Journal of Infrastructure, Policy and Development 2025, 9(1), 10057.
https://doi.org/10.24294/jipd10057

Article

Identifying readiness and stakeholder involvement in creating innovative services at the Daarul Rahman Islamic boarding school

Konita Lutfiyah*, Mohammad Syamsul Maarif, Yudha Heryawan Asnawi, Laily Dwi Arsyianti

School of Business, IPB University, Bogor 16128, Indonesia
*** Corresponding author:** Konita Lutfiyah, qonita13qonita@apps.ipb.ac.id

CITATION

Lutfiyah K, Maarif MS, Asnawi YH, Arsyianti LD. (2025). Identifying readiness and stakeholder involvement in creating innovative services at the Daarul Rahman Islamic boarding school. Journal of Infrastructure, Policy and Development. 9(1): 10057. https://doi.org/10.24294/jipd10057

ARTICLE INFO

Received: 3 November 2024
Accepted: 28 November 2024
Available online: 2 January 2025

Abstract: Modernizing the Internet of Things in Islamic boarding schools is essential to eliminate backwardness and skills gaps. Santri must have cognitive, affective, psychomotor, and creative intelligence to be ready to enter the industrial and business world. The students' need for information transparency can be resolved using technology. This is because the empowerment of the Internet of Things has become a separate part of Islamic boarding school activities with students who can connect in real-time. This research aims to analyze current conditions and stakeholder involvement regarding the application of the Internet of Things in innovative Islamic boarding school services in the era of disruption. The Descriptive Method and Individual Interest Matrix Analysis were used by involving 130 respondents from the internal environment of the Daarul Rahman Islamic boarding school and completing the questionnaire through FGD (Focus Group Discussion) with the leaders of the Daarul Rahman Islamic boarding school. The results show that the current condition of Islamic boarding schools is that most need to learn or understand IoT, even though they are enthusiastic about learning new things and flexible in accepting change. The challenges required in implementing IoT are financial investment, increasing human resources through training, and synergy between Islamic boarding school policy makers. Mutually supportive and solid conditions are required between foundations, school principals, and school committees to implement IoT at Daarul Rahman Islamic Boarding School. Collaboration with various parties is needed because the implementation of IoT cannot be done alone by Islamic boarding schools but with the support of various related parties.

Keywords: innovative; internet of things; Islamic education; Islamic boarding schools; stakeholders

1. Introduction

Islamic boarding schools are the oldest Islamic educational institutions deeply rooted in the history of the Indonesian nation. Since the 15th century, Islamic boarding schools have existed as a manifestation of the synergistic encounter between universal Islamic teachings and local wisdom. Islamic boarding schools can survive across time and generations because the Islamic boarding school education system prioritizes the formation of spirituality, morality, noble morals, and manners in students. Islamic boarding schools are religious institutions as well as educational institutions that are very typical of Indonesia and rich in culture. Education in Islamic boarding schools occurs while the students live in dormitories with kai, aside (educators), and musyrif (guides). In Islamic boarding schools, students learn the meaning of life, live together, learn discipline, learn to live, socialize, organize, be independent, respect the clerics, be patient in seeking and mastering knowledge, and so on.

Islamic boarding schools must continue to apply various innovations and creativity in responding to the increasingly rapid developments in the modern era, including the digitalization of the IoT-based education system (Arafah et al., 2021). Among the skepticism about the use of digitalization in Islamic boarding schools is that it affects students' interaction and learning patterns. This has an impact on students' loss of politeness towards teachers. Another factor is that digital media can eliminate the habit of face-to-face learning, or muhadapah. Apart from that, the habit of looking for references through Turot books or estimates can be replaced by the habit of googling or staring at the screen. This negative impact can be reduced by encouraging students to be digitally literate. Teachers have this responsibility because times change rapidly, and innovations occur every few seconds (Ahwarumi and Swarjuwono, 2023).

Innovative terminology in the Islamic boarding school context refers to using creative ideas and new solutions to improve the effectiveness of education, management, and services in Islamic boarding schools. Innovation in Islamic boarding schools can help strengthen religious education, character development, and community empowerment in the Islamic boarding school environment while still maintaining strong traditional values. By involving IoT in Islamic boarding schools, they can increase their innovation. Some innovative terms related to Islamic boarding schools in terms of creating services include technology-based education, Islamic boarding school management, innovative curriculum, environmental management, social media, and communication. Innovation in Islamic boarding schools refers to the development of new ideas, concepts, or approaches implemented to improve the efficiency, quality, and positive impact of the services provided by Islamic boarding schools.

According to Hamdan (2018), a progressive and future-oriented Islamic boarding school must have several criteria, such as being based on a modern Islamic education system, having advanced modern infrastructure and facilities, having confidence in religious principles and attitudes, having a social outlook, and having nationality. - universal humanity, good governance, and neat, modern, and open government administration. What is meant by "technological revolution" is that the era of technological disruption is a stage where the way humans carry out their activities experiences changes, differences, limitations, and changes from before. Islamic boarding schools have yet to utilize the Internet of Things (IoT) to run their organizations, so they remain conventional (Harris, 2023). Even though essential things disrupt IoT, such as optimizing facility management, where IoT allows efficient monitoring and management of facilities, this research aims to analyze conditions (eg infrastructure, staff readiness, student perceptions) related to the application of the Internet of Things (IoT) in innovative Islamic boarding school services in Daarul Rahman.

Internet of Things (IoT) has become essential in Islamic boarding school activities with its students (Harris, 2023). Technology does not disrupt human life; on the contrary, technology helps society improve. Islamic boarding schools can maintain Islamic boarding school culture by adhering to good old traditions but still have to accept changes that are more profitable (Ulum and Mun'im, 2019). In this way, broader insight will be gained to help Islamic boarding schools advance and develop.

Islamic boarding schools are also starting to build or provide formal education, although they still follow the old education system, such as Bandung, slogan, and veteran (Krisdiyanto et al., 2019). Islamic boarding schools have not utilized the Internet of Things (IoT) to run their organizations, so they tend to remain conventional. Even though essential things disrupt IoT, such as optimizing facility management, where IoT allows efficient monitoring and management of facilities, for example, smart sensors can help monitor energy consumption, regulate room temperature, and optimize resource use. Apart from that, Islamic boarding schools are also improving educational experience services where IoT can improve the student's learning experience by providing access to more interactive educational content.

The application of IoT in Islamic boarding schools can open up great innovation opportunities to improve service quality, namely in terms of security and overall management efficiency of Islamic boarding schools. However, apart from these benefits, data security and privacy must also be considered to protect sensitive user information. Applying the Internet of Things (IoT) in Islamic boarding schools can create innovative conditions to improve students' and managers' efficiency, comfort, and experience. This research question concerns the current conditions in preparing the Daarul Rahman Islamic Boarding School to adopt the Internet of Things and how to map stakeholders to accelerate the IoT implementation process. This research aims to analyze current conditions and stakeholder involvement regarding the application of the Internet of Things in innovative Islamic boarding school services in the era of disruption. This research is an interesting exploratory effort to apply modern technology in the Islamic religious education environment, especially at the Daarul Rahman Islamic boarding school. The main focus of this research is to investigate how the Internet of Things technology can be applied in an Islamic boarding school environment by collecting views and potential contributions from various parties involved.

The evolution of the Internet occurred due to the active role of the Internet of Things (IoT), which has a direct relationship between users and digital processing combined with an informality prohibited in everyday life (Inang et al., 2022). IoT is a network of connected devices that is useful for supporting the communication process of device equipment. Several technologies use IoT, such as sensors, calculators, operational systems, microcontrollers, communication technology, securities, and IoT platforms (Iswan and Kihara, 2022). The IoT technology working system already processes and transfers digital information obtained from digital sensors such as Radio Frequency Identification (RFID), infrared sensors, and Global Positioning System (GPS). Apart from the application of IoT in business activities, physical housing systems have also been integrated with IoT, which is more often known as Smart Grid technology. Management is needed in organizational activities to carry out activities so that a goal is achieved effectively and efficiently. Within the scope of social media trend management, researchers divide it into two areas: (1) Managing physical social media trends and (2) Managing non-physical social media trends.

The application of IoT in Islamic boarding schools can open up great innovation opportunities to improve service quality, security, and overall management efficiency of Islamic boarding schools. However, with these advantages, data security and privacy must also be considered to protect sensitive user information. Applying the

Internet of Things (IoT) in Islamic boarding schools can create innovative conditions to improve students' and managers' efficiency, comfort, and experience. The following are several innovative phenomena that occur in Santri Health Monitoring. IoT Wearables: IoT-based devices such as smartwatches or health sensors can monitor students' health parameters, such as heart rate, body temperature, and physical activity levels. This data can be accessed by Islamic boarding school managers and medical personnel for real-time health monitoring. Next is Security and Environmental Monitoring. Smart Security System: Implementation of an intelligent security system connected to the IoT network, including smart security cameras, motion sensors, and facial recognition systems to ensure the security of Islamic boarding schools

According to Ja'far (2019), the Internet of Things (IoT) has a structure in the form of objects; people are given exclusive identities, and the ability to transfer data over a network requires a dual network-to-machine interface, namely a source to destination and a computer-to-computer interface. The Internet of Things is an ongoing scientific development that optimizes life based on intelligent smartphone sensors that work directly via the Internet (Jancey, 2013). The Internet of Things has become a technological revolution that fundamentally changes computers into communications, where digital development relies on dynamic technological innovation in various fields, from wireless sensors to digital technology. This technology is designed to connect various types of objects in each signaling device to a network in an extensive digital network. Internet of Things problems have also become more accessible with developments in telecommunications technology, such as the introduction of broader capital, the new version of the IP V6 internet protocol, and the integration of digital technology into many products in life equipment. The idea of connecting various objects in a device to a network of digital devices managed via the web and enabling interaction with software is in line with the evolution of educational technology, moving from e-learning to m-learning. The main characteristics of e-learning include increased access to learning content in a computer-supported collaborative learning environment and a digital setting.

2. Materials and methods

The quantitative approach is research that is descriptive in nature and uses more in-depth The analysis provides a complete explanation by concluding several occurring phenomena (Mundri et al., 2019). Apart from that, an analysis of stakeholder involvement in Islamic boarding schools was also carried out—a matrix analysis of individual interests. After systematic analysis of the findings, the findings were then identified and formulated. This research begins with descriptive research that aims to describe and then combine real natural and potentially dangerous phenomena. The type of descriptive research in this research aims to collect specimens, describe them, identify them, classify them, and make a comprehensive inventory of all possible discovery ideas. Furthermore, this research uses individual stakeholder analysis to determine stakeholder actors to encourage innovative Islamic boarding schools. The sample was obtained by purposive sampling, namely Islamic boarding school stakeholders who had work experience of more than five years.

Primary data collection was carried out by filling out questionnaires in public surveys representing stakeholders to obtain more precise and objective justification. The sources in this research are individuals with knowledge, understanding, and unique methods used to solve problems in the organization. The number of respondents was 130 people, consisting of school principals, teachers, curriculum staff, and administrative staff. The questionnaire was adapted from administrative staff. This questionnaire was adapted from previous research (Parasuraman, 2015).

Stakeholder analysis aims to map the interests of critical actors in policy advocacy. With this identification, program managers become sensitive to stakeholder interests and, in the long term, can create strategies to ask for support from specific stakeholders. Stakeholder analysis can be done using the Analysis Individual Interest Matrix (AIIM). Reliability refers to the consistency of a measure of whether the results can be reproduced under the same conditions), we are used to check the reliability of the data itself. Validity refers to the accuracy of a measure by using face validity and content validation with other experts to check whether the questionnaire is acceptable. The statistical test of the data or software used is SPSS version 22 and uses descriptive analysis. Some of AIIM's steps are identifying all stakeholders in the policy process, identifying the level of interest and alignment of stakeholders towards the policy, and identifying stakeholders who have the power to intervene in policies at the Daarul Rahman Islamic Boarding School.

3. Results and discussion

Based on the findings in **Table 1**, 130 Islamic boarding school respondents were appointed for further analysis regarding the current situation. Most respondents were teachers aged 17–29 years and had a bachelor's degree of 1–5 years. Most respondents know quite a lot about the Internet of Things and feel that the management of the Daarul Rahman Islamic Boarding School needs to support the implementation of the Internet of Things in Islamic boarding schools. Currently, no special department or team in your area is tasked with transforming the Daarul Rahman Islamic Boarding School towards the Internet of Things. Most respondents feel that digitalization has been implemented but has not provided optimal results for the Internet of Things. The majority of respondents also do not know the amount of investment that the Daarul Rahman Islamic Boarding School has made in IoT transformation.

Table 1. Respondent demographics.

No	Type of Worker	Age	Length	Education Level
1	Teachers: 122 people	17–29 years old: 79 People	1–5 years: 54 People	S1: 112 people
2	Curriculum staff: 3 people	30–39 years old: 32 People	6–10 years: 37 People	S2: 18 people
3	Principal: 1 person	40–55 years: 19 people	11–25 years: 39 People	
4	Administrative Staff: 4 Persons			
	Total	130 Respondents		

Based on the findings of descriptive results. Most respondents know quite a lot about the Internet of Things and feel that the management of the Daarul Rahman Islamic Boarding School does not yet support the implementation of the Internet of Things in Islamic boarding schools. Currently, no special department or team in your area is tasked with transforming the Daarul Rahman Islamic Boarding School towards the Internet of Things. Most respondents feel that digitalization has been implemented but has not provided optimal results for the Internet of Things. Most respondents also need to learn about the investment the Daarul Rahman Islamic Boarding School has made in IoT transformation.

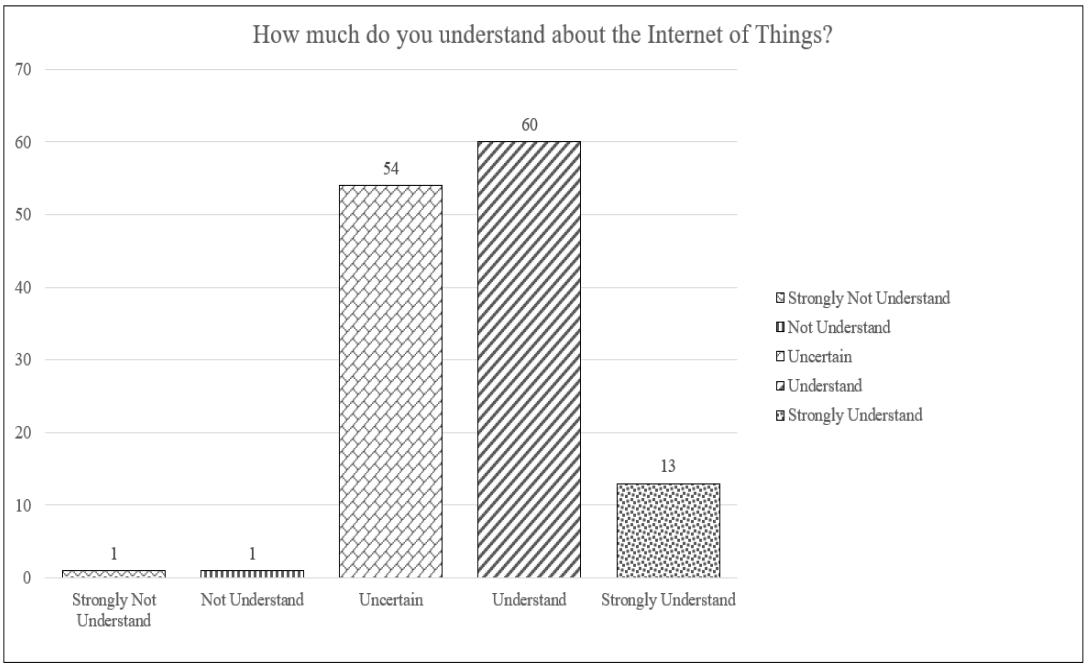

Figure 1. Understanding of Islamic boarding school residents regarding the Internet of Things.

Based on **Figure 1**. Descriptive results also found that Islamic boarding school residents chose the learning process, finance, and security as essential areas in implementing the Internet of Things. In general, Daarul Rahman Islamic Boarding School employees are flexible towards change and are accustomed to making continuous improvements. Teachers and administrative staff also feel that all employees are very open to technological changes and are ready to support them in continuing to learn with new technology. Employees at Daarul Rahman also assess that there needs to be training, workshops, education, and certification related to the Internet of Things at the Daarul Rahman Islamic Boarding School. The majority of respondents assessed that the IoT information data available at the Daarul Rahman Islamic Boarding School was generally used to improve the quality of service to all Islamic Boarding School residents. Daarul Rahman Islamic Boarding School needs to provide services integrated with technology in security and monitoring, for example, bright door and window sensors, security cameras, or motion sensors that monitor and protect the assets and safety of Islamic Boarding School residents.

Currently, the findings from the descriptive results show that there is still minimal machine-to-machine connectivity (communication between machines) via the

internet/intranet in the Daarul Rahman Islamic Boarding School infrastructure. Respondents also assessed that Daarul Rahman Islamic Boarding School's technological needs were building network connectivity. IoT networks must support slow and fast sensors, such as fast sensors from CCTV cameras that analyze data in real-time. The amount of data sensors generate will depend on IoT equipment communicating via communication channels such as Wi-Fi. Daarul Rahman Islamic Boarding School only has some data storage.

Respondents also believed that the main obstacle to implementing IoT at the Daarul Rahman Islamic Boarding School was human resources (HR), such as readiness, ability, and knowledge related to IoT. Apart from that, the problem in implementing IoT is cost because implementing the Internet of Things (IoT) requires quite a significant investment. Furthermore, implementing Internet of Things-based services at the Daarul Rahman Islamic Boarding School is urgent for education, security, and financial administration services.

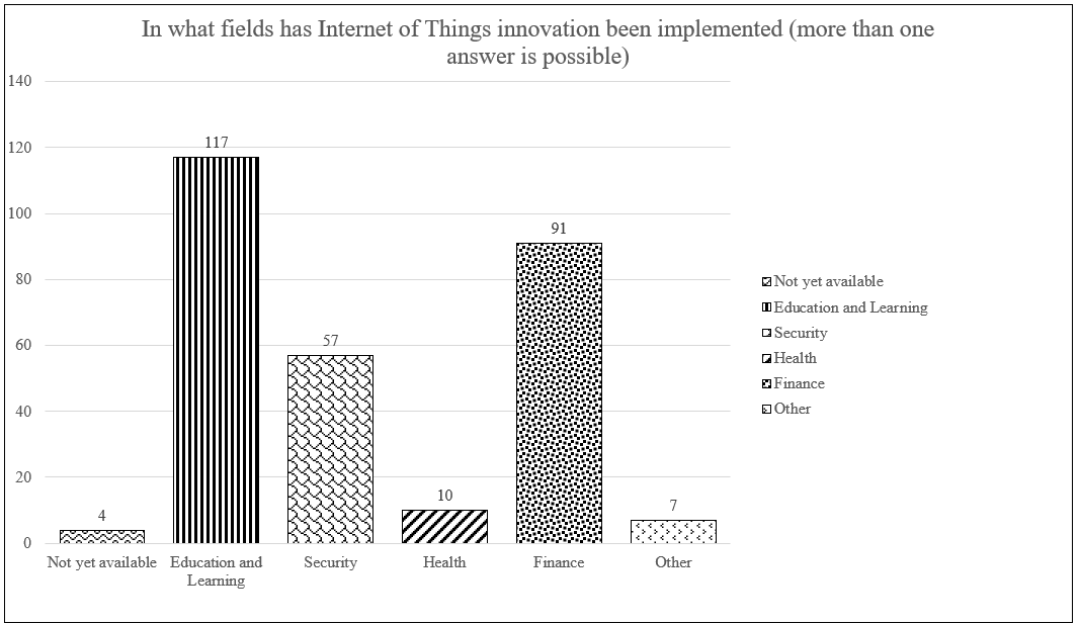

Figure 2. Areas of IoT service innovation needed by Islamic boarding school Daarul Rahman.

Based on **Figure 2**, apart from that, Pondok Pesantren considers that analyzing stakeholder needs is essential in planning IoT implementation, supported by training and outreach for all stakeholders. Regarding infrastructure, the Daarul Rahman Islamic Boarding School needs optimal IoT-based equipment or infrastructure such as sensors, smart devices, or other tools. However, it has started to bring in consultants/experts to provide input. Daarul Rahman, Islamic Boarding School, also requires management of data security and privacy related to the use of IoT technology and concern for data security and privacy related to the use of IoT technology. IoT technology supports the life of the Daarul Rahman Islamic Boarding School. On the Technology Readiness Index, most respondents agree that products and services that use IoT technology are much more comfortable to use. Apart from that, IoT was used, and it was agreed that they liked the idea of doing business through IoT because it was not limited to regular working hours. Previous research by Akintode et al. (2022) tried

to design an IoT-based solar energy system at the Assyifa Islamic Boarding School Laboratory, Subang Regency, as an active contribution to overcoming air pollution as well as renewable energy solutions and handling air pollution as well as solutions to current problems. Energy depletion. The system is planned to have solar panels, an inverter, and an electric current controller with built-in WiFi connectivity (Education and financial administration).

At Daarul Rahman Islamic Boarding School, IoT is vital in helping organizations monitor and control educational activities. These activities include several activities in services for students, teachers, and Islamic boarding school residents. For example, a system for recording entry and exit at Islamic boarding school gates, access to information about learning, student attendance activities, and payment and security administration systems. By utilizing IoT in Islamic boarding school services, the speed and accuracy of service can be guaranteed.

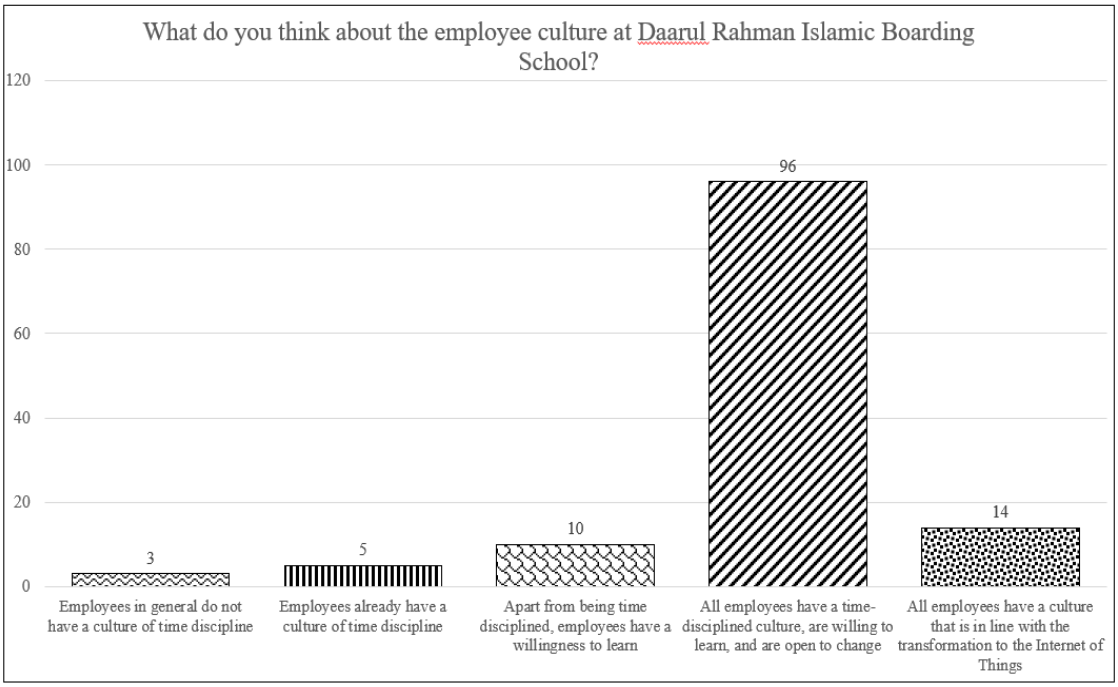

Figure 3. Work culture of Daarul Rahman Islamic boarding school employees.

Based on **Figure 3**, service applications utilizing IoT can be considered a powerful and appropriate creative tool in assisting educational activities and the entire service process in Islamic boarding schools. The Internet of Things (IoT) can support educational activities and all service processes. The two cannot be separated because these two things are like two sides of a coin that cannot be separated but complement each other. Everyone is equally vital in achieving innovative service goals in Islamic boarding schools. However, the Daarul Rahman Islamic boarding school must still implement IoT technology and be connected. IoT technology is vital in helping organizations monitor and control educational service activities, security, and internal and external communication with student parents. For example, a system for recording entry and exit at Islamic boarding school gates, access to information about learning, student attendance activities, payment, and security administration systems.

Islamic boarding schools have yet to fully utilize the Internet of Things (IoT) to run their organizations, so they remain conventional. There are essential things in implementing IoT, such as optimizing facility management, where IoT allows efficient monitoring and management of facilities; for example, smart sensors can help monitor energy consumption, manage room temperature, and optimize resource use. Additionally, an IoT-based financial administration management system can increase efficiency in managing Islamic boarding school financial administration, such as financial management and reporting the required data. Daarul Rahman Islamic Boarding School needs to implement a coherent policy by integrating IoT in educational services, such as the use of E-Learning as a form of information technology used to shorten learning target schedules, save costs, and manage learning using software such as learning management systems (LMS). This facility allows learning activities to be managed without direct face-to-face contact because it is represented by email, chat channels, or video conferences used to supervise homeroom teachers and teachers. Islamic boarding schools have started using digital libraries as a learning resource center. Digital libraries are needed to interact with learning resources by making optimal use of available learning resources.

AIIM findings

This research is an interesting exploratory effort to apply modern technology in the Islamic religious education environment, especially at the Daarul Rahman Islamic boarding school. The main focus of this research is to investigate how Internet of Things (IoT) technology can be applied in an Islamic boarding school environment by collecting views and potential contributions from various parties involved. The subject of the research includes internal and external stakeholders. All of these parties have an essential role in developing and applying IoT technology in the Daarul Rahman Islamic boarding school environment. In the context of the Daarul Rahman Islamic Boarding School, IoT implementation can include various aspects, such as the use of eye sensors to detect the location of students, the use of CCTV to monitor security, the application of a fingerprint system for access to facilities, automatic tap sensors for ablution facilities, emergency call systems, learning centers online for students to prepare material before class and also the use of headband-shaped sensors to monitor students' concentration levels.

In the FGD (Focus Group Discussion) discussion, the participants involved were the leadership and core management of the Daarul Rahman Islamic boarding school, who discussed the roles and contributions of ten relevant stakeholders, including external parties, in designing and implementing adequate IoT solutions to improve the efficiency and quality of integrated services at Daarul Rahman Islamic Boarding School. The mapping results of 10 stakeholders are the School Committee, Islamic Boarding School Principals, Foundations, BSI Bank, IT Staff Partners, Indonesian Ministry of Education and Culture, Santri, Community Security, Organizations, and Goods Procurement Vendors. In determining stakeholder priorities for developing innovation, we adopted a structured approach using individual Matrix analysis by Mendelow (1960) with four key questions:

1) How important are these stakeholders in business operations for the Daarul Rahman Islamic boarding school?

The majority of respondents, namely 25% (7 out of 13 people), consider the school committee (including teachers, parents, and school employees) and the foundation or owner to be critical stakeholders and greatly influence business operations at the Daarul Rahman Islamic Boarding School. Meanwhile, other respondents agreed that the Ministry of Education, Research and Technology (Kemendikbukristek) and the West Java Region II Education Office had high importance and low power in business operations, around 22.7% (5 out of 13 people). This is because it influences providing funding for schools in the form of BOS funds. On the other hand, BSI Bank can provide high power to business operations for IoT implementation, but its importance is low in **Figure 4**.

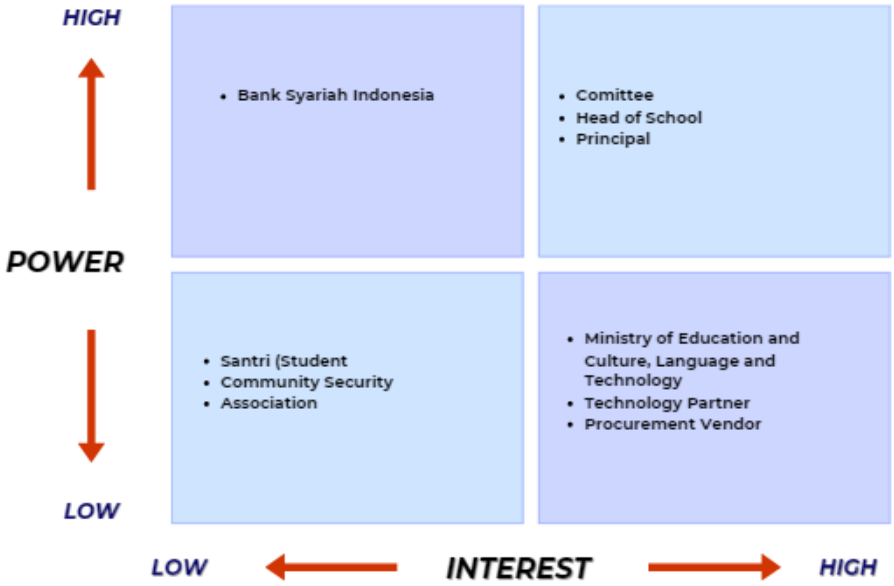

Figure 4. Stakeholder mapping related to business operations for the Daarul Rahman Islamic boarding school.

Based on **Figure 5**, The majority of respondents, namely 23.5% (8 out of 13 people), considered the school committee (including teachers, parents, and school employees) and foundations to be essential stakeholders and have the highest interests. Furthermore, 50% (7 out of 13 people) consider the same vital stakeholders, namely students, school principals, and organizations, to have a high interest but low power in influencing policies related to operations at the Daarul Rahman Islamic Boarding School. Moreover, the Ministry of Education and Culture has high power but low importance.

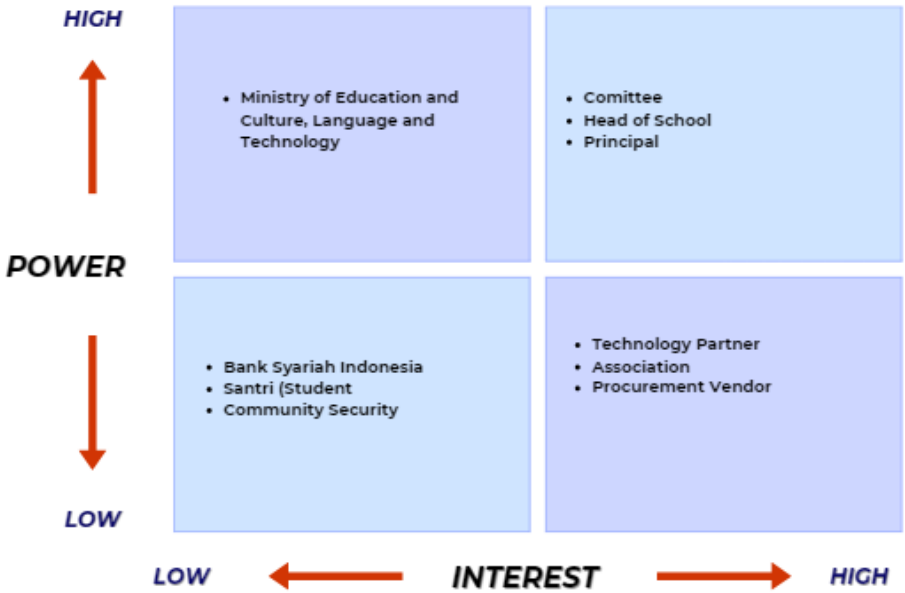

Figure 5. Mapping of relevant stakeholders influencing policies for the Daarul Rahman Islamic boarding school.

Based on **Figure 6**, The majority of respondents, namely 15.4% (6 out of 13 people), considered school committees and foundations important stakeholders in building consistent communication with stakeholders at the Daarul Rahman Islamic Boarding School. Meanwhile, other respondents (scale 3) must build consistent communication with stakeholders, namely around 28.6% (6 out of 13 people). This is considered because the school committee is a liaison for internal information that needs to monitor the progress of existing innovations.

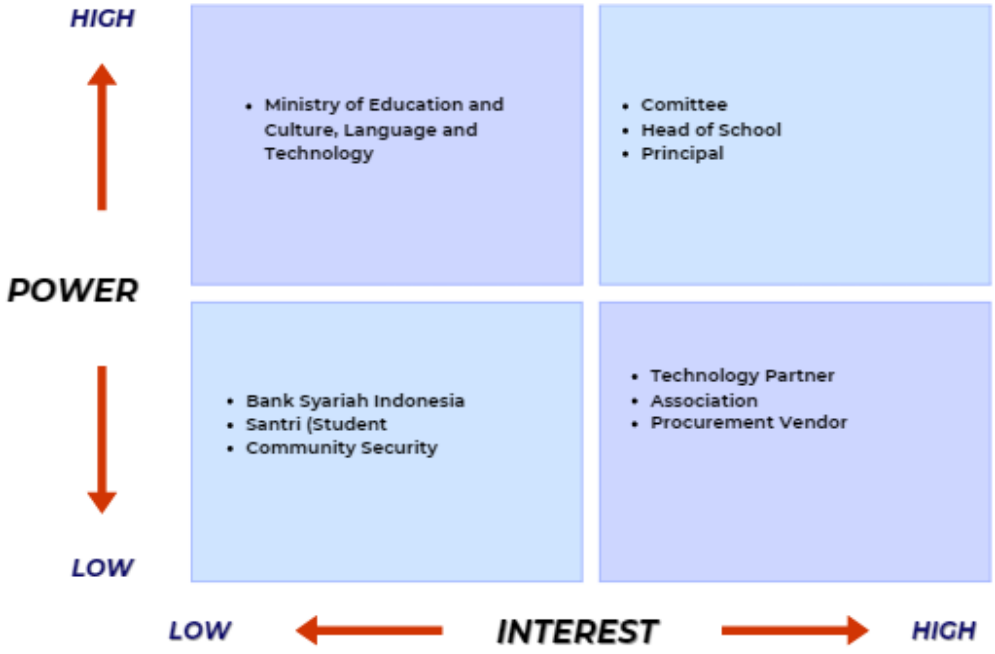

Figure 6. Mapping of relevant stakeholders influencing policy.

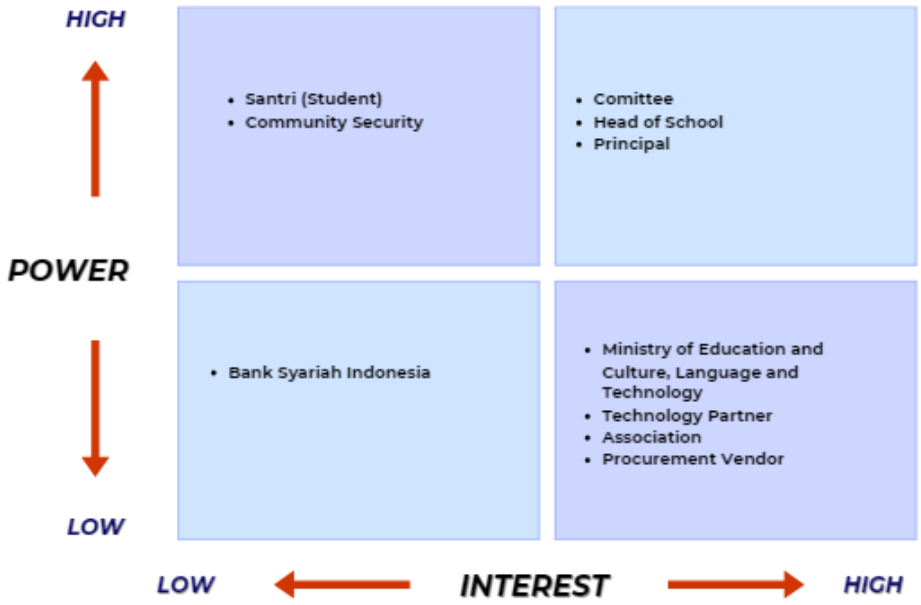

Figure 7. Stakeholder mapping related to communication that must be established at the Daarul Rahman Islamic boarding school.

Based on **Figures 6** and **7**, The majority of respondents, namely 20.7% (7 out of 13 people), considered the school committee (including teachers, parents, and school employees) to be critical stakeholders, and the related foundations had high power and high importance. Apart from that, 25% (7 out of 13 people) think that the purchasing and technology department must continue to be monitored in its activities for the Daarul Rahman Islamic Boarding School in implementing IoT because of its high importance but low power. On the other hand, students and communities have high power and low importance.

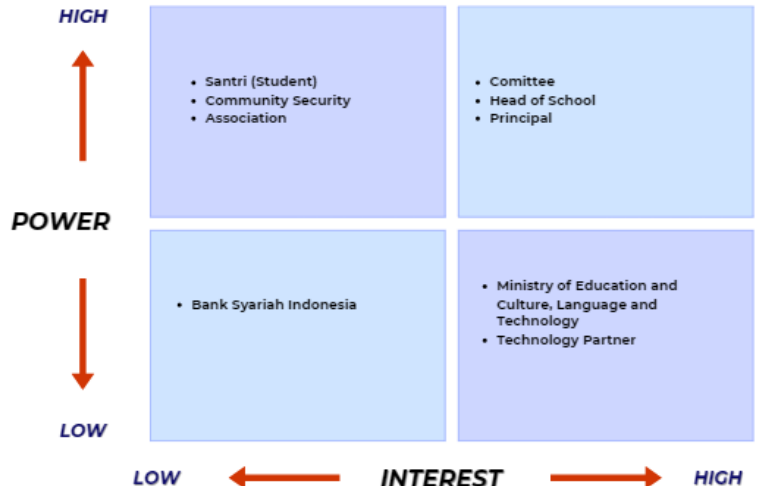

Figure 8. Mapping of relevant stakeholders monitored in their activities at the Daarul Rahman Islamic boarding school.

Based on **Figure 8**, a solid school committee supported by foundations and school principals will have characteristics that can influence Islamic boarding schools,

especially in terms of decision-making, flexibility, and balance in implementing IoT. Wide and fast IoT access allows Islamic boarding schools to connect with all residents. This creates new opportunities to communicate with various stakeholders, collect input, and promote innovative Islamic boarding school services (Ramaditya et al., 2022).

The Internet of Things allows Islamic boarding schools to connect with various stakeholders, including residents, parents, the government, and the wider community. This allows Islamic boarding schools to expand the reach of their services. By connecting one system to another, Islamic boarding schools can collect input and feedback from various sources more efficiently (Mujianto et al., 2022). This can help improve Islamic boarding school services and decision-making. Utilizing the Internet of Things (IoT) technology allows Islamic boarding schools to automate routine tasks, identify trends, and provide more innovative services. Islamic boarding schools need to be open to new technology and committed to utilizing ineffective services and tend to be more adaptive to change. Islamic boarding schools must be able to respond to technological changes that occur to the needs of Islamic boarding school residents. These results are in line with previous research by Ahwarumi et al. (2017), who tried to design an IoT-based solar energy system for the Assyifa Islamic Boarding School Laboratory in Subang Regency as an active contribution to overcoming air pollution as well as renewable energy solutions and handling air pollution as well as solutions to air pollution problems. I am running out of energy right now.

4. Discussion

Daarul Rahman Islamic Boarding School can promote innovative services more effectively through the Internet of Things. They can use IoT tools, websites, and other online platforms to provide services to support Islamic boarding schools' goals of creating innovative services. The Internet of Things allows Islamic boarding schools to build more robust networks with stakeholders to create the collaboration needed to implement innovative services. IoT can facilitate remote collaboration, speed up information exchange, and enable access to innovative services to increase efficiency and flexibility in Islamic boarding schools. Islamic boarding school culture can become more adaptive and open to technology. IoT in Islamic boarding schools reflects the need for flexibility in changing the way of working and the perspective of Islamic boarding school residents. The Internet of Things allows Islamic boarding schools to collect, analyze, and understand data better. This can assist in more intelligent decision-making, increased operational efficiency, and a deeper understanding of Islamic boarding school residents and students' parents refers to the readiness of educators and students to adapt to and utilize new technology. In the context of pesantren, this involves assessing their skills, knowledge, and willingness to embrace IoT. Key aspects of human resource readiness include:

1) Educators and students must possess the technical skills necessary to operate IoT devices and platforms. Conducting a skills gap analysis can help identify areas where additional training is needed.

2) Providing comprehensive training programs tailored to the specific needs of the pesantren can enhance human resource readiness. These programs should focus

not only on technical skills but also on the integration of IoT into the existing curriculum.

3) Creating a supportive environment that encourages experimentation with technology can foster a positive attitude towards IoT. Recognizing and rewarding those who embrace new technology can motivate others to follow in their footsteps.

This research also supports previous studies related to IoT adoption, as shown in the image below, which illustrates various factors and sub-factors influencing IoT adoption. In terms of cost savings, with new sensor information, IoT can help Islamic boarding schools save money by minimizing equipment failures and allowing businesses to perform planned maintenance. IoT will enhance asset tracking (equipment, machinery, tools, etc.) using sensors and connectivity, which helps organizations gain benefits from real-time insights. With the help of IoT, organizations can more easily identify issues in assets and perform preventive maintenance to achieve better asset utilization. IoT helps reduce operational costs by providing real-time operational insights to organizations. For example, in manufacturing dormitories, IoT collects data from logistics networks, factory floors, and supply chains. This will help the boarding school to reduce inventory, time to market, and downtime due to maintenance. Improving asset utilization, productivity, and process efficiency can save on operating and maintenance costs. The implementation of security procedures such as hardware encryption, physical building security, and network security is necessary to maintain the security of sensors and equipment connected in IoT. Identity and authentication structures also need to be updated to minimize privacy risks associated with IoT in organizations. According to Nord et al. (2020), security decision-makers are unknown in the IoT area because there are many partners involved in IoT, including designing devices, supplying software components, operating the networks where devices are embedded, and deploying devices. There is a need for comprehensive international norms. Successful IoT adoption only occurs when security and privacy risks are minimized. Successful IoT implementation occurs when IoT devices are connected to standard-based IP networks, rather than using proprietary networks for communication. Interoperability and reliability are necessary to support the global IoT network and connections with the partner ecosystem.

5. Conclusion

This research provides valuable insight into the current conditions at the Daarul Rahman Islamic Boarding School and the role of stakeholders in the IoT implementation process. Although some progress has been made in security and environmental monitoring, significant challenges still need to be addressed, especially regarding human resources and financial constraints. Stakeholder analysis revealed that school committees, Islamic boarding school leaders, and technology procurement partners are vital actors who can encourage IoT adoption in Islamic boarding schools. To fully realize the potential benefits of IoT, such as improved efficiency, security, and learning outcomes, Islamic boarding schools need to develop comprehensive strategies that address identified barriers and involve all relevant stakeholders. This may involve providing training and support for staff, allocating adequate financial resources, and collaborating with external partners with expertise in IoT

implementation. By embracing technological innovation while preserving its unique values and traditions, Islamic boarding schools can create a more dynamic and future-oriented learning environment that prepares students to face the challenges of an era of disruption.

Author contributions: Conceptualization, KL and MSM; methodology, YHA; software, LDA; validation, KL, MSM and YHA; formal analysis, KL; investigation, MSM; resources, YHA and LDA; data curation, Kl and YHA; writing—original draft preparation, MSM; writing—review and editing, KL and LDA; visualization, KL; supervision, YHA; project administration, KL and MSM; funding acquisition, KL. All authors have read and agreed to the published version of the manuscript.

Conflict of interest: The authors declare no conflict of interest.

References

Abbas, Dirvi S., et al. Pengantar manajemen untuk organisasi publik dan bisnis. Edited by Muniarty, Puji, CV WIDINA MEDIA UTAMA, 2020.

Ahwarumi B, Sawarjuwono T. 2017. Enhancing innovation roles of Pesantren business incubator in Pondok Pesantren Sunan Drajat. Journal of Innovation in Business and Economics. 1(02): 71-82.

Akintonde AA, Awujoola OA. 2022. Information and communication technology skills and digital preservation practices by library personnel in some selected University libraries in South-West, Nigeria. Library Philosophy and Practice. 1-17.

Arafah, R., Kristiawan, M., & Danim, S. (2021). Clusterizations, Mergers and Acquisitions of Higher Education in Indonesia. Proceedings of the International Conference on Educational Sciences and Teacher Profession (ICETeP 2020), 532(532), 391–398. https://doi.org/10.2991/assehr.k.210227.066

Hamdan H. 2018. Industri 4.0: Pengaruh revolusi industri pada kewirausahaan demi kemandirian ekonomi. Jurnal Nusantara Aplikasi Manajemen Bisnis. 3(2): 1-8.

Haris MA. 2023. Urgensi digitalisasi pendidikan pesantren di era society 5.0 (peluang dan tantangannya di pondok pesantren Al-Amin Indramayu). Islamic Management: Jurnal Manajemen Pendidikan Islam. 6(01): 49-64

Havelaar AH, Kirk MD, Torgerson PR, Gibb HJ, Hald T, Lake RJ, World Health Organization Foodborne Disease Burden Epidemiology Reference Group. 2015. World Health Organization global estimates and regional comparisons of the burden of foodborne disease in 2010. PLoS Medicine. 12(12), e1001923.

Heifetz RA, Laurie DL. 1997. The work of leadership. Harvard Business Review. 75: 124-134.

Hernández. (2010) Metodologia De La Investigación. 5th ed. México (US): McGraw- Hill/Interamericana Editores,.

Inang I, Thaitami SH, Mulia FA. 2022. Model pengembangan kewirausahaan Sekolah Menengah Kejuruan Negeri 8 Kabupaten Tebo dalam program school of entrepreneurship untuk menciptakan siswa mandiri ekonomi. Jurnal Tata Rias Dan Kecantikan. 1(2): 32-41.

Iswan AK, Kihara A. 2022. Organizational internal resources and sustainable competitive advantage among faith based non-profit organizations in Kenya: A review of the literature. Journal of Business and Strategic Management. 7(2): 37-64.

Ja'far A. 2019. Literasi digital pesantren: perubahan dan kontestasi. Islamic Review: Jurnal Riset Dan Kajian Keislaman. 8(1): 17-35.

Jancey J, Burns S. 2013. Institutional factors and the postgraduate student experience. Quality Assurance in Education. 21(3): 311-322.

Janssen O. 2000. Job demands, perceptions of effort-reward fairness and innovative work behaviour. Journal of Occupational and Organizational Psychology. 73(3): 287–302. https://doi.org/10.1348/096317900167038

Mujianto, M., Ramaditya, M., Mustika, M., Tanuraharjo, H., & Maronrong, R. (2022). Dampak Pandemi Covid-19 pada UMKM Warung Ritel Tradisional di Indonesia dan Strategi Bertahannya. Jurnal STEI Ekonomi, 30(02), 60 - 74. https://doi.org/10.36406/jemi.v30i02.494

Mundiri A, Nawiro I. 2019. Ortodoksi dan heterodoksi nilai-nilai di pesantren: studi kasus pada perubahan perilaku santri di era teknologi digital. Jurnal Tatsqif. 17(1): 1-18.

Munifah M. 2019. Antara tradisi dan modernitas: metamorfosis pesantren di era digital. Prosiding Nasional. 2: 1-24.

Pangestu A, Iftikhor AZ, Damayanti & Bakri M. 2020. Sistem rumah cerdas berbasis IoT dengan mikrokontroler NodeMCU dan aplikasi telegram. Jurnal Teknik Dan Sistem Komputer, 1(1):8–14. https://doi.org/10.33365/jtikom.v1i1.47

Poluakan MV, Dikayuana D, Wibowo H, Raharjo ST. 2019. Potret generasi milenial pada era revolusi industri 4.0. Focus: Jurnal Pekerjaan Sosial, 2(2): 187-197.

Putra , A, Fathan, I. ., Desi Permata Sari, Vicky Brama Kumbara, & Muhammad Ramaditya. (2023). Sosialisasi Strategi Pemasaran Kreatif pada Dapue Kopi Roastery Padang. Majalah Ilmiah UPI YPTK, 30(1), 26–31. https://doi.org/10.35134/jmi.v30i1.145

Ramaditya, M., Maarif, M. S., Affandi, J., & Sukmawati, A. (2022). Reinventing talent management: How to maximize performance in higher education. Frontiers in Education, 7. https://doi.org/10.3389/feduc.2022.929697 (4), 6342–6360. https://doi.org/10.35445/alishlah.v15i4.3773

Stallings W. 2015. Foundation of Modern Networking SDN, NFV, QoE, iot, and Cloud. New Jersey (US): Pearson Education.

Suyatman U. 2017. Pesantren dan kemandirian ekonomi kaum santri (Kasus Pondok Pesantren Fathiyyah Al-Idrisiyyah Tasikmalaya). Al-Tsaqafa: Jurnal Ilmiah Peradaban Islam. 14(2): 303-314.

Syahansyah Z. 2023. Implementasi pesantren dalam pendidikan karakter santri di era digitalisasi:(studi kasus di pondok modern Al-Rifa'ie 2 Gondanglegi Kab. Malang). Jurnal Studi Pesantren. 3(1): 42-54.

Syakroni, A., Zamroni, Muali, C., Baharun, H., Sunarto, M. Z., Musthofa, B., & Wijaya, M. 2019. Motivation and learning outcomes through the Internet of Things; Learning in pesantren. Journal of Physics: Conference Series, 1363, 012084. https://doi.org/10.1088/1742-6596/1363/1/012084

Tang Y, Yun FS, Yi JC. 2019. Assessing the mediation mechanism of job satisfaction and organizational commitment on innovative behavior: the perspective of psychological capital. Frontiers in Psychology. 10(12):1–12. doi: 10.3389/fpsyg.2019.02699.

Tornatzky L, Fleischer M. 1990. The Process Of Technology Innovation, Lexington, MA (US): Lexington Books

Tracy M, Wiersema F. 1993. Costumer Intimacy and Other Value Disiplines. New York (US): Harvard Business Review

Ulum M, Munim A. 2019. Digitalisasi pendidikan pesantren (paradigma dan tantangan dalam menjaga kultur pesantren). In Proceedings of Annual Conference for Muslim Scholars. 3(1): 664-670.

URABE K. 1988. Innovation and the Japanese Management System, In: K. Urabe, J. Child and T. Kagono (Eds.)Innovation and Management, International Comparisons, De Gruyter & Co: Berlin, pp 3-25 (PDF) Strategic and operational process innovations in NPD processes applying evolutionary change management. [Internet]. [diakses 1 Oktober 2023]. Tersedia pada: https://www.researchgate.net/publication/228581430_Strategic_and_operational_process_innovations_in_NPD_processes_applying_evolutionary_change_management.

Utami NW, Arthana IKR, Darmawiguna IGM. 202). Evaluasi usability pada e-learning Universitas Pendidikan Ganesha dengan metode usability testing. Jurnal Nasional Pendidikan Teknik Informatika: JANAPATI. 9(1): 107-118.

Vilppola J, Lämsä J, Vähäsantanen K, Hämäläinen R. 202). Teacher trainees' experiences of the components of ICT competencies and key factors in ICT competence development in work-based vocational teacher training in Finland. International Journal for Research in Vocational Education and Training (IJRVET). 9(2): 146-166.

Vitello S, Greatorex J, Shaw S. 2021. What Is Competence? A Shared Interpretation of Competence to Support Teaching, Learning and Assessment. Research Report. Cambridge (GB): Cambridge University Press & Assessment, December.

Wang TC, Thu Nguyen TT, Phan BN. 2022. Analyzing higher education performance by entropy-TOPSIS method: A case study in Viet Nam private universities. Measurement and Control. 55(5-6): 385-410.

Wernerfelt B. 1984. A resource-based view of the firm. Strategic Management Journal. 5(2): 171-180.

Wiengarten F, Humphreys P, Cao G, McHugh M. 2013. Exploring the important role of organizational factors in IT business value: Taking a contingency perspective on the resource-based view. International Journal of Management Reviews. 15(1): 30-46.

Zafi AA, Jamaluddin D, Partono P, Fuadi SI, Chamadi MR. 2021. The existence of Pesantren Based technology: digitalization of learning in Pondok Pesantren Darul Ulum Kudus. Jurnal Pendidikan Agama Islam. 18(2): 493–510. https://doi.org/10.14421/jpai.2021.182-15.

Zakaria GAN. 2010. Pondok pesantren: changes and its future. Journal of Islamic and Arabic Education. 2(2): 45-52.