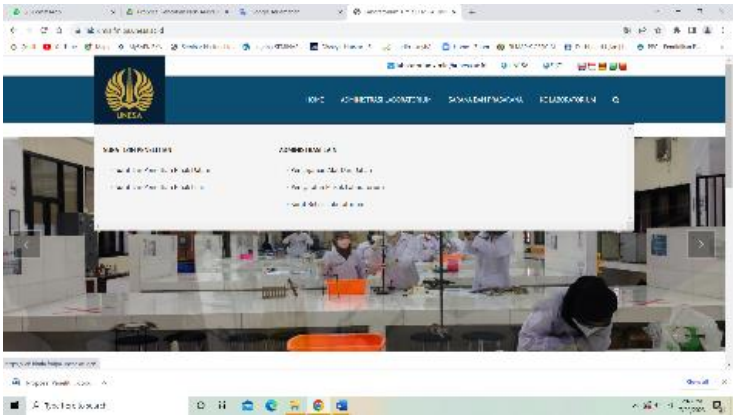

Fig. 2. Laboratory administration menu.

Fig. 3. Laboratory administration page.

The laboratory administration webpage comprises various interactive menus, specifically research permits, laboratory discharge correspondence, records for borrowed materials and equipment, and laboratory entry prerequisites. Within the research permit section, a flowchart

is available to enhance students' comprehension of the procedural intricacies underpinning laboratory usage permit administration. This segment offers multiple button selections tailored to recipients, encompassing both students and lecturers who engage with the laboratory. Upon selection, these buttons guide users to a Google Form. Subsequent to data submission, this information is automatically channelled to generate a research permit. The permit is subsequently forwarded via email to students after securing requisite endorsements from their thesis supervisor and the chemistry laboratory's head. This website is also interconnected with other laboratory websites within the chemistry department. For instance, when accessing the analytical and inorganic laboratories' pages, there are menus like equipment logbooks and Material Safety Data Sheets (MSDS) available on the laboratory website. This website for keeping track of equipment usage includes links to Google Forms. Students can use these forms if they use electrical equipment in the analytical chemistry lab or the inorganic chemistry lab. This record is important to get a discharge letter from the lab.

The Material Safety Data Sheet (MSDS) is a crucial source of information about the dangers of the chemicals used in the lab, like if they're flammable, toxic, corrosive, explosive, reactive, sensitive, or hazardous [9]. Because of this, having the MSDS on the website, categorized based on the lab activities, makes it simple for students to find. An example of this MSDS section is shown in Figure 4.

Fig. 4. Material safety data sheet page.

The inventory is carried out with the aim of assisting the smooth administration of companies and agencies so that assets can be properly monitored. The other objectives of the inventory are:

- Maintain the infrastructure owned by an agency or company,
- Facilitate inventory control activities against the use of the company budget.
- Being considered for procurement or maintenance.
- Help plan, channel, maintain and store assets owned by agencies/companies.
- As a guideline for calculating the value of assets.
- Speed up the report generation process.
- As a reference material in the event of employee fraud or theft within the company/agency.
- To check and control the entry and exit of goods, including goods grants/gifts.

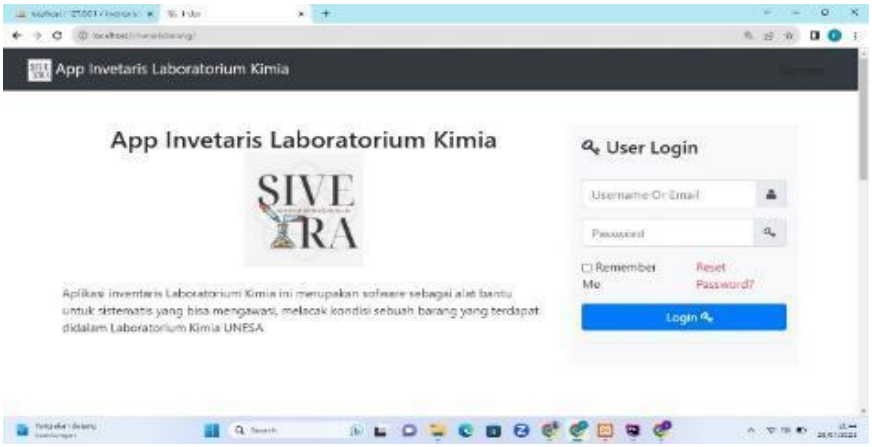

Fig. 5 Inventory application.

Therefore, an inventory system is very important. In the analytical chemistry and inorganic chemistry laboratories the inventory system is still stored in a simple Excel format, so using this website-based system can make it easier for the academic community to access tools and materials in the laboratory. In the system, there is some information. the information is the name, specification, amount and which laboratory is located. This applies to the inventory of tools and materials.

3.1 Website validation.

Validation was done by 3 material expert lecturers, 3 media expert lecturers and 3 language expert lecturers. Website validation is using the Likert scale. In order to obtain accurate, efficient, and communicative results, the variables measured by the specified interval are expressed in numbers. The validation data is ordinal data which has the characteristic that mathematical operations cannot be carried out, so the determination is carried out in a mode, which means that decisions are made at the largest number. the website is said to be valid if the minimum criteria obtained are 3 or the category is quite valid.

Table 1. Linkert scale.

Category	Scale
Invalid	1
Less Valid	2
Quite Valid	3
Valid	4
Very Valid	5

3.2 Result analysis

The website is said to be valid if the minimum criteria obtained are 3 or if the category is sufficient. The results of content validation from the website get a mode of 4 or a good category so that the e-module can be categorized as valid.

Table 2. Material Validation

No	Statement	V1	V2	V3	Mode
1	Information regarding equipment inventory is presented clearly	4	4	5	4
2	Equipment and their specifications are presented clearly	4	4	5	4
3	Information about equipment according to the needs for practicum courses	5	4	5	5
4	Information about equipment suitable for research	5	4	5	5
5	Information regarding reagent inventory is presented clearly	4	4	5	4
6	Material Safety Data Sheet (MSDS) are clearly presented	5	5	4	5
7	Information about chemical reagents is suitable for practicum courses	5	4	5	5
8	Information about chemicals reagents is suitable for research	5	4	5	5
9	The website makes it easy for the chemistry academic community to borrow equipment and chemical usage	5	5	5	5
10	The website provides up-to-date information	5	5	5	5

Based on Table 2 that the majority of the scores are 4 or 5, which suggests that the respondents generally viewed the website positively. The mode for each statement is either 4 or 5, reinforcing this positive evaluation. For many statements, all three versions or evaluators gave the same score, as indicated by the mode matching the individual scores. The results of material validation got a mode of 5, so it categorized as very valid.

Table 3. Website Validation

No	Statement	V1	V2	V3	Mode
1	The website guide is presented clearly	4	4	4	4
2	The background color matches with the text	4	5	5	5
3	Images are suitable for the website	5	4	5	5
4	font color, font size and font type Images are suitable for the website	4	4	5	4
5	Website speed response	5	4	4	4
6	Easy operating website	4	4	4	4
7	Can be operated from different devices	5	5	5	5
8	Attractive website display	4	4	4	4
9	The website is easy to navigate	5	5	4	5
10	The website creates a positive experience for the user	4	5	4	4

The average column appears to be rounded to the nearest whole number rather than providing a precise mean. Each aspect has been assessed as good to excellent, with no aspect

falling below a score of 4. It means that the website validation results got a mode of 4 so it was categorized as valid.

4 Conclusion

The initiation of the website design process entails the incorporation of various features to enhance its visual appeal. These elements are then used as a basis for coding both the website's menu and content. Following the coding process, comprehensive testing is performed to identify and rectify potential errors. Upon error-free confirmation, a trial involving student laboratory users is conducted to ascertain the website's functionality and user experience. The website validation results got a mode of 4 so it was categorized as valid.

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