Microprocessors and Microsystems 82 (2021) 103935

Contents lists available at ScienceDirect

Microprocessors and Microsystems

journal homepage: www.elsevier.com/locate/micpro

Research on prepaid account financing model based on embedded system and Internet of Things

Xiaoyi Zhang [a], Yongsheng Wang [b,*]

[a] School of Accounting, TongLing University, Tongling, Anhui 244061, China
[b] School of Mathemmtics and Computer Science, TongLing University, Tongling, Anhui 244061, China

ARTICLE INFO

Keywords:
K means algorithm
Embedded systems
Internet of Things
Financial management
Prepaid accounting system

ABSTRACT

Internet of Things (IoT) network interconnection to create objects and things will play the Internet to play an active role in the global network in the future. For the Internet of Things, which is widely adopted through funding models, it must be trusted in the IoT security infrastructure. Efficiently and Securely IoT is very important to define how each other can communicate with remote servers and get Exchange account information. Prepayments for effective financial management and an important choice for financial IoT for service providers and customers. However, it must be supported by real-time credit checking and costing. Internet resources are consumed by these real-time action stuff providers and impose high costs on the old system. To solve this problem, to propose the K Means Algorithm scalable accounting solutions, where the user is hosted each occupies a prepaid account, constitute the components of embedded systems. Based on each of our prepaid billing components' supervision, it is at the same time consumed by the embedded system of all services, based on the calculation of the service packages consumed by the customer. Prepaid accounts are reassigned when the customer had sufficient credit to supplement their use and are allocated based on IoT services' consumption. This work aims to reduce the cost of pre-paid services and ensure that service delivery is not to interfere with the charging unit. Also, embedded systems' theoretical and experimental analysis shows that this work can store long-lived services on the Internet of Things to provide inexpensive accounting solutions.

1. Introduction

The prepaid card market is the most dynamic and fastest-growing retail financial services industry parts. Based on different business models than traditional credit and debit cards, prepaid cards are "previous wages" as debit cardholders, rather than the product of the future purchase of goods or services once paid by the cardholder needs. Or credit cardholders who pay after purchase, progress has been made. The early prepaid model essentially eliminates the risk of default of the issuing bank by requiring cardholders to pay. As a result, the bank can be more flexible, widely distributed, credit may be no formal banking relationships, and risk and bring strong contribution records by the consumer associated with these cards less attention. The Internet of Things (IoT) is also exploding again, as it makes human work easier and more profitable.

Financial analysis is typically used as the basis for the development of this feature. It also follows these two developments in its financial and accounting functions. After World War II, it became a basic rule from the introduction of financial management and accounting functions until it became an integral part of the management of the church of finance and autonomy specialize in finance and business.

It can be said that the concept of quantitative analysis used in the second half of the 20th century as a result of the evolution of financial functions in the fields of business and financial decision making. And it uses a quantitative method to analyze phenomena and behaviors during use. Programs such as investment, relationships between loans and variables, and the establishment of financial investment portfolios, such as how an organization and its activities and the direction of controlling its activities and decisions are used to organize activities.

2. Related work

To support rich media services, mobile network operators can launch services platforms to support a new adaptive charging mode, different from the most simple voice service for charging. The traditional man is a flexible, efficient prepaid billing solution, provided [1] service providers

* Corresponding author.
E-mail address: tlxy2020@163.com (Y. Wang).

https://doi.org/10.1016/j.micpro.2021.103935
Received 10 December 2020; Received in revised form 31 December 2020; Accepted 5 January 2021
Available online 8 January 2021

enter the entire market. The prepaid meter is a new and improved version of the traditional embedded system. The embedded system has drawbacks such as its payment down, billing overflow (bill loss, high accounts receivable / sales, and simple meter tempering). These shortcomings have led to the installation of new weighing systems around the world. The installation of prepaid meters in Bangladesh began in 2005, and people in this country have begun to use prepaid meters [2]. It focuses on the commercial impact of prepaid meters on technology and distribution systems. Prepaid meter systems have been found to increase tax revenues, reduce system losses and improve system reliability. Electricity is necessary for economic growth, an important factor in poverty reduction and social development. With a stable and economically viable distribution system, the prepaid weighing system's effective and reliable tax system is clear. It is the most effective means of a reliable, improved power system because it reduces most [3].

Weighing an important technical advance, effective demand-side management can be. However, the successful use of this technology depends on a good user experience. Therefore, consumer awareness must be in the early stages of development, even before considering this technology's deployment—prepaid two power-weight consumer research conducted for the state in the Philippines [4]. In the first study, the results were through applying the Technology Acceptance Model (TAM) to consumers' perception of ease of use, practicality, and their economy against a prepaid metric, which in line with their intentions. Showed that are using the overall attitude. Use the associated prepaid meter. A second study on the characteristics of basic prepaid weighing systems [4] emphasizes the results of consumer preference.

In developing countries, utilities face the difficulty of collecting electricity bills on a full scale. Therefore, prepaid weighing systems are becoming more and more popular for securing collections in buildings. However, this does not take into account unauthorized energy use, as these cannot be measured. This article forms the framework for intelligent systems for prepaid energy metering solutions. It is based on collecting electrical energy data from the consumer's source end [5]. Similarly, meter commands are connected to the consumer from the source. This development aims to control and monitor prepaid electricity meters and, at the same time, carry out localized energy theft, thereby taking accounting fraudulent energy use [6].

For mobile phone users, because there are usually two types of prepaid services provided by mobile operators. Prepaid service is more popular than the quality of paid services between people. If a prepaid mobile phone service users, must have a particular currency balance to use the service. Here, the concept of charging the mobile phone is [7]. Pay for electricity and management and distribution of electricity in Iraq one of the main challenges to its charging process. Traditional methods of electricity systems require employees to read the meter. It can be read regularly to visit the company. If the readings from a long-distance [8] taking this approach, there is no meter reading and many of the family's problems. It also seized a long charging time balance right subscription (excluded) (or joined a customer's account), and abstained customer's meter when the administrator had to cancel. Administrators can receive feedback from customers by providing feedback and sending it to the maintenance team as needed. The system provides the customer by adding the balance of a specific amount, depending on power failure [9], to determine a property penalty. When a user requests a prepaid service, the customer balance must be sufficient to start using the service.

For session-based services, your balance must be checked regularly during the processing of your service consumption, and can refuse to use further services based on your remaining loan amount. With the use of services and related resources, users consume credits in their account, and at one moment, they reach a certain lower limit on the remaining credits [10].

Prepaid billing is a basic option for cloud service accounting, providing both service providers and customers with effective financial management. However, it must be supported by real-time credit checking and costing. These real-time movements provide network resource consumption and impose high costs. To solve this problem, to propose each cloud system in the cluster hosting a scalable accounting solution constitutes in. In the cluster, each time interval is calculated based on bundled services for all services. It presides over oversight of service consumption while consuming one customer [11] the accounting components. Who use prepaid electronic payment means of payment options for consumers, but they do not need a credit or debit accounts bundled charges. When the prepaid card transactions are the use of Point of Sale (PoS) or terminals, ATMs initiated by multiple entities are allowed. These entities were acquired through its global network of banks and payment processors. Each entity has some of its software solutions for processing transactions [12].

The system is used by smart meters and GSM (General Sales Manager) features, and utility servers to handle all accounting and reinstallation processes. The system enables communication with suppliers or microgrid owners, consumers and retailers via. The second embodiment has been replaced by a Zigbee module that allows regional communication without cellular access to the GSM module. The system consists of a smart meter and a base station [13] that communicate at a distance. Microgrids are offered in many developing countries, and investment in transmission infrastructure promises rural communities that are expensive to supply electricity. Many communities have adopted diesel power generation to meet their basic lighting and cooling requirements. With their dessert [14] load efficiency loss inefficiency of small diesel generators' operation, 10–20% suffered a notorious portion.

Having a diesel generator to allow the storage microgrid composition ensures the generator is in a closed or near its optimum operating point economical operation. As a result, significant fuel savings, especially in countries that imported fossil fuels. Best work under discussion diesel power and storage policies. Need to change these policies account for the loss inspired by the simulation study. Investment in storage and capital costs hindered widespread deployment. Pre-paid tariff system, payment of accounts receivable from these costs to free up funds were discussed [15]. Block Chaining technology is a distributed computing infrastructure and model. The latest version is represented by super-ledger. The perspective of big data will elaborate on a more systematic sorting blockchain technology; the core technology came out, the nature of application status blockchain technology in the accounting industry [16]. Interview commentary is a tool that allows researchers to support qualitative emotions, to understand the interview experience and opinions, and by their structure, it can affect the analysis. Secondly, the author reads and interprets data to identify each interview response keyword. In this process, the author personally evaluates the interview's intent and purpose and the opinions of [17] in answering the interview questions.

Information, the user, needs, quality information. One competitive advantage is the quality of accounting information of an organization. Quality information is useful to help users make decisions is useful. Quality information can improve decision-making, reduce uncertainty, and improve your ability to plan and schedule activities. Conversely, if the billing information is not limited, it will be useless charging information [18].

The percentage of factoring loans is an important coefficient of determination for banks and businesses. The highest factoring lending ratio can help banks get the most profit under low risk and help them run their business. Based on domestic banks that provide accounts with credit loans to domestic. Expected profits of the supply chain of multinational corporations consist of the ratio of factoring domestic suppliers' loans to external retailers and accounts receivable based on the credit risk and currency risk they face. This article's innovation considers the percentage of recourse factoring loans and related influencing factors to analyze how exchange rate fluctuations, compensation ratios and other factors affect the ratio of factoring loans during the factoring business [19].

It describes the double-entry bookkeeping, which is reflected in the traditional theory and accounting and auditing weaknesses advantage of

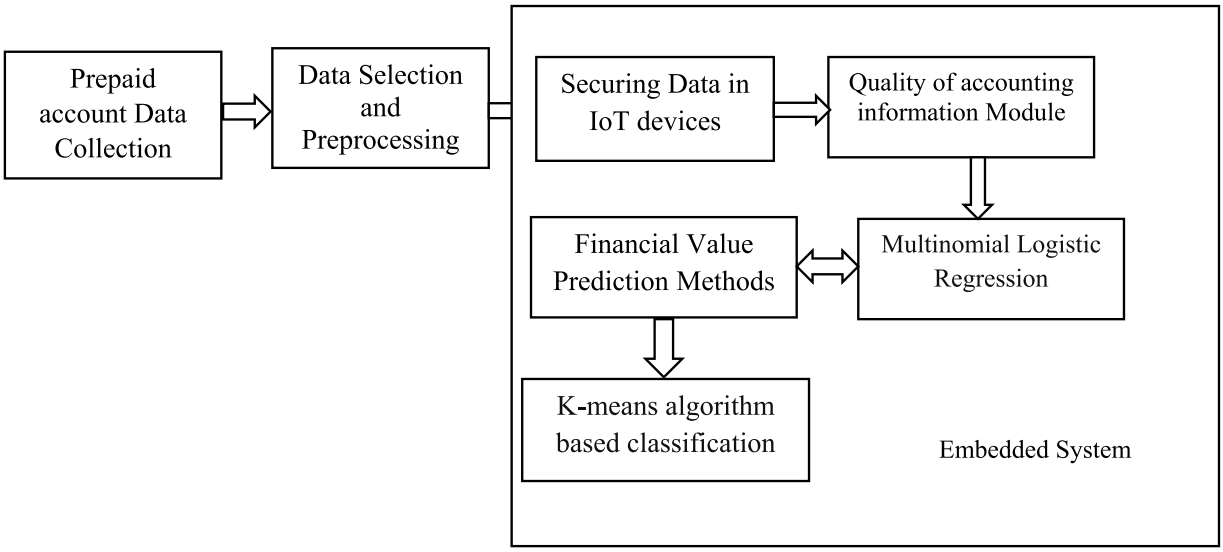


Fig. 1. Proposed K-means Architecture Diagram.

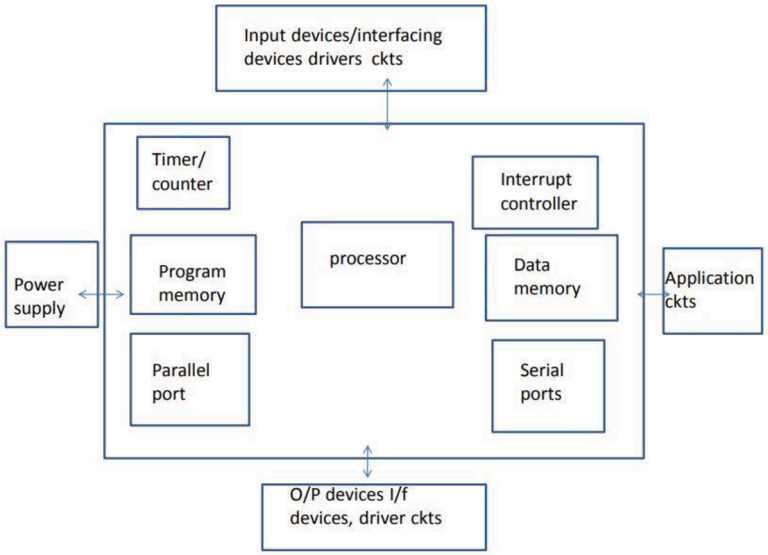


Fig. 2. Embedded System Diagram.

being overthrown. It also predicted that the accounting analysis in the future decentralized application of the accounting profession in the blockchain, "Internet + financial" solution-related issues raised, and quickly understand the blockchain technology and insights, existing emerging influence right. It is providing business development and strategy [20] How to build technology and trends.

3. Implementation of the proposed system

In the proposed architecture, the automated embedded system enables online prepayment of funds. A regular customer and billing center owner can use their valid user name and password, upload the embedded system, the user's mobile phone number and the amount of recharge. The database server stores information upload. The file is constantly monitored to check the new requirements on the server.

Data for the study to collected from prepaid account statements reported by various banks on currency and financial statistical analysis. Also, to analyze the financing model of prepaid accounts, detailed information is collected from IoT sensors with various financing accounts. To obtain reliable results in Fig. 1, it is necessary to develop scientific methods for data collection and apply the appropriate and reliable technical information analysis.

3.1. Data selection and preprocessing module

The objective Data Selection and Preprocessing Module (DSPM) is to establish a central data warehouse to support more information on prepaid accounts, task sharing, and information quality. Things connected to various data sources. Data selection process to choose, such as department database and embedded system, customer credit files from different data sources, and data on the company's online servers. First, the data related to the interaction with the various data sources are updated daily. If the data can be collected, then things will be decided. For example, embedded system behavior can be collected from prepaid user information. Meanwhile, market information is available from the Treasury Department to analyze government policies, market trends, and competitors.

Fig. 2 illustrates the concept of a processor embedded system.

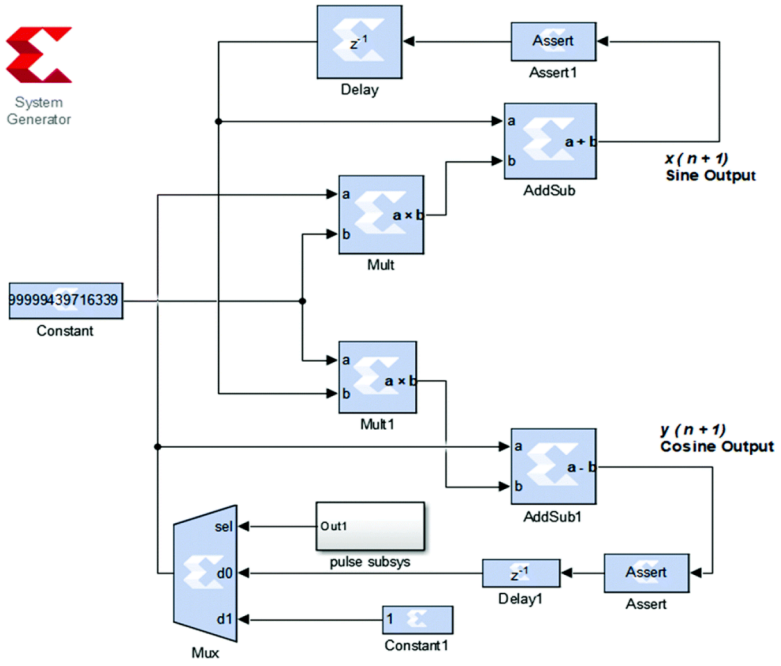


Fig. 3. Securing Data in IoT devices Based Circuit Diagram.

Internal electricity is essential. Time starts the mission as going to power from the power supply. It needs to organize various tasks and maintain the carrier's real-time programming that drives the timer to boot the system. It starts and executes various instructions from the address to reset the requirements of the operation counter. The item counter processor sets the address.

3.2. Securing data in IOT devices

Implementing the Internet of Things on the Internet is a very urgent development to confirm that it is a very urgent development. Thunder should be considered fast to open a business unit in the field of online communication. These days, small retailers use some or other types of online communication like road nutrition merchants. In this way, the Internet of Things implementation can make these validations and significant improvements to online trading.

Based on the IoT device's fixed data in the schematic in Fig. 3, the hardware design is now racking complicated because programmable hardware such as IoT and the number of transistors is complicated. The above shows that it is a very complicated task. This study outlines some of the key tools for model-based hardware design. In addition to the many benefits of the Internet of Things, the risk of security breaches cannot be ignored. With a lot of data shared horizontally across countless gadgets and things, programmers will inevitably get permission to access this valuable data.

3.3. Quality of accounting information

Analyzed by the embedded system proposed in this quality prepaid billing information is used as the explanatory variables and the main principles for measuring the quality of accounting information, including objectivity, comparability, relevance and timeliness. The principle of objectivity is the most basic, the most important principle. For real economic business accounting practice, the principle objective is to prove the existence or occurrence of economic management, to be honest, need legal documents to reflect the company's financial situation and the company's operating performance. Ensure that the content and the information is true, accurate and complete.

3.4. Multinomial logistic regression based financial value prediction methods

For example, in this method, instead of new loans to classify applications, new loan application attempts to predict the expected amount of default. Predicted values are numbers because they require numerical data to be a target (or predictive) variable modeling technique. Logistic regression and multiple regression are used for this purpose. Customer analysis for the most commonly used data mining techniques are:

- Cluster (description)
- Classification (forecast) and regression (forecast)
- Discovery of association rules (explanation) and sequence pattern discovery (prediction).

It is often used in assignment scores and embedded systems for specific customers and potential customers to show that an individual may behave in a particular way. For example, to measure the score's tendency to respond to offers for particular insurance or prepaid account or switch to a competitor's financial model.

3.5. K-means algorithm based classification

Step1: If the input variable is multidimensional, it must be converted before starting by the K-means algorithm as the maximum suitable format mining normalization process. The original value object is happy, where x is the new maximum value of the object after normalization. The ith object that represents the new value.

Step2: $x = \{\text{xi} | i = 1, 2\ldots \text{u}\}$ as a new value for the object is defined and represents the number of K-means algorithm under the set of object data described.

The new value of an object$(\chi \text{ij}) = \frac{Original\ value(\chi \text{ij})}{\max value\ x^{i}j}$

Step3: Details of the first user prepaid account IOT n collected randomly assigned to each one. C represents the cluster where the CJ on behalf of the jth cluster. $C = \{\text{CK} \mid K = 1{,}2, \ldots, \text{V}\}$ N °C cluster group of a group = device, this device. The value of k is input to the base of the algorithm's financial account, the number desired by a user.

Step4: Find the distance between the target and advance, according to the average. Distance denoted by d, dijk = | xi - cjk |.

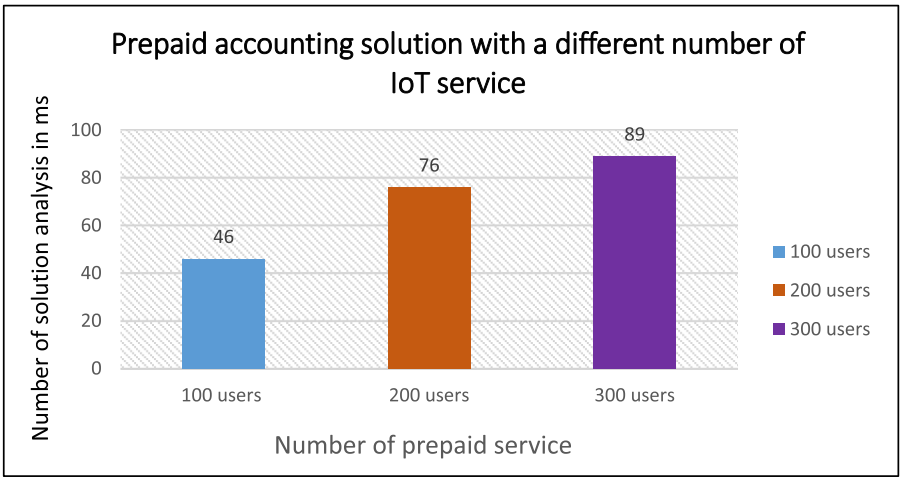


Fig. 4. Prepaid accounting solution with a different number of things comparison service.

Table. 1
Analysis of controllable prepaid account profit.

Years	Prepaid account profit level in %
2012–2016	78
2017–2020	95

Step5: Such equations are used to calculate the distance of one-dimensional data in the presence of IoT multidimensional data; the Euclidean distance is closest to the center of gravity thereof to minimize the square of the distance of each point.

$$Min\,Dij = (dijk)2$$

Step6: Again, steps 2 and 3 find the prepaid financial account object, where the average is the distance between the remaining members.

4. Result and discussion

To introduce this section and confirm the comparison with theoretical analysis, to conducted a series of experiments. It DL165 G5 server consists of three HP DL120 G5 server and three HP. Our campus network connects these servers. The rest of the workflow server is a generator of accounting embedded system and host, a workflow-based service and session duration number specification generator can be generated. Both generators and accounting embedded systems implement RESTful web services in Java.

Fig. 4 compares the above based on the number of different services Internet of Things (IoT) analyzing the prepaid charging solution.

The above Table 1 shows the Analysis of controllable prepaid account profit analysis depends upon the financial year based.

The above Fig. 5, the controllable income sector, the average number of samples in the selected control data is significantly reduced. It is impractical to assess the quality of information data because it occupies the above-described quality characteristics are difficult to quantify.

The above Table 2 shows the related increase in the prepaid account and system loss level. The proposed K means algorithm to compare the previous Bayesian network.

Fig. 6 above shows the depletion of prepaid accounts and prepaid systems. The increase in inaccurate relationships is reduced. Prepaid accounts are digital, and all the small loads are taken from the financial system accounts, so there are few unpaid losses. Since humans can make mistakes, errors can easily be reduced by prepaid accounts in embedded

Table. 2
Relation increase of prepaid account and system loss.

Algorithm	Normalized increase prepaid users in%	Decrease the system loss in%
K means	87	54
Bayesian network	76	45

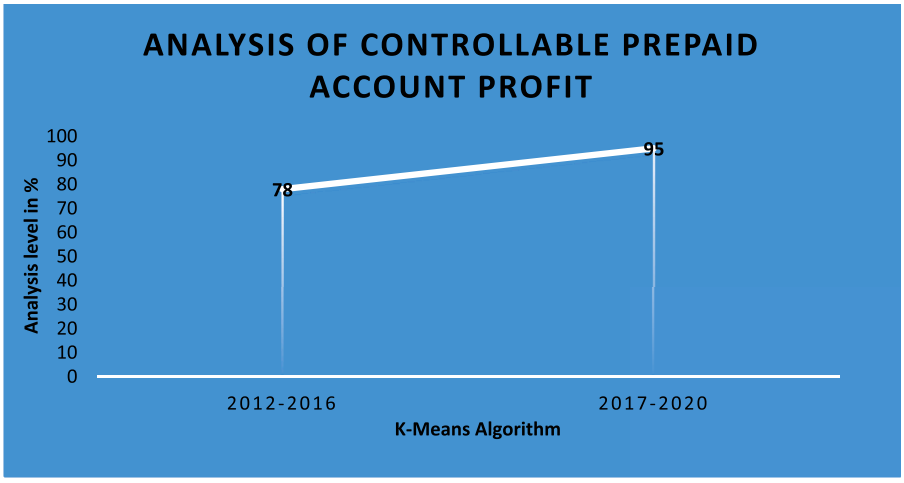


Fig. 5. Analysis of controllable prepaid account profit.

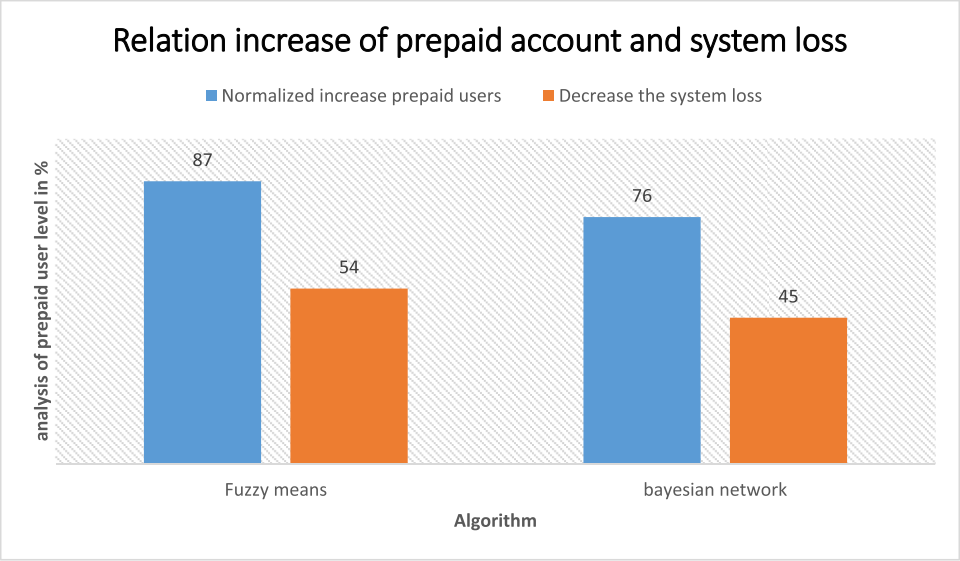


Fig. 6. Relation increase of prepaid account and system loss.

systems due to account reading and payment issues.

5. Conclusion

This K-means offers a new dimension to the financial system for prepaid accounts. To acquire a digital card, the financial model realizes this project adopts the most prestigious model—the IoT to connect to the competition for information technology. Therefore, need to take the initiative to implement this type of proposed real-time environment. Who Prepaid Weighing Consumers Perceived Shrinking Their IoT Data, Whether Prepaid Weighing Is Too Complex, and Who They Make Prepaid Financial Accounts Useful in terms of Reasonable and Affordable Believers, use, and believe that they are expressing interest in prepaid accounts. Those who communicate a more positive attitude towards prepaid accounts, in turn, report higher levels of intent as expected consumers and who will use prepaid billing. This proposal establishes the overall benefits of the K-Means system but recognizes that further efforts are needed to convince consumers to adopt this financial accounting model voluntarily.

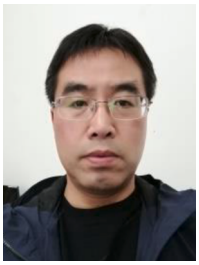
Declaration of Competing Interest

The authors declared that they have no conflicts of interest to this work. We declare that we do not have any commercial or associative interest that represents a conflict of interest in connection with the work submitted.

References

[1] A. Sarajlic, D Omerasevic, Connection and interworking MNO's m-commerce platform and bank's application for on-line mobile prepaid account recharging, in the IMS environment, in: 2012 20th Telecommunications Forum (TELFOR), 2012, https://doi.org/10.1109/telfor.2012.6419493.
[2] T. Akand, Z. Haq, A.A Mejbah, Analytical study of impact of prepaid metering system in power distribution sector in Bangladesh, in: 2019 International Conference on Energy and Power Engineering (ICEPE), 2019, https://doi.org/10.1109/cepe.2019.8726848.
[3] E.A Ogujor, "Reliability assessment of electric power distribution: a case study of 2 x 15MVA, 33/11 kV Ugbowo injection substation." Nigeria, Int. J. Res. Appl. Sci. Eng. Technol. 5 (VI) (2017). June.
[4] J.R.C. Orillaza, L.B. Orillaza, A.L Barra, Consumer acceptance of prepaid metering and consumer preferences, in: 2014 IEEE PES Pacific Power and Energy Engineering Conference (PPEEC), 2014, https://doi.org/10.1109/appeec.2014.7066149.
[5] M.S. Parvin, S.M.L Kabir, A framework of a smart system for the prepaid electric metering scheme, in: 2015 International Conference on Informatics, Electronics & Vision (ICIEV), 2015, https://doi.org/10.1109/iciev.2015.7334061.
[6] S. Chowdhury, P.R. Chakraborty, A.K. Chowdhury, M.L.M Lemon, Automated recharge of prepaid mobile phones, in: , 2012, https://doi.org/10.1109/iccitechn.2012.6509779.
[7] A.S. Abbas, E. Ali Abbood, A. Alabaichi, S Abdulkadhm, Proposed prepaid system for electricity bills in Iraq, in: 2018 13th International Conference on Computer Engineering and Systems (ICCES), 2018, https://doi.org/10.1109/icces.2018.8639424.
[8] T. Sravanthi, et al., Prepaid electricity billing system using GSM mobile, Int. J. Adv. Res. Comput. Sci. Electron. Eng. 2 (2) (2013) 186–192.
[9] Damian O. Dike, et al., Minimizing household electricity theft in Nigeria using GSM based prepaid meter, J. Eng. Res. 4 (1) (2015) 59–69.
[10] A. Sarajlic, D Omerasevic, Mobile account TopUp over m-commerce platform in the IMS environment, in: 2012 IX International Symposium on Telecommunications (BIHTEL), 2012, https://doi.org/10.1109/bihtel.2012.6412074.
[11] L. Xu, E.B. Lakew, F. Hernandez-Rodriguez, E Elmroth, A scalable accounting solution for prepaid services in cloud systems, in: 2012 IEEE Ninth International Conference on Services Computing, 2012, https://doi.org/10.1109/scc.2012.40.
[12] A.H. Qureshi, A.A Malik, Evolution of prepaid payment processor's software architecture: an empirical study, in: 2012 10th International Conference on Frontiers of Information Technology, 2012, https://doi.org/10.1109/fit.2012.41.
[13] A.B. Batiller, E.F.I. Bugayong, A.A. Caisip, N.P. Coligado, C.A.C. Padilla, M.A. A. Pedrasa, Prepaid metering system for isolated microgrids, in: 2016 IEEE Innovative Smart Grid Technologies, 2016, https://doi.org/10.1109/isgt.2016.7796440.
[14] J. Porter, M. Pedrasa, A. Woo, K Poolla, Combining storage and generation for prepaid electricity service, in: 2015 IEEE International Conference on Smart Grid Communications (SmartGridComm), 2015, https://doi.org/10.1109/smartgridcomm.2015.7436337.
[15] A. Sanoh, L. Parshall, O. Fall Sarr, S. Kum, V. Modi, Local and national electricity planning in Senegal: scenarios and policies, Energy Sustain. Dev. 16 (1) (2012) 13–25.
[16] S. Liu, S He, Application of block chaining technology in finance and accounting field, in: 2019 International Conference on Intelligent Transportation, Big Data & Smart City (ICITBS), 2019, https://doi.org/10.1109/icitbs.2019.00090.
[17] A. Wicaksono, M. Kartikasary, N Salma, Analyze cloud accounting software implementation and security system for accounting in MSMEs and cloud accounting software developer, in: 2020 International Conference on Information Management and Technology (ICIMTech), 2020, https://doi.org/10.1109/icimtech50083.2020.9211271.
[18] B.L. Meiryani, Handoko, S. Sabrina, E Hendra, The influence of leadership styles on accounting information systems quality and its impact on state-owned enterprises' information quality survey, in: 2017 IEEE 17th International Conference on Communication Technology (ICCT), 2017, https://doi.org/10.1109/icct.2017.8359977.
[19] Cheng Kangkang, Smart Rural Financial innovation based on 5 G network and Internet of Things, Microprocess. Microsyst. (2020), 103500. ISSN 0141-9331.
[20] Yu Bin, Blockchain financial development based on FPGA and Convolutional Neural Network, Microprocess. Microsyst. (2020), 103492. ISSN 0141-9331.

Xiaoyi Zhang: director and associate professor of Audit Department, School of Accounting, Tongling University. Research interests: accounting standards and practice, auditing theory and practice, enterprise internal control.



Yongsheng Wang: lab technician of School of Mathemmtics and Computer Science, TongLing University. Research interests: intelligent robot, graphics and image processing.