

# Advancement of Banking and Financial Services Employing Artificial Intelligence and the Internet of Things

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## Abstract

Cryptocurrencies and financial systems have become prominent in recent years. Artificial Intelligence is needed to decrease investing risk, and anticipate price, trend, portfolio creation, and fraud. The paper highlights current AI research on Bitcoin, the most prominent cryptocurrency. The article reviews AI and IoT approaches related to cryptocurrencies and Bitcoin. In addition, a number of potential study possibilities and areas for improving the effectiveness of the findings were noted. AI and cybersecurity have grown rapidly in recent years. Its adoption has greatly benefited finance, institutions, markets, and law. AI simulates intelligent human-like devices. Finance AI is altering money communication. It optimizes credit judgements, marketing, quantitative analysis, as well as economic risk management for the financial business. This study examined artificial intelligence's current effects. It's about AI's attractiveness, conflict, possibilities, and career impact. The research study utilizes AI to help banks produce funds and deliver excellent customer service. The rising Indonesian banking sector—BRI, BNI, Mandiri, etc. has digitally incorporated chat-bots that help clients.

**Keywords:** Artificial Intelligence, Machine Learning, Internet of Things, Financial and Banking Services.

## 1 Introduction

Although artificial intelligence has been around for a longer time at this point, the level of interest in, and progress made within, the topic has exploded considerably in the last ten years. As a result of declining costs associated with computation, ever more powerful computers are being manufactured. These computers do not lack the necessary hardware and computing capacity to make intelligent conclusions that are right based on the data that they have acquired.

The development of artificial intelligence will transform not just the way of life but also the way people carry out even the most basic of responsibilities. While this is happening, the Internet of Things (IoT) is quickly becoming more widespread, and it will unavoidably grow to depend on artificial intelligence. The data that is gathered as a result of the interconnection of all of the computational

devices in our immediate environment is far too extensive for human manipulation, but it can be easily understood and analysed by a computer, which can then determine how to make the most effective use of the data (Bhuvana et al., 2016). Both of these occurrences will have an influence not only on our lives but also on the many business sectors of the future. They are destined to mold and transform the future. The provision of financial services stands out as an industry that is quite likely to reap huge benefits.

The Internet of Things is no longer only an idea. It has become a reality. Because a seamless and helpful experience can only then be delivered to the user, manufacturers have begun releasing goods that are meant to function in tandem with one another. In addition, manufacturers are attempting to improve interoperability across devices produced by various suppliers (Catalini et al., 2018). The seamless integration of these intelligent gadgets into our way of life, as well as their interaction with one another, is what will make them have such a significant influence on the way people manage their finances in the future. The fields of banking, healthcare, and insurance stand to gain the most from this development which will also result in improved and expanded opportunities for integrating IoT technologies with cutting-edge financial goods and services (Jewandah, 2018).

### **1.1 Personalized Financial Services**

AI is used by automated financial advisers to provide assistance to users in the management and decision-making processes associated with their various financial concerns. These robo advisors keep an eye on the user's financial objectives as well as the stock market and then provide recommendations to the user on which stocks or bonds they should purchase or sell. Applications powered by AI that are downloaded, installed, and operated on user devices analyse vast volumes of data in order to provide appropriate financial advice and projections (Chakraborty et al., 2017). Intelligent wallets study its users' routines and requirements via the use of artificial intelligence and then provide feedback on their spending so the user may acquire self-control.

### **1.2 Healthcare**

There is now high-tech equipment available on the market that can monitor every facet of a person's health. These gadgets are only going to grow more capable and smarter as Internet of Things technology advances. Monitoring the data generated by these devices will make it possible to monitor the user's health and respond appropriately in circumstances in which intervention may be required. This procedure will also make it possible for health insurance companies to be better prepared in advance and to begin treating and preventing illnesses at an earlier stage, before they develop into chronic conditions (EY, February 2017). Not only will this result in lower costs for patients as well as for the healthcare providers, but it will also enable dynamic pricing in insurance rates that are dependent on the history of a person's health and fitness.

### **1.3 Car Insurance**

The Internet of Things will make it possible for insurance firms to keep track on drivers and their cars, enabling them to monitor and record data such as the number of miles travelled, driving patterns, variations in speed, as well as the time of day drivers are out on the road. This will result in better premium rates for customers who have a history of safe driving.

## **1.4 Home Insurance**

Even in today's day and age, home insurance companies are offering financial incentives to clients who install devices that monitor their property in order to encourage them to do so. Intelligent tracking systems have the ability to identify and alert users to the presence of possible dangers, such as water leaks (Agarwal et al., 2019), carbon monoxide levels, and smoke in the event that a fire breaks out. Predicting future occurrences, like as weather patterns in a certain geographical region, may be done using analytics that are based on data from the internet of things (Goel & Mehta, 2017). Drones are also being used by insurance firms in the event of a catastrophe to determine the extent of the damage caused by the event. All of this will make it possible to offer better pricing for customers and service providers alike.

## **1.5 IoT in Banking**

Customers will have the ability to use a variety of devices to complete transactions and make queries. Banks will have the ability to gather information and track patterns of behaviour in order to give better and more reliable financial guidance and services.

The Internet of Things has an impact on many facets of our financial life, including those listed above. Banks will be able to provide banking and financial services via the use of data and sensors gleaned from Internet of Things devices. For instance, banks are able to keep tabs on the user's company and track its growth in order to guarantee that the loan will be repaid on time (Chen, 2010). However, it is difficult for people to handle all of this data from thousands of clients that is pouring into the bank's system, and it is also hard to put this data to any meaningful use without utilising significant computer capacity to infer and forecast behaviours and patterns. Computers will be used to organise and gather this data for this reason, and artificial intelligence will be used so that the most may be gained from it (Kaur et al., 2020). Without artificial intelligence, the Internet of Things will not be able to provide all of the potential advantages it promises.

# **2 Methodology**

## **2.1 Selection of Papers**

Following the best practices for a "Systematic Literature Review (SLR)", researchers selected the database as well as keywords based on a thorough literature review. Scopus and WoS provided research publications. These databases were chosen to complement each other and enable access to scientific papers. This is the first stage in assuring high-quality article inclusion. "Artificial intelligence OR machine learning OR deep learning OR neural networks OR Intelligent systems AND Bank AND consumer OR customer OR user" searched the title, abstract, and keywords. Grounded on literature analysis, the keywords included different business operations, including banking. 11,684 documents were found. After filtering by "English," "article only," and "Management, Business Finance, accounting, and Business," 626 papers were found.

This research employed the recommended reporting technique for systematic reviews as well as meta (PRISMA) to follow a structured approach and monitor data over SLR phases (Moher et al., 2009). Once extracted, each of the 628 articles were given a unique ID number to distinguish it throughout the analytic procedure. "ID number," "database source," "Author," "title," "Abstract," "keywords," "Year," Australian Business Deans Council (ABDC) Journals, and keyword proof fields were used to arrange the data.

The following papers were excluded: a) All recopy documents in the dataset were removed; b) for a second quality inspection, publications not published in ABDC journals were excluded to make sure a standard of quality for inclusion in the review, Query a practice coherent with other current SLRs; c) to paired comparisons of articles in the database, AI technical computation papers were eliminated. 44 publications were chosen for analysis.

## 2.2 Thematic Analysis

Thematic analysis organizes research subjects and finds, analyses, and reports data patterns. Manually categorizing the papers into themes and sub-themes after Chatha and Butt (2015). Second, Leximancer assisted manual categorization. These two methods strengthen study results.

Leximancer, a text-mining program, finds concept and co-occurrences to offer intellectual and relational information. After submitting all 44 papers to Leximancer, researchers added "English" to the stop list to exclude terms such "or/and/like" that was irrelevant to emerging themes. "pp.," "Figure," and "re" were manually deleted. Finally, researchers produced two maps: a conceptual map that highlighted major themes and ideas, and a relational cloud map that connected concepts.

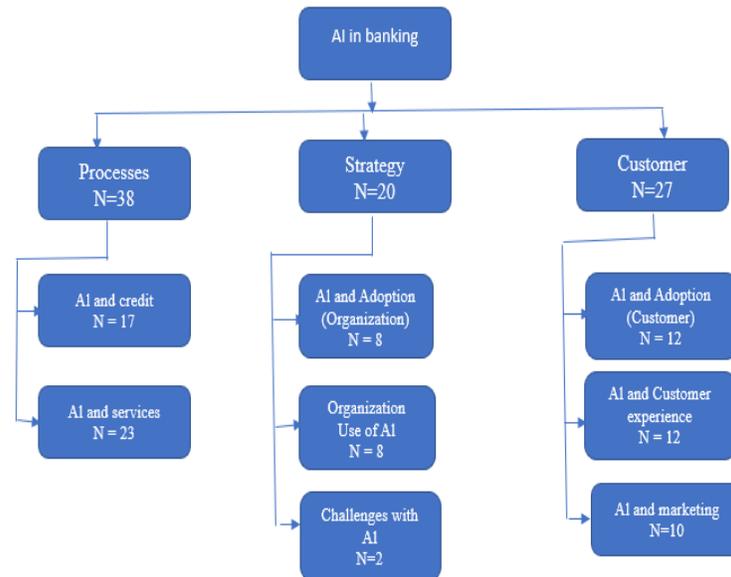


Figure 1: Thematic Map

## 3 Result and Discussion

RQ 1: What themes and sub-themes do earlier literature on AI in banking reveal?

### 3.1 Thematic Analysis

Theme identification started with a logical technique to group content into specified categories. Inductively identifying sub-themes and providing context for the larger topics followed. The core topics were determined by evaluating relevant systematic literature reviews, finding keywords and creating codes (themes) from chosen publications, then studying titles, abstracts, and complete papers, if required, to determine suitable allocation within these themes. Strategy, Procedures, and Customers emerged from the process.

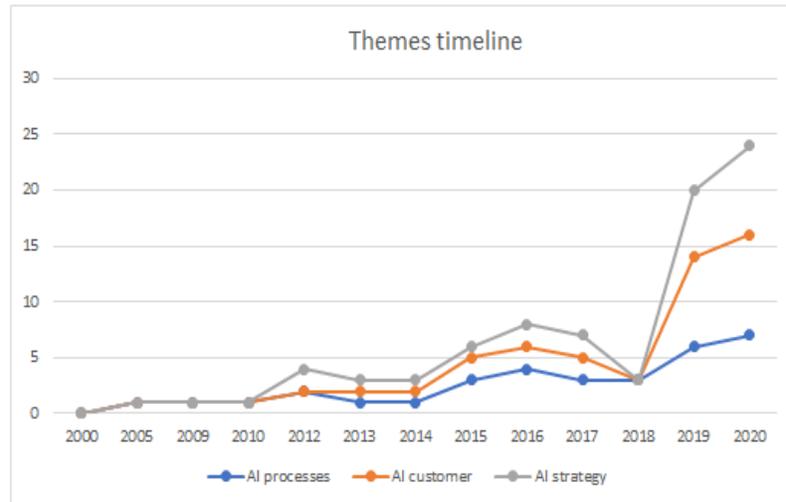


Figure 2: Themes by Timeline

### 3.2 Strategy

Early research in the Strategy area (21 publications) (See Figure 1) indicates organisational AI applications and acceptance. AI's data mining has predicted bankruptcy and optimised risk models. AI-driven organisational effectiveness technologies provide financial organisations higher business efficiency than conventional risk model building and planning. 14 papers address how banks employ AI to create organisational value. AI drives company strategy and internal business activity (Leo et al., 2019). Medhi and Mondal (2016) suggested using AI to predict outsourcing success. These results show that AI tools may drive efficient organisational strategies, but deploying them requires human resources and organisational cultural changes. Recently, financial organisations have started debating AI implementation problems. Three articles address organisational difficulties, including AI integration, under the sub-theme Challenges with AI. To sustain AI in banking, Mohapatra (2020) describes human-machine interface problems. The results suggest that adoption and integration will be one of the biggest opportunities in the future, despite most current study focusing on technology. Six studies addressed motivation and organisational hurdles to AI adoption in financial organisations. Fountain identified worker fear, corporate culture, and financial limits as organisational adoption hurdles. Organizational applications of AI dominated the Strategy topic, highlighting the constant emphasis on technological development over system integration. The literature on organisational problems of AI deployment is few.

### 3.3 Processes

After the dot-com bust and Web 2.0, financial AI research began in the Processes area (34 publications). AI predictions of stock market performance and stock selection may have caused this. At this point, banking AI literature focused on credit and loan analysis. Early AI deployment requires rapid, dependable AI infrastructure. Neural networks helped Baesens forecast loan defaults as well as premature repayments. "Ince and Aktan (2009)" demonstrated that artificial intelligence-driven data mining was more successful than conventional approaches for credit score analysis. Khandani found machine-learning models useful in evaluating consumer credit risk. AI and credit (15 articles) uses ML and data mining to enhance credit assessment, study, and granting. Dhanabalan & Sathish (2018) used data mining neural networks to create a consumer credit rating model. After 2013, research into how AI

enhances non-credit analytic procedures has increased. AI and services (20 articles) tackles process optimization and augmentation using AI. Institutions enhance internal service procedures using technology. Soltani used ML to enhance appointment preparation and decrease service period. Our results show that AI may improve banking procedures, but practical research on technology integration in the financial sector is lacking. While credit risk research abounds, other financial products are understudied.

### 3.4 Customers

Researchers found that AI is being used more to study consumer acceptance of digital banking services in the Customer topic (26 publications). In the eleven articles that make up the subtheme AI and Customer Adoption, artificial intelligence (AI) is used as a research methodology to examine the elements that encourage or discourage customers from adopting digital banking technologies. Arif examined client hurdles to online banking adoption using a neural network. Belanche examine issues affecting banking AI technology adoption. Payne examines the drivers of artificial intelligence-enabled mobile banking adoption. Additionally, bank marketers may utilize AI to better target, segment, as well as position their banking goods and services (Pathak et al., 2016). AI is used for client segmentation, marketing model building, and more successful marketing campaigns in the nine articles on AI and marketing. Smeureanu suggested segmenting bank clients using machine learning. Schwartz examined allocation of resources in targeted ads using AI. AI's impact on customer experience has been studied more recently. AI and customer experience (Papers 11) addresses using AI to improve banking services and customer experience. Trivedi (2019) examined the influence of banking chatbots on customer knowledge.

Table 1 lists the number of articles in subjects and sub-themes. Customer (59%), Processes (77%), and Strategy (48%) papers were the most common. From 2013, Processes, Strategy, as well as Customers interacted more. Since 2016, process-customer research has increased while since 2017, customer-strategic papers have increased (Figure 2).

Table 1: Thematic count

Sr. No.	Thematic classification	Number of papers
1	AI processes	38
2	AI customer	27
3	Adoption of AI in financial institutions	08
4	AI and use of services	23
5	Adoption of AI-consumer perspective	12
6	Challenges with AI	02
7	AI and credit	17
8	AI and customer experience	12
9	Organizational uses of AI-strategy perspective	17
10	AI strategy	20
11	AI and marketing	10

### 3.5 Leximancer Analysis

Leximancer analysed all research papers. Two primary classes and 56 ideas were produced. "Concept" means a group of connected words. Concept co-occurrence is the extent to which two ideas occur simultaneously. The word "association percentage", however, is the conditional likelihood that two ideas will occur together.





credit. Customer interactions with banking touchpoints are the front-stage (e.g., chatbots). Back-stage activities assist customer-facing front-stage actions. Support mechanisms assist backstage and organisational relationships. This section describes how to apply for credit solutions online and uses literary samples to demonstrate AI integration.

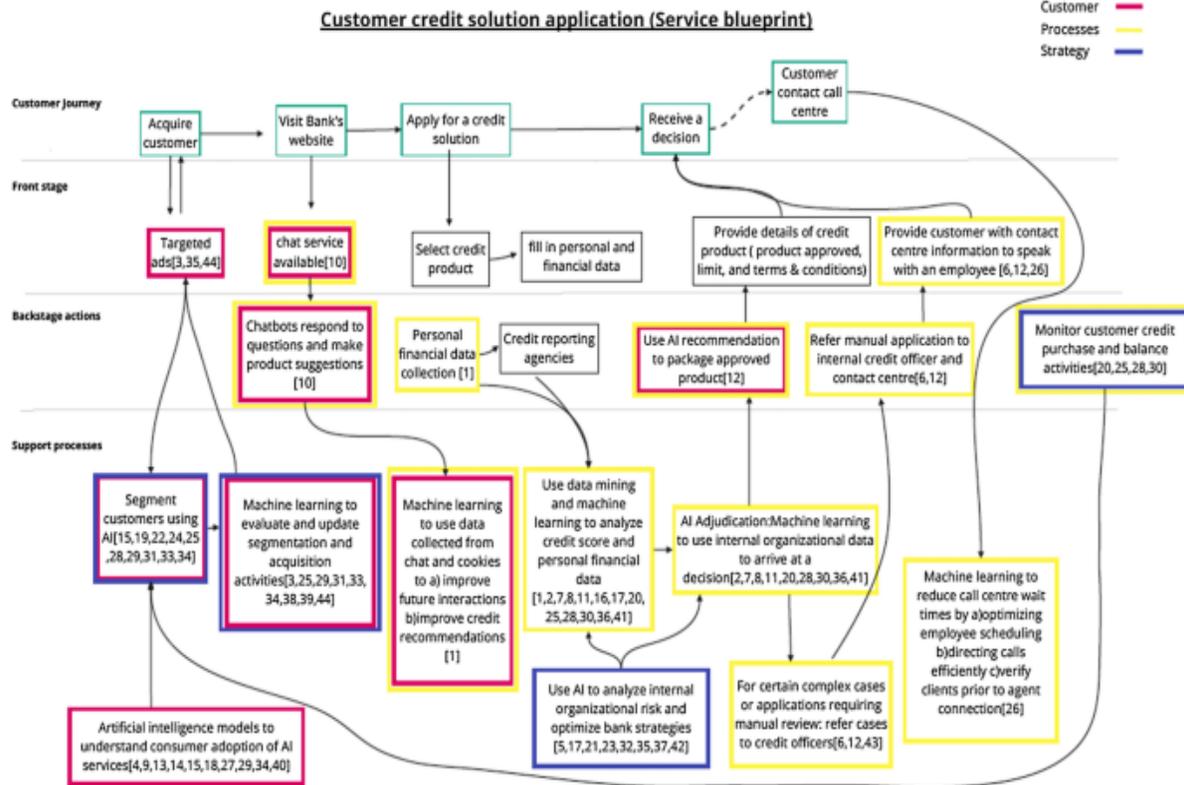


Figure 5: Credit Application Process

### 3.7 Acquire Customer

Customer acquisition, credit decision, and post-decision follows. Targeting consumers to arrive on the website and become active customers is the acquisition process. Support operations now incorporate AI to better understand clients' banking adoption patterns.

### 3.8 Visit Bank's Website to Apply for a Credit Solution

At this point, banks want website visitors to apply for credit. Robo-advisors will assist clients choose a credit solution that suits their banking requirements and qualifications. A robo-advisor may assist clients choose the right solution after collecting basic individual fiscal information and promptly confirming it with credit reporting bureaus. Personalization moderates information, network, and service quality to provide a smooth chatbot user experience, according to Trivedi. Robo-advisors can examine bank accounts and solve problems. Then, machine learning will analyse the data to improve the product and client experience. Kaur and Shirohi (2013) optimised data from several channels using machine learning to provide inclusive credit recommendations. While the suggested procedure benefits consumers and banks, many customers are reticent to disclose their data, therefore confidence in the bank is essential to improving customer knowledge.

### 3.9 Obtain a Decision

Data mining and artificial intelligence will optimise credit choices after online data collection. Robo-advisors provide credit decisions at this point. Traditional credit judgments take two weeks since the request travels through the advisory system, underwriting, and back to the consumer. AI gives customers rapid credit decisions, saving time and empowering them. Decisions should balance organizational risk, profit, and financial inclusion. Khandani used machine learning to forecast clients' credit risk (Ng, 2016). Koutanaei suggested a “data mining technique” to boost credit score certainty. Mall (2018) employed a neural network to analyse defaulting customers' behaviour to reduce credit risk and boost loan-providing banks' profits.

### 3.10 Customer Help Line

Researchers describe the human-AI interaction then. Xu observed that consumers prefer people for high-complex jobs, thus manual review cases must be reviewed by humans since AI may make mistakes or misunderstood one of the “C's of credit”. Artificial intelligence helps clients and enterprises, but Jakšič and Marinč (2019) argue that relationship banking gives financial institutions a competitive edge. Optimizing financial channels can include AI now. Soltani (2019) suggested using ML to improve appointment development and minimise facility time in banks.

## 4 Conclusion

AI, famed for its adaptability, has excellent information-based decision-making abilities. These devices can react to context and emotion. AI encrypts well and tracks questionable activity. It let clients choose loan amounts at attractive interest rates. Based on prior contacts, it understands consumers and their behaviour better. AI is improving daily to make banking security a non-issue. Expertise and proper use can encrypt completely. Using AI intelligently may speed up everything. It self-regulates and understands emotions. Economizing saves banks millions of money. Since cryptocurrency and Bitcoin are digital currencies, it is crucial to limit investment risk, make accurate predictions, and safeguard it from fraud. Better cryptocurrency prediction and outcomes are being researched. AI and ML are being used. Discussed were AI and ML methods. Long Short-Term Memory Model, Support Vector Machine, and Artificial Neural Network performed best overall. LSTM models operate well with short-term data, whereas neural network models need longer-term data. Cryptocurrency and Bitcoin are more market-driven, therefore emotive analysis and AI-based price prediction models may include them. A novel cointegration method uses other cryptocurrency data to forecast Bitcoin's future.

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### Authors' Contributions

All authors contributed toward data analysis, drafting and revising the paper and agreed to be responsible for all the aspects of this work.

### **Declaration of Conflicts of Interests**

Authors declare that they have no conflict of interest.

### **Consent for Publication**

All authors read and aware of publishing the manuscript in Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications

### **Data Availability Statement**

The database generated and /or analysed during the current study are not publicly available due to privacy, but are available from the corresponding author on reasonable request.

### **Declarations**

Author(s) declare that all works are original and this manuscript has not been published in any other journal.

### **Reference**

- [1] Agarwal, B., Agarwal, H., & Talib, P. (2019). Application of artificial intelligence for successful strategy Implementation in Indias Banking Sector. *International Journal of Advanced Research*, 7, 157-166.
- [2] Banking in the age of disruption, | EY, February 2017. <https://www.scribd.com/document/456214666/ey-banking-in-the-age-of-disruption-pdf#>
- [3] Bhuvana, M., Thirumagal, P.G., & Vasantha, S. (2016). Big data analytics-a leveraging technology for Indian commercial banks. *Indian Journal of Science and Technology*, 9(32), 1-5.
- [4] Catalini, C., Foster, C., & Nanda, R. (2018). *Machine intelligence vs. human judgement in new venture finance*. Mimeo.
- [5] Chakraborty, C., & Joseph, A. (2017). Machine learning at central banks, 1-85.
- [6] Chen, H. (2010). Business and market intelligence 2.0, Part 2. *IEEE Intelligent Systems*, 25(2), 74-82.
- [7] Dhanabalan, T., & Sathish, A. (2018). Transforming Indian industries through artificial intelligence and robotics in industry 4.0. *International Journal of Mechanical Engineering and Technology*, 9(10), 835-845.
- [8] Goel, S.K., & Mehta, N. (2017). A Survey on the role of artificial intelligence in FinTech. *International Journal of Innovative Research in Computer and Communication Engineering*, 5(6), 11809-11813.
- [9] Jewandah, S. (2018). How artificial intelligence is changing the banking sector—A case study of top four commercial Indian banks. *International Journal of Management, Technology and Engineering*, 8(7), 525-530.
- [10] Jewandah, S. (2018). How artificial intelligence is changing the banking sector—A case study of top four commercial Indian banks. *International Journal of Management, Technology and Engineering*, 8(7), 525-530.
- [11] Kaur, D., Sahdev, S.L., Sharma, D., & Siddiqui, L. (2020). Banking 4.0: The influence of artificial intelligence on the banking industry & how ai is changing the face of modern-day banks. *International Journal of Management*, 11(6), 577-585.
- [12] Kaur, N., & Sirohi, R. (2013). Effect of rupee depreciation on common Man. *International Journal of Scientific and Research Publications*, 3(10), 1-14.

- [13] Leo, M., Sharma, S., & Maddulety, K. (2019). Machine learning in banking risk management: A literature review. *Risks*, 7(1), 1-22.
- [14] Lawal, S., & Krishnan, R. (2020). Policy Review in Attribute Based Access Control-A Policy Machine Case Study. *Journal of Internet Services and Information Security*, 10(2), 67-81.
- [15] Ng, A. (2016). What artificial intelligence can and can't do right now. *Harvard Business Review*, 9(11), 1-4.
- [16] Pathak, M.A., Kamalakar, K., Mohapatra, S., & Nagaraj, U. (2016). Development of control software for stair detection in a mobile robot using artificial intelligence and image processing. *International Journal of Computer Engineering and Technology*, 7(3), 93-98.

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