**Aptisi Transactions on Technopreneurship (ATT)**
**Vol. 4 No. 2 July 2022**

**P-ISSN: 2655-8807**
**E-ISSN: 2656-8888**

# The Impact of Artificial Intelligence in Smart City Air Purifier Systems

**Alwiyah[1], Sayyida[2], Diana Putri Lazirkha[3]**
Wiraraja University[1,2], University of Raharja[2]
Raya Pamekasan - Sumenep No.KM, Jawa Timur, Indonesia[1,2]
Jenderal Sudirman No.40, Cikokol, Kec. Tangerang, Kota Tangerang, Banten, Indonesia[3]
e-mail: alwiyah@wiraraja.ac.id[1], sayyida_unija@yahoo.com[2], diana.putri@raharja.info[3]

Author Notification
28 June 2022
Final Revised
18 July 2022
Published
28 July 2022

Alwiyah, Sayyida, & Lazirkha, D. P. (2022). The Impact of Artificial Intelligence in Smart City Air Purifier Systems. Aptisi Transactions on Technopreneurship (ATT), 4(2), 205–214.

**DOI:** https://doi.org/10.34306/att.v4i2.180

***Abstract***

*Dirty air or air pollution is one of the many natural problems that we face, the problem of harmful air pollution is very representative of a colony. If the air conditioner is not healthy so that it disturbs human health. Referring to the World Most Most Polluted Country Index, Indonesia is one of 10 countries where the air is unhealthy or polluted, requiring solutions to these natural problems. This paper aims to find solutions and minimize the impact of wider air pollution through air purification by utilizing the Artificial Intelligence mobility method, especially for outdoor areas. The problem with this system is that it provides clean air in a large area, for example, land, flats, offices, and so on, the majority of people will go out of the house and stay outside the house for a long time. Providing an intelligent sensor-based automatic drive is an advantage of this research because many air purifiers are related to the same purpose but are only explicitly made in a small room area. There are no mobility methods and no Artificial Intelligence system using the three main function formulation methods. The first formulation using "smart mobility" of the machine will be given high Artificial Intelligence. The second formulation is purification using an Arduino-based microprocessor, and the final formulation a human detector. After that, this system can be installed in residential areas and provides healthier air, referring to the structure of the formula "You Only Look Once" (YOLO). All systems will provide performance in that each function is integrated to explain the ease of this tool moves. If there is a low level of pollution, this tool will go to that place and vice versa. This tool works simultaneously, which filters air pollution & provides healthy air to humans (Artificial Intelligence). With this, the researchers tried to do several methodologies to solve air pollution outside the room and clean the dirty air to be suitable for breathing.*

**Keywords:** *Air Pollution, Arduino, Artificial Intelligence, YOLO*

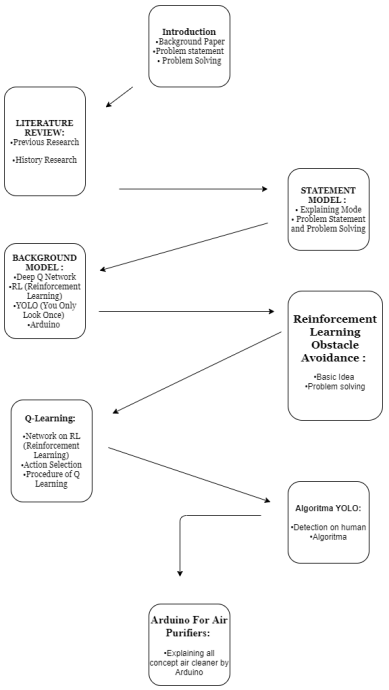
## 1. Introduction

Introduction Industrial technology greatly influences significant changes from those that harm the natural environment such as industrial fumes or provides an ease in food production. The problem that is quite concerning the environment is dirty air or air pollution.

Almost all major cities in the world have been polluted with dirty air or air pollution, for example cities or large coverage areas in the State of Indonesia, Jakarta with a population point value of 114 to 89 points, Tangerang with points 79 to 104 and several major cities in Indonesia, even in India, Golden Temple got an index of 876 points. Referring to the World Health Organization (WHO) and NASA and waqi.info (air pollution checking sites) in the city area contain a lot of microscopic air pollutants that are not good for humans scattered in the atmosphere of the city, this environmental problem affects 8 million pneumonia and premature deaths per year. With so many victims and losses, this critical environmental problem requires solutions, both at national and international levels, and prioritizing solving the problem. As for some ways to solve this problem such as air cleaning indoors or in a small area and only for the purpose of providing air to the surrounding room alone cannot solve this large-scale environmental problem. This problem will only solve the initial cause of the problem rather than by solving a small number of problems that don't even solve this problem at all. This research works on air purifiers and provides outdoor air. This air filter or purifier will work by supplying fresh and clean air in the outdoor or indoor area. There are several formulations in this system where the formulations are integrated with one another. The following functions or formulas that are integrated with each other:

1. To move from a place where pollution is not good to a place that is heavily polluted with heavy air.
2. To clean the air in that place.
3. To purify the air around pedestrians by moving around them

From the above functions will work with the Reinforcement Learning concept along with Deep Q (Q-value) Network [1] [2], AI Deep-Learning, real-time object detection or YOLO (You Only Look Once) Algorithms, Arduino with this system called AMS (Autonomous Mobile System), using Reinforcement Learning for this system is able to overcome pollution air that is not only efficient but also effective. This research is largely related to in-depth study of the functions of the work system that is integrated with the main concept of research, namely Reinforcement Learning.




Picture 1. Research Layout

## 2. Research Method

### 2.1 Literature Review

By reading and researching research that had previously been made but could not be done effectively and the absence of a computational system, the previous researchers only

made research that specialized in small or indoor areas. Researchers propose an air purifier system capable of recognizing AQI (Air Quality Index) in certain areas. Referring to the AQI (Air Quality Index) in low value areas, the air in the safe area, if the A QI (Air Quality Index) value is high, the system will begin the process of cleaning the air as long as the AQI (Air Quality Index) value is high so the AQI (Air value) Quality Index) becomes low, if there is an area with high value (Air Quality Index) then the tool will move to an area with high value AQI (Air Quality Index) [3] [4]. During all processes, the YOLO algorithm helps this system to detect surrounding humans and initiates cleaning of dirty air and providing pure air so that some humans and living things around can utilize this system. The entire methodology with the whole system can overcome the problem of dirty air pollution and make clean air last longer not only in supplying healthy and good air but also very well from the standpoint of the currently patented technology of 4.0. The initial approach is chemistry using ozone corona, an ozone pre-changer that is no longer good or bad and a semiconductor filter that is powered by electricity. This system has a mechanism that is safety control that is safety security [5]. This cleaner is called AIP without having computing. Then some researchers used another method, namely by using gas to purify the air, this method has two (2) types, namely POU purifiers and based on welded Ni Pellets. And the next few years researchers will use the Negative Generator [6] [7]. For technology now all cleaning tools or air purifiers are effective and competent without using AI (Artificial Intelligence) and more researchers only focus on the Indoor scale. Then a few years later air purifiers appeared using the AHP method [8]. This air purifier system uses the BAP-1700 as a complement to air purifiers, after several systems applying electrical and chemical technology appear smart air purifiers as well as the latest emerging technologies with the application of IoT [9]. In 2016, an air purifier with an intelligent bio-tank with a monitoring and air control system in the indoor house appeared. With this system, this tool aims to improve air quality in small areas with the application of IoT [10]. After that the application of IoT air purifiers is mobility in a small area which comes with a breakthrough with the application of pedestrian detection [11]. The air purifiers studied by researchers are quite similar to this only our air purifiers are applied in large scale or outdoor areas and formulations with new technologies are deep-learning and Reinforcement Learning. This system is not only an air purifier but can be combined with other functions. To support this system, one of which is an intelligent air purifier with a sweeper that has been developed [12]. With the era of Deep-Learning and Reinforcement Learning to come, it will be efficient and can develop deeper Reinforcement Learning. Deep-Learning that is used in models provides quality advantages over other technologies. This approach makes it easy for the model to work in several ways that help the robot to analyze each action [13], [14], after which the robot will realize whether it has made a mistake in the system or not and then other actions. With this every action taken by a robot is an action that has been optimized and maximized.

1. The air purifier will move from a place where the air pollution value is low to a place where the air pollution value is high.
2. The device will purify and clean the air in a place with high pollution value.
3. Providing air and purifying the air around places that humans normally visit.

Combining several Deep-Learning approaches with the Deep Quality-Network approach is used to help the system to be able to implement systems that are mobility [15], [16]. The function of robots is to move from places with low pollution to areas of high pollution without getting hit by other objects. With this application the goal is to avoid objects around [17], when the robot moves around. Pedestrian or human tracking in the surrounding area is implemented by the YOLO (You Look Only Once) algorithm, helping robots to identify living things that tend to be around and cannot get too far away [18] [19], then air purification will work if there is a pedestrian or human passing through the area. Purification or cleaning of air using Arduino and this sensor together with all the above functions, the robot must display the value of air pollution in real-time by displaying the LED screen on the robot. Research similar tools such as this "Wayu" does not apply AI to the system. In this study will be noted how to learn from errors and precision air cleaning using Reinforcement Learning [20] [21].

## 3. Findings

### 3.1 Problem

Air pollution is a serious environmental problem that is being experienced by humans with critical conditions. For the sake of making it easier to solve this problem a permanent solution is needed. There are already some effective solutions but only on a small-scale area or in an indoor space that cannot solve the problem adequately [22] [23]. Humans need to breathe good air outside the home, not only indoors, therefore this research was made. Not only outdoor air purifiers or large-scale smart sensing machines can control and control pollution in large open areas. The Procedure system consists of the latest technology in the field, namely the AI (Artificial Intelligence) system is different from some of the air purifiers that only work in the room [24] [25] [26]. By inputting the concepts of RL (Reinforcement Learning) and Deep-Learning using the YOLO Algorithm to be effective in the use of air filters. The system is supported by Arduino, it is this combination of the three formulations in the system that addresses the problem faster.

### 3.2 Research Implementation

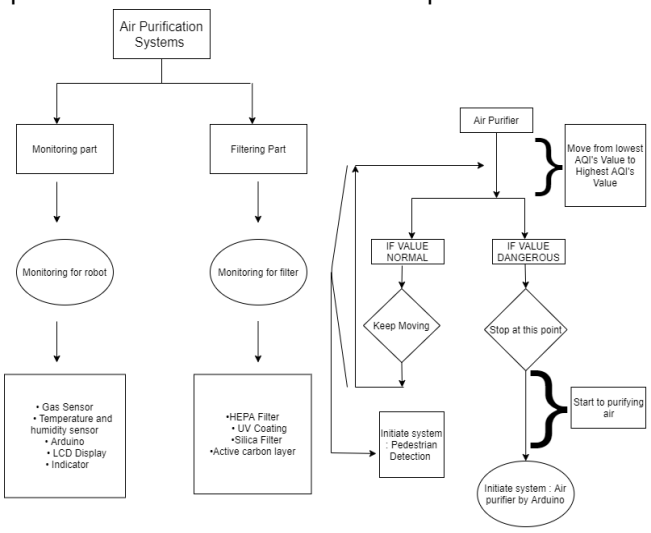
3.2.1 Reinforcement Learning Robot for Obstacle Avoidance

a. DRL Concept (Deep Learning and Reinforcement Learning)

Includes all network algorithms as a function of value. With 3 (three) problem resolutions, namely:

- Experience Replay: This method applies memory as a reminder that is intended if there is an error in the system, with this method the application of real-time pad air population values is not used in this scope.
- Reward Clipping: This method rewards clipping values on the DL (Deep Learning) system are changed by range [-1. +1]
- Target Network: Add a New DQN (Deep Quality-Network) to the System.

With this method to update the weights one of them is used to calculate the target value, in the whole process of Reinforcement Learning in applying Deep Network Neural. The environment or land, the apartment in which the robot will work as assessed in real-time by referring to the low AQI (Air Quality Index) value and high air pollution. Some countries can be a point in time.

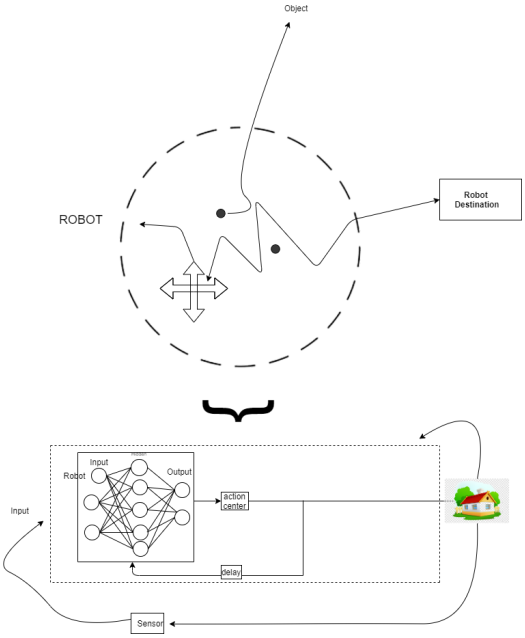



Picture 2. Entire System

3.2.2 Quality Learning (Q-Learning)

This section explains the basics of Quality Learning relating to Reinforcement Learning which aims to avoid object obstacles faced by robots.

a. Reinforcement Learning Artificial Neural Networks Architecture for Obstacles.
By explaining the Deep Q-Network in the previous section, the relationship that is related now is the problem of obstacle avoidance. Explained to the situation related to the previous problem, the robot must avoid objects in its path automatically without any uncertain conditions. Therefore, this study uses a Q-Learning approach to save all relations of action in this country, during the research the speed of all processes may be delayed due to the impact of noise to be added [27] [28] [29]. The main reason for this noise is initially and at any point during the update in the Deep Network Neural does not recognize the QQ system *, only known after the system implementation continues. To eliminate noise and increase efficiency, Replay Experience is used to record the robot's previous experience (memory experience) at each step of the tool transfer. With the generated token value Q, an Update will be performed. The following picture:




Picture 3. Architectural about Reinforcement Learning for Obstacle Avoidance.

b. Decision action and selection system
The action or decision making in Reinforcement Learning explains the action applied with the agent to be an optimal and effective action. This study explains the action space based on the Greedy algorithm, when Q (x, a) converges the value of Q, Optimal $Q$ * $(x, a)$ So the action generated through the equation is given below through greedy policy.

$$a * (x) = \arg max_{b \in a} Q(x, b)$$

When learning, agents must know to do various actions, one can choose one based on probability contribution, namely Boltzmann:

$$p=(a|x)\frac{eQ(x,a)}{T \sum eQ(x,b)/T}$$

**Where**, T = Probability of choosing, not ***greedy action.***

During the Deep Learning process for greedy action, action selection will be processed and remembered as a **Replay Experience.**

c. Quality Learning Procedures
Algorithm 1: Reinforcement Learning for Obstacle Avoidance Algorithm based on Quality Learning (Q-Learning) method.

- Initiate = Artificial Neural Network (Nn).
- Starting system air purifier system.
- Real-time extract.
- Extract Q, (x, a) for each action changing the status and real-time action to Nn (1).
- Search for the action of the given equation, : Action=max ($\boldsymbol{Q}(,\boldsymbol{a})$).
- The robot will move itself to get the status and real time value of the AQI (Air Quality Index).
- If it fails, then there is a collision and reward clipping -1 and return to the beginning again.
- target Q According to the equation: (Target Q) (x, a) = g (x, a, y) + ymax $b \in \boldsymbol{a}$ Q (y, b)
  (Q is for Quality)
  Repeat 3-8 (The robot can learn from error memory)

3.2.3 YOLO Algorithm

YOLO Algorithm is You Only Look Once Algorithms that apply neural networks or Network Neural, which are useful for detecting objects from shapes and objects by providing: YOLO algorithm in this study is used in several ways, namely:

a. YOLO algorithm in air purifiers system
   - Helps detect passengers and other objects very efficiently.
   - Once detected, the next goal is to avoid collisions on objects.
   - After that YOLO was integrated with the concept of Reinforcement Learning.
   - Once detected from YOLO the algorithm is used accurately and does not crash into other objects.

b. Introduction to Architectural Model
   In this study the Yolo algorithm was updated and used to detect human or pedestrian using the YOLO Network Model, in this study the original YOLO network contained several layers, namely two (2) pass-throughs added, namely:

   - Router Layer: Used to transfer pedestrian information from the specified layer.
   - Reorg Layer: Used to identify feature maps. This is applied in the next report.

   This method is related to pedestrian features with high resolution and low resolution. Deep Network to streamline Deep Learning as layer changes are also changed from 16 to 12 to modify and support network extracting information.

   Algorithm 2: Human at Park detection algorithm based on the YOLO algorithm
   1. First the whole picture is divided by two sides, is n X n which is (two side for picture frame)
      IF (Human = In the garden or Park [Human detected each lattice work predicts 2 detection 'B'. Framework detection for each image on value = N

x N x B.

2. For Each Box 'B', the predicted value is = (Confidence, W, X, H, Y where Y and X = Offsetting Prediction on Box (In Center)
   W, H = frame width for the entire image.
3. For Each,
   If, (The frame contains human detection. This predicts the conditional prob Pr(class | object))
4. Then, during the sensing detection, the probable prob X predicts B Confidence to get a Confidence Score of B for each detection box.

Formula (1): Pr is (class) is the probability if a human is found on the frame picture. If the IOU value is proportional to the accuracy of humans. The final result vector of each image is: equation: NxNxBx (frame) [confidence, W, Y, X, H, confidence].

3.2.4 Arduino For Purification

The dirty air filter applied in this study is based on research [30], [31]. After the air filter stops at the navigation point area due to an increase in the value of the AQI (Air Quality Index) in that area, it starts the filter, cleaning the air in that place. This cleaner uses a gas sensor and detects dirty air by applying a code to Arduino. Bad air will be considered as input to the sensor and then the output that results in the detection of dirty air in the air. When it works and displays the real-time AQI (Air Quality Index) of an area with a high AQI (Air Quality Index) value, the instrument will ring a special bell to inform that air pollution is dangerous and immediately start the system. Filtering devices and filters monitor air quality with multiple layers [32].

a. Monitor tools and air purifiers
   The monitoring sections include temperature, humidity and gas. After each calculation the results will appear on the LCD display
   - Gas sensor: Detects propane or gas content such as hydrogen, carbon, dangerous gas leaks
   - Humidity and temperature sensor: DHT11 are implemented using a capacitive humidity sensor and thermostat to check the environment.
   - Arduino: as a microcontroller-based LCD device and Atmega328, each has several analog and digital pins
   - LCD Display: Liquid crystal functions to display temperature, humidity
   - Indicators: LED Bulbs are used as bell indicators

b. Filter Section
   During the cleaning process several filters are used to ensure good system performance to clean the air. Several filters used
   - HEPA Filter: Is an air filter that effectively filters air and collects dust particles.
   - UV Coating: This second layer is the UV layer, using UV lights through some assistance to eliminate mold, kill viruses and bacteria in the air.
   - Silica Layer: This third layer is a silica layer used to help moisture in the air
   - Activated Carbon Coating: The Fourth Layer used to reduce the chemistry of carbon dioxide in the air and some gases that are harmful to health. Its functions: 1) Take the airm, 2) dump it into several layers for air filtering.

## 4. Conclusion

With this the researchers conclude, environmental problems, especially dirty air pollution that has been running for years - causing unstable weather and climate and causing the impact of critical health problems for all humans. This problem continues to be

the demand of all humans and researchers in order to overcome this problem massively and permanently and effectively. This research formulates the Learning Machine and Smart Sensor, Self-driving (Automatic Machine), into this system. The purpose of research and manufacture of this system is to overcome air pollution in large indoor or indoor areas and areas of land where many people live, this tool can move - move from a place with a value of AQI (Air Quality Index) index less to a place with AQI value ( The Air Quality Index) index is high based on the real-time index value of the AQI (Air Quality Index) and Smart Sensor on this system. By implementing Deep Learning, after that cleaning and filtering air using Arduino and by applying the YOLO system to this design, this system can detect pedestrians or pedestrians while providing good air for them. This is the way this design works and produces good air anywhere outside the room. This research and design was inspired by "Deep-Learning" which made this design better than the previous researchers' design. It does not only focus on "Deep-Mind" but also YOLO's algorithm to detect humans around and together with air purification carried out jointly by Arduino which provides a small sample of research on research. With this tool the researchers hope to build an automatic air purifier (self-driving) with high mobility that can purify and clean the air outside the room.

**References**


[1] T. Hariguna, U. Rahardja, and A. Ruangkanjanases, “The impact of citizen perceived value on their intention to use e-government services: an empirical study,” *Electronic Government, an International Journal*, vol. 16, no. 4, pp. 426–440, 2020.

[2] U. Rahardja, Q. Aini, M. D. A. Ngadi, M. Hardini, and F. P. Oganda, “The Blockchain Manifesto,” 2020. doi: 10.1109/ICORIS50180.2020.9320798.

[3] B. P. Singh, V. S. Bisht, P. Bhandari, and K. S. Rawat, “Thermo-Fluidic Modelling of a Heat Exchanger Tube with Conical Shaped Insert having Protrusion and Dimple Roughness,” *Aptisi Transactions on Technopreneurship (ATT)*, vol. 3, no. 2, pp. 127–143, 2021.

[4] C. Lukita, M. Hatta, E. P. Harahap, and U. Rahardja, “Crowd funding management platform based on block chain technology using smart contracts,” *Journal of Advanced Research in Dynamical and Control Systems*, vol. 12, no. 2, 2020, doi: 10.5373/JARDCS/V12I2/S20201236.

[5] M. Wang, M. Duan, and J. Zhu, “Research on the security criteria of hash functions in the blockchain,” in *Proceedings of the 2nd ACM Workshop on Blockchains, Cryptocurrencies, and Contracts*, 2018, pp. 47–55.

[6] U. Rahardja, I. J. Dewanto, A. Djajadi, A. P. Candra, and M. Hardini, “Analysis of Covid 19 Data in Indonesia Using Supervised Emerging Patterns,” *APTISI Transactions on Management (ATM)*, vol. 6, no. 1, pp. 91–101, 2022.

[7] N. F. Rozy, R. Ramadhiansya, P. A. Sunarya, and U. Rahardja, “Performance Comparison Routing Protocol AODV, DSDV, and AOMDV with Video Streaming in Manet,” *2019 7th International Conference on Cyber and IT Service Management, CITSM 2019*, 2019, doi: 10.1109/CITSM47753.2019.8965386.

[8] B. Rawat, N. Mehra, A. S. Bist, M. Yusup, and Y. P. A. Sanjaya, “Quantum Computing and AI: Impacts & Possibilities,” *ADI Journal on Recent Innovation*, vol. 3, no. 2, pp. 202–207, 2022.

[9] H. T. Sukmana, T. Hariguna, N. Lutfiani, and U. Rahardja, “Exploring the moderating effect of technology readiness of user intention in the context of mobile payment service,” *International Journal of Advanced Trends in Computer Science and Engineering*, vol. 8, no. 1.5 Special Issue, pp. 249–257, 2019, doi: 10.30534/ijatcse/2019/4481.52019.

[10] I. Handayani, U. Rahardja, E. Febriyanto, H. Yulius, and Q. Aini, “Longer Time Frame Concept for Foreign Exchange Trading Indicator using Matrix Correlation Technique,” in *2019 Fourth International Conference on Informatics and Computing (ICIC)*, 2019, pp. 1–5.

[11] A. Kumar, P. Bhandari, and K. S. Rawat, “Numerical Simulation of Solar Air Heater using Paraffin Wax-Aluminum Compound as Phase Changing Material,” *Aptisi Transactions on Technopreneurship (ATT)*, vol. 3, no. 2, pp. 164–170, 2021.

[12] Q. Aini, U. Rahardja, I. Handayani, M. Hardini, and A. Ali, "Utilization of google spreadsheets as activity information media at the official site alphabet incubator," *Proceedings of the International Conference on Industrial Engineering and Operations Management*, no. 7, pp. 1330–1341, 2019.
[13] W. Anggraini, "Deep Learning Untuk Deteksi Wajah Yang Berhijab Menggunakan Algoritma Convolutional Neural Network (CNN) Dengan Tensorflow." UIN Ar-Raniry Banda Aceh, 2020.
[14] T. Nurhikmat, "Implementasi deep learning untuk image classification menggunakan algoritma Convolutional Neural Network (CNN) pada citra wayang golek," 2018.
[15] Q. Aini, I. Handayani, and F. H. N. Lestari, "Utilization Of Scientific Publication Media To Improve The Quality Of Scientific Work," *Aptisi Transactions on Management (ATM)*, vol. 4, no. 1, pp. 1–12, 2020.
[16] A. Alwiyah, C. Greisy, and A. Afitri, "Implementation Of Information Systems On E-commerce Websites As Media To Deliver Information," *Aptisi Transactions On Technopreneurship (ATT)*, vol. 1, no. 2, pp. 127–133, Aug. 2019, doi: 10.34306/att.v1i2.63.
[17] Q. Aini, T. Hariguna, P. O. H. Putra, and U. Rahardja, "Understanding how gamification influences behaviour in education," *International Journal of Advanced Trends in Computer Science and Engineering*, vol. 8, no. 1.5 Special Issue, pp. 269–274, 2019, doi: 10.30534/ijatcse/2019/4781.52019.
[18] Q. Aini, S. Riza Bob, N. P. L. Santoso, A. Faturahman, and U. Rahardja, "Digitalization of Smart Student Assessment Quality in Era 4.0," *International Journal of Advanced Trends in Computer Science and Engineering*, vol. 9, no. 1.2, pp. 257–265, Apr. 2020, doi: 10.30534/ijatcse/2020/3891.22020.
[19] D. Apriani, A. Williams, U. Rahardja, A. Khoirunisa, and S. Avionita, "The Use of Science Technology In Islamic Practices and Rules In The Past Now and The Future," *International Journal of Cyber and IT Service Management*, vol. 1, no. 1, pp. 48–64, 2021.
[20] T. Crawford, P. Fritz, and T. Wainman, "Changes in IAQ Caused By Corona Discharge Air Cleaner.," *ASHRAE Journal*, vol. 60, no. 12, pp. 64–68, 2018.
[21] A. U. Hasanah, Y. Shino, and S. Kosasih, "The Role Of Information Technology In Improving The Competitiveness Of Small And SME Enterprises," *IAIC Transactions on Sustainable Digital Innovation (ITSDI)*, vol. 3, no. 2, pp. 168–174, 2022.
[22] B. E. Sibarani, "The Influence of Curriculum Based on the Indonesian National Qualifications Framework (KKNI) on the Quality of Student Learning (Studies on Students at the State University of Medan)," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 3, no. 2, pp. 171–180, 2021.
[23] W. Lan, J. Dang, Y. Wang, and S. Wang, "Pedestrian detection based on YOLO network model," in *2018 IEEE international conference on mechatronics and automation (ICMA)*, 2018, pp. 1547–1551.
[24] L. Chandra, Amroni, B. Frizca, Q. Aini, and U. Rahardja, "Utilization Of Blockchain Decentralized System In Repairing Management Of Certificate Issuance System," *Journal of Advanced Research in Dynamical and Control Systems*, vol. 12, no. 2, pp. 1922–1927, 2020, doi: 10.5373/JARDCS/V12I2/S20201235.
[25] U. Rahardja, A. N. Hidayanto, T. Hariguna, and Q. Aini, "Design Framework on Tertiary Education System in Indonesia Using Blockchain Technology," *2019 7th International Conference on Cyber and IT Service Management, CITSM 2019*, pp. 5–8, 2019, doi: 10.1109/CITSM47753.2019.8965380.
[26] Q. Aini, U. Rahardja, N. P. L. Santoso, and A. Oktariyani, "Aplikasi Berbasis Blockchain dalam Dunia Pendidikan dengan Metode Systematics Review," *CESS (Journal of Computer Engineering, System and Science)*, vol. 6, no. 1, pp. 58–66, 2021.
[27] R. Supriati, E. R. Dewi, D. Supriyanti, and N. Azizah, "Implementation Framework for Merdeka Belajar Kampus Merdeka (MBKM) in Higher Education Academic Activities," *IAIC Transactions on Sustainable Digital Innovation (ITSDI)*, vol. 3, no. 2, pp. 150–161, 2022.

[28] A. S. Bist, B. Rawat, U. Rahardja, Q. Aini, and A. G. Prawiyogi, “An Exhaustive Analysis of Stress on Faculty Members Engaged in Higher Education,” *IAIC Transactions on Sustainable Digital Innovation (ITSDI)*, vol. 3, no. 2, pp. 126–135, 2022.
[29] I. Faridah, F. R. Sari, T. Wahyuningsih, F. P. Oganda, and U. Rahardja, “Effect Digital Learning on Student Motivation during Covid-19,” in *2020 8th International Conference on Cyber and IT Service Management (CITSM)*, 2020, pp. 1–5.
[30] N. Sany, G. K. Hanum, and S. Sutrisno, “Perancangan Aplikasi Pendeteksi Kebersihan Air Dalam Tangki Air Menggunakan Smartphone Berbasis IoT,” *Technomedia Journal*, vol. 4, no. 2 Februari, pp. 235–247, 2020.
[31] M. Y. Jabarulla and H.-N. Lee, “A blockchain and artificial intelligence-based, patient-centric healthcare system for combating the COVID-19 pandemic: opportunities and applications,” in *Healthcare*, 2021, vol. 9, no. 8, p. 1019.