Retraction

Retracted: Application of BIM and Internet of Things Technology in Material Management of Construction Projects

Advances in Materials Science and Engineering

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1].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.

References

[1] W. Shen, "Application of BIM and Internet of Things Technology in Material Management of Construction Projects," *Advances in Materials Science and Engineering*, vol. 2022, Article ID 5381252, 11 pages, 2022.

Research Article

Application of BIM and Internet of Things Technology in Material Management of Construction Projects

Wangchao Shen ⓘ

University of Shanghai for Science and Technology, Shanghai, Shanghai 200093, China

Correspondence should be addressed to Wangchao Shen; shenwc@usst.edu.cn

In order to solve the problems of difficulty in daily management of engineering materials and equipment and difficulty in collecting statistical data of materials and equipment, a method based on the combination of BIM (building information modeling) technology and Internet of Things technology is proposed to construct 3D model files, engineering quantity files, and construction schedule plans to determine BIM and Internet of Things technology methods in material management of construction projects. The method based on BIM technology and Internet of Things technology 5D material-integrated management platform can realize the daily management of materials more finely. For the construction industry, cost management is always an important factor related to the direct interests of design companies. The cost of building materials accounts for about 70% of the total project cost. The frequency of the tag is usually 2.4 GHz~5.8 GHz, and its reading range can reach more than 100 m. This shows the importance of construction material management in construction projects. Taking BIM technology and Internet of Things technology as the starting point, this paper deeply analyzes the advantages of BIM technology and Internet of Things technology. It is verified that combining with the main points of material management of construction projects, from the perspective of practical application of technology, it focuses on the effectiveness of practical application of material management of construction projects.

1. Introduction

In recent years, the development of China's construction industry has become more and more standardized. At the same time, the industry also puts forward higher requirements for the construction management level of construction enterprises. For the construction industry, especially for the construction enterprises, the project material cost accounts for about 70% of the total project cost, so the material management is directly related to the cost control effect of the enterprise. Therefore, for the construction enterprises, how to realize the scientific management of project materials with the help of modern information technology is directly related to the operating profit of the enterprise. The emergence of BIM technology and Internet of Things technology is a representative technology of the rapid development of network information technology. As an advanced and efficient modern information management

technology, it can be applied to modeling, animation, pipeline synthesis, and other aspects in relevant fields. In particular, the combination with the construction industry can further optimize the construction project management process. At the same time, combined with the Internet of Things technology, it can further optimize the construction material management, fine manage the project construction materials, and build a perfect and efficient information management of project construction materials.

Raya et al. said that there are relatively many studies on construction progress and material management abroad [1]. Some scholars analyzed various factors affecting the construction progress of large-scale construction projects and put forward the multiple linear regression model and neural network system based on the concept of lean construction (LC) management to predict the project progress. Nguyen and others said that some scholars also proposed a scheduling system (ISS) based on the computer simulation model

and intelligent optimization, which enables the project manager to find an approximate optimal scheduling model according to the project objectives and project constraints, comprehensively consider the main influencing factors such as schedule, cost, manpower, equipment, materials, and space, and make the schedule model close to the optimal result [2]. Trach et al. said that by giving the BIM model time information, the construction schedule of each process is automatically generated, including the planned time, project efficiency, and duration of the construction schedule. The construction schedule of the overall project is obtained according to the time arrangement of different processes [3]. Xie et al. said that in terms of project construction material management, some scholars proposed that the reasonable layout of building materials is very important before the formal commencement of construction. According to the use frequency of different materials, the application model of building material layout is provided to ensure the integration and traceability of materials on the GIS platform [4]. Cao et al. said that the project management system based on BIM 5D was proposed in 2014 to realize the integrated management of construction progress, cost, and material information and carry out information management for building materials [5]. Xiong et al. said that by using BIM technology to solve the construction material supply model, we can provide a scheme for the supply time, specification, quantity, and site division of materials and generate the best material management plan through BIM three-dimensional model information combined with site layout [6]. Tang et al. said that the whole life cycle performance evaluation method was introduced through BIM to estimate the type and quantity of renewable building materials in the building life cycle and the recycled materials produced by prefabricated components. The model can provide decision support mechanism for architects and designers [7]. Kirwan et al. said that in the application of Internet of Things technology, some scholars discussed the feasibility of the combination of Internet of Things technology and experimental equipment management system, analyzed the old experimental equipment system, improved the old experimental equipment system by using Internet of Things technology, and realized the upgrading of the system, so as to more effectively help manage and maintain experimental equipment and make all experimental equipment effective equipment; aiming at the dynamic management of equipment, an equipment management system based on RFID (radio frequency identification) tag technology is proposed [8]. Evjen et al. said that using the remote unique device characteristics of RFID tags, the rapid identification and matching of equipment and equipment components can be realized in the process of equipment disassembly, transfer, and installation, so as to shorten the operation time of assembly operation. The system has special advantages in scenes requiring dynamic management involving a large number of parts and complicated operation processes [9]. Hashim et al. said that China's research is based more on the background of engineering project management. For example, they have created a mathematical model for the supply of building materials to provide solutions to the problems in the process of material procurement and supply of construction enterprises; various practical material management methods are studied, such as material procurement and material use. By ensuring the specific route of optimizing material management, more advantages are obtained in the cost management of construction companies (especially highway and bridge construction companies), which brings theoretical support [10]. This paper expounds the importance of using RFID technology for material management in the manufacturing environment of modern enterprises and introduces the definition, system configuration, and operation principle of RFID, as well as the function of MMIS and the method of using data in software engineering. RFID technology is used to analyze and design MMIS functional structure, software and hardware architecture, and database ER model and provide detailed operation algorithm for the BOM module; the application of BIM technology to site management improves the management efficiency and reduces the material management cost. When a variety of materials need to be temporarily stored on the construction site at the same time, but the free space on the construction site is limited, the BIM model is used to extract the relevant spatial information, which can effectively identify the internal and external available space of the construction object and the ISGP multiobjective programming algorithm is used to realize the best temporary storage location of materials on the construction site, so as to help managers make material management decision, as shown in Figure 1.

2. Method

In the process of building from the traditional two-dimensional CAD model to modern three-dimensional BIM model, the three-dimensional model must be consistent with the actual building construction size and have the same attributes. Otherwise, it will not only lead to the failure of subsequent work but also increase the difficulty of subsequent modification. The BIM 5D model is not only a 5D platform but also compatible with other non-BIM platform software packages such as GCL graphic quantity calculation software and project construction schedule preparation software, in the construction of BIM files. However, not all BIM 5D platform software on the market can be compatible with each other in the actual use of BIM 5D. At present, the commonly used modeling software includes Revit, CATIA, Archi CAD, Bentley, and other series of BIM software. Now, the characteristics and scope of application of each modeling software package are analyzed, as shown in Table 1 [11]. Through the analysis of its functions, Revit software is used as the basic software for BIM model construction.

Revit series software is mostly in line with the use principle of BIM 5D project management. Revit series software can not only model the structure, foundation, electromechanical, and other disciplines of buildings but also provide construction attribute information. It has a large number of built-in model files, which reduces the complex work of construction and improves the use efficiency of BIM [12, 13]. In the overall design stage of the
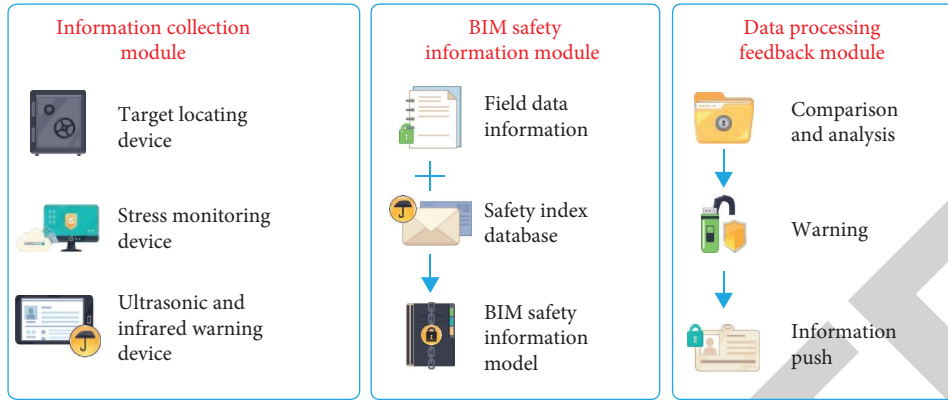
FIGURE 1: Application of BIM and Internet of Things technology in material management of construction projects.

TABLE 1: Analysis of different BIM software.

Software	Revit	Catia	Archi CAD	Bentley
Data format	Rvt	CATProduct	Pln	Skp
Ife interface	Have	Nothing	Have	Have
Compatibility	Good	Poor	Good	Good
Scope of application	Construction industry	Machinery, water, and electricity	Construction industry	Construction industry
Software features	Interface operation	Parameterized high and low score	Presentation and graphics	Steel structure work

project, BIM is used for the overall design of the project. The scheme can be optimized and selected with the help of different types of software applications of BIM according to different building subjects. The application process is shown in Figure 2.

For example, Ecotect software can be used to analyze the professional performance of lighting, ventilation, and HVAC; NavisWorks software for construction can carry out collision detection for structural, electrical, and water supply and drainage disciplines to check whether there is any unreasonable damage in the design of pipeline wall; we can use BIM graphic quantity calculation software to associate the BIM model with pricing list to obtain project cost information, which is convenient for cost control in the design stage [14, 15]. The Revit civil engineering, electromechanical, and site models are imported into the BIM 5D platform. In the "flow view," the flow section is divided by establishing a single body, discipline, and floor and associated with the construction model. In the "construction simulation view," the project file is imported, the set flow section information is associated, and the front tasks are set, so as to realize the integration of construction progress information in the BIM 5D platform. The preparation process is shown in Figure 3.

The Revit model file initially established by the designer is usually handed over to the cost estimator for engineering quantity calculation. The obtained engineering quantity calculation file is imported into the BIM 5D management platform and associated with the list and model to obtain the cost budget of each stage of the project. By associating the outcome documents of each platform, the material demand in the civil engineering stage reflects the rapid statistical function of BIM 5D management platform for material demand information [16]. When the construction project

needs to use new materials to replace the original materials, it is necessary to timely adjust the materials and update the specifications and parameters of the materials. According to the change list, the properties of materials can be modified in batches in the BIM 5D management platform. BIM managers then associate the construction progress information with the adjusted material information and material pricing list to generate the construction progress plan, material demand plan, and project pricing information of the information. The specific process is shown in Figure 4.

In the whole construction process of the project, each construction process restricts each other logically. Therefore, if the project schedule changes, the construction schedule should be adjusted [17, 18]. When the project schedule is changed, the MRP needs to be changed dynamically according to the project schedule. The construction department adjusts the construction progress according to the engineering change instructions. Without changing the construction logic, its integration can automatically generate the material purchase list. The specific process is shown in Figure 5.

The supervision unit shall supervise the change using BIM 5D technology based on the management purpose of mutual restriction. For example, we propose to change the construction sequence or construction method of the project. The supervision unit can use BIM 5D technology to supervise the project quality more intuitively. When other departments propose engineering changes, the supervision unit evaluates the changes by using BIM technology. After the evaluation is passed, it will be handed over to the construction department for engineering changes. The construction department will adjust the construction progress and associate the BIM model with the project schedule in real time to generate the
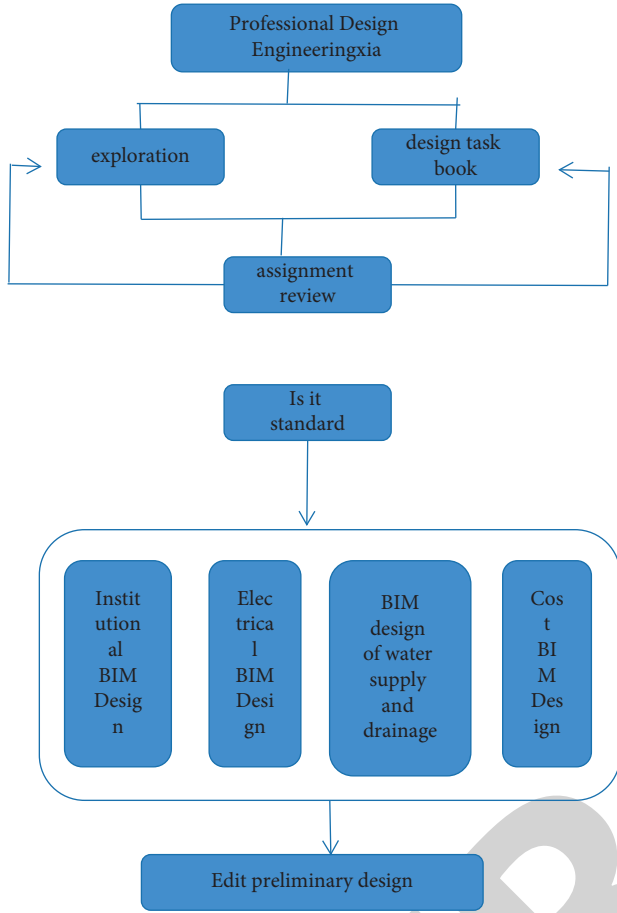
FIGURE 2: Preparation flow chart of BIM 5D design stage.

FIGURE 3: BIM 5D construction plan preparation flow chart.

material demand plan. The specific process is shown in Figure 6.

Firstly, we select the material over consumption analysis object, determine the material type, time range, WBS code of divisional and subdivisional works involved and corresponding model components to be analyzed, and use X_1, X_2,...,X_n to represent the theoretical value of material consumption of each component. X_i is obtained from the design information of material quantity in BIM model components. The theoretical value of total material consumption of the analysis object is calculated as shown in

$$X = \sum_{i=1}^{n} X_i.\qquad(1)$$

Y_1, Y_2, ... , Y_n represent the actual value of material consumption of each component. Considering that it is difficult to accurately distribute the actually consumed materials to each component during on-site construction, in the material over consumption warning mechanism, the actual total amount of material consumption y is calculated by the difference between the total amount of materials Y_L received by the labor team of the analysis object within the corresponding time and component range and the remaining amount of material inventory Y_S and the actual
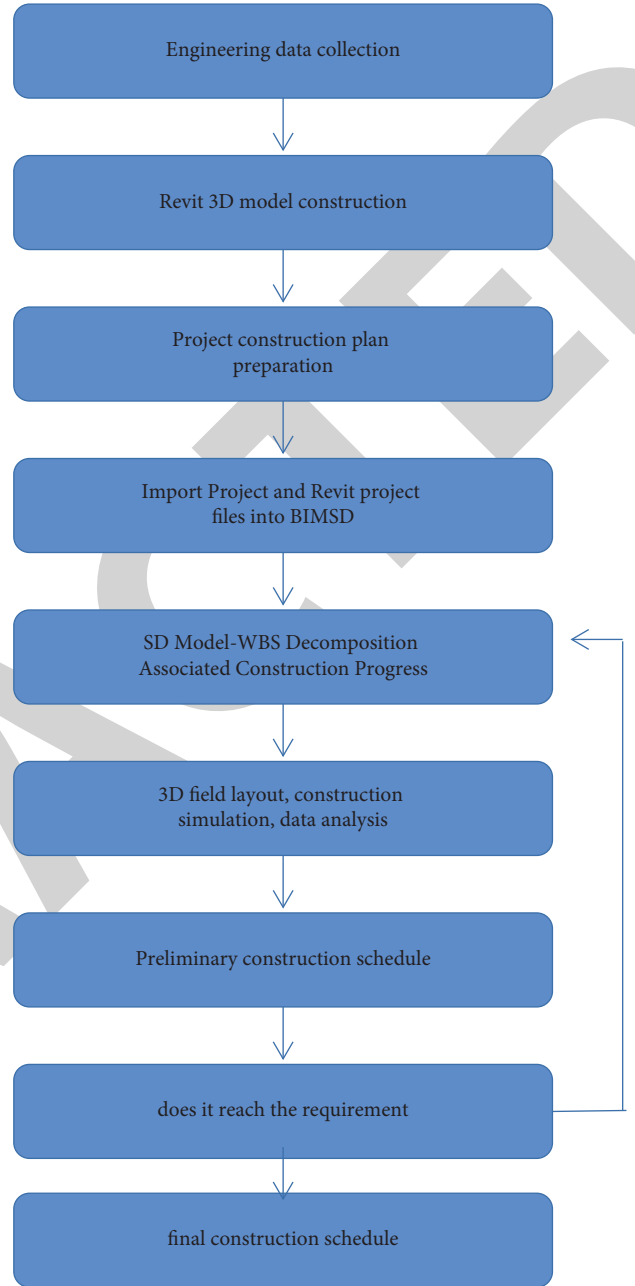
value of the total amount of material consumption of the analysis object will be calculated as shown in

$$Y = \sum_{i='}^{n} Y_i = Y_L - Y_S.\qquad(2)$$

L_0 represents the set material loss rate limit, and the actual material loss rate is expressed in L. The calculation formula is shown in

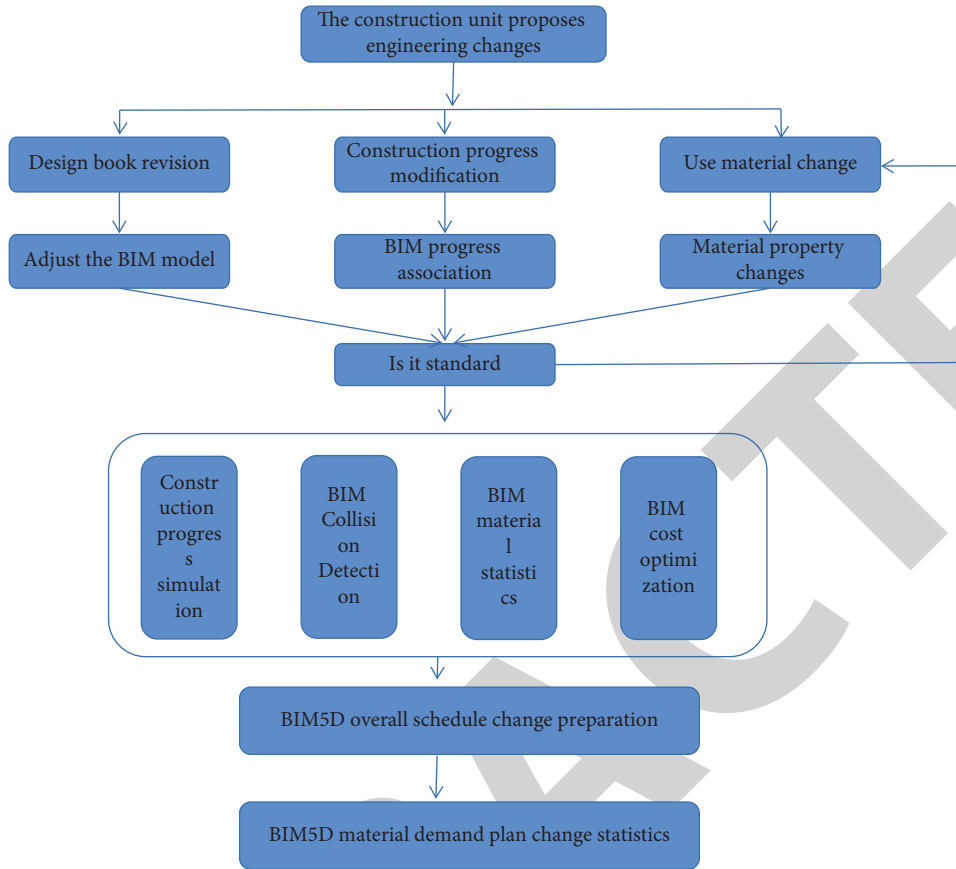$$L = \frac{Y - X}{X} \times 100\%.\qquad(3)$$

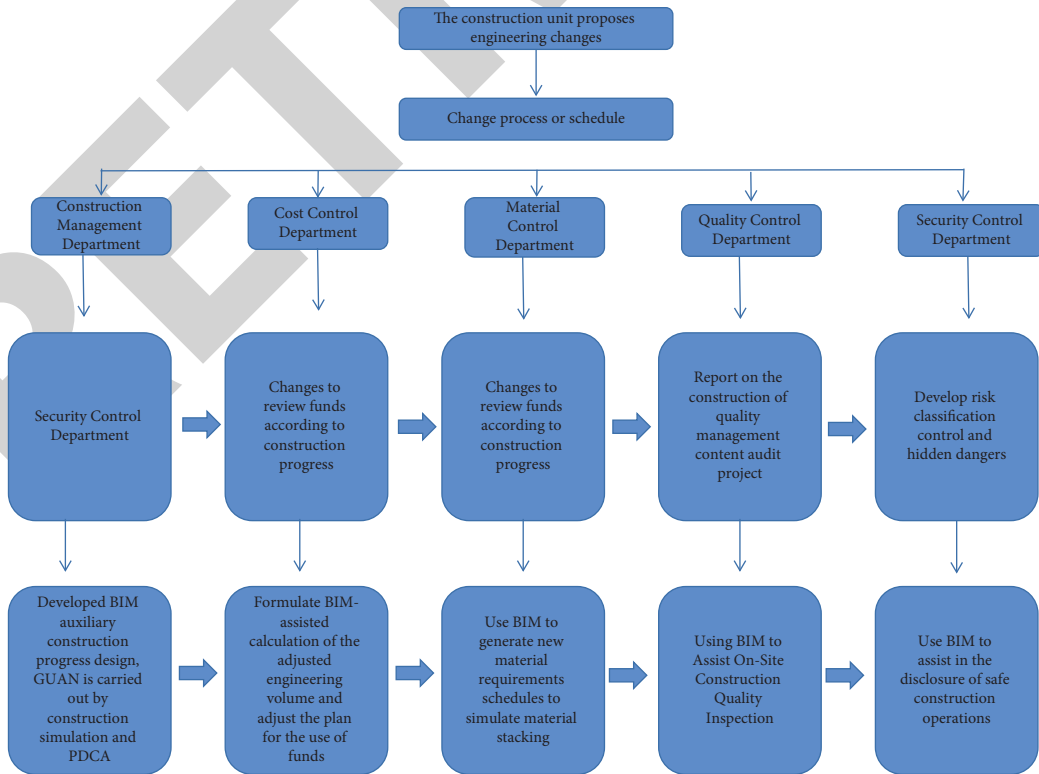FIGURE 4: Project change proposed by the construction unit.

FIGURE 5: Flow chart of engineering change proposed by the construction unit.
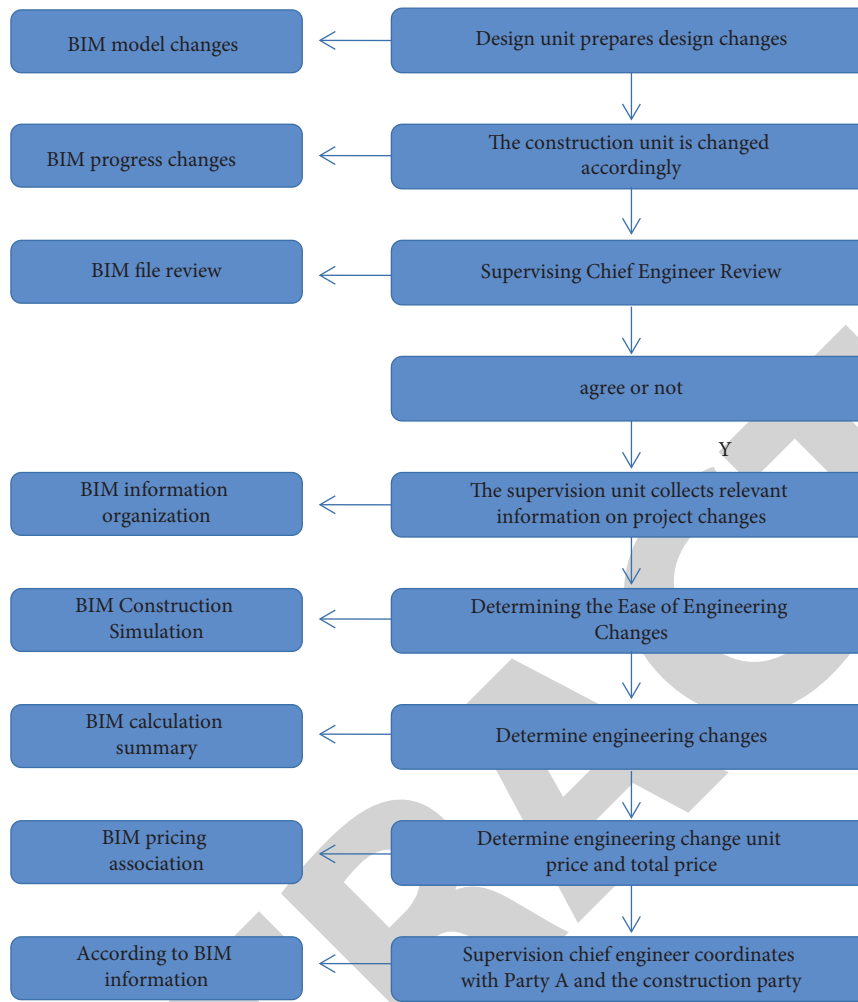
FIGURE 6: Schematic diagram of supervision engineering change.

By comparing the size relationship between L and L_0, the evaluation criteria of early warning mechanism are shown in Table 2.

It can be seen from Table 2 that when the early warning level is "large," it indicates that the material consumption seriously exceeds the standard value; when the warning level is "small," it indicates that the actual quantity loss of material consumption is zero or lower than the theoretical net consumption. If the alert level is "none," it means that the material loss rate is within the set loss rate limit, indicating that the material consumption is normal. In order to solve the problem that the recovery of surplus materials is not timely or not implemented, the BIM collaborative management platform has set up a special residual material recovery process to grasp the whereabouts of each batch of materials in real time, from warehousing, receiving, and using parts, so as to ensure that the cost of each batch of materials can be followed. After recycling, the surplus materials are generally returned to the warehouse or transferred to adjacent construction sites. Most of them are recycled by means of transfer. The material allocation

TABLE 2: Evaluation criteria.

Early warning level	Large	Nothing	Small
Evaluation boundary	$L > L_0$	$0 < L < L_0$	$L \leq L_0$

information between work sites is recorded in detail through the surplus material recovery process [10]. Under the traditional material management mode, the material allocation is often arbitrary and even can be allocated by one phone, which is very unfavorable to the standardized management and cost accounting of materials. The material allocation module is used to standardize the management of the mutual transfer of material libraries between various divisions and work areas and complete the process data of each batch of allocated materials. When the surplus materials are transported to the site according to the material requirements, they are generally coordinated through the material allocation between adjacent construction sections, which can not only reduce the transportation distance but also ensure the timeliness of material use and construction progress. The residual material return process set by BIM collaborative management platform provides
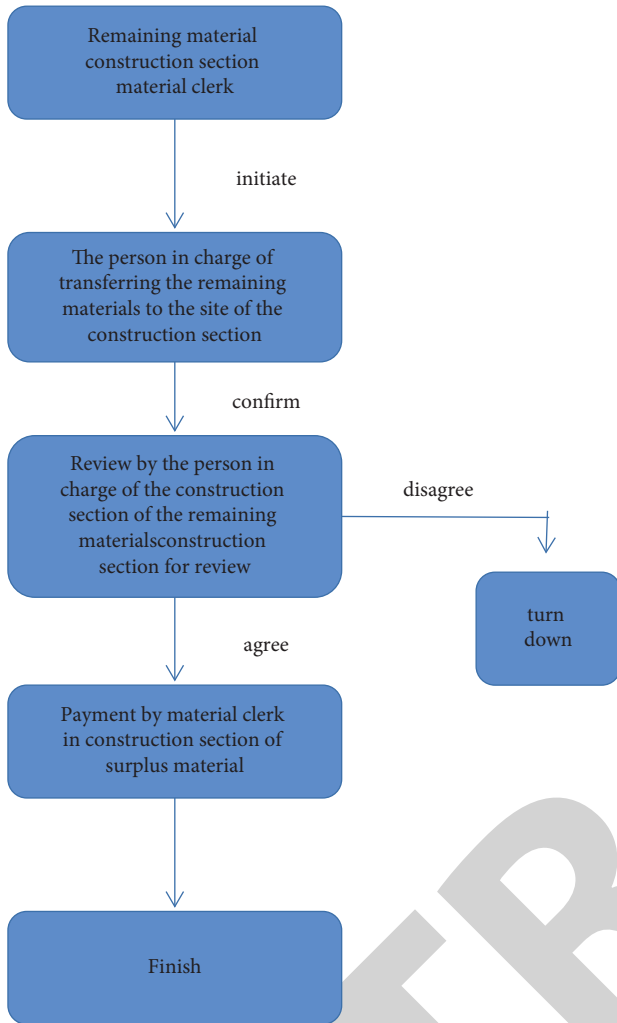
Figure 7: Operation flow chart of residual material recovery.

conditions for the realization of material allocation. The residual material recovery process is shown in Figure 7.

3. Experiment and Analysis

The sensing layer hardware implemented by the equipment status monitoring module is mainly responsible for collecting the equipment operation status information. It mainly relies on the power measurement of electrical appliances by smart sockets and the fingerprint information collection of RFID tags by readers and writers. Finally, all equipment information of the single room is summarized by the information transmission node and sent to the server through the network layer [8, 19]. The identification mainly involves the selection and implementation of RFID technology; on-off monitoring involves the embedded development of intelligent socket as lower computer; the transmission node involves the embedded development of the host computer. The reader layer and the writer layer of the RFID device are the unique identification of the RFID device. At present, RFID tags on the market can be roughly divided into active tags and passive tags according to energy supply means. The active tags are powered by the battery loaded inside the tag. The tag frequency is usually 2.4 GHz ~5.8 GHz, and its reading range can reach more than 100 m; there is no battery inside the passive tag. When the reader reads or writes the tag, the RF field of the reader provides energy for the tag. Passive tags usually have a frequency of no more than 960 MHz and a reading distance of about 20 m. The system adopts 900 MHz UHF Passive RFID tag and the corresponding reader following iso18000-6c standard. The standard has many excellent characteristics: fast reading and writing speed, and the data rate can reach 40 kbps to 640 kbps; it supports a large number of tags to be read at the same time, up to 1000 tags in theory; it has a variety of read-write protection modes and strong functions. The software flow of using the reader/writer is shown in Figure 8.

RFID tag function is mainly used to read/write information to RFID tag. This function is a nononline function, and the client computer needs to be externally connected with a RFID card reader to realize the communication with RFID tag [20]. The system reserves an interface to read the information of warehousing equipment in the database for this function. After obtaining or manually entering the device information from the database, the RFID tag can be burned. In order to realize on-off detection, an intelligent socket is designed and implemented. The operation status information of the equipment is collected, and the power message to the information node is uploaded. The functional block diagram of intelligent socket is shown in Figure 9.

Power modules used were RPD3W05E701S and AMS1117. The former is mainly used to stabilize 220 V to 5 V isolated DC and provide stable 5 V power supply for the intelligent socket; the latter is used to convert 5 V to 3.3 V power chip. The communication module was an nRF24L01 wireless module [21, 22]. The NRF module is a monolithic RF transceiver, which works in the ISM band of 2.4 GHz ~2.5 GHz. There are built-in frequency synthesizer, power amplifier, crystal oscillator, modulator, and other functional modules. They are mainly used for wireless communication with information nodes. The electrical schematic diagram of communication module is shown in Figure 10. Also, there is an MCU: STM32F103 C 32 bit ARM microcontroller. The chip is based on Cortex-M3 core and inherits many peripheral functions such as timer, can, ADC, SPI, I2C, USB, and UART. The size of flash memory is 256 K. The main function is to carry out logic processing and control the intelligent socket. The nearest neighbor algorithm is the most widely used fingerprint location algorithm. When positioning, it records the signal strength obtained by N APS included in the network deployment as shown in

$$S = (RSS_1, RSS_2, \ldots, RSS_n). \tag{4}$$

In the offline database building stage, the fingerprint data for matching is collected in advance and the fingerprint data in the fingerprint database is recorded as shown in

$$F_i = (RSS_{i1}, RSS_{i2}, \ldots, RSS_{in}). \tag{5}$$

We use the matching algorithm to match s and F_i, calculate their Euclidean distance, and then take the
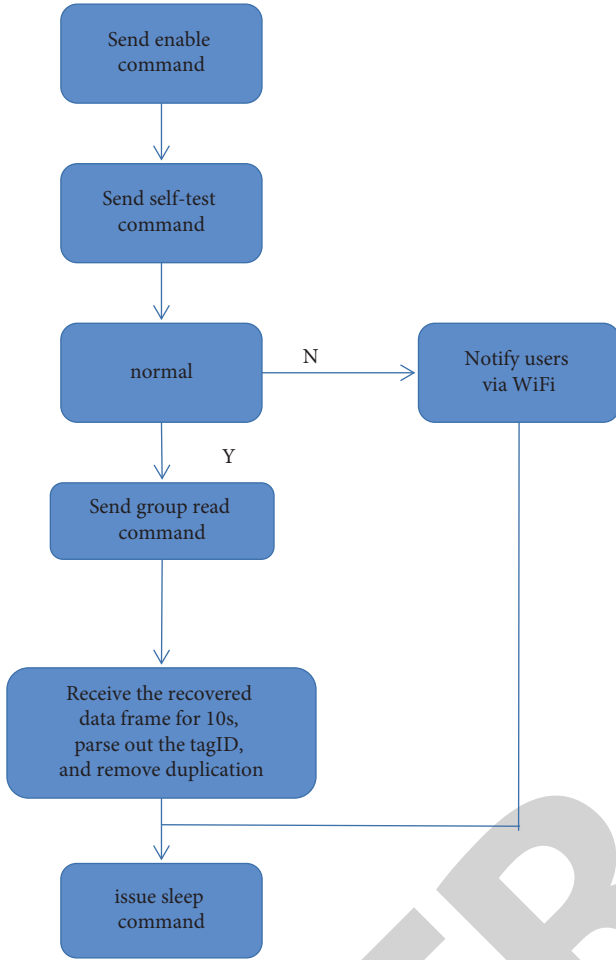
FIGURE 8: RFID reader software flow.

FIGURE 9: Functional block diagram of intelligent socket.
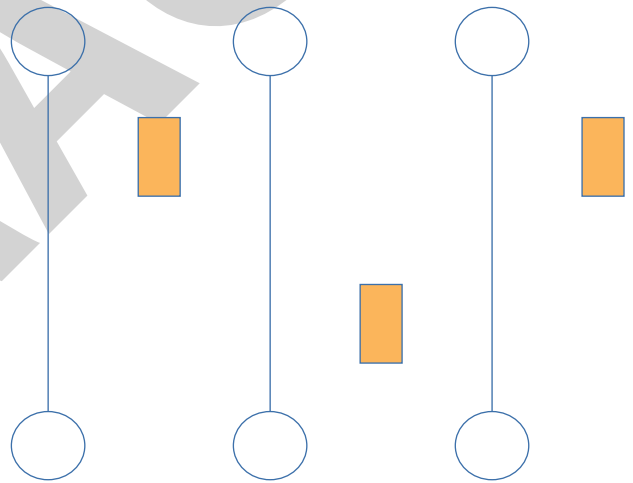
FIGURE 10: Schematic diagram of LANDMARC location algorithm.

coordinate corresponding to $\mathrm{Min}(D_i)$ as the final positioning position coordinate of the terminal node, as shown in

$$D_i = \left(\sum_{j=1}^{n} \left| RSS_J - RSS_{ij} \right|^2 \right)^{1/q}, \quad (i = 1, 2, \ldots, n). \tag{6}$$

Here, if $q = 1$, then Di is the Manhattan distance; if $q = 2$, Di is the Euclidean distance; K-nearest neighbor algorithm is optimized and improved by NN algorithm. On the basis of formula (6), we sort Di and select the smallest K values and calculate the average value (x, y) of the position coordinates of the K reference points with formula (7) as the estimated position coordinates of KNN algorithm, shown as follows:

$$(x, y) = \frac{1}{K} \sum_{i=1}^{K} (x_i, y_i). \tag{7}$$

This method can effectively reduce the amount of calculation, but how to obtain a better K value needs to be carefully measured: too small K value will make the data noise have a great impact on the results; if the value of K is too high, the calculation cost will be very high.

The weighted k-nearest neighbor algorithm is obtained by adding wK fingerprint reference points on the basis of KNN algorithm. The main difference between WKNN and
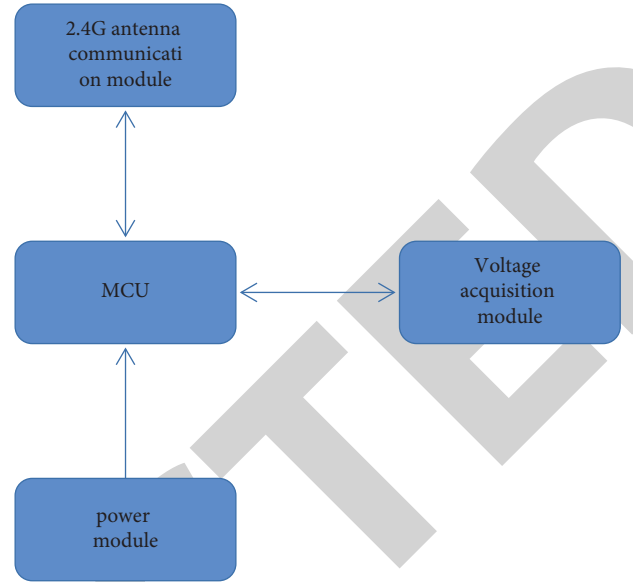
KNN is that after selecting K reference points, it does not directly calculate the average value of the position coordinates of K reference points but multiplies the coordinates of K fingerprint reference points by a weighting coefficient w, w and then takes the K weighted sum as the result of estimating the position coordinates, as shown in

$$(x, y) = \frac{1}{K} \sum_{i=1}^{K} W_i (x_i, y_i), \tag{8}$$

$$w = \frac{(D_i + \varepsilon)^{-1}}{\sum_{i=1}^{k} (D_i + \varepsilon)^{-1}}. \tag{9}$$

The LANDMARC positioning system is a dynamic identification positioning system that uses the set reference tag for auxiliary positioning and actively measures the signal strength of RFID tag. It has the advantages of low system

cost, good adaptability to complex electromagnetic environment, higher ranging and positioning accuracy, and better stability than traditional RSSI.

We set the number of AP points in the system as n, the number of auxiliary reference point labels as m, and the number of labels to be located as u. The signal strength vector of the tag to be located measured by AP is as shown in

$$S = (S1, S2, \ldots, S_n). \tag{10}$$

The reference label signal strength vector measured by AP is shown in

$$\theta = (\theta_1, \theta_2, \ldots, \theta_n). \tag{11}$$

Combined with the previous two formulas, it is easy to get that the Euclidean distance between the j-th reference label and each label to be tested is used to represent the relative signal strength value between the reference label and the label to be tested, as shown in

$$E_j = \sqrt{\sum_{i=1}^{n} (\theta_i - S_i)^2}, \quad j = 1, 2, \ldots, m. \tag{12}$$

M Euclidean distances can form a set of vectors $E = (E_1, E_2, \ldots, E_m)$ geometrically.

Then, according to the k-nearest neighbor algorithm, we arrange the values in E in ascending order, select the first k values, and multiply them by the weighting coefficient w to obtain the weighted sum of position coordinates. Its expression is shown as follows:

$$(x, y) = \sum_{i=1}^{K} W_i (x_i, y_i). \tag{13}$$

Among them, the weighting coefficient w is calculated by experience and the mathematical expression is shown in

$$w = \frac{E_i^2}{\sum_{i=1}^{K} E_i^2}. \tag{14}$$

Combined with the above calculation process, the schematic diagram of the final LANDMARC positioning algorithm is shown in Figure 10.

Figure 10 explains the final LANDMARC localization algorithm in detail. The auxiliary reference point label is a fixed point, and its signal strength is easily disturbed by the external environment, affecting the positioning accuracy. In order to improve the mapping reliability between RSSI value and actual position, in the offline database building stage, the original signal is collected for each reference point for many times and then filtered and preprocessed to obtain a stable and reliable auxiliary positioning RSSI signal value [23]. The filtering method has the advantages of low computation, fast processing speed, and remarkable effect. The process is shown in

$$\mu = \frac{1}{m} \sum_{i=1}^{m} RSSI_i, \tag{15}$$

$$\sigma = \sqrt{\frac{1}{m} \sum_{i=1}^{m} (RSSI_i - \mu)^2}. \tag{16}$$

After the rough positioning of the classical LANDMARC algorithm, this algorithm selects three reference labels when $k = 3$ for triangular positioning, so as to refine the region and improve the positioning accuracy. The calculation amount is small and the steps are simple, which reduces the influence of field strength change caused by environmental factors on the reference label [24]. The position coordinates of the experimental data of 28 points to be located in the experimental area are estimated by two different algorithms: the classical LANDMARC 3-KNN algorithm and the improved algorithm. The experimental data of the positioning algorithm are shown in Table 3.

According to the data in Table 3, the cumulative error of LANDMARC3-KNN algorithm is 103.67 and the cumulative error of the improved algorithm is 87.85. Here, the vertical axis is the coordinate error of the algorithm, the unit is the absolute value accumulation of pix, and the horizontal axis is the number of experiments. It can be seen that the performance of the improved algorithm is significantly improved compared with the traditional LANDMARC3 algorithm, the cumulative error is reduced by 7%, and the positioning estimation accuracy is improved, as shown in Figure 11.

This experiment only verifies the feasibility of the algorithm on a small scale, and the actual application scenario will be more complex, because the noise increases and the positioning accuracy decreases due to soft and hard partition walls, metal objects, and other wireless communication equipment and other reasons. The next section will give the actual application scenario test of the indoor positioning subsystem. Equipment scrap management function is an online function of declaration - > approval - > execution process when equipment needs to be eliminated. The application form will enter the application form storage pool in the "unprocessed" state. Users with scrap application approval permission can pull the list of unprocessed applications to be approved and fill in approval comments. After approval, the instance will be marked as processed and returned to the application form storage pool again [25, 26]. The executive (usually the equipment administrator) can view all instances marked as processed and process the equipment according to the approval opinions. The asset scrap management function is divided into two parts: equipment scrap declaration and equipment scrap approval, which are operated by ordinary users. Equipment scrapping declaration: after discovering damaged or expired equipment, users can fill in the equipment ID, name, location, applicant information, equipment damage description, and damage determination picture through the system, generate a new instance marked as "unprocessed," and submit it to

Table 3: Experimental data of location algorithm.

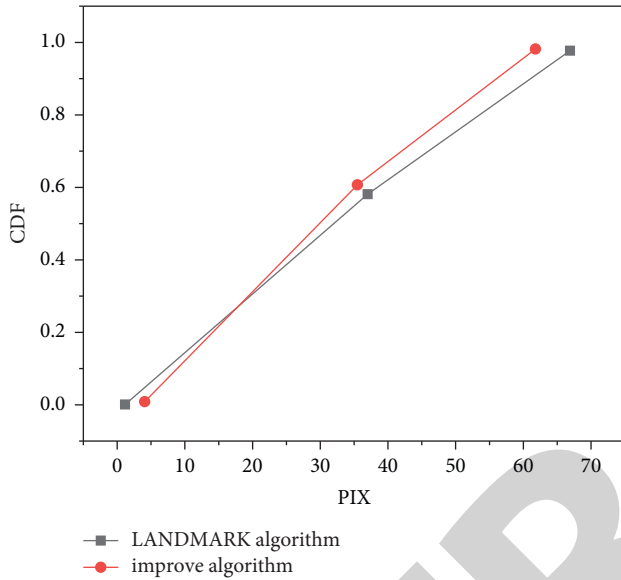| Serial number	Actual coordinates	LANDMARC3-KNN	Improved algorithm
1	(0.0)	(−0.73.2.50)	(1.50.0.06)
2	(0.50)	(0.24.48.68)	(3.03.48.53)
3	(0, 100)	(1.57.100.78)	(1.20.102.22)
4	(0.150)	(0.72.149.24)	(2.40,153.03)
5	(83.0)	(80.61, −1.15)	(2.40,153.03)
6	(0.150)	(80.80.52.87)	(86.28.50.08)
7	(83.100)	(86.21.97.33)	(83.23.100.66)
8	(83.150)	(80.46.152.93)	(84.12.150.25)

Figure 11: Comparison of error cumulative distribution function.

the server for unified processing by users with approval authority. Equipment scrapping approval: users with approval permission can obtain the list of scrapped equipment to be approved under this function, including the details of the application. They can choose to agree or reject according to the situation. Regardless of the approval result, the instance will be marked as processed. When the instance is marked "processed" and the approval opinion is "agreed," the equipment information query page will highlight the equipment to facilitate the staff to deal with it in time. The equipment statistics function can generate the usage statistics of all equipment in the selected time period for the overall analysis and statistics of assets. The statistical information table includes the total asset value, purchase quantity, inventory quantity, scrap quantity, etc. of the equipment. At the same time, there will be charts to assist data observation.

4. Conclusion

This paper mainly expounds the construction of the refined management mode of building materials based on BIM technology and Internet of Things technology and introduces the basic work of applying BIM technology to manage building materials from three aspects, that is, establishing BIM organization, establishing the BIM model, and selecting

BIM collaboration. The management platform then elaborated the refined management process of building materials based on BIM technology from three stages, that is, procurement stage, warehousing stage, and on-site consumption stage. However, in the process of enterprise application, there will be more or less problems that are not applicable to their own business. The current solution is to find partners and customize a BIM collaborative management platform that meets the needs of construction companies. Refinement management of building materials procurement stage based on BIM technology involves the following steps: first, establish a material procurement model based on BIM collaborative management platform information transparency and organically connect suppliers, material departments, engineering departments, and cost departments; then, according to BIM model information and based on the construction progress plan of the WBS code, formulate the material procurement plan, which greatly improves the speed of the material procurement plan and provides more sufficient time for the material department to select material suppliers; finally, select material suppliers, through the BIM collaborative management platform supplier list and hierarchical management can promote construction companies to establish good long-term cooperative relations with reputable material suppliers. Starting from the three links of material acceptance and storage, material inventory management, and material storage, through the material storage and storage process set by the BIM collaborative management platform, the material storage and storage process is standardized and the awareness of material storage is increased. Material manager responsibilities are as follows: upload the original orders related to the construction material management process, solve the problem of easy loss and damage of the original orders, and provide management efficiency by automatically printing the materials in and out of the warehouse; material inventory is based on material coding, the principle of "first in, first out, last in, last out," and video monitoring, to achieve real-time supervision of inventory materials. Moreover, through the MVT integration framework of Django technology, the software part of the system is designed and implemented and the user interaction part of the system is completed and improved. Combined with the analysis of the process of equipment management system in this paper, it provides sufficient preliminary preparation for the practice of staff in related fields. It conducts comprehensive system testing, including system functional testing, system response speed testing, and

system concurrent responsiveness testing, to verify that the system meets the expected design requirements. At this point, the system can be put into use at any time.

Data Availability

No data were used to support this study.

Conflicts of Interest

The author declares that there are no conflicts of interest regarding the publication of this article.

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