Design and Application of Industrial Engineering Experimental Platform Based on IOT

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Abstract. As the lack of advanced technology, experimental content inherent relevance, systematic and comprehensive innovation of the Industrial Engineering Experiment at present, Internet of Things technology, information technology, service-oriented architecture technology are used to integrate various existing independent industrial engineering experiments resources. A modern industrial engineering experimental platform is studied and established. The operation experiment of automatic warehouse, logistics and distribution management experiment, production control and operation experiment, human factors engineering experiments and other industrial engineering experiments are designed based on this platform. And the feasibility, superiority and intelligence are proved by the actual operating results of industrial Engineering experiment platform in Wuhan University of Science, which has guiding significance for Industrial Engineering Laboratory in colleges.

1. Introduction

Internet of Things is the third wave of the world information industry after computer, Internet and mobile communication network. As America's ‘wisdom of the Earth’, Japan's ‘I-Japan’, South Korea's ‘U-Korea’, Europe ‘I2010’ and the country's ‘Internet +’ plan, Internet of Things has been written into China's ‘Twelfth Five-Year Plan’ strategic planning of new industries [3].

As a comprehensive discipline, Industrial Engineering is provided with strong interdisciplinary, application and practice. Experiment teaching is its essential part of the teaching process. With the economic globalization and the rapid development of information technology, how to build laboratory with Industrial Engineering characteristics and insure the quality of Industrial Engineering training talent with existing technology and resources are particularly important for colleges today. The pace of industrial engineering discipline developed very quickly since the State Board of Education approved the Xi'an Jiao tong University and Tianjin University to establish the first industrial engineering in1992 [4]. Colleges and universities which have set up industrial engineering attach great importance and support the practical aspects of teaching, continue to strengthen laboratory construction and equipment investment [5]. However, due to financial, technical, stages of investment and other reasons, resulting in multiple ‘experiment islands’ exist in industrial engineering laboratories [6], lack of advanced technology experiment, experiment content and the relevance of inherent lack of systematic, comprehensive lack of innovation and other issues.

As to the current problems of industrial engineering laboratories, with the rapid development of the Internet of Things, the advantage of networking technology, wireless communication technology, automation control and other advanced technology are taken to integrate and update the existing laboratory equipment resources. A modern industrial engineering experiments platform is build, so that the whole industrial engineering laboratory to form a unified system, deep integrating each isolated experiments, and providing good expansion interface for subsequent new experiment. A good teaching practices and innovative learning platform is provided for school teachers and students.

2. Design Goals

Through the analysis of Industrial Engineering laboratory in Wuhan University of Science and Technology, improve and perfect on the basis of the laboratory construction, increase the necessary equipment, combine with the school teaching requirements to plan Industrial Engineering experimental platform in the context of Internet of Things. With advanced IoT technology [7], automation technology, network technology and the concept of experimental establish, integrate 'industrial Engineering' and 'enterprise application', combine the theory teaching and practice, so that students better knowledge and understanding of what they have learned, and to develop their practical skills. The experimental platform and ultimately achieve the following objectives:

(1) By the experimental equipment upgrades, renovation and renewal, to achieve the internet of real world and the virtual world, as well as remote access to experimental resources, monitoring and intelligent control, to effectively support human-computer interaction, interaction between people and objects, social interaction between people, and to transform the traditional teaching methods to systematic, vivid, openness and innovative industrial engineering practice teaching;

(2) Realize the digital, networked experiment teaching, constantly enriched and updated teaching experiment content, improve students' modern IE (IT + IE) skills to train students to use industrial engineering knowledge of the planning, design, analysis, organization, optimization, control, decision and information technology applications;

(3) Combined with the features of industrial engineering in Wuhan University of Science and Technology, design an experimental platform for industrial engineering, enrich and improve our school industrial engineering pilot project, the latter can also add new modules as needed.

(4) The design of Industrial Engineering experimental platform under IoT background, not only to provide an experimental environment for students, but also provide a platform for teachers and graduate studies, the experimental platform play an important role in training higher engineering and technical personnel and the formation of professional features.

3. Platform Design

Internet of Things technology and SOA technology as emerging areas of information technology, its rapid development has brought opportunity to the construction of specialties industrial engineering experiment teaching system in different universities. As shown in Fig 1, industrial engineering experimental platform under the background of IoT is utilized three-layer structure, which contains data acquisition and control hardware layer, experiment integration and tracking layer and optimization management and decision analysis. The underlying hardware control and data collection realized by the Internet of Things technology, and various independent experiments integrated based on SOA and modular technology.

(1) Data Collection and hardware control layer

Data Collection and hardware control layer are composed by modern industrial engineering laboratory facilities ,which composed of hardware devices as follows: automated warehouse, stacker, roller conveyors, sorting equipment, sculpture robot with 5 degrees of freedom, AGV, RFID tags picking machines, assembly lines, labels and RFID reader equipment and a variety of sensors and other experiments. Through PC-PLC docking, docked with the upper control system and experimental data acquisition and real-time monitoring. Through wireless sensor technology and communications technology, a large amount of data is uploaded to the distributed servers, which provides the underlying hardware and data support for the experiment, experimental analysis and experiment management.

(2) The experimental process of tracking and integration layer

Through SOA architecture and enterprise service bus, every experiment application is integrated and realized information communication subsystem for each experiment. Subsystem experimental based on ERP system, such as production planning and control experiments, the material chosen experiments, experimental production line assembly, warehousing experiments et al; and other

experiments, such as human factors engineering experiments, operations research experiments. The industrial engineering experimental platform has good stability, integration and scalability because of its modular technology and service-oriented technology.

(3) Experiments optimize management and decision analysis layer

Through the integration of the underlying data acquisition, hardware control layer and senior information management system, various subsystems experimental are centralized analyzed and processed. Combined with automated, intelligent and visualization technologies to optimize of the whole laboratory management. This layer is divided into two different modules based on users which are teacher analysis and management module and students experiment module.

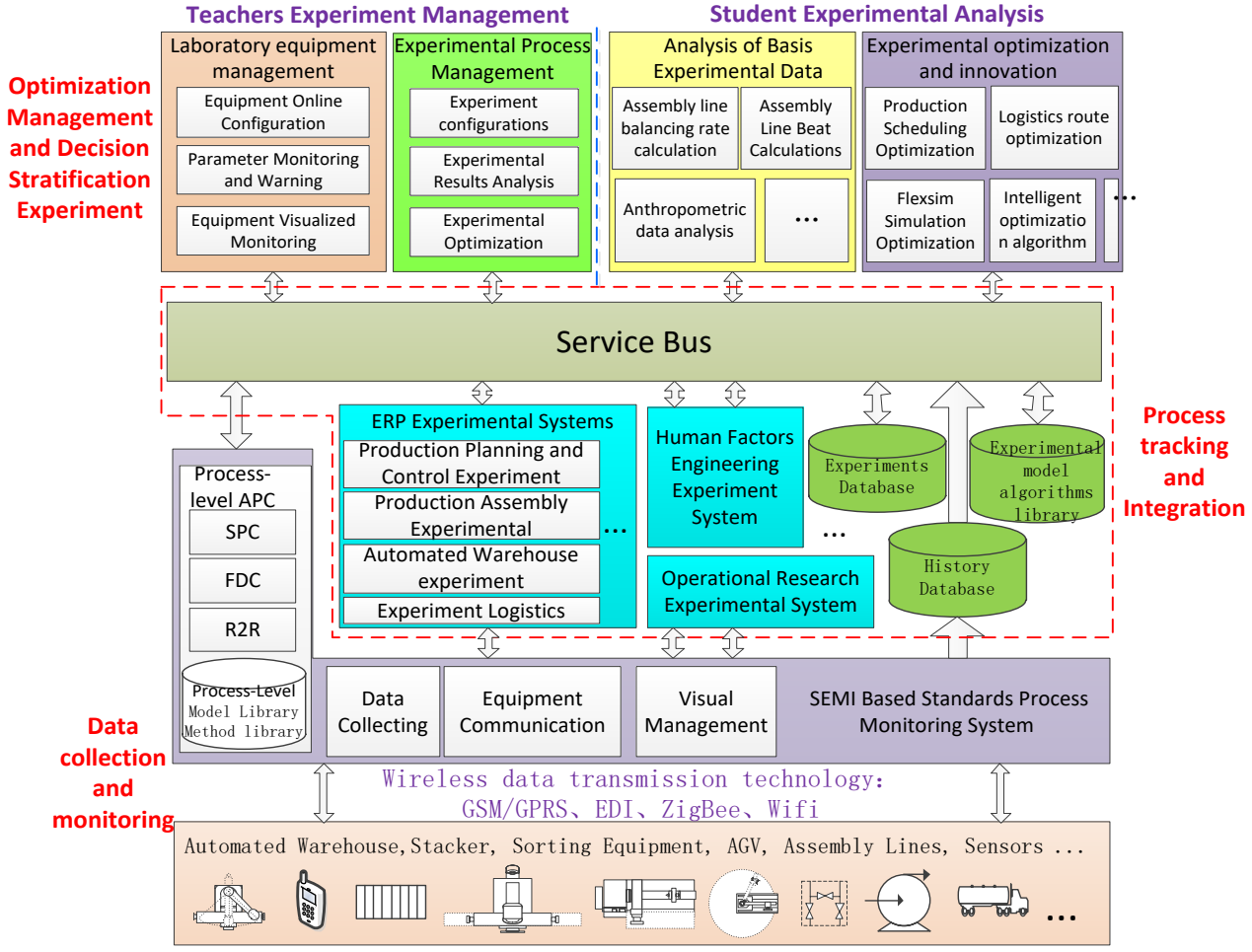

Fig.1 Industrial Engineering Experimental Platform Architecture

4. Experimental Design

Combined with Industrial engineering disciplines in Wuhan University of Science, based on established industrial engineering experiment platform in this paper, experiments based on ERP system and other types of experiments are designed as follows.

4.1 Design of the Experiments Based on ERP System

The ERP system is based on actual business process of MTO enterprise which is optimized by methods of industrial engineering and is designed for undergraduates and graduates. It mainly contains order management, production management, warehouse management, transportation management, financial management and other functional modules, which shows the complexity of production management in the most intuitive way in front of students and turns the abstract, complex management philosophy to visualize and allows students to participate in the entire process of production. The will have a comprehensive understanding after the experience of the relationship and responsibilities between the various departments in the company. As shown in Figure 2, production

planning and control experiment, the material chosen experiments, experimental production line assembly, automated warehouse operation experiment and logistics experiment have been successfully running for two years. Next, production planning and control experiments and the production line assembly experiments will be introduced in details.

(1) Production Planning and Control Experiment

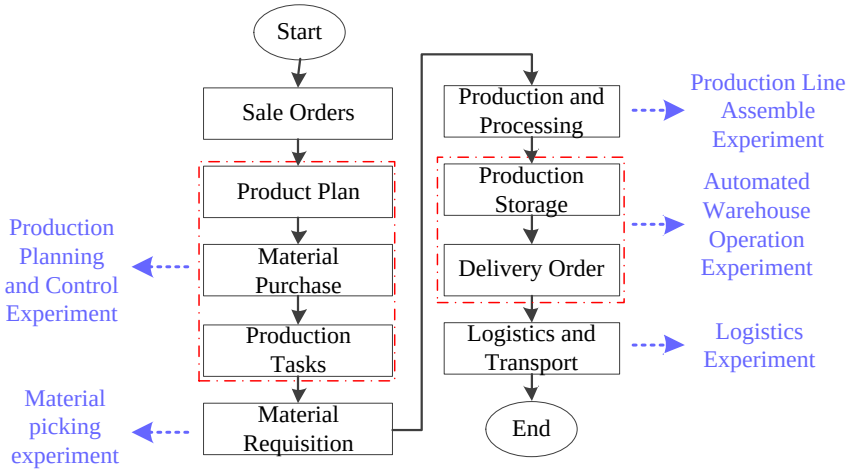

Fig. 2 Experimental Design Based on ERP

This experiment mainly corresponds to the ERP production planning, material procurement and production tasking business processes, while closely associated with "production planning and control" which is the industrial engineering course. Through this experiment, students can take an order as an example to learn about system planning, analysis, design and implementation, and to comprehensive business collaboration between different management roles during the production of. In this way, on the one hand, students can have a thorough understanding of planning production planning and control management, analysis and design knowledge systematically and skills of its operation method, rather than learn the steps for a single aspect independently; On the other hand, after the students earnestly fulfill various aspects of business simulation in the ERP system, they can understand the production site management system planning, analysis, design and implementation work. Mainly related knowledge is master production scheduling, material requirements planning, capacity requirements are planning, job shop planning methods, as well as a Gantt chart drawing method and Flexsilm simulation software.

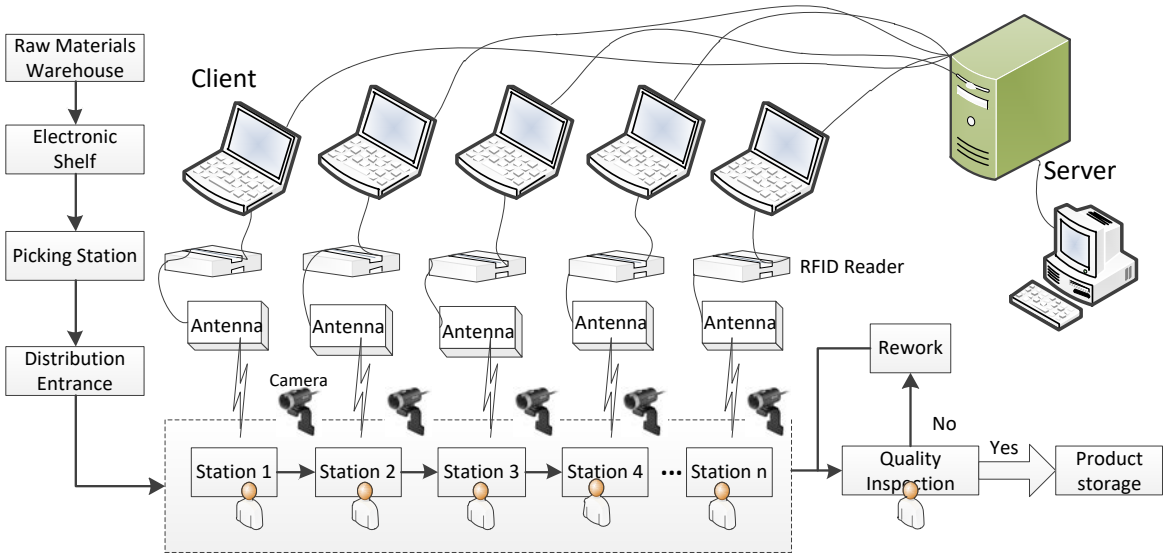

Fig.3 a schematic view of the assembly line

(2) Production line assemble Experiment

Assembly line schematic design shown as figure three, the tray posted a RFID card record product information is delivered to each station. After the card read by the RFID reader, the operating

material required information, the steps and precautions at current station will be displayed on the station signage in detail. At the same time the system automatically records the start time of the operation, and when the operation is finished with the confirmation, the system automatically records the end time and submits the operation recorded by the camera video on each station. Then the tray is delivered to the next station automatically. Information for each product processing in each station on the production line can be collected automatically through this experiment. Real-time tracking and unified data management is achieved at same time. It can also provide the basic data for analysis and follow-up process for the program, the evaluation test work, learning curve analysis experiments and the combined operation, two-handed operation analysis, time study experiment, moiling chart analysis and analysis of experimental videos and other industrial engineering based experiments.

4.2 Other Experimental Design

In addition to ERP experimental system, the industrial engineering experimental platform also incorporates human factors engineering laboratory equipment and related control systems. The reaction time measurement, the relationship between heart rate and oxygen consumption measurement, labor intensity and determination of fatigue, the relationship between lighting and productivity measurement, microclimate measurement, environmental noise measurement, ambient lighting measurement, physiological measurements and operation design, psychology and cognitive tests, body measurement, human perception characteristics and quality integrated test system experiments can be conducted based on the platform. Experimental data can be captured digitally, recorded automatically and management visually, which will facilitate the follow-up experiment analysis. Based on these data, teachers can analyze the situation of experiment students conducted and optimize it, which can help the teacher to get better teaching effect.

5. Conclusion

For the current problems of industrial engineering experiment under the background of Internet of things, a full experimental system is set up through the development of industry-engineering-oriented ERP experimental system which integrates production planning and control experiments, the material chosen experiments, the production line assembly experiments, automated warehouse operation experiment. The complexity of production management is shown in front of students in the most intuitive way and it allows students to participate in, so that students are more truly understand and apply what they have learned in class. While the service-oriented architecture is used to integrates Human Factors Engineering, Operations Research experimental and other disciplines, which form a complete industrial engineering experimental platform, and provides a good interface for future expansion development of the laboratory. After two years of practice runs, the experimental platform provides the majority of teachers and students a comprehensive study, experimentation, innovation platform.

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