Development of an Integrated Library Management System (iLMS)

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Abstract—This paper describes the design and development of a library management system that was based on an evaluation of various factors such as technology, infrastructure, current conditions, available resources, and automation levels, as determined through a survey of 98 respondents using a descriptive developmental method. The research revealed that there was a need to provide guidance to users on how to utilize technology effectively and that peer influence played a role in technology adoption. The difficulties were also identified such as navigating virtual libraries, accessing materials, and encouraging physical visits due to the widespread availability of online information. Moreover, the commonly cited issues included a lack of new technologies and the absence of 3D printing capabilities. The study also identified research gaps and recommendations for the Library Management System from published studies. Employing these data sources enables the development of a stronger system that can address pain points and overcome challenges.

Keywords—library management system, software development, assessment

1 Introduction of the study

The pandemic presented new challenges in educational institutions. Research findings indicated that school administrators' and teachers' quality of life, levels of internet addiction, feelings of loneliness, and happiness are directly affected by COVID-19[27] including performance [34] and anxiety [32] Over 1.6 billion students in 200+ countries were impacted by the outbreak, and it induced psychological distress, related burnout, depression, and addiction to social media [28]. Despite the upheaval caused by the pandemic, individuals have managed to transition to digital operations to maintain continuity and sustainability in their work. Most people have embraced and adhered to health guidelines while prioritizing safety, including those in the library. As a result, many physical libraries temporarily closed and offered online services, such as

digital books and online references. The majority have adapted to remote working, utilizing social constructivism and reflexive learning [38] to thrive in this era.

The adjustments varied depending on local government guidelines. New approaches included delivering print materials while addressing digital inequities, halting physical borrowing but offering electronic delivery, and establishing virtual help desks and contactless services [23]. The traditional methods of library work have been altered by new approaches. These include implementing digital literacy programs such as online library orientation and database tutorials, as well as offering specialized guidance. Webinars and various virtual events were held to address misinformation, and research-related activities were maintained. Penalties for unreturned resources were relaxed during this time. These efforts allowed the library to flourish during these unique circumstances.

As protocol changes and alert level fluctuates vis-a-vis the number of positive COVID-19 cases, a new breed of hybrid learners that demands better services from the library in multi-modal delivery has emerged. However, the current library systems, procedures, and processes are not capable of meeting their needs. A survey was conducted to identify their requirements and concerns in terms of technology response, infrastructure, existing conditions, facilities, technology readiness of human resources, automation sufficiency level, and support of technical staff. The data gathered were subjected to statistical treatment using the descriptive developmental method. Through these, an appropriate solution to the issues and problems that stakeholders are struggling with was identified. Designing and developing software based on research is important to ensure the accuracy and reliability of the system. This approach addresses specific problems or challenges by employing evidence-based results through gaps and recommendations. By doing so, it provided a stronger foundation and validated grounds for scientific principles. This results in more informed and effective solutions to pain points and challenges related to the development of an integrated library management system.

2   Significance of the study

The developed application satisfies the needs and demands of its users. These pain points and challenges were analyzed and handled during the system's development together with the most recent findings and developments in the field of library management. The result is an integrated library management system with enhanced features that improved, library operations, services, and procedures that are better suited for its users and the community. Since the study combines solutions for the needs and demands coupled with bridging research gaps and recommendations, this integrated LMS is relevant for a very long period.

3   Statement of the objectives

The goal of this study is to develop an integrated Library Management System (LMS) that addresses the needs and challenges of its users by determining their pain

points and incorporating the latest research and advancements in the field of library management.

4 Theoretical framework

The framework for this research was Design Process Theory. In the design requirement, survey questionnaires, and research gaps in published studies on LMS were the sources of data. The answers from the survey questionnaire captured the need and pain points in the library as assessed by the students, faculty, staff, and librarians in the areas of response to technology, infrastructure, existing condition, facilities, technology readiness of human resources, automation sufficiency level, and support of technical staff among twenty-three (23) selected libraries in Manila. Having identified these, it served as the foundation for designing and developing an Integrated Library Management System (ILMS) software.
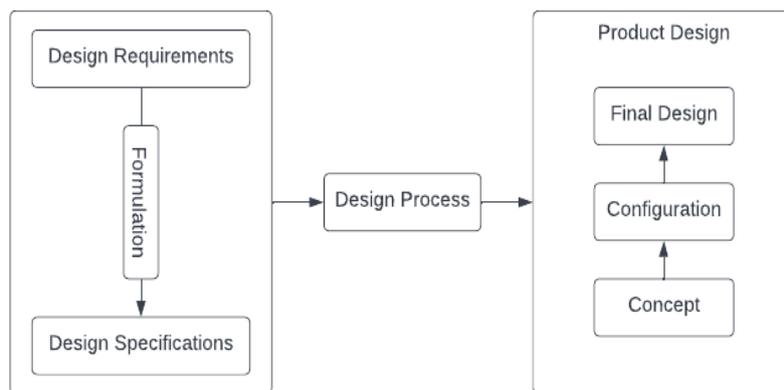

Fig. 1. Design Process Theory

5 Research methodology

The research employed the descriptive developmental method, which involved analyzing and comprehending data by describing, comparing, and interpreting it in relation to the current situation. Two sources of data were used in the study. The primary source was gathered by collecting data from librarians (18), staff (5), students (64), and faculty (11) during the 1st Semester of SY 2021-2022, using triangulation of data and methods. The sample size was determined using Slovin's formula, with a 5% margin of error, and was randomly selected. The secondary data was obtained from published research on the gaps in library management systems and their recommendations, which served as a basis for improving library operations and services.

6 Results and discussion

6.1 Needs assessment

Part 1 of the findings were derived from the answers of librarians, library staff, students, and faculty in the areas of response to technology, infrastructure, existing condition, facilities, technology readiness of human resources, automation sufficiency level, and support of technical staff [21].

Table 1. Technology Response

Criteria	Student		Faculty		Librarians		Staff	
	f	*%*	*f*	*%*	*f*	*%*	*f*	*%*
I usually avoid using new technologies.	1	2%	0	0%	0	0	0	0
I generally take a while to use technologies.	7	11%	0	0%	0	0	1	14%
I use new technologies at the same time other people do.	36	56%	7	64%	11	48%	1	14%
I use new technologies when someone teaches me how to use them	13	20%	2	18%	3	13%	3	43%
I tend to use new technologies somewhat before others do.	4	6%	1	9%	5	22%	1	14%
I usually use new technologies before anyone else.	3	5%	1	9%	4	17%	1	14%

According to the survey results presented in this table, 48% of respondents indicated that they would only use new technology if they were taught how to use it and 43% said they would use it if they saw others using it. The respondent's behavior in using technology is based on when someone will teach them and when someone is using it. This confirms that people use technology when someone they know does/use that same technology [3]. Demonstration and the influence of others are excellent strategies to increase technology adoption. This was the same experience when the Android-Based Digital Library Application was installed in The State University of Surabaya during its trial run [17].

6.2 On library experience

Following confirmation of respondents' motives for using the library, the following information was discovered: 97% of respondents use the library for reference/research, 57% borrow tools and supplies for education, and 4% borrow movies, CDs, or audio tapes. There was a minimal change for students and staff when comparing the low turnout of respondents' visits to the library in the pre-pandemic 52% and pandemic 48% respectively. These respondents indicated that since they can find the information they require online, going to the library is not appealing to them. This shows that the availability of technology impacted the use of libraries.

While it is good to note that 16% of respondents said they always find what they're looking for in a physical library, an unsettling 52% said they never do. The following were the main reasons given by respondents for not being able to locate the items they were looking for: the library did not have any materials on the topic; the item was checked out or borrowed; there are no physical or electronic catalogs or library records with 31%, 35%, and 21%, respectively. This information supported the conclusions in the previous table about people who used the internet to get what they needed. These results may be considered when identifying the essential elements of human behavior relating to learning styles and how they are expressed in digital systems [22].

Findings on respondents' satisfaction with the conference rooms, computer areas, reading rooms, and collaborative spaces are also very high. Most responders' responses range from extremely satisfied to satisfied. The following categories, including signage, furniture, fixtures, accessibility, and cleanliness, yielded similar results: bookcases, counters, atmosphere, and overall library environment. Furthermore, it's important to note that 31% of users reported difficulty navigating their school's virtual library during the pandemic. These findings sum up that there is a need to improve the library experience of the respondents because the collective experience of customers creates a reputation for the library [1].

6.3 Library services and technology

The technological infrastructure of the school is the biggest challenge to face [25]. To confirm this, the respondent's schools and university libraries were asked how frequently new technology was introduced. According to the data, respondents selected "sometimes," "always," "rarely," and "never" with percentages of 52%,35%,11%, and 3% respectively. This information demonstrates that one of the needs of libraries' patrons is the need for innovations and technologies.

On the other hand, the respondents noted that the libraries in their individual academic institutions had modern technology-level facilities, tools, and automation. Modern technology, which received an 80% grade from the respondents, is what they really want. In the current period, where library resources and services are evolving and individuals don't have time to visit libraries to obtain the needed materials of their preferences without wasting time, cutting-edge technology might be a game changer, as Hussain noted [16].

6.4 On automation

The availability of online full-text articles, web tools, design software, recording equipment, print scanners, ready-access computers with internet access, electronic bulletin boards, tablets, streaming services, audiobooks, and assistive technology as part of the services provided by the library are all generally viewed favorably by the respondents. Additionally, most respondents (53%, 60%, 58%, 68%, and 69%, respectively) reported improvements in the following features: the library website, email/chat with a librarian, online research tools, online book reservations, and book

delivery service. More digital tools must be created or rebuilt as good practices to offer improved learning environments [24].

However, one piece of equipment that is essential in modern library settings but is absent from most libraries is 3D printing. 39 out of 49 respondents' libraries don't have a 3D printer, but 32 percent said they need one and are eager to get one. To automate and modernize libraries, 3D printers must be purchased.

The need for much further knowledge in data analytics and visualization was reinforced by the librarian's existing understanding of the developments in technology applied to library services, as shown in the table. 43% of respondents admit they only understand the basics of big data, while 17% have just a basic understanding and 10% have none at all. Data visualization is useful for data cleaning, exploring data structure, detecting outliers and unusual groups, identifying trends and clusters, spotting local patterns, evaluating modeling output, and presenting results. [11]. In fact, the diffusion of innovations is linked to self-efficacy [26].

Table 2. Knowledge of the Latest Trends in Technology

Criteria	Internet of Things		Artificial Intelligence		Big Data		Robotics		Embedded Systems	
	f	*%*	*f*	*%*	*f*	*%*	*f*	*%*	*f*	*%*
No knowledge	0	0%	2	7%	3	10%	6	20%	5	17%
Minimal Knowledge	4	13%	4	13%	5	17%	6	20%	3	10%
Basic Knowledge	11	37%	15	50%	13	43%	14	47%	10	37%
Adequate Knowledge	13	43%	8	27%	8	27%	3	10%	11	33%
Superior Knowledge	2	7%	1	3%	1	3%	1	3%	1	3%

It's important to note that despite the issues, respondents are generally happy with the library services offered by their respective schools and universities, as evidenced by the overall satisfaction score in Table 3. This rating was received by the following services offered at the reference, circulation, and virtual library help desk, on ready access computers, research assistance, and customer service.

Table 3. Satisfaction with their school/university library services

Criteria	Reference Help Desk		Circulation Help Desk		Virtual Library Help Desk		Ready Access Computers		Research Assistance		Customer Service	
	F	*%*	*f*	*%*	*f*	*%*	*f*	*%*	*f*	*%*	*f*	*%*
Not applicable	6	8%	6	8%	9	12%	6	8%	10	13%	5	7%
Very dissatisfied	2	3%	1	1%	2	3%	3	4%	1	1%	2	3%
Dissatisfied	4	5%	6	8%	10	13%	8	11%	6	8%	4	5%
Satisfied	51	68%	51	68%	42	56%	43	57%	41	55%	42	56%
Very satisfied	12	16%	11	15%	12	16%	15	20%	17	23%	22	29%

Changes in these areas should also be considered to improve the system because well-organized links, well-organized material, and a live help desk may all directly improve user perception and make it simpler and faster to get information [18].

6.5 Data gathered from research gaps and research recommendations

Evidenced-based research was also employed to gather bases for the development of a library management system. Consolidated as follows:

1. **Data Analytics and Visualization.** Academic librarians should be able to gather and use data from a variety of sources, including usage data, social media data, bibliometric data, feedback, and assessment data, etc., to help them make choices, provide services, and more [4]. The prices from publisher purchases, the use of a badge system for instructional courses click-through and page views, journal rankings, and faculty publication statistics are just a few of the records and services that the library may gather [15]. All this information should be presented in a way that is most useful to the librarian through visualization. However, most of the current library systems do not have access to this feature. This is being done manually by librarians.

2. **Innovative Spaces.** the creation of collaborative spaces [5] and unplugged areas [13] where interaction and creativity can occur including the use of games to teach learning concepts [35]. The availability of Open-source architecture for educational research laboratories for concurrent experiments, connected clients, and other use cases like VR and smart environments may also be employed [40]. The days of library walls covered in signs indicating quiet areas and reading areas are long gone. Instead, libraries should move away from spaces that value and encourage collaborative participation and intelligent noise.

3. **Holistic Development Programs.** Provision for opportunities where the students, faculty, and staff social, emotional, physical, mental, and intellectual growth as a person is addressed by attending programs and activities on Artificial Intelligence [29] Learners as Creators [7] Mental Health Programs [14], and Leaders of Professional Learning [8]. This approach to personal or organizational growth considers various facets of a person's or organization's life or development instead of concentrating on one area alone, in reaching the individual full potential and well-being. Furthermore, the importance of adaptive methodology and the development of transdisciplinary competence in science education is also a knowledge to consider [33] or the use of the super-efficiency SBM model to study the growth of the faculty [31]

4. **Green Libraries.** Green libraries are libraries that prioritize environmentally sustainable practices in their operations and services such as reducing energy consumption, using renewable energy sources, promoting recycling and waste reduction, purchasing environmentally friendly products, and offering educational programs and resources on environmental issues. Rethinking how library operations affect the environment is necessary [5]. In fact, sustainability, and climate change

[4] are among the global issues that libraries should engage in to ensure that programs and activities are eco-friendly.

5. **Community Engagement.** By providing a location where inhabitants of neighboring towns may gather to talk about issues that impact them, it fosters community partnerships [7] and community connections [12]. Free programs in art and life skills for the neighborhood's residents not only support local development but also foster involvement and draw more people to the library.

6. **Software and Systems.** Open-source solutions adoption [10] library dashboard adoption and equitable information access adoption [9] are a few of the findings that call for changes in various library management systems.

Combining the findings from the assessment made and the findings of the mentioned studies an integrated library management system was developed.

6.6   Software development method

The concept of user stories is the reason why the agile development method is used in the software development process. These stories are contained in sprints that were developed by the team in a short period. Each sprint is released based on the user requirements and edited at once, if necessary, as presented to the users. This cycle of requirements, design, development, testing, deployment, and review was the foundation of the development of the integrated library management system.

In this case as presented in Figure 3 the features are listed and the roles were identified. The common modules existing in the library management system were modules on Online Public Access Catalog, Borrow/Request/Return Books and Other Items, Reference Request, Talk to A Librarian, Reserve A Room, Add/Update/Archive Resource, Manage User Database, User Reservations Approval, Answer User Queries and Generate Usage Statistics and Other Reports with numbers 1, 2, 3, 4, 9,10,11,12 and 16.

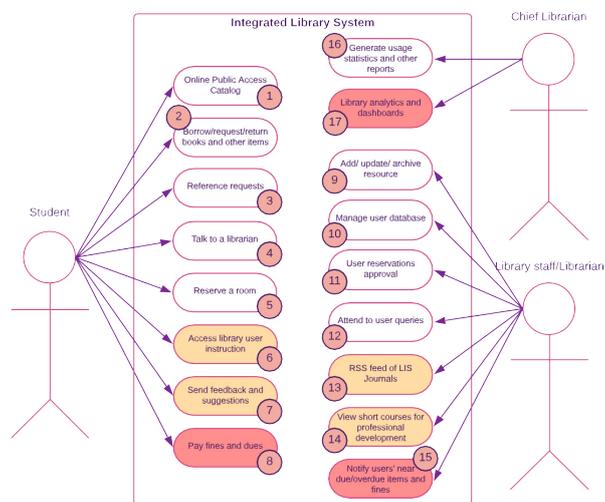**Fig. 2.** Agile Development Model

Fig. 3. LMS Use Case Model

Using the results of this study the enhanced and the new modules were incorporated into the new ILMS. These enhanced modules are as follows Access Library User Instruction, Send Feedback and Suggestions, RSS Feed of Lis Journals, and View Short Courses for Professional Development with numbers 6,7,13, and 14 while the new modules were Pay Fines and Dues, Notify the User's Near/Due/Overdue Items and Fines and Library Analytics and Dashboards with numbers 8, 15, and 17.

The function of each module is as follows:

1. **Online Public Access Catalog** - A module that displays and allows access to the whole catalog of the library's books, movies, music, and other media formats. This list offers organized ways to determine the availability, location, and number of necessary materials.
2. **Borrow/request/return books and other items** – Loan requests, reservations, and searches can be done in two ways at the Circulation Counter and on the designated OPAC units. The design of the proposed system is flexible if any of these choices have been selected.
3. **Reference requests** – Librarians manage reference requests using the reference transactions module. They assist patrons with diverse information requirements, both on-site and remotely, by providing recommendations, clarifications, evaluations, and utilizing information resources.
4. **Talk to a Librarian** – The chat module allows registered users to communicate with a librarian regarding the assistance they need. Students were able to self-regulate their learning with the help of this module. Self-regulation was found to be a predictor of student intention to take more online courses [19].
5. **Reserve a room** – The creation of collaborative spaces, which users can reserve for later usage or depending on the agreed-upon date in the proposed system, is one of the gaps that has been discovered.

6. **Access library user instruction** – Through instructional videos and web guides for new users or procedures that may change over time, this on-demand access in the module instructs and familiarizes users and patrons with the usage of library facilities, resources, and services.

7. **Send feedback and suggestions** – This module enables users to share feedback and suggestions for enhancing the library's operations and services. Like the way twelve Moroccan public universities used the developed real-time Twitter sentiment prediction system in their decision-making [30].

8. **Pay fines and dues** – Merging the old method with the new procedures and technology for paying fines, obligations, past-due, and other demands the digital wallet was included. These changes automate the procedure on paper trails, records, and reports for transaction transparency.

9. **Add/update/archive resource** – The suggested systems included the cycle of obtaining, updating, and archiving. This guarantees accurate document archiving, zero incidents of data loss, and unaffected data in the event of failure archiving cloud services will be utilized.

10. **Manage user database** –The proposed module would allow end users to query, update, and generate reports from the database. Application users may perform queries appropriate to their skill level and sophisticated users may use query languages to complete tasks that are not supported by the systems' interface.

11. **User reservations approval** - Reservation requests for books, equipment, and rooms in this module can be approved by the librarian and/or the library staff. The user will receive confirmation by summarizing their preferences once they have placed a reservation.

12. **Answer user queries** - Web-based query systems were employed to increase service speed, particularly when responding to and providing users with information.

13. **RSS feed of LIS Journals** – The users of this module are given up-to-date news, information, and/or a list of notifications regarding the newest library materials and technological advances.

14. **View short courses for professional development** – This functionality was developed to address the upskilling demands of librarians and staff as part of the study's conclusions. Employees can utilize the system to acquire up-to-date information on training relevant to their line of work.

15. **Notify users of near-due/overdue items and fines** – This new function in the suggested system sends customers automated warnings when resources are late, close to being due, or have fines associated with them.

16. **Generate usage statistics and other reports** – The creation of tabular reports on item usage data and ILS user activity. This includes general information, user statistics, session information, and audit trail data. These are school needs for reportorial functions for submission to government agencies and accreditation.

17. **Library analytics and dashboards** – This feature answers one of the highlighted gaps by combining ILS reports and usage data such as circulation, visits, collection, acquisitions, use of electronic resources, reference/chat interactions, library teaching sessions, and other data into a dashboard. This feature is a good tool to make better

decisions. The librarians can now analyze and display data patterns which are very useful for decision-making.

6.7 Technical requirements

An up-to-date version and a stronger internet connection are needed to guarantee the efficient performance of the system. However, the following minimum requirements are hereby recommended; One (1) GB of RAM, 2GHz of the processor with monitor Screen Size 800×600 and Operating Systems Windows XP or newer, Mac OSX 10.6 and newer, Linux, and Chrome OS.

7 Conclusion

The accessibility of connecting to the internet, the presence of digital resources, inadequate investment in technology and resources, the need for interactive and collaborative learning, and the outdatedness of resources are among the identified needs and pain points that have impacted the use of the library. These were considered in the design and development of the integrated library system, both in terms of the system itself and the recommended course of action.

The design retained the common modules existing in the library management system. These modules are Online Public Access Catalog, Borrow/Request/Return Books and Other Items, Reference Request, Talk to A Librarian, Reserve A Room, Add/Update/Archive Resource, Manage User Database, User Reservations Approval, Answer User Queries and Generate Usage Statistics and Other Reports with numbers.

Moreover, the module to Access Library User Instruction, Send Feedback and Suggestions, RSS Feed of LIS Journals, and View Short Courses for Professional Development were enhanced to address the unavailability of information on which technology to procure. This also covers notification received by the library staff for their training needs as a jumpstart in increasing their knowledge of the latest trends in the technology relevant to their field. The Unavailability of/Difficulty in locating materials and references could be solved by procuring additional references as listed by regulatory bodies with which the school/university is affiliated.

In addition, part of the enhancement is for the user to gain information on the materials they are looking for in different modes, from the open public access catalog, by reference request, and through open communication through the Chabot. To address reportorial and data analytics and visualization needs, new modules like Pay Fines and Dues, Notify the User's Near/Due/Overdue Items and Fines, and Library Analytics and Dashboards were created.

8 Recommendations

The following actions will support the proposed system in addressing the pain points found in this study.

1. Creation of new policies to embed the proposed system into the existing procedure of the Schools/Universities.
2. Overall improvement of the library environment through innovative spaces, procurement of equipment (e.g., 3D printers), pieces of furniture, and fixtures.
3. Intensify community involvement by offering workshops, seminars, and training on topics and programs that promote social awareness and environmental sustainability.
4. The use of the Project Successful Deployment (PSD) method which was found to be effective in evaluating the success of digitalization projects [39].

8.1   Future studies

For further studies, ISO/IEC 9126 may be used to assess compliance with the standard on software quality model while The Unified Theory of Acceptance and Use of Technology (UTAUT2) is for the evaluation of the acceptance and adoption of the users to the developed system. Moreover, since the study focuses on the design and development of an integrated learning management system, a study on the application of the Internet of Things (IoT) and Artificial Intelligence could be the next cycle of technology implementation leading to the digital transformation of these universities. However, digital transformation may differ depending on the culture and leaders, especially in emerging economies [36]. Leading toward digital transformation, leaders must possess specific skills and perspectives that are essential for successful implementation. [37]. Furthermore, the pandemic has resulted in significant changes in the traditional workplace, leading to a skills gap and displacement [38] a training needs assessment is required.

8.2   Software presentation

A view of the proposed ILMS is provided via this link: https://youtu.be/Ge5zwh-HrTU.

9   References

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