Embedding the Management System Information into Circular Education System through the Smart IoT: A Front Analysis

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Abstract

This research explored how to embed the management system information into circular education system through the smart IoT. Besides, the front analysis of this research aimed to determined what form of IoT that educators need to help them in organized their system information. This research involving qualitative descriptive methods to get the analytical profound through survey technic within cross sectional design. To harvest the front analysis, this research employed 54 educators from any background study within 54 different school's department consist of public and private schools. The results show that 85.19% of respondents has been including IoT in their school activity, 5.56% occasionally used IoT, and 9.26% not using IoT yet. The majority of IoT that used are projectors, laptop and CCTV. Besides, the platform that usually used are google and YouTube. In the context of information systems management, 100% of educators argue that they need for specialized IoT that can integrate all learning information systems including learning materials, grades, attendance, and tracking students' activities. This will enable the information systems management to be transparent and easily accessible to all stakeholders in a circular education system. Based on survey data analysis, teachers expressed a desire for a specialized platform that could involve parents more actively. Additionally, by involving parents, educational transparency can be synergized effectively, ensuring a more robust circular education system. In conclusion, this research recommends for future IoT development to create the IoT that consist of a complete school information management

system, and it can be used by students, teachers, and parents, while keeping everyone's information private.

1. Introduction

Circular education system proposed a framework that reuses student work from one course as future input for itself and other courses. This concept employed the objective learning, courses, and program level(McGinley & Karlshøj, 2022). More than that, what is important in circular education is the involvement of education stakeholders consisting of teachers, students and parents.

The combined efforts of parents and teachers contribute to a higher quality of education for children (Wanlinga et al., 2023). But unfortunately, the lack of parental access to the school's information system is leading to mismanagement and miscommunication. This is evident in the examination of school/teacher-pupil interaction seen in issues with classroom interactions, home-school connections, and the use of technology in the curriculum (S.Ahmed, 2017).

The application of management information system in schools for administering academic activities is termed as a fundamental practice of delivering quality education (Anold M, 2020). In fact, learning management system have already been implemented and used widely in many institutions in Indonesia. However, the implementation of such a system faces various challenges. One of the key challenges is adapting a business-oriented system to the often significantly different context of education. Additionally, user perception of the new system can significantly impact the success of its implementation (Ahmad Fauzi Sarumpaet & Rayyan Firdaus, 2024).

According to (Telem, 1996), a poorly implemented information system can disrupt established workflows and require significant user training to overcome. Whereas information management systems in education are designed to streamline the collection, organization, and dissemination of information, thereby enhancing the efficiency of educational processes and facilitating better decision-making (Rusdiana et al., 2014).

In response to the evolving challenges in education, the strategic implementation of school information management systems, utilizing digital resources effectively, is imperative to improve educational outcomes (Meilani, 2023). Besides, to ensure the successful implementation of a MIS, it is imperative to invest in thorough training for all stakeholders and allocate sufficient funds for infrastructure development and system maintenance (Amollo et al., 2022).

In this digital era, IoT can be a solution to solve MIS problems. Much research conducted the IoT involvements in education. The role of IoT is emphasize in optimizing knowledge management processes, including production, organization, sharing, and utilization, to improve institutional services (Khalifa et al., 2024). The integration of IoT in educational management enhances operational efficiency through real-time facility monitoring, automated maintenance, and improved security. This enables early detection of damages, reduces costs, and fosters a sustainable learning environment, despite the initial challenges of high setup costs and the need for training (Manajemen et al., 2024).

IoT offers a promising avenue for streamlining educational processes, from initial planning to final evaluation. Nonetheless, the current IoT landscape is fragmented, with many solutions addressing specific stages of the educational journey. To fully leverage the potential of IoT in education, a holistic system capable of supporting the entire educational lifecycle is essential (Wei & Jin, 2023). Extensively, the integration of IoT technology could be optimize resource allocation, improve operational efficiency, and elevate the overall school experience (Meylani, 2024).

The intersection of education and technology has become a focal point of educational discourse, with discussions surrounding the optimal use of technology in the classroom. In this context, IoT emerges as a promising technology, capable of revolutionizing education by enhancing learning experiences, improving operational efficiency, and providing real-time data on student performance (Ghashim & Arshad, 2023) .

Based on various studies related to information systems management and their relationship with IoT, a research gap has been identified that schools require an information system that is integrated with IoT. However, no research has specifically addressed the question of what and how IoT specifications are needed in schools. Therefore, this study provides a detailed explanation of the specific IoT that teachers need in relation to school information systems management.

1.1 Literature Review

Management Information System in Education

Various scholars have offered the following definitions of management information systems such as, Gordon B. Davis defined a management information system as an integrated man-machine system that provides information to support operational, managerial, and decision-making functions within an organization (Gordon.B Davis, 1993).

Robert W. Holmes defined a management information system as a system designed to provide selective, decision-oriented information to plan, control, and evaluate organizational activities within a structured framework. D. Joseph F. Kelly stated that a management information system is a combination of human and other resources, based on computers, resulting in a collection of data storage, retrieval, communication, and utilization for efficient management operations.

Based on any definitions, (Eti Rochaety, 2017) conclude that a management information system is a combination of software, hardware, and human resources that interact to process data into useful information through the creation of a system. Beyond the use of computers, humans are also integral parts of this system. Humans contribute ideas, thoughts, and calculations in utilizing computers equipped with software and hardware. Additionally, there are processes involved such as planning, control, coordination, and decision-making. Therefore, information systems are also referred to as complex systems

Meanwhile, educational management information system (EMIS) is a combination of human resources and information technology applications to select, store, process and retrieve data in order to support the decision-making process in education. From various theories presented by experts, it can be concluded that the definition of an educational management information system is a system of human resources and technology systems that are interconnected so that both can produce the information needed by its users and can be used to solve existing problems (Tanjung, 2021). An Information System can be operationalized when three essential elements are present, there are:

a) Hardware: Consisting of computers and their peripherals, communication networks such as modems and telephones.
b) Software: Comprising programs that execute processes on a computer.
c) Brainware: This refers to the human element that operates the Information System (Gordon.B Davis, 1993).

Humans (users) are the final component but are the most crucial. Without adequately prepared human resources, an Information System cannot function. Given that an Information System is an interaction between humans and machines, it follows that the designers of an Information System must understand human capabilities as information processors and human behavior. Therefore, the capabilities of personnel operating the Information System play a vital role in supporting its operations (Whitten, 2001).

The implementation of an educational management information system (EMIS) on a small or simple scale only requires a system analyst who doubles as a programmer or vice versa. However, for large-scale and complex EMIS implementations, the work must be carried out by a team of people within system analyst manager, system analysts, programmers, database administrators, network designers, and

technicians. In addition, EMIS is also expected to provide quality services. The quality of these educational services is based on the dimensions of reliability, responsiveness, assurance, empathy, and tangibles (Amollo et al., 2022). The objectives of implementing EMIS are as follows (Maulana et al., 2023):

a) To assist all parties involved in education by providing comprehensive information on education from elementary to secondary school or equivalent levels.
b) To provide a platform for all stakeholders in education to actively participate in advancing the field of education.
c) To fulfill public accountability by providing transparent information on policies and the utilization of resources allocated to education.
d) To enhance the knowledge of teachers and students in the field of informatics and to explore the benefits that can be obtained through various training programs.
e) To provide easy and comprehensive access to information for educators and students regarding knowledge and other educational information.

Circular Education System

Education involves acquiring and sharing knowledge. The goal of education is to equip future generations with the necessary skills, knowledge, and values to positively contribute to society. Circular education system also known as sustainable education. The prevailing discourse on sustainable education often centers on the content of education, neglecting the sustainability of the educational system itself. UNESCO's definition, while emphasizing sustainable learning practices, does not explicitly address the sustainability of the educational process. To ensure the long-term viability of education, it is crucial to consider the environmental, social, and economic dimensions of the system (McGinley & Karlshøj, 2022). A cycle of the education system can be illustrated through the following image:

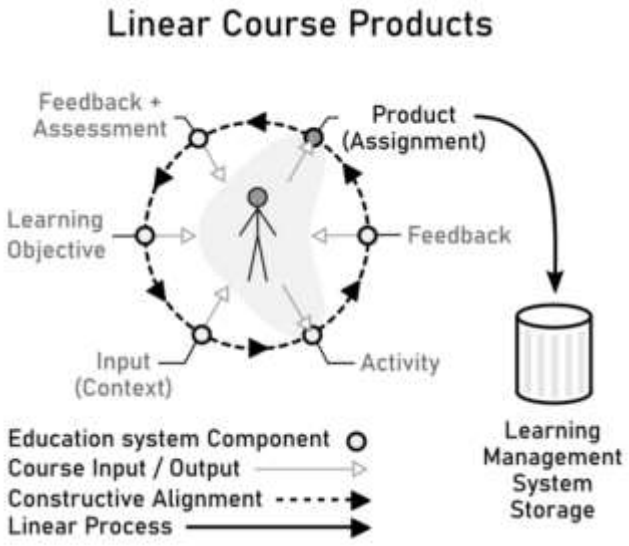

Fig 1. Circular (aligned) education with linear course products by (McGinley & Karlshøj, 2022)

The 'technical cycle' learning products typically address real-world problems. In this process, various activities are assigned to students. This educational cycle provides an overview of learning objectives, inputs, feedback, student assessments, student activities during learning, and the final products produced. All materials, both input and output, should be stored in a learning management system.

On the other hand, while focusing on students' side, circular education system also involves parents and teachers on their cycle. Parental involvement encompasses a range of behaviors and practices that parents undertake to support their children's growth and development. These actions may include being actively involved in their child's education, providing a supportive home environment, and communicating

regularly with teachers (Rizky Nopiyanti & Husin, 2021). A complete cycle of the education system can be illustrated through the following image:

Fig 2. Complete circular (aligned) education with linear course products by researcher (2024)

Based on the image, it can be interpreted that parents are involved in every stage of their child's education, from input to output. This implies that parents are required to understand every aspect of their child's education process as a control agent. Parental involvement is expected from the pre-learning stage to the assessment stage.

IoT

The Internet of Things (IoT) connects everyday objects to the internet. These objects can collect and share data, allowing them to perform tasks and provide useful information. IoT devices use sensors to gather data about their surroundings or their own condition. On a broader scale, IoT was embedded into educational system namely smart education. Smart education uses technology to make learning more engaging and personalized. It goes beyond traditional classrooms and uses digital tools and platforms to create interactive and accessible learning experiences. Students can access a variety of resources online, allowing for self-paced learning (Saniya Sapale & Banerjee, 2023).

The Internet of Things (IoT) has revolutionized the landscape of education. The utilization of digital technologies such as smartphones and tablets, coupled with the implementation of augmented reality and 3D graphics, has rendered learning more engaging and comprehensible. Moreover, IoT has facilitated enhanced interactions among students, teachers, and various learning resources. As a result, IoT has cultivated a more dynamic, efficient, and inclusive learning environment (Amane, et.al, 2023).

The integration of IoT involves the utilization of various devices such as gadgets, tablets, e-book readers, and social media. With the aid of the internet, learners can access information and knowledge through interconnected devices. The development of such learning systems aims to enhance the quality of learning and facilitate accessibility. For instance, if learners are unable to keep up with the pace of classroom instruction or are hindered by unforeseen circumstances, they can easily access learning materials through IoT-enabled devices (Megawati & Lawi, 2021) .

2. Research Methods

This research employed a qualitative descriptive method within survey analysis technic. The survey analysis technic that used in this research involved cross sectional design. According to Sugiyono (2020) the descriptive method is a method used to describe or analyze research findings but is not used to draw broader conclusions. Meanwhile, survey analysis with cross sectional design is a study that examines objects at a specific point in time/not continuously over a long period (Sugiyono, 2020).

Notoatmodjo states that cross-sectional research is a study that examines risk factors and effects through an observational or data collection approach simultaneously. Furthermore, Umar, as explained by Nurrahman, states that "cross-sectional research is a study that examines objects at a specific point in time (not continuously over a long period). In this type of research, information from a portion of the population is collected directly from empirical events with the aim of determining the opinions of a portion of the population regarding the object being studied in the field (Abduh et al., 2022) .The research steps in this study were adapted from Creswell's (2015) cross-sectional survey design, which includes the following (John Creswell, 2015): (a) Deciding whether a survey is the best design to use. (b) Identifying the research questions or hypotheses. (c) Identifying the population, sampling frame, and sample. (d) Determining the survey design and data collection procedures. (e) Developing the instrument. (f) Managing the instrument. (g) Analyzing the data. (h) Writing the report.

Data was collected through a survey using an open-ended questionnaire consisting of 12 questions. The questionnaire included 4 questions regarding the involvement of IoT in learning, 2 questions about the specific IoT used, 1 question concerning the integration of TPACK in learning, 1 question about the opportunities and challenges in integrating IoT in learning, and 4 questions about the required IoT specifications for learning information system management.

54 teachers from various backgrounds participated in the study, comprising 22 teachers from public schools and 32 teachers from private schools at various educational levels from early childhood education (ECE) to high school. The teachers had diverse academic backgrounds, including science (biology, mathematics, physics, chemistry), social studies (social studies, economics, language), and religious studies (fiqh, akidah akhlak, Quran-hadith), among others.

3. Result and Discussion

- **The involvement of IoT in learning**

In this survey we employed at least 4 questions about the involvement of IoT in learning. The following is a list of the questions and their corresponding explanations:

Table 1. The list of the questions and their corresponding explanations

No	Questions	Respondent summary	Explanations
1	Have you been incorporating IoT into your teaching?	The results show that 85.19% (46 out of 54) of respondents has been including IoT in their school activity, 5.56% (3 out of 54) occasionally used IoT, and 9.26% not using IoT yet.	Without considering the school background, 85.19% of respondents have already involved IoT in their learning. This indicates that IoT is no longer unfamiliar in the learning process. It means that both teachers and students are familiar with the existence of IoT. Therefore, when there is a development in IoT, it can be assumed that they will immediately follow the development of IoT.

2	What IoT devices do you use most frequently?	The results show that 83.33% (45 out of 54) of respondents used projectors, laptop and CCTV.	This data indicates that technologies such as projectors, laptops, and CCTV have become an integral part of respondents' daily lives and activities. Most respondents have access to and the ability to use these devices. Given the high level of usage, there is significant potential to further develop or utilize these technologies, for instance, in education, business, or entertainment.
3	Do you often use certain websites to help you learn, like Canva or YouTube? If yes, please tell us which ones you use the most!	The results show that 7.41% (4 out of 54) of respondents are not using both Canva and YouTube on their learning process. But the majority website that used are Goggle and YouTube	Based on the data obtained, although the majority use Canva, YouTube, or Google, there is also a small portion that does not use any of these three platforms. Other websites used include Quizizz, Kahoot, Mentimeter, Wordwall, and Phet.
4	Could you please list the IoT devices available in your classroom?	Common IoT devices available in classrooms are projectors. However, some schools do not have laptop facilities, requiring teachers to bring their personal laptops. Nevertheless, most students are allowed to bring their smartphones.	In essence, increasing integration of technology, particularly IoT devices, in educational settings, with projectors being the most prevalent. It also acknowledges the varying levels of technological infrastructure in different schools and the growing reliance on personal devices like smartphones for learning purposes.

Based on the data from the four questions and the respondents' answers, it can be concluded that IoT is already quite familiar in many schools and has a high frequency of involvement in learning. With this front analysis, we can see that there are no significant barriers to the use of IoT in learning.

These findings are related to Saniya, et.al (2023) which states that the Internet of Things (IoT) has revolutionized the education system, ushering in a new era of connectivity, data-driven insights, and personalized learning experiences. With IoT devices and sensors integrated into classrooms and learning tools, students and teachers now have access to a wealth of real- time information and interactive resources. The integration of IoT technology has enabled personalized learning experiences by collecting and analyzing student data to tailor instruction. Smart classrooms equipped with IoT devices enhance student engagement and interaction with learning materials. Distance learning has been significantly facilitated by IoT, enabling remote connectivity between teachers and students. Additionally, IoT-enabled tools provide real-time feedback on student performance, enabling teachers to offer timely support. Furthermore, IoT can optimize resource management in schools

through intelligent systems for lighting, HVAC, and occupancy detection (Saniya Sapale & Banerjee, n.d.).

- **The specific IoT used and TPACK**
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Table 2. The list of the questions and their corresponding explanations

No	Questions	Respondent summary	Explanations
1	Do you incorporate the use of virtual labs and other learning platforms such as Google Classroom into your teaching, and if so, why?	As many as 57.41% (31 out of 54) of respondents indicated that they do not utilize learning platforms such as virtual labs and Google Classroom, citing various reasons	Not all teachers utilize virtual labs and Google Classroom due to various reasons, including a preference for face-to-face instruction. This implies that the integration of IoT in the learning process is still relatively low. IoT is more commonly used in pre-learning and evaluation stages.
2	To what extent have you integrated TPACK into your teaching?	As many as 57.41% 31 out of 54) of respondents indicated that they only integrate TPACK in the introductory and evaluation phases of learning, while the core learning process still exhibits minimal technological utilization.	Most respondents are not fully integrating technology into their teaching practices. They primarily use it for introductory activities and assessments, but not for the core learning activities.

Based on the data collected, it is evident that the use of technology in learning is primarily limited to stimulation and evaluation phases. Core learning activities, on the other hand, exhibit minimal technological integration. One respondent suggested that this is due to restrictions on content exploration and concerns about student misuse of gadgets. Consequently, technology integration is strictly monitored during the stimulation and evaluation stages. Additionally, the lack of comprehensive learning platforms hinders the integration of IoT in core learning activities as it may confuse students in their search for information.

This finding is novel and does not align with previous research. Istiqomah et al., (2023) states that IoT is utilized in every phase of the learning process, from pre-learning activities to core learning and evaluation. Moreover, IoT is employed to support extracurricular activities that provide students with empirical experiences.

Arpan et al., (2024) states on their research that the Internet of Things (IoT) has great potential to improve learning and school management efficiency. The implementation of IoT in the school environment enriches teaching methods and increases student engagement.

- **Challenge and opportunities to integrates IoT in learning process**
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Table 3. The list of the questions and their corresponding explanations

No	Questions	Respondent summary	Explanations
1	Have you ever encountered difficulties	Of the 54 respondents, 16 indicated that they had previously	Of the 54 respondents, 16 (approximately 30%) reported experiencing difficulties in using

	in using a particular technology?	experienced difficulties in using and integrating technology into their teaching. However, they were willing to learn more about technology outside of school hours	and integrating technology into their teaching. This suggests that not all educators feel comfortable or proficient in using technology in the classroom.
2	What IoT devices do you actually need but have not yet purchased or whose usage has not been maximized?	More than 50% (32 out of 54) of respondents indicated that IoT devices were not being fully utilized due to the limited availability of technology in schools. In terms of the learning process, no existing IoT device can comprehensively cover all teaching materials.	The data highlights the need for increased access to technology in schools and the development of more comprehensive IoT solutions to fully leverage the potential of technology in education.

Based on the data, it can be concluded that the challenges in integrating the IoT on learning progress due to:

a) Limited technology access: Over half of the respondents reported that IoT devices are not being used to their full potential due to a lack of technology in schools. This means that many schools may not have enough devices or the right kind of devices to implement IoT effectively.
b) Incomplete coverage of curriculum**:** No single IoT device can currently cover all aspects of the curriculum. This suggests that a more integrated approach is needed, possibly combining multiple devices or platforms to address the full range of learning needs.

Despite these challenges, respondents demonstrated a strong willingness to learn more about technology outside of school hours, indicating a desire to enhance their technological competencies. Therefore, ongoing training and development are crucial. This data highlights the importance of providing educators with continuous professional development opportunities to improve their ability to use technology in teaching.

- **The required IoT specifications for learning information system management.**
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Table 4. The list of the questions and their corresponding explanations

No	Questions	Respondent summary	Explanations
1	Does your school have a dedicated platform for efficient grade management and student activity monitoring?	A significant majority of respondents 81.48% (44 out of 54) reported that there is a gap in the market for a platform that can handle both grade processing and student activity monitoring. Currently, these two functions are	This data indicates that a significant majority (over 80%) of respondents believe there's a need for a more integrated platform for managing both grades and student activities. Currently, these tasks are often handled separately using different tools, such as RDM for grades and manual methods for tracking student activities. This

		often siloed, with general platforms like RDM being used for grades and manual processes for tracking student activities.	fragmented approach suggests a demand for a comprehensive solution that can streamline these processes.
2	In your opinion, is there a need for a dedicated website that integrates student attendance, teaching journals detailing topics covered, and daily student grades?	100% of respondents agreed that there is a need for a dedicated platform to manage both student grades and activities, which should also be accessible to parents.	This data indicates that all the respondents (100%) agreed on the need for a specific platform designed to manage both student grades and activities. Additionally, they emphasized the importance of making this platform accessible to parents. Essentially, this means that there's a strong consensus among respondents that a centralized platform would be highly beneficial for both teachers and parents in managing student progress and performance.
3	How do you envision this website assisting you in the assessment and monitoring of your students' learning, and how can it be made accessible to parents as well?	There is a hope for a platform that can be easily accessed and engage all stakeholders and processes within a circular education system.	Essentially, the statement is calling for a technological solution that can streamline and improve various aspects of education, from learning and teaching to resource management and environmental sustainability.

Based on the data, it can be concluded that "In the context of school information system management, a specialized platform is required that encompasses all elements of a circular education system. This platform should be capable of connecting all educational stakeholders, including students, teachers, and parents.

Many researchers argue about integrating educational management system information into IoT. Research from Ramadani, et.al (2023) shows that integrating school management systems is very efficient and useful in teachers' work and the teaching process. In this research, any information about students, lessons, and report generation for students is securely stored through e-school. This access can be done from any hardware that has an internet connection so that teacher-student-parent communication is deepened through this e-school (Ramadani et al., 2023).

Stepanova et al., (2023) states that that the teachers surveyed are actively using modern digital technologies to effectively deliver e-learning. There is also a marked improvement in student learning outcomes when using modern electronic tools and learning support. Communication between parents and teachers contributes to supporting the e-learning system. The final recommendation is to create effective communication channels between teachers, students and parents to facilitate information exchange and interaction and increase parental involvement in innovative educational developments through electronic means.

Hayes et al., (2017)states that the effective information management is essential for parents to actively participate in their child's educational development. However, existing educational

information management tools are designed only from the perspective of educators and students, not parents. This research supports the fact that parents need technological solutions to improve the management and use of educational information regarding their children. When it comes to education information management, the web-based software applications used by school districts allow parents to track their students' academic progress for the school year, but do not effectively allow parents to compare year-to-year progress, integrate education information from other sources, or organize information in a way that can better meet parents' needs.

4. Conclusions

In today's technological era, the integration of IoT in education must continue to evolve to meet the specific needs of educators. Survey results indicate that teachers are now more comfortable using IoT, although challenges such as limited technology and school facilities persist. Despite these challenges, teachers' IoT capabilities have improved significantly. However, specialized training is still required to enhance their technological proficiency. Regarding information system management, the survey findings suggest the need for a robust data management system that is accessible to all stakeholders while maintaining confidentiality. This research recommends the implementation of IoT in school information systems to accommodate all educational needs, from pre-learning to learning activities, monitoring, and evaluation. This implies that the specifications of IoT in education must be refined to address the challenges faced by schools.

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