Research Article

ERP System Design for Hydrogen Equipment Manufacturing Industry Based on Low Code Technology

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Research Problem. Aiming at the problems such as fast update and iteration speed, high development cost, and isolated enterprise data in hydrogen equipment manufacturing industry, a low code programming system based on enterprise data center and business center was proposed and designed. Research Method. This paper designs the data center service and business center architecture of hydrogen equipment manufacturing industry. The data center collects, mines, and integrates massive data into unified standard structured data and stores them. The business center provides architectural support for the establishment of enterprise resource management system. With the data center service as the system data interaction center and the business center as the model to build the system architecture, the hydrogen equipment manufacturing industry resource management system is constructed through the steps of data interaction, process modeling, and UI editing. Research Results. According to the specific requirements of hydrogen equipment manufacturing industry, the business process of hydrogen enterprise resource management system is constructed, and the construction and development of low code system are studied and discussed by integrating data center and business center. Conclusions. Low code is not just a tool to increase productivity, it has the potential to be a catalyst for technology and culture to promote enterprise innovation and business agility, and ERP systems for hydrogen equipment manufacturing based on low coding technology are needed for the industry of the future. This article contributes to the hydrogen equipment manufacturing industry of low code programming system, users can according to their own needs, through the combination of components, quickly generate a complete management system, update system iteration, greatly reduce the development cost, solve the problem of enterprise data isolation, reduce the development cost, and realize the seamless integration of modern software development practice, so as to promote enterprise innovation and business agility.

1. Introduction

The development of the Internet of Things has undergone a transformation from informatization to digitalization. In the future, digitalization construction will gradually evolve into digital intelligence construction [1]. In the construction of digital intelligence, low code system plays a key role. Customers can use the combination of modified components and data nodes to realize requirements change without modifying the underlying code of the system. In view of the problem of isolated data island in various systems between enterprises, a low code system based on enterprise data center is built to collect and integrate all kinds of data, and the data and each module are interconnected and integrated by means of component association, so as to solve the problem of isolated data island in enterprises.

Faced with more requirements of the Internet of Things, traditional microservice system development is facing the impact of low code trend and will be overturned. Nowadays, lightweight system based on low code platform has obviously become a mainstream technical solution and plays an important role in the digital transformation of enterprises. Gartner survey data shows that nearly half of executives (45%) are working on their own low-code projects, and more (52%) are in the evaluation phase [2]. Ordinary business personnel can develop a set of management system in
2. Requirement Analysis and Design

2.1. System Design Objectives. Using low code system to build lightweight ERP aims to break the problems of data isolation and data isolation caused by existing business, procurement, and management systems and build industrial data-business synergy platform with big data storage, big data flow, and big data processing as the core. The multisource, multitype, and multidimensional data generated in the operation process of industrial enterprises can be comprehensively analyzed and utilized and finally fed back to the actual business to stimulate the improvement of the quality and efficiency of traditional business.

2.2. System Functional Requirement Analysis. Before constructing lightweight ERP based on hydrogen equipment manufacturing industry, it is necessary to investigate the functions to be realized in this industry. In general, the function of this system is to quickly generate enterprise ERP according to customer’s personalized needs and support all kinds of data exchange and integration based on enterprise data center and business center to avoid isolated data islands. The function of each ERP module is encapsulated in each module of the system. Users can quickly build ERP by selecting corresponding modules and building data flow nodes. Demand module analysis is shown in Table 1 [10].

3. System Platform Design

3.1. Technology Selection. Low code platform is built on enterprise data center and business center, which is a fast demand realization platform integrating many advantages of data center and business center. Therefore, the system platform chooses data center and business center as technical support. Business center is an intelligent comprehensive modeling language for industrial Internet business process, which can support the trusted transmission mechanism of cross-domain business process data, release and support complex process model mining algorithms, and can be flexibly carried out and verified in typical industrial Internet industries. Through the new system layer, integrate the functions that may be repeatedly developed, adapt to the differences between the front and rear business needs, and be called by different applications in the form of open services, so as to avoid the phenomenon of “replication wheel” in application innovation.

Data center was born in the enterprise’s strategy of “big center, small front desk” [11]. Building a front desk architecture with enterprise big data service center and cutting interaction with users and the market can effectively improve the plasticity of enterprise development and speed up the process of enterprise digital intelligence development.

3.2. System Architecture. Centering on the main characteristics of hydrogen energy enterprise business, the system aggregates internal resources based on enterprise data center and above enterprise business center, provides collaborative manufacturing services for enterprises, realizes efficient linkage of production links, constructs data space and business space of hydrogen energy equipment manufacturing

a short time with the help of lightweight low code platform, which greatly reduces the human and material costs of functional module development.

Hydrogen energy equipment manufacturing industry is mainly engaged in the research, design, production, sales, and service of hydrogen energy equipment and studies the utilization and development of hydrogen energy. At present, the hydrogen equipment manufacturing industry lacks the information foundation, and most process management uses Excel forms, board, documents, and drawings. Communication methods rely on oral communication and telephone communication, and process management has broken links and no feedback, resulting in a huge waste of labor and time costs in the management process [3–5].

Enterprise resource planning (ERP) for hydrogen equipment manufacturing industry is the main production object of low code system. Accurate application of ERP in hydrogen production equipment engineering procurement, material management, order management, production planning, quality management, logistics management, and after-sales management [6], closed-loop management requirements, combined with the existing information base of the enterprise, form enterprise business process management standards, use business space to build hydrogen production enterprise data space, build product image and fault maintenance knowledge map, and realize the design and maintenance in the process of enterprise operation procurement, production, after-sales service, and logistics tracking.

1.1. Low Code Development Trend at Home and Abroad. By investigating the development trend of software technology industry at home and abroad, we can discover that many enterprises have carried out relevant discussions and studies on the development of low-code platform.

Low code started to rise in China in 2018. After two years of development, Alibaba released a suitable low code software development platform in 2020 relying on Dingding platform, which is mainly to provide a set of low-cost enterprise application building solutions for the majority of small and medium-sized enterprises. According to the survey of HAP ACADEMY, at least 500 million new applications need to be developed to meet the needs of digital transformation of Chinese enterprises in the next five years, and these are most likely to be met through low code development platforms [7].

Lightweight and low code are in the growth stage of the market, and the development maturity of all kinds of relevant technologies is constantly improving. The development of low code is bound to impact the traditional business architecture dominated by microservices [8, 9].

As early as 2016, Grape City launched the self-developed “Movable type grid” low-code platform. After four years of development, the low-code market ushered in a period of vigorous development. At present, there are four software architectures in the market, namely, traditional software, SaaS (application software service), low code, and no code. The development trend of these architectures is shown in Figure 1.
industry, and realizes data-business system evolution. Complete the application demonstration for the rapid development of enterprise resource management and product intelligent service software. The system architecture is shown in Figure 2.

As can be seen from Figure 2, low code system architecture does not need to code from scratch, minimize the time of system development, reduce the labor cost, at the same time make development more flexible, more conform to the requirements of enterprise characteristics, and even if do not have professional system developers enterprises can also operate according to the enterprise needs to adapt to their own enterprise management system, to avoid the inconvenience of “data island.”

3.2.1. Data Center. The goal of enterprise data center construction is to summarize the whole enterprise data to the data center, so that all enterprise data can be traced in the data center service and prepare for the construction of unified warehouse layer, label data layer, and application data layer.

A data source can be a place where an existing system stores service data or a data application scenario stores result data for an application scenario. According to different business systems and data application scenarios, data sources also have different choices. For example, market demand analysis has high requirements on timeliness, and accordingly, data source read performance will be high. Some scenarios require multidimensional analysis of large quantities of data, so data sources need to support multidimensional analysis of large quantities of data. For these scenarios, there are many kinds of data sources involved, which can be roughly divided into:

1. **Customer Market Demand Analysis.** Such as market proportion of each product and market public opinion analysis
2. **Structured Data.** Such as enterprise logistics data and production data
3. **Unstructured Data.** Such as BOM (bill of materials) and execution plan
(4) Manual Record Data. Such as cargo transfer

The collected data is stored in the DATA lake CDH (distributed big data cluster) in the way of data flow to provide data support for data service release. Intelligent platform for enterprises to create intelligent control platform, collect the current market information, mining the internal relationship between enterprises and products, and for enterprises to make intelligent procurement analysis and decision-making. The data center flow diagram is shown in Figure 3.

The enterprise data center breaks the traditional enterprise isolated data island mode; integrates the enterprise data flow in the whole domain [12]; builds an intelligent center with the functions of enterprise intelligent procurement, market analysis, intelligent production, and relationship mining; and provides data services related to intelligent data query application, enterprise insight application, and industrial chain application [13].

3.2.2. Business Center. The business platform has undergone a transformation from a single system such as CRM and OA to a multifunctional integrated system such as ERP and EIP. The data collected by the enterprise will be used for the business and products themselves.

The enterprise business center is derived from the enterprise process-driven analysis, which is to extract valuable data and model it to analyze the relationship between business functions and data. The bottom-up refinement of business components is recombined to form highly cohesive and loosely coupled industry models. When conducting fine-grained division of business modules, we usually refer to classic models in the industry, such as SCOR model of supply chain and ETOM model of telecom industry [14]. The flow chart of hydrogen equipment manufacturing industry is shown in Figure 4.

The business center consists of data interaction, data parsing and storage, business modeling, UI editing environment, and API services and management.

The data interaction module contains two functions: the edge layer and the data center data interaction. The data interaction of the edge layer is to establish the data connection between the business center and the edge gateway, obtain the data information of the factory equipment in real time, store the original data, and transfer commands through the connection. Data center interactions retrieve data stored in the data center by invoking data center data services.

The data parsing and storage module stores the edge layer data collected after parsing according to different protocols, mainly including structured data and time series data.

Business modeling module is divided into object modeling and process modeling. Object modeling is mainly used to decompose devices and sensors in the physical world into digital models based on the object-oriented design concept. Process modeling provides tools and visual interfaces for building business processes and provides a complete set of process control tools by digitally streamlining the production and operation processes of enterprises.

User interface editing provides visual editing interface and preconfigured interface components, supports the rapid establishment of industrial applications, and meets the requirements of rapid service response.
4. Detailed ERP Function Design for Hydrogen Equipment Manufacturing Industry

ERP of hydrogen equipment manufacturing industry is generated on the business center and data center. Data center access management provides a set of componentized services from data collection to data service provision to support the business center. Service center provides a series of service components, such as equipment monitoring, equipment prediction, materials, and production schedule, to meet the customized service requirements of different users.

4.1. System Roles and Data Flow. The system roles are shown in Table 2.

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**Figure 3: Data center flow diagram.**

**Figure 4: Enterprise business center flow chart.**
Roles in the system have different permissions. Each role manages its own module data. The super administrator can access any data module and has the maximum permission in the system.

4.2. ERP Process Construction Based on Data and Business Center. The data center provides data services for ERP, and the business center provides architectural support for the establishment of ERP. ERP process construction based on data center and business center is divided into three steps.

4.2.1. Data Interaction. Data interaction is the first step to build enterprise ERP. Enterprise ERP based on low code system is an intelligent system driven by data, and data interaction plays the role of system engine. Data interaction can be divided into data center and business center interaction and data center and edge layer device and facility interaction.

The interaction between data center and business center mainly lies in the direct access of enterprise users to data center services. Enterprise data center stores enterprise material information, bill of materials, warehouse information, customer information, and other data. For data with high real-time performance, it is stored in data flow. ERP can effectively obtain high real-time data through the interaction between business center and data center. High real-time data can greatly improve the user’s perception of the system modules and the outside world, so as to make beneficial decisions such as intelligent production and intelligent procurement. The system has set up a channel for each module of the enterprise to access the data management center. Users can access specific data content according to their different permissions, which provides effective support for the integrated development of enterprises and the breaking of isolated data islands.

The interaction between the equipment and facilities of the data center and the edge layer actually means that the equipment and facilities of the edge layer of the enterprise send production and monitoring data to the enterprise data center in real time. Combined with the enterprise’s own production and management process, it provides effective help for the production and maintenance of the enterprise and provides digital drivers for the visual development of the enterprise’s digital twin.

4.2.2. Business Modeling. According to the characteristics of the process network and the requirements of the business center, the basic unit of the model consists of “process model” and “object model.” “Process model” mainly plays the role of connecting various objects. In the actual system, it is realized by data delivery and data synchronization. The object model is abstracted into four types during modeling, which are generation object model, termination object model, intermediate object model, and convergence object model.

In order to realize the interconnection between objects, the generative object model defines a connection endpoint. The terminating object model also defines a connection endpoint; both the intermediate object model and the process model have two endpoints and belong to the dual endpoint model. The number of endpoints of the sink node model is uncertain and needs to be determined according to the input and output of the sink center. Therefore, it is a dynamic model when the model is built, and the number of endpoints needs to be manually set when modeling.

Enterprises with different specifications and industries have different ERP processes. Here, take hydrogen energy industry as an example to build an ERP business model of hydrogen energy industry, as shown in Figure 5.

The lightweight ERP consists of seven service modules and one system module. The starting point of the entire business process is the customer order, which is imported or manually entered into the system. The system makes production plans based on customer orders, and material demand plans are made based on production plans and BOM information. The material demand plan will subdivide the materials needed in the whole production plan into the demand and output of specific production links according to the technological process and divide the sources of all materials used (including raw materials and semi-finished products) into three parts: inventory, production, and procurement. The formulation of the purchase plan depends on the purchase demand, and the system purchases according to the purchase plan and generates the purchase order.

Table 2: System roles.

| Serial number | Character name             | Role of note                                           |
|---------------|----------------------------|-------------------------------------------------------|
| 1             | Super administrator        | Super administrator                                    |
| 2             | Marketing department       | Contract signing, uploading, and viewing              |
| 3             | Project leader             | Drawing design, BOM design                            |
| 4             | Designer                   |                                                       |
| 5             | Purchasing department      | Material purchasing requirements and supplier contracts |
| 6             | Quality inspection personnel | Material quality control and product quality control experiment |
| 7             | Library staff              | Material management, material loss management, and warehousing management |
| 8             | Production personnel       | Electric, process, automatic control, and electrolytic cell production process |
| 9             | Logistics group            | Vehicle scheduling and logistics tracking             |
| 10            | After-sales personnel      | Unpacking inspection, installation guidance, site debugging, and fault maintenance |
Warehousing inspection shall be conducted after the arrival of the purchase, warehousing shall be handled for those qualified, and return and exchange shall be handled for those unqualified.

System according to the production demands for the production task list, according to the task list for material production. After the completion of the production task, the enterprise shall carry out the production and storage.

**Figure 5: ERP business model diagram of hydrogen energy industry.**
inspection of the already produced products. After the
inspection, the qualified products shall be put into storage,
and the unqualified products shall be degraded or scrapped.
The rework order shall be generated, and the production
task shall be reformulated according to the rework order
for production. If the raw materials are found unqualified
or the remaining materials are found after the production
task is completed, the materials shall be returned and
replenished.

4.2.3. UI Editing. UI editing takes a logical design around
the interactive requirements of UI visual features. For non-
software technicians in enterprises to quickly implement
ERP system, UI editing adopts interactive design of module
functions and requirements. Users can select functional
modules according to their own needs and add them to
the system. In the system generation window interface, UI
selection interface and drag-and-drop system integration
of each module function are provided. The UI units of each
module of the system are divided into points, lines, and
planes, which can clearly display the flow of processes
and functional attributes, etc., and provide inertial guidance
for users when they operate, so that users can have a better
use experience when creating the system. For the adminis-
trator user, the system provides the resource process infor-
mation of total material procurement progress, production
process progress, logistics and transportation progress,
and historical information balance comparison progress,
as shown in Figure 6.

| Items to be reviewed | Progress has not been updated in the last 7 days | Concerns (message to remind) |
|----------------------|-----------------------------------------------|-------------------------------|
| Project status       | Distribution of material condition             | For example:                 |
| status distribution  |                                               | 1. The cycle begins with 20 days and projects |
|                      |                                               | have not yet begun            |
|                      |                                               | 2. Material purchase information update |
|                      |                                               | reminder                     |
|                      |                                               | 3. Logistics information update |
|                      |                                               | reminder                     |
|                      |                                               | 4. Production scheduling plan change |
|                      |                                               | reminder                     |

5. Conclusions

The data center collects, mines, and integrates massive data
into unified standard structured data and stores it to form
to enterprise data assets [15]. The business center covers the
core business structure of the enterprise, aggregates the busi-
ness process of the enterprise, and precipitates the business
line and external service capabilities of the enterprise [16].
Based on the enterprise data center and business center, this
paper designs a low-code programming system for the
hydrogen energy equipment manufacturing industry. This
system is suitable for R&D personnel and non-R&D person-
nel. Users can quickly generate a complete management sys-
tem by combining components according to their own
management process requirements. For the generated sys-
tem, users can select the functions in the components to iter-
atively update the system, which greatly reduces the
development cost. The open source, low-code system plat-
form provides high productivity while seamlessly integrating
with the overall architecture of modern software develop-
ment practices within the enterprise. Low-code is not just a
productivity tool, and it has the potential to be a technolog-
ical and cultural catalyst for enterprise innovation and busi-
ness agility [17].

Data Availability

The data underlying the results presented in the study are
available within the manuscript.
Conflicts of Interest

There is no potential conflict of interest in our paper, and all authors have seen the manuscript and approved to submit to your journal.

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References

[1] L. Ning, “Research on the development strategy and path of China’s industrial design in the era of intelligent interconnection,” Nanjing Academy of Arts, 2021.

[2] L. Xian, “Opportunities behind the truth of low code development of enterprise information system,” Family Business, no. 5, pp. 79–81, 2021.

[3] H. Gaohuan, “Application of enterprise resource planning (ERP) system in modern enterprise management,” Era of Economic and Trade, vol. 36, no. 23, p. 27, 2018.

[4] M. Honglian and Y. Hong, “Application of enterprise resource planning system in modern enterprise management,” Reform and Strategy, vol. 795, no. 31, pp. 77–78, 2018.

[5] L. Haiqing, “Application of enterprise resource planning (ERP) system in modern enterprise management,” Economic Perspective, no. 5, pp. 76–77, 2015.

[6] G. Feng, Design and Implementation of Human Resource Management System for Chemical Enterprises, East China Normal University, 2010.

[7] S. Tao, China Low Code/no Code Market Research Report 2021, HAP Academy, 2021.

[8] S. Zhenhua, Design and Implementation for Low-Code Modeling Platform for the Internet of Things, Shandong University, 2021.

[9] S. Pawalak, “Use low code technology for software development,” Modern Manufacturing, vol. 23, p. 63, 2020.

[10] G. Yuan, “Discussion on ERP system design of chemical enterprise,” China Management Informationization, vol. 24, no. 6, pp. 105-106, 2021.

[11] Z. Yuesong, “It is imperative for the design institute to construct the mode of "big middle stage and small front stage"," China Engineering & Consulting, vol. 11, pp. 72–74, 2019.

[12] Z. Shengnan, L. Yonghui, and H. Wanli, “Design of business middle platform of power trading platform,” Power System Technology, vol. 45, no. 4, pp. 1364–1370, 2021.

[13] Z. Chi, “Study of big data middle end core values on responding to sudden public events,” Huazhong University of Science & Technology, vol. 35, no. 1, pp. 77–84, 2021.

[14] Z. Qingchun, “ETOM model and application of eTOM model for telecom integration modeling,” Information Security and Communications Privacy, Solutions & Applications, vol. 4, pp. 56–58, 2004.

[15] X. Wang and D. Jianfeng, “Design and application of smart campus framework based on data center and service center,” Education informatization in China, vol. 15, pp. 76–78, 2021.

[16] M. Ji, "Wu ling, yin Hong cai. An analysis of the new information technology era and the enterprise big data application strategy," Journal of Bengbu University, vol. 8, no. 2, pp. 61–64, 2019.

[17] L. Xian, “The opportunity behind the low code development enterprise information systems truth,” Family Business, vol. 5, pp. 79–81, 2021.