

## Digital Monitoring and its Effects on Organizational Performance

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### ABSTRACT

In every successful organization, the critical factors of time, cost, and quality preservation are paramount. Effectively managing and controlling these factors necessitates the implementation of strategic measures. Specifically, the reduction of wastage emerges as a key approach to conserving time, cost, and quality. Achieving this goal hinges on the optimal utilization of organizational resources, which entails precise planning, allocation, monitoring, and control.

While various methods for planning and resource tracking exist across organizations, this study focuses on strategies employed within the manufacturing industry. These strategies have demonstrated greater efficiency compared to traditional methods. Moreover, the study proposes the integration of Internet of Things (IoT) technology to address this challenge effectively.

The research recommends the use of IoT technology as a comprehensive solution. Prior studies have often utilized the JIT method solely for resource utilization or TPM method solely for resource management. In contrast, this research advocates for the individual application of these methods to plan each resource meticulously. Specifically, the JIT method is proposed for material utilization, the TPM method for equipment utilization, and the Kaizen method for labor allocation. Furthermore, it emphasizes the integration of IoT with these lean methods. While some researchers have explored IoT, they have not fully integrated it with lean methods and techniques. The synergy of lean production methods and IoT technology offers an ideal opportunity for optimizing the utilization of organizational resources.

Through these techniques, organizational resources can be efficiently planned and allocated to the production process. IoT provides valuable tools such as sensors, which can be installed at various resources, facilitating real-time data transmission to managers. This enables remote monitoring from office settings and timely data acquisition, thus addressing the challenge of optimal organizational resource utilization effectively.

**Keywords-** Internet of Things, Monitor, Organizational Resources, Optimal Utilization, Waste.

## I. INTRODUCTION

The physical resources of a manufacturing organization encompass materials, equipment, and labor, and their efficient utilization is essential for enhanced productivity (Lee, 2019). Achieving optimal utilization of these organizational resources relies on effective planning, which is further enhanced by adopting

innovative methods that prove to be more productive than traditional approaches. Following the planning phase, the subsequent step involves the monitoring and control of resources, a task made feasible through the application of technology such as the Internet of Things (IoT). IoT stands out as a prime choice for closely managing manufacturing sites and resources, with a wide range of general applications (Xu & Chen, 2016).

One notable application of IoT is in material monitoring, which involves tracking the location of materials and the use of RFID tags installed on them. This integration of planning techniques, particularly Just-in-Time (JIT) principles, with IoT technology leads to the development of the JIT-IOT model. This model is particularly valuable in the construction sector, where it contributes to increased efficiency and especially improved material utilization. JIT underscores the importance of eliminating wastage in terms of both materials and time, aligning its primary goal with ensuring the timely utilization of materials for selected activities and at the specific locations where they are needed (Tang et al., 2019).

Research has recommended the adoption of the JIT-IOT model for the efficient utilization of construction materials. This model has been applied to an actual construction project in Afghanistan, facilitating a comparison between conventional methods and the newly recommended approach. The research also involved conducting a questionnaire, which yielded favorable results for the new model.

Moving forward, another critical organizational resource is equipment, and the Total Productive Maintenance (TPM) methodology is recommended for its efficient utilization. TPM is focused on minimizing time wastage during the working process by implementing maintenance during scheduled breaks, thereby avoiding delays and ensuring the timely completion of planned activities. This method encourages the utilization of machinery for scheduled activities on time and emphasizes the monitoring and control of its productivity and efficiency on an hourly and daily basis. IoT plays a crucial role in achieving these goals by facilitating close monitoring and control of machinery (Kanan et al., 2018).

IoT offers the capability to install sensors on machinery, providing insights into machinery health to preempt breakdowns during working hours. These sensors collect data on machine temperature, speed, location, and diagnostic and prognostic information. These variables are vital for controlling machinery and achieving efficient and productive outcomes. The TPM-IOT model, through real-time monitoring and control of machinery, effectively operates as a real-time tracking system applicable to construction projects.

Lastly, the utilization of labor is a pivotal aspect of resource management. The Kaizen model optimizes labor allocation to specific activities within defined timeframes. If labor fails to complete scheduled activities on time, Kaizen emphasizes the importance of identifying the reasons for incomplete tasks to prevent reoccurrence. To virtualize this approach, the integration of IoT is recommended, resulting in the Kaizen-IOT model. This

model comprises two components: the planning and utilization part, which follows Kaizen principles, and the second part, responsible for real-time monitoring and control of labor through IoT. IoT's contribution is significant, particularly in addressing issues related to labor safety and health. It enables the monitoring of labor safety, tracking of labor location, and provides insights into labor health through electronic wearables (Shao et al., 2019).

## II. HYPOTHESES

**H1:** Production cost saving will lead high efficient Success of organization.

**H2:** Reduce wastage of time during production will lead efficient Organizational Performance.

**H3:** There is significant relationship between product quality and winner competition.

**H4:** There is significant relationship between real time production and Success of organization in the market.

## III. METHODOLOGY

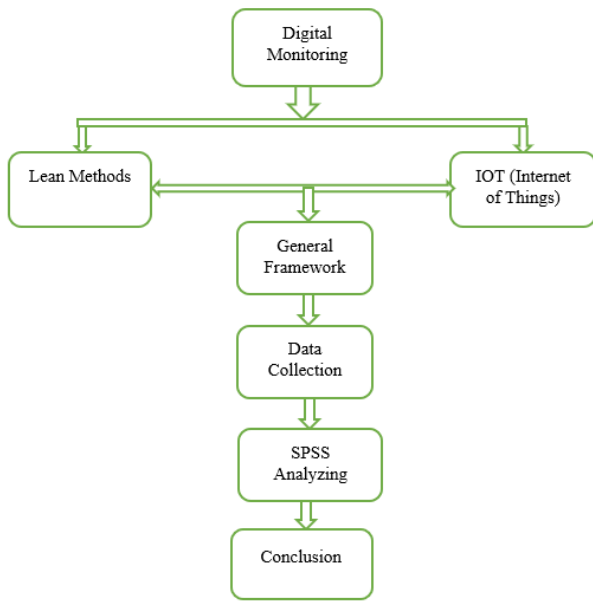
The Research approach involves the application of lean methods to optimize the utilization of organizational resources. Specifically, we utilize the Just-in-Time (JIT) method for material utilization, the Total Productive Maintenance (TPM) method for equipment utilization, and the Kaizen method for labor utilization.

Once the allocation of resources is determined, close supervision becomes crucial to ensure alignment with our planned objectives. To achieve this, we employ Internet of Things (IoT) technology for each type of resource. This entails the installation of specific sensors at each resource, enabling real-time data collection. We have integrated a cloud-based system and dynamic scheduling to facilitate timely feedback and informed decision-making.

To validate the effectiveness of our methodology, we conducted data collection through a questionnaire administered within the manufacturing industry in Kabul, Afghanistan. This survey aimed to gain insights into the practical implementation of our recommendations.

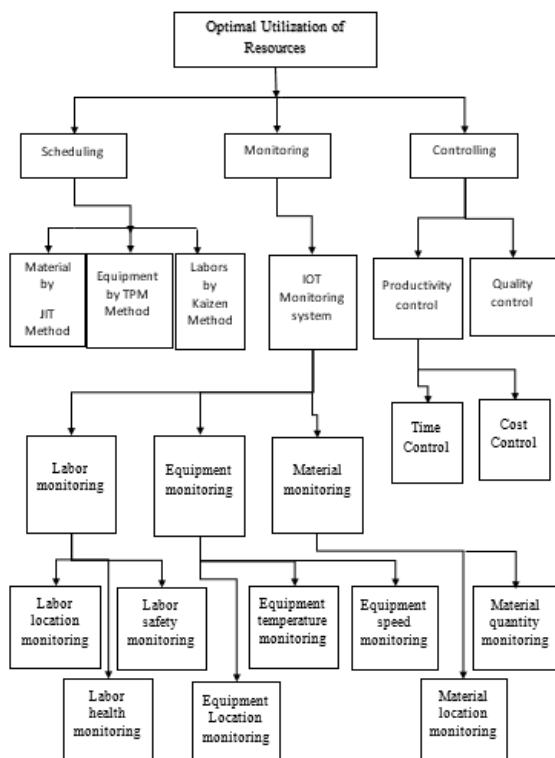
Our findings indicate that the recommended methods and methodology outperform conventional approaches in terms of efficiency within manufacturing industries. The summarized methodology is illustrated in the accompanying figure.

**Analytical tools used:** SPSS Correlations and others statistical tests used for analysis.



**IV. CONCEPTUAL FRAMEWORK OF THE STUDY**

On behalf of the individual frameworks for each resource utilization we have gained and prepared the above general framework for all three types of resources which are material, equipment and labor. Based on the above general framework the construction industry will be able to integrate the utilization of resources and monitor the utilized resources as per IOT requirement.



**V. RESULT AND DISCUSSION**

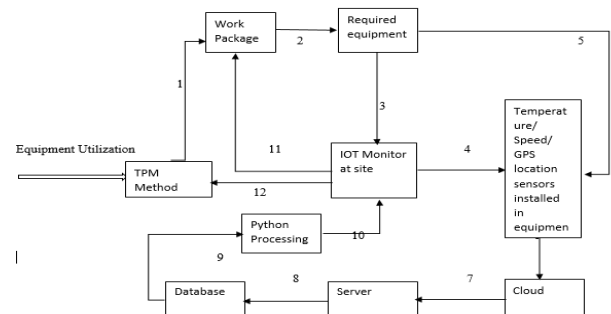
*Lean Methods:*

*TPM model for Equipment Utilization with IOT technology*

TPM means Total Productive Maintenance, the main aim of this method is continuous maintenance and checking of machinery. Or we can say the maintenance of machinery before breaking to lose the time or cost of project. The TPM method focused on every day checking of machinery to forecast above the health of equipment. Every day checking means while the work has stopped at end of day the machinery should check and repair for tomorrow. The IOT has several sensors to install on equipment and alarm the project manager about the health of equipment like temperature sensor, before boiling the water in machine to break the machine it will give you alarm about the temperature of machine. The second example is the speed sensor it give us chance to know the speed of equipment because the slow machinery will affect the cost and time of work. So, this sensor allow you to control the speed of machinery and equipment so you can control from far away and give your instruction to driver of equipment and get the suitable speed and avoid from time losing or cost losing.

The equipment utilization through TPM method explaining that each activity need for an equipment and each activity has its own quantity and the project manager should know the productivity of each equipment it means the done work or equipment/ hour. The TPM focused that each operator should check the equipment continuously and avoid the breakdown. If the operator missed that checking the second person should ask about it. It is the supervisor of project. If supervisor also missed the manager should ask for checking and efficiency also on that day. The IOT become easily these checking and it is the real-time checking of equipment and knowing about the health of equipment before breakdowns. The TPM planning and IOT integration is so friendly to plan by TPM and monitor by IOT because both of them focused on avoiding breakdowns and minor stop, or speed of equipment. The TPM-IOT focused on efficiency of equipment to gain the optimal result. The brief result of this model is as following:

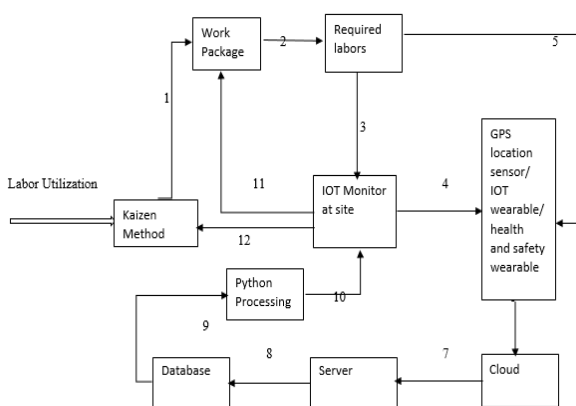
No breakdowns, No stops or slow running and No defects.



Equipment utilization through TPM method and monitoring of equipment through IOT technology has started from defining work package or activities. After that each activity required and equipment to implement that defined activity. So for this purpose we should utilize the equipment and install the required sensors for efficiency of equipment. There are installed the speed sensor, machine monitoring like temperature of machine sensor to alarm the operator before failure and also the location or GPS sensor to know the location of equipment. The IOT basis frame work shows the period of this purpose so while we know the location, Speed and machine diagnosis we will have an efficient result from doing activity with utilized equipment. The installed sensors linked with cloud and the data send by cloud to the server and data base after that the data processing by python language and is readable to site manager. The site manager can control from far away and the site manager can control his schedule as dynamically. The dynamic scheduling is more efficient than conventional method. Because the time consuming in this method of scheduling.

***Kaizen Method with IOT Technology for Labor Utilization***

The word of Kaizen comes from two Japanese words, it are Kai means change and Zen means improvement. When Kaizen applied to work site it means of continuous improvement of human resources like workers, managers, engineers, and so on. Therefore the continuous improvement and training of labor reduce the cost and avoid or eliminate the wastages the come from labor on project. If we implement the kaizen method it will bring the following benefits to the companies are Inventory reduction, Processing time reduction, Productivity improvement, delivery time reduction, walking distance reduction, reduce Waste.



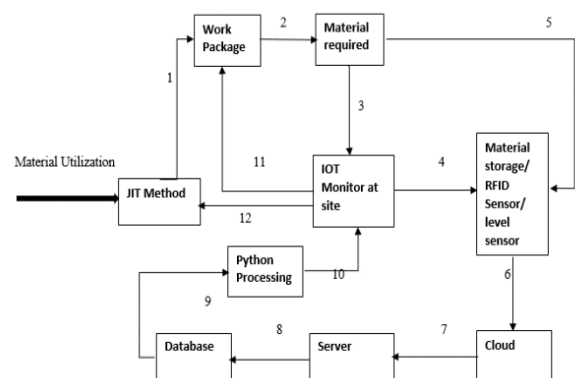
Otherwise, the utilization of resources will face to a problem in each step of utilization. The monitoring of the utilized labor resource is facilitate by IOT technology and the site manager can to control and check them on real-time basis. Therefore there will be dynamic scheduling system and avoid the time for updating the schedule and also will be helpful for elimination of wastages and this type of resource.

Based on the above framework the utilization of labor started with kaizen method with all scope and objectives as mentioned before and then the work package or activity should define and based on estimation of required labor it will defined and utilized to activity, after that the IOT site monitor installed the required sensors on labor helmet and IOT wearable for worker safety and health purpose. The IOT sensors send the data to cloud and cloud send the data to server and database, after receiving the data to database it will send to convert it into information by python language and will be readable to site monitor and site monitor will be able to supervise the site from far away and will have the dynamic scheduling system by IOT technology. The site monitor linked to the first step which was the Kaizen methodology and the project site manager will able to get all information on time and take decision to this regard. So the on time information from site will help the manager to eliminate or avoid the waste of time and save the cost. Elimination of wastages and saving of cost in utilization of resources is direct linked to the productivity and efficiency of project. Our main purpose is the efficiency of project and based on this two option that are Kaizen-IOT is virtual possible and gain the main target.

***JIT Method with IOT technology for Material Utilization.***

JIT is the full form of Just In Time and its definition is for material inventory system is the high disciplined inventory management is the purpose of JIT it means to eliminate the wastage by receiving material Just it needed or can say that receiving of production material on right time, on right place with right quality and with right quantity is the main aim of JIT.

JIT is the lean method for manufacture industry, This method is focused on waste elimination and avoiding the wastages include time wastage, cost wastage, quality wastages, feedback wastages, schedule wastages, quality wastages. So while these wastages controlled there is no defect and the system is controlled as planned. The JIT method also focused on eliminated or zero inventory system it means while the activity get ready on that time should the material take ready because if the material stored for more time it cause the inventory cost and should affect the quality of material as well.



On the other hand, IOT (Internet of Things) help to update the schedule on time or have dynamic scheduling it help to have on time feedback and give the required instruction to site. It will help the project to save time, cost and quality of work and material as well. The

IOT technology will know us to know about the material which are present at site or needed for site.

**Data Analyzing Tests**

**Correlations Test**

Correlation between the methods and IOT efficiency

**Correlations**

		JIT- IOT	TPM- IOT	Kaizen- IOT	Performance Efficiency
JIT-IOT	Pearson Correlation	1	.842**	.767**	.866**
	Sig. (2-tailed)		.000	.000	.000
	N	60	60	60	60
TPM- IOT	Pearson Correlation	.842**	1	.634**	.771**
	Sig. (2-tailed)	.000		.000	.000
	N	60	60	60	60
Kaizen- IOT	Pearson Correlation	.767**	.634**	1	.800**
	Sig. (2-tailed)	.000	.000		.000
	N	60	60	60	60
Organizational Performance	Pearson Correlation	.864**	.779**	.802**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	60	60	60	60

\*\* . Correlation is significant at the 0.01 level (2-tailed).

Based on the above table, Organizational Performance have the high degree of correlation with JIT with IOT and, it means, there is strong positive relation between the usage of JIT method with IOT and Organizational Performance, whereby the value of correlation is (r=.866,p<.05),Kaizen with IOT also have the high degree of correlation the Organizational Performance (r=.800,p<.05),and TPM with IOT have moderate degree of correlation Organizational Performance because the r value is between (r=0.75 -

0.5,p<0.5). In the table it shows that every variable are significant because P value are not more than 0.05.

**Multiple regression:**

In multiple regression test, few independent variables(Usage of JIT with IOT,TPM with IOT and Kaizen with IOT material utalization) and one dependent variable (Organizational Performane) tested to protect linear relationship among them.

**Model summary of Regression**

**Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.914 <sup>a</sup>	.840	.820	.24019

a. Predictors: (Constant), Kaizen with IOT, TPM with IOT, JIT with IOT

The table shows that R-Square is .820 or 82% which indicate a relatively high percentage of the variation in IOT and project efficiency can be explained by the variables entered in the equation (R - squared = 84%; R- squared (adjusted) = 82%).Thus 82.% of the variance in IOT and Organizational Performance can be explained by JIT,TPM and Kiazen. (p < 0.01) indicates the regression of work IOT and efficiency on the dimensions assessed, expressed through the adjusted

squared multiple (R - squared (adj.) = 82%) is statistically significant. Hence the null hypothesis is rejected. These variables account for 82% of the variance in JIT and efficiency. it express that there is strong positive significant relation between independent variables(Usage of JIT with IOT,TPM with IOT and Kaizen with IOT) and dependent variable(Organizational Performane).

**ANOVA**

**ANOVA<sup>a</sup>**

Model	Sum of Squares	Df	Mean Square	F	Sig.
1 Regression	16.369	3	5.456	94.577	.000 <sup>b</sup>



Residual	3.231	56	.058		
Total	19.600	59			

a. Dependent Variable: Organizational Performance

b. Predictors: (Constant), Kaizen with IOT, TPM with IOT, JIT with IOT

The ANOVA table stated, there are independent variables that have significant linear relationship with Organizational Performance. To express the exact variables, the next table will be explained.

**Coefficients:**

Table 09. Coficient table from questionnaire SPSS analysis

**Coefficients<sup>a</sup>**

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1	(Constant)	.057	.159	.360	.720
	JIT- IOT	.715	.127	-4.615	.000
	TPM- IOT	.110	.107	3.776	.000
	Kaizen- IOT	.405	.098	7.256	.000

a. Dependent Variable: Organizational Performance

According to the table above, all P values are not more than .05. This expressed that all independent variables have significant positive linear relationship Organizational Performance. The B value is the portion of the variable within the overall relationship. According to the above table, JIT with OIT has most noteworthy portion that is .715. So it is the strong independent variable. In the other hand TPM with OIT is the weakest independent variable with the portion of 0.110.

**VI. DISCUSSION**

The management, utilization and monitoring and controlling of organizational physical resources that are material, equipment and labor is a vital and basic job for each Organization to gain the main goals that are time and cost saving. Therefore the Organizational Performance linked directly to time, cost and quality saving during the working. For the virtual possibility of Organizational Performance, the productivity of each resource is a base for gaining of this target. So the manufacture industry has need for new method and methodology to work on it and facilitate the main goals. The new methods which have been used in manufacture industries we have bring it and linked with IOT technology to help the production manager for better management of organizational resources. As we mentioned in above sections the planning of each resource has their individual method that are JIT method for production material, TPM method for equipment and Kaizen method for labor utilization and the supervision of each resource linked the method with IOT and the result of each resource has its own model as following:

**TPM-IOT Model:**

The TPM or Total Productive Maintenance method have implemented to the utilization of product equipment for the planning purpose of equipment and the supervision is done by IOT or Internet of Things. Each activity which has need for equipment should defined and utilized the equipment for it, after that the supervision or tracking of equipment is a vital job for production manager to know about it. The TPM method emphasize on continuous maintenance of equipment and also the speed, location of equipment is also need for production manager to know about it. The IOT facilitate to know the location, speed, temperature and also the diagnosis of machine before failure so the action on time will help the project to avoid the wastage of time and cost. The study shows that the TPM-IOT has closed to each other and is more productive and more efficient than conventional method. Therefore the IOT facilitate to know more about the equipment location, speed and also avoid the machine failure because the IOT alarm us based on system to know about machine diagnosis. The construction manager can to have a dynamic scheduling system and avoid from wastage of time and cost on site.

The main result that gaining from this model is as following:

1. Productivity
2. Efficiency
3. On time maintenance
4. Dynamic scheduling
5. Saving time
6. Saving cost
7. Elimination and avoiding of wastage

**KAIZEN-IOT Model**

Kaizen means continuous improvement of labor, managers and engineers. This method emphasized on improvement of this type of organizational resources. The kaizen result that continuous training for labor helped us to have safe site environment for work and avoid the wastage of time and cost because while we utilized the labor for each activity then we should know the status of workers. This method helped us to be ensure that each activity has required labor or human resource on time and on good place. The IOT linked with this method because for it better supervision. IOT recommended the IOT wearable for human resource safety and health and also the GPS location sensor installed on human or labor helmet for it defining the location.

When we have planned with Kaizen method then we utilized the human resource for each activity and the site manager will monitor or track the human resource from far away or based on IOT system that connected with cloud to the server and database that is available on site. Based on this model we gained better efficiency and better productivity on organization. So this model saved the time and cost as well.

**JIT-IOT model:**

Considered for material utilization and supervision at site, this model present the planning of production material with the help of JIT method and its supervision is done with IOT or Internet of Things. This model help with organization to have a good planning for production material and have on time supervision from material at site. Because this model facilitate that each activity should defined first then estimate production material for it and then utilize the material. The IOT helped the supervision from material its quality, quantity and location of it. So the supervision of material help the industry to know and manage the material at site and plan for other material that required for other work package. After more research, study and literature review we have found that these methods are more efficient than conventional one and we have done the questionnaire and the result was more closed to each other. The questionnaire shows the correlation between the JIT method and IOT that are very closed and linked to each other, the questionnaire done with 60 experienced individuals, project managers and the result was that these model is more efficient and more productive than conventional methods and techniques.

**VII. CONCLUSION**

In conclusion, the efficient utilization of organizational resources plays a pivotal role in effective production management. In our pursuit of optimizing resource utilization, we have introduced highly efficient and productive methods, namely Just-in-Time (JIT) for material utilization, Total Productive Maintenance (TPM) for equipment utilization, and the Kaizen method for labor utilization. By implementing these methods, we not only

enhance the utilization of physical resources but also conserve non-physical resources, such as time and cost. This approach stands to be more efficient than conventional methods, delivering substantial savings in both physical and non-physical resource utilization within manufacturing industries.

In the latter part of our research, we recommend the integration of Internet of Things (IoT) technology to oversee and monitor organizational resources in real-time. IoT not only aids production managers in resource supervision but also contributes to significant time and cost savings. Furthermore, it facilitates the implementation of dynamic scheduling systems, thereby enhancing the overall efficiency of production processes.

**SUGGESTIONS**

- ❖ Employ a more efficient method, such as Just-in-Time (JIT), for production material planning.
- ❖ Enhance the productivity of production equipment planning by adopting the Total Productive Maintenance (TPM) approach.
- ❖ Optimize human resource planning by implementing the Kaizen method, which ensures safety and efficiency.
- ❖ Implement Internet of Things (IoT) technology for the real-time monitoring and control of physical resources, including materials, equipment, and human resources, leveraging IoT's sensor-based system connected to cloud and databases.
- ❖ The questionnaire results underscore the seamless integration of lean methodologies (JIT, TPM, Kaizen) with IoT technology for more efficient resource planning and supervision.
- ❖ IoT technology offers organizations the opportunity to implement these lean methods securely and efficiently, ensuring better outcomes.
- ❖ The adoption of these methods, coupled with IoT technology, simplifies the allocation, utilization, and tracking of resources for manufacturing industries and production managers.

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