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Retraction

Retracted: Performance Evaluation System Based on Online Monitoring of Internet of Things

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This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] N. Li, Q. Zhang, and Z. Zhao, "Performance Evaluation System Based on Online Monitoring of Internet of Things," *Security and Communication Networks*, vol. 2022, Article ID 7745227, 8 pages, 2022.

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Research Article

Performance Evaluation System Based on Online Monitoring of Internet of Things

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Research on performance evaluation system based on online monitoring of Internet of things technology, taking medical imaging equipment as an example. Build the performance management platform of the Internet of things through four aspects: data acquisition, network architecture, CPU, and display output. Select 100 medical imaging devices in clinical use in the hospital and divide them into the control group (50 sets) and the observation group (50 sets) according to different management modes. The control group adopts conventional performance management mode, and the observation group implements Internet of things performance management mode. Compare the differences of equipment operation performance, cost-effectiveness, and service effect between the two groups. The experimental results showed that the equipment utilization rate, operation rate, inspection schedule balance, and technician schedule balance of the observation group were better than those of the control group, and the difference was statistically significant ($P < 0.05$). The quarterly cost-benefit increase of x-ray examination equipment, CT equipment, Mr equipment, interventional radiotherapy equipment, color ultrasound instrument, and nuclear medicine equipment in the observation group was higher than that in the control group ($P < 0.05$). The satisfaction of imaging doctors, technicians, engineers, and patients with the equipment service quality of the observation group was higher than that of the control group; the difference was statistically significant ($P < 0.05$). It is proved that the Internet of things performance management platform of medical imaging equipment can solve the problems of untimely information collection and unscientific scheduling during equipment operation, realize the real-time display and statistics of equipment operation performance, and improve the operation efficiency and service level of medical imaging equipment.

1. Introduction

In recent years, with the continuous maturity of computer technology and the popularization of information technology, the Internet of things has gradually sprung up and developed into people's daily production and life. The Internet of things (IOT) is an expansion and extension based on the development of the Internet. It relies on mature Internet theory and IOT-related technologies to achieve the purpose of IOT and IOT interconnection. As early as 1995, Bill Gates proposed the prototype of the Internet of things like the Internet of things in the road to the future, but it did not attract much response and attention because the research facilities and conditions at that time could not meet the requirements [1]. The concept of the Internet of things was first proposed in 1999, and the definition of the Internet of things was explained by MIT. Through sensor technology and equipment, RFID technology, positioning system, embedded system, and other technologies, the collection, conversion, transmission, and processing of item information are realized so that the items are connected with the Internet, and the intelligent identification, tracking, positioning, and supervision of items are realized. With the continuous development and improvement of computer technology, combined with the research of Internet of things-related technologies, the international community has put forward a clear future development direction for the Internet of things: make every item connect with each other through the Internet, break the barriers between the virtual network world and the real physical world, and connect the whole world more closely. Although it is the younger generation of the Internet, the Internet of things technology has been widely used in all walks of life. No matter at anytime and anywhere, as long as there is a network connection, we can realize the efficient management of resources through the Internet of things technology. In short, if the Internet is to build an information interaction network, then the Internet of things is to surf the Internet and build an item management network [2].

Internet of things is a strategic emerging information technology, which can open an opportunity window for user enterprises to obtain competitive advantage. As shown in Figure 1, in recent years, more and more enterprises begin to pay attention to and apply Internet of things technology, such as information collection, goods tracking, transportation monitoring and visual management of logistics enterprises, as well as supply chain management, production process monitoring, and safety production management of manufacturing enterprises. However, many enterprises find that it is difficult to obtain the expected income by investing in Internet of things technology, and only those enterprises that build an effective business model while applying Internet of things technology can finally form a competitive advantage. It can be seen that the practice of "winning business model" in the Internet era in the past continues, but the protagonist has become the Internet of things [3].

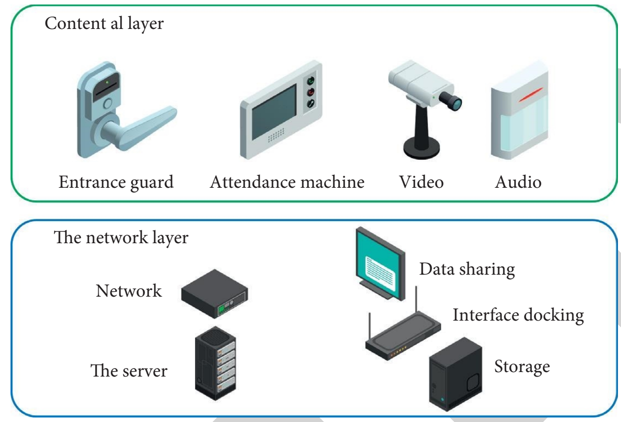

Figure 1: Online monitoring of the Internet of Things.

2. Literature Review

Wang and Fapojuwo pointed out that it is one sided to study the Internet of things only from the perspective of technology. In order to obtain the business value of the Internet of things, it needs to be studied from the perspective of business model because business model is the main means to connect and co-ordinate the application of Internet of things technology and the acquisition of Internet of things value. In the field of the Internet of things, although many studies have discussed the technical types and technical capabilities of the Internet of things and many studies have discussed the commercial value of the Internet of things, few have discussed the business model of the Internet of things in combination with the technical capabilities and commercial value of the Internet of things. Some studies have preliminarily discussed the types of business models of the Internet of things for enterprises upstream of the Internet of things industrial chain (such as network operators). However, these studies have not touched on the Internet of things business model of end-user enterprises in the industrial chain nor provided an operable concept of Internet of things business model and have not involved in the theoretical and empirical research on the impact of Internet of things business model on enterprise performance [4]. Yassein and Altiti also pointed out that enterprises integrated with customers are more likely to gain competitive advantage because they can better respond to changes in demand and reduce business costs. Internet of things is an interorganizational information technology, so it has the ability to communicate, cooperate, and integrate with customers along the supply chain. From this perspective, the business model of Internet of things can have an indirect impact on enterprise performance through customer integration. Therefore, when studying the impact of IOT business model on enterprise performance, this paper not only studies the direct impact of IOT business model on enterprise performance but also studies the indirect impact of IOT business model on enterprise performance through customer integration [5]. Internet of things monitoring is mostly used in power. Xinfa and Qiong pays attention to the energy waste of electric load and monitors the changes of the surrounding environment of electric load through electromagnetic field detector (EMF), so as to draw the corresponding power consumption curve as the characteristic quantity of load identification [6]. Huang et al. considered that different electrical loads will emit different degrees of noise during operation and tried to find the characteristic quantity from the perspective of acoustics. However, this method requires additional installation of acoustic sensors and is vulnerable to environmental noise, so it is not suitable for high-noise environments such as factories and workshops [7]. Zheng and Guo introduced how to extract characteristic values from physical quantities such as "voltage, current, and power value" to determine the type of electrical load, so as to identify the electrical load. However, this method is generally used for the classification of electrical load switching and is not applicable to the identification of multistate electrical load [8]. Qi et al. in the process of load identification, Bayesian classifier is used to find the corresponding category from the load cluster state value according to the category value of a single consumer. The design of this classifier is complex and requires many parameter types, and the recognition rate is not ideal [9]. Guo et al. proposed a method of drawing "voltage-current" curve for load identification. In order to achieve unity in different dimensions, this method normalizes the eigenvalues in each dimension to the same standard. This method can effectively identify the operating states of different electrical appliances, but its "voltage-current" trajectory value lacks intuitive representation [10]. Sciullo et al. uses the clustering method to analyze the power data of the load and aggregates the electric loads with similar power characteristics into the same category, so as to realize the load identification. Because different clustering methods will produce different classification results, it may bring instability to the system [11]. Li advocated using transient characteristics to identify load types, such as voltage pulse or current spike caused by electric load switching. This method has high accuracy, but due to the high sampling frequency required for the extraction of transient characteristics, it has high requirements for hardware. Moreover, the switching operation of electric load occurs only at the beginning and end of operation, and the transient characteristics cannot be extracted during the time period of stable operation, so this method is not suitable for electric load identification in stable operation [12]. Liu et al. divided the electric load into linear load and nonlinear load. Generally speaking, the linear load can be identified by feature comparison. For nonlinear loads, it is advocated to adopt the method of neural network to build a deep learning network to learn the operating state characteristics of electric load and the behavior characteristics of users, so as to improve the accuracy of electric load identification [13].

Based on the current research, the performance management platform of the Internet of things is built through four aspects: data acquisition, network architecture, CPU, and display output. Select 100 medical imaging devices in clinical use in the hospital and divide them into the control group (50 sets) and the observation group (50 sets) according to different management modes. The control group adopts conventional performance management mode, and the observation group implements Internet of things performance management mode. Compare the differences of equipment operation performance, cost-effectiveness, and service effect between the two groups.

3. Construction of Internet of Things Performance Management Platform for Medical Imaging Equipment

In order to realize the transformation of modern information mode from “target management” to “process management,” this study discusses the Internet of things architecture of medical imaging equipment based on the analysis of user management requirements and functional conditions. Integrate the relatively decentralized and independent performance management of medical imaging equipment into the Internet of things performance management platform, feedback and analyze the equipment operation parameters and function use data in real time, and provide decision making and empirical basis for improving the utilization rate and configuration effectiveness of medical imaging equipment.

3.1. Platform Architecture. The Internet of things performance management platform strictly complies with national laws, regulations, and relevant policy requirements and fully considers the security of clinical diagnosis and treatment data. From the physical structure, it is divided into four parts: data acquisition, network architecture, central processor, and display output. Among them, data acquisition mainly includes the data acquisition of medical imaging equipment of various brands. Its main function is to record the performance information of clinical diagnosis and treatment and transmit the performance data to the central processor through the network architecture. The central processor completes the data collection, translation and standardization, and outputs it to the centralized display terminal in real time in the data statistics mode. The architecture of IOT performance management platform is shown in Figure 2.

3.2. Performance Data Collection

3.2.1. Equipment Operation Statistics. The performance management platform of the Internet of things uses data collectors to collect equipment operation data from medical imaging equipment operation log files, medical digital imaging, and communications (DICOM) transmission files and equipment sensors, including startup standby data, clinical service data, equipment operation data, and patient diagnosis and treatment data, which can evaluate and analyze the overall operation status of medical imaging equipment and improve the fine management level of equipment operation. See Figure 3 for the operation statistics of IOT performance management platform.

3.2.2. Equipment Operation Process Data. Observe the process data such as equipment utilization, on-off, and operation rate from the time axis and analyze the patient reception volume, disease type and examination item distribution, equipment idle ratio change, and service performance of different imaging technicians in different time periods. The service performance of medical imaging equipment can be improved by optimizing shift scheduling, inspection appointment, business improvement, and technical support, that is, to improve the cost-effectiveness and social benefits of the equipment [14]. The operation process data interface of the Internet of things performance management platform is shown in Figure 4.

3.3. Task Allocation and Scheduling. Using the Internet of things performance management platform, the on-off time, inspection activity cycle, and idle time of medical imaging equipment are monitored in real time, and the scheduling model is constructed based on the equipment utilization index. Set the utilization rate of the i-th equipment as η_i, the number of people that can be served as N_i, the total working time as T_i, the operation time of the class J inspection items as t_j, and the proportion of the class J inspection items executed by the i-th equipment as r_{ij}, then the calculation method of the equipment utilization rate η_i is formula (1):

$$\eta_i = \frac{1}{T_i} \sum_{j=1}^{M} r_{ij} \times N_i \times t_j, \tag{1}$$

where M is the total number of inspection items. According to the scheduling model, the utilization status and trend of different medical imaging equipment are analyzed and predicted, and the optimal equipment operation and task

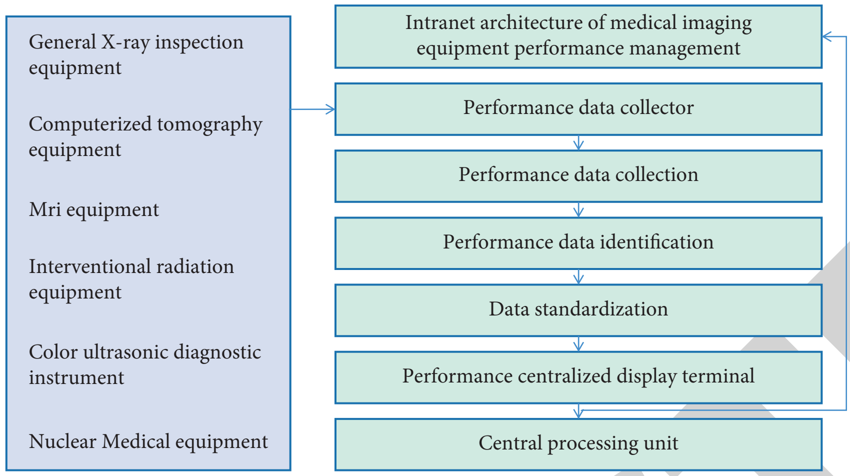

Figure 2: Internet of things performance management platform architecture.

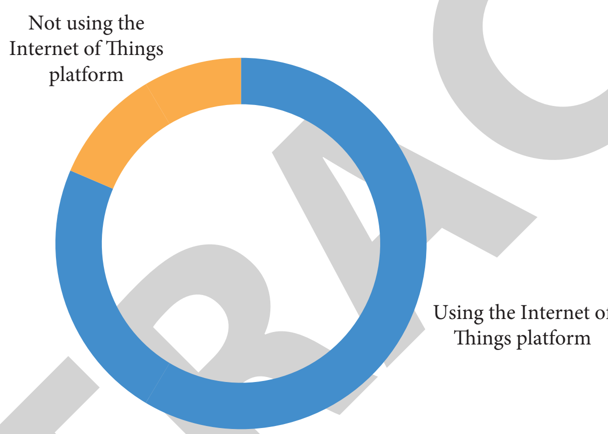

Figure 3: Operation statistics interface of platform acquisition equipment.

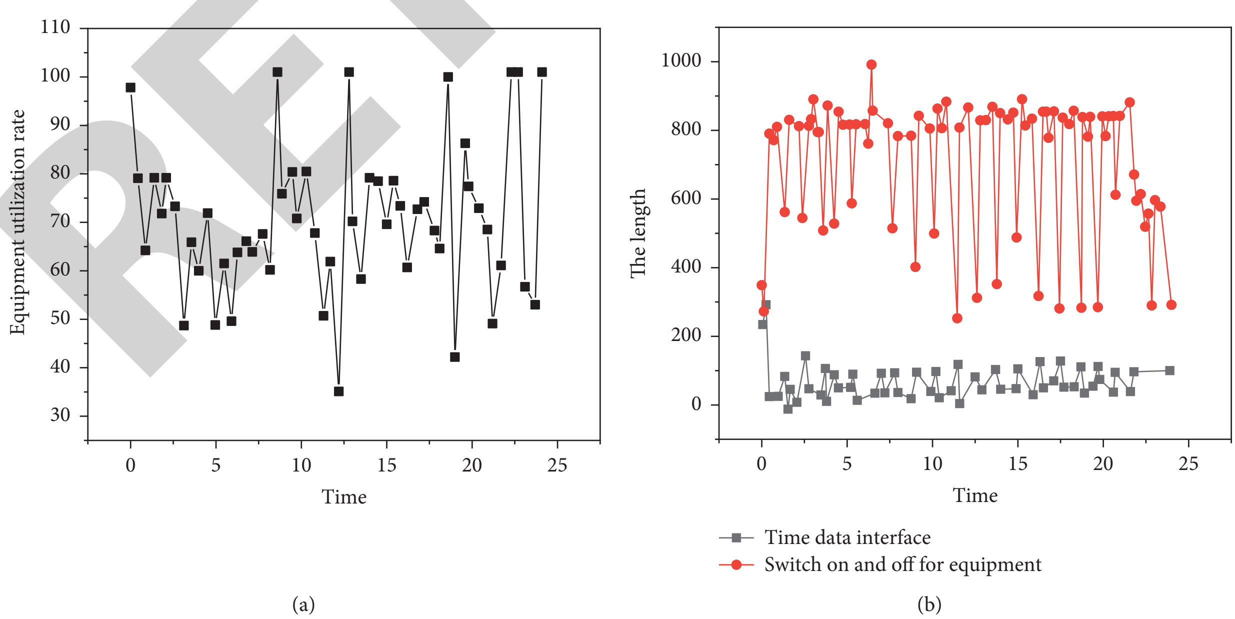

Figure 4: Operation process data interface of platform acquisition equipment. (a) Interface for equipment utilization/time data. (b) Switch on/off/time data interface for equipment.

allocation methods are decided to improve the performance level of equipment clinical service.

4. Application of Internet of Things Performance Management Platform for Medical Imaging Equipment

4.1. Equipment Data. 100 sets of medical imaging equipment in clinical use in the medical imaging department and nuclear medicine department of a hospital from January 2020 to December 2021 were selected, including general x-ray examination equipment, computer x-ray tomography equipment, nuclear magnetic resonance examination equipment, interventional radiology equipment, color ultrasound diagnostic instrument, and nuclear medicine equipment. According to different performance management modes, 50 sets of medical imaging equipment from January to December 2020 were included in the control group, and the conventional performance management mode was adopted; 50 sets of medical imaging equipment from January to December 2021 were included in the observation group, and the Internet of things performance management mode was adopted. There is no statistical difference in the brand type, startup rate, inspection items, and basic data of relevant staff such as image technicians and technical engineers between the two groups, so a comparative study can be carried out [15].

4.2. Inclusion and Exclusion Criteria

(1) Inclusion criteria: ① Equipment value ≥ 200000 yuan, ② equipment with complete clinical operation data during the study cycle, and ③ the medical data of patients involved in the study are approved by the hospital ethics committee, and the patients and their families sign the informed consent form.

(2) Exclusion criteria: ① Newly purchased or scrapped equipment during the year and ② equipment with startup rate ≤80%.

4.3. Performance Management Methods

(1) Control group: the conventional performance management mode is adopted. The performance objectives of medical imaging equipment are formulated by the department management team, and each equipment supervisor technician is responsible for implementation and evaluation.

(2) Observation group: implement the performance management mode of the Internet of things, collect the performance data of medical imaging equipment in real time through the performance management platform of the Internet of things, formulate stage objectives, and jointly conduct process monitoring and evaluation and performance management path optimization with the medical engineering department.

4.4. Observation and Evaluation Indicators

(1) Equipment operation performance: observe the utilization rate, operation rate, inspection schedule balance, and technician schedule balance of the two groups of equipment. ① Utilization rate refers to the ratio of the actual startup time of each equipment to the required startup time; ② operation rate refers to the ratio of the operation time of each equipment to the actual operation time; ③ inspection schedule balance refers to the difference between the proportion of inspection items in the morning and afternoon of each equipment working day; and ④ technician scheduling balance refers to the absolute difference between the effective working time and the average working time of each imaging technician divided by the average working time. The closer the balance is to zero, the better [16].

(2) Cost-effectiveness of equipment: according to different types of equipment, the quarterly cost-benefit growth of six types of equipment, namely, ordinary x-ray examination equipment, computer x-ray tomography equipment, nuclear magnetic resonance examination equipment, interventional radiation equipment, color ultrasonic diagnostic instrument, and nuclear medical equipment, was observed, that is, the quarterly cost-benefit growth rate of each equipment compared with that of the previous quarter.

(3) Equipment service effect: the satisfaction survey form made by the hospital is used to investigate the satisfaction of imaging doctors and technicians in medical imaging department and nuclear medicine discipline, imaging equipment technicians in medical engineering department, and patients undergoing imaging examination. The survey form includes the effectiveness of equipment scheduling, operation quality, and clinical examination service efficiency. There are 25 options in total, including 4 points of satisfaction, 3 points of basic satisfaction, 1 point of general satisfaction, and 0 point of dissatisfaction. The full score is 100 points in total.

4.5. Statistical Methods. SPSS 22.0 software was used for statistical analysis of the data. The measurement data were in line with the normal distribution, expressed as mean ± standard deviation ($\overline{x} \pm s$). The independent sample t test was used for comparison between groups, and the difference was statistically significant with $P < 0.05$.

4.6. Results

4.6.1. Comparison of Operation Performance between the Two Groups of Equipment. The four indexes of equipment utilization rate, operation rate, inspection scheduling balance, and technician scheduling balance in the observation group were 96.15%, 91.82%, 19.08%, and 8.34%, respectively, and those in the control group were 87.72%, 83.56%, 30.26%, and

17.63%, respectively. The difference between the groups was statistically significant ($P < 0.05$), as shown in Figure 5.

4.6.2. Comparison of Quarterly Cost-Benefit Growth of the Two Groups of Equipment. The quarterly cost-benefit increases of six types of equipment in the observation group were 1.75%, 2.68%, 3.11%, 1.83%, 1.75%, and 0.96%, respectively. The control group was 0.72%, 1.29%, 1.45%, 0.94%, 0.67%, and 0.34%, respectively. The difference between the groups was statistically significant ($P < 0.05$) [17], as shown in Figure 6.

4.6.3. Comparison of Clinical Service Satisfaction between the Two Groups. During the clinical application of the equipment, the satisfaction scores of imaging doctors, technicians, engineers, and patients with the service quality of the equipment in the observation group were 93.07, 89.72, 86.75, and 86.13, respectively, and those in the control group were 80.24, 81.56, 76.93, and 69.25, respectively. The difference between the groups was statistically significant ($P < 0.05$), as shown in Figure 7.

Medical imaging equipment is an important guarantee condition for hospitals to carry out clinical diagnosis and treatment activities. It is difficult to realize information traceability under the traditional performance management mode, so there is a certain blind spot in the process supervision and target evaluation of equipment operation and quality management. The Internet of things performance management platform finds the "blocking points" and "growth points" in equipment operation through real-time observation of equipment operation status [18] and puts forward reasonable suggestions from the aspects of imaging technician training, radiological examination scheduling, and idle time utilization, so as to enhance the performance management analysis and prediction ability under the background of big data. In order to achieve clinical auxiliary decision support, add more data support, reduce medical risks, improve medical quality, and lay a good data foundation for the establishment of smart hospitals. With the development of medical equipment and the increase of clinical diagnosis and treatment activities, data sorting has become a boring, heavy, and mechanical work and the difficulty of data analysis is also great. The construction of Internet of things performance management platform has become an important path for hospitals to build a modern management model [19–21]. In order to improve the safety of the operation of medical imaging equipment and the scientificity of hospital management decision making, improve the service level of clinical diagnosis and treatment activities, and improve the efficiency of the hospital, this study selects the medical imaging equipment of the medical imaging department and nuclear medicine discipline of the hospital and is divided into the control group and the observation group according to different performance management modes. The observation group built the Internet of things performance management platform based on the clinical service needs of medical imaging equipment and realized the real-time monitoring and task scheduling decision of equipment operation statistics and process data from four parts: data acquisition, network architecture, CPU, and display output [22–24]. The research data showed that the utilization rate, operation rate, examination scheduling balance, and technician scheduling balance of the observation group were better than those of the control group. The quarterly cost-benefit increase of ordinary x-ray examination equipment, computer x-ray tomography equipment, nuclear magnetic resonance examination equipment, interventional radiology equipment, color ultrasound diagnostic instrument, and nuclear medicine equipment was higher than that of the control group. After the clinical application of the equipment, the satisfaction of imaging doctors, technicians, engineers,

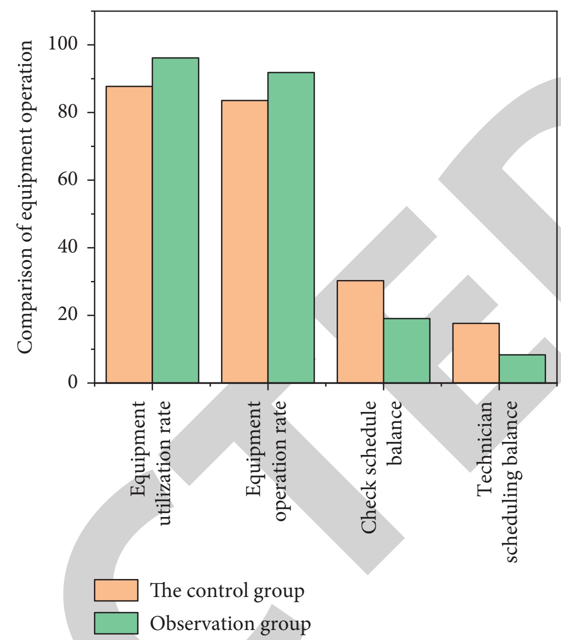

Figure 5: Comparison of operation performance of two groups of equipment (%, ±*s*).

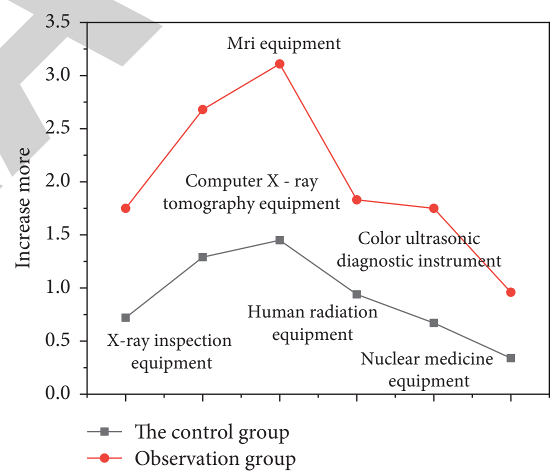

Figure 6: Comparison of quarterly cost-benefit growth of two groups of equipment (%, ±*s*).

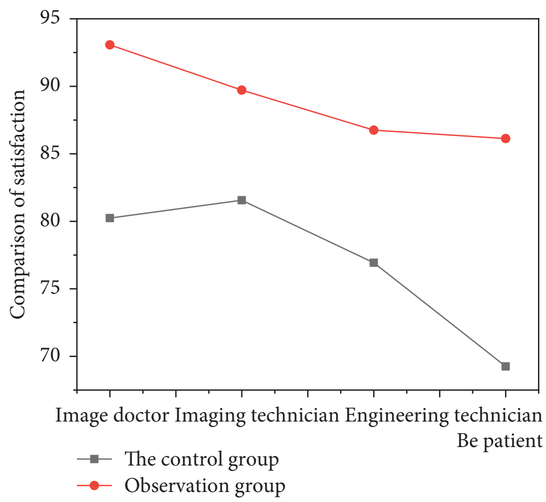

Figure 7: Comparison of clinical service satisfaction of two groups of equipment (score, ±*s*).

and patients with the service quality of the equipment was higher than that of the control group. The results show that the Internet of things performance management platform realizes the real-time display and statistics of equipment operation performance through the collection and analysis of medical imaging equipment clinical service informatization data. It provides an important basis for optimizing the scheduling of clinical activities and personnel division, improves the operation efficiency and service level of medical imaging equipment, and has important application value in equipment performance management [25, 26].

5. Conclusion

Improve the safety of medical imaging equipment operation and the scientificity of hospital management decision making, improve the service level of clinical diagnosis and treatment activities, and improve the hospital benefits. This study selects the medical imaging equipment of the medical imaging department and nuclear medicine discipline of the hospital and is divided into control group and observation group according to different performance management modes. The observation group built the Internet of things performance management platform based on the clinical service needs of medical imaging equipment and realized the real-time monitoring and task scheduling decision of equipment operation statistics and process data from four parts: data acquisition, network architecture, CPU, and display output.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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