# Digitalization Empowering the High-Quality Development of Traditional Manufacturing: A Case Study of the Pump and Valve Industry in Yongjia, China

**Qiqi Chen[1], Winitra Leelapattana[2], Bhadpiroon Watcharasresomroeng[3] and Napat Ruangnapakul[4*]**

[1] International College, Maejo University, Chiang Mai, Thailand

[2] International College, Maejo University, Chiang Mai, Thailand

[3] Faculty of Engineering and Architecture, Rajamangala University of Technology Suvarnabhumi, Bangkok, Thailand

[4] Faculty of Information and Communication, Maejo University, Chiang Mai, Thailand

[*] E-mail: napat_r@mju.ac.th

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## Abstract

China's economy is transitioning from quantity-driven growth to quality-driven growth, necessitating high-quality economic development. High-quality economic development requires high-quality development in the manufacturing industry as its foundation. And digitalization offers a new pathway and impetus for high-quality development in traditional manufacturing. Therefore, this paper empirically analyzes the impacts of digitalization on the high-quality development of the pump and valve industry and its mediating effects of resource and structural empowerment, using structural equation modeling (SEM) to analyze causal relationships between these variables based on 349 sample data. It is found that digitalization can significantly promote high-quality development, while the impact mechanism shows that digitalization can promote high-quality development through resource and structural empowerment, though resource empowerment cannot significantly promote high-quality development in this case. The findings provide implications for other traditional manufacturing industries, which need to enhance their digitalization efforts in three key areas: digital infrastructure, digital operation, and digital management. And they can achieve high-quality development in terms of intelligent production, technological empowerment, intelligent monitoring, platform empowerment, and green manufacturing.

**Keyword:** Digitalization, High-Quality Development, Traditional Manufacturing

## Introduction

High-quality development has been proposed by the Chinese government against the backdrop of China's economic transition from the pursuit of quantitative growth to the pursuit of quality-oriented development (Pan et al., 2021). High-quality development refers to improved innovation capabilities, a focus on quality, improved efficiency, synergistic development, and green development, representing a more advanced stage of development (Chi, 2023; Gou & Hong, 2021). Manufacturing, as a crucial component of economic activities, has become a key area for achieving high-quality development. However, the development of traditional manufacturing contradicts the goals of high-quality development due to its characteristics of labor intensiveness, outdated technology, extensive management, and high energy consumption. Therefore, realizing high-quality development in traditional manufacturing is a focal direction for China's overall high-quality economic development. Traditional industries typically refer to labor-intensive manufacturing and processing sectors that rely on traditional and existing time-tested technologies rather than emerging technologies (Cheah & Wang, 2017), such as the food processing industry, textile and clothing industry, construction and building materials industry, and machinery and equipment industry.

The pump and valve industry in Yongjia is a microcosm of many traditional manufacturing industries in China. They exhibit a high degree of industrial agglomeration, focusing development on a specific region. Many traditional manufacturing industries in China concentrate in a specific area, eventually developing into numerous industrial towns. The pump and valve industry studied in this paper is located in an industrial town of Yongjia county, Wenzhou city, Zhejiang province in southeastern China (see Figure 1 and Figure 2).




**Figure 1** The location of Zhejiang province in China

Source:(EJET, 2024)




**Figure 2** The map of Wenzhou city

Source:(EJET, 2024)

Pumps and valves, as industrial products, are widely used in various fields such as petroleum, the chemical industry, power stations, mining, gas and heat pipe networks, water supply and drainage systems, and metallurgy-related industries.

There are more than 3,100 pump and valve enterprises in Wenzhou City (Wang & Lai, 2023), with most of them located in Yongjia County. In 2023, the market size of pumps and valves in China reached 329.135 billion yuan (Molanshuzhi, 2023), and the pump and valve industry in

Yongjia achieved a total output value of 76 billion yuan in 2023, accounting for nearly 25% of the national market share. It developed from family workshops since the late 1960s and now forms an industrial cluster with a large production scale and high industry concentration, covering more than 3,000 varieties and 40,000 specifications of pump and valve products. However, the pump and valve industry in Yongjia faces both external fierce competition from other regions (Shanghai, Jiangsu, Liaoning, etc.) in China and foreign counterparts, and internal issues such as low innovation capacity, outdated management and production models, and low industry synergy. These are also common problems faced by other traditional manufacturing industries. Therefore, research on the Yongjia pump and valve industry can also provide valuable reference for the high-quality development of other similar traditional manufacturing industries.

However, how traditional manufacturing can achieve high-quality development is worthy of in-depth investigation. Currently, the global economy has entered the digital age. The digital economy features virtuality, high permeability, high innovation, and added value. In the digital economy, the term "digital" refers to digital technologies such as big data, cloud computing, and blockchain, as well as "data" itself (Zhao et al., 2023). Therefore, digitalization emphasizes the use of digital technologies, which can drive systematic and comprehensive innovation and transformation across business models, operational methods, and products (Legner et al., 2017). The impact of digitalization on the economy, society, and production activities is revolutionary, especially for traditional manufacturing. For example, digital technology can be used to carry out all-round, end-to-end changes in the production process, product form, and industrial chain of traditional industries, thereby resulting in cost reduction and efficiency improvement (Yin et al., 2022). Therefore, the emergence of digitalization raises the question: Can it empower the traditional manufacturing industries and foster its high-quality development? To answer this question, this paper suggests a study on the part that digitalization plays in supporting the high-quality growth of traditional manufacturing. This will help people around the world understand China’s idea of high-quality development is actually showing up in different industries and how it works.

The contributions of this paper are as follows. Firstly, the existing literature mainly focuses on macro-level studies of

the impact of the digital economy on manufacturing and its regional disparities (Li & Zhou, 2019; Wang & Shao, 2024), but offers limited specific empirical studies on enterprise digital empowerment practices (Wang & Wang, 2021). This paper will examine the level of digitalization and high-quality development of the pump and valve industry from a micro perspective, thereby addressing the gaps in existing literature. Secondly, the coupling degree between the digital economy and high-quality development in manufacturing is currently at a low level in China, therefore; the digitalization level of enterprises has become a significant concern affecting their development (Zhao et al., 2023). This paper will explore the empowering role of digitalization on the high-quality development of traditional manufacturing industries and provide confidence and motion for manufacturing enterprises to carry out digitalization. Thirdly, this paper will reveal how digitalization affects high-quality development by exploring the impact mechanisms of digitalization, which can provide insights for the traditional manufacturing industries on how they can apply digitalization strategies to drive high-quality development.

## Objectives

1. To analyze the role of digitalization in promoting high-quality development.

2. To clarify the impact mechanisms between digitalization and high-quality development.

3. To explore how other similar traditional manufacturing industries can apply and adjust the digitalization empowerment strategies.

## Literature Review

### 1. Digitalization

Digitalization, based on informatization, makes business online and use digital technology to systematically and integrally innovate and transform the business models, operation methods, and products (Legner et al., 2017). In the digital era, the advancements of digital technology bring about the applications of big data analytics, artificial intelligence (AI) and machine learning, and Internet of Things (IoT) technologies (Xu et al., 2018), which provide infrastructure of digitalization (Wen et al., 2022). Digitalization can empower the operation processes and management of the enterprises. Utilizing digital software such as Computer-Aided Design (CAD) and Computer-Aided Engineering (CAE) for 3D

model creation and simulation analysis can assist the R&D process. Production processes can be made intelligent through the Internet of Things (IoT) and robotics, which can also be optimized through digital twin technology, thereby improving production efficiency and quality. AI learning and big data analysis can be used to optimize manager decisions; knowledge can be shared and circulated in digital forms to promote innovation and enhance employee skills, thereby improving management efficiency. Therefore, this provides an effective framework for measuring digitalization from three aspects: digital infrastructure, digital operations, and digital management.

**2. High-Quality Development**

As a catch-up economy, China's economic growth pattern experiences phases of high growth driven by quantity expansion, moderate growth driven by quality improvement, and low growth led by innovation (Zhang, 2014). China is currently in a critical period of economic transformation, shifting its focus from pursuing speed and overall scale of economic growth ("high-speed growth") to pursuing quality and innovative growth ("high-quality growth"). The framework for high-quality development includes three levels: macroeconomics, industry, and enterprises (Zhao et al., 2019). At the macroeconomics level, the concept of high-quality development is based on the five principles of innovation, coordination, green development, openness, and sharing (Chi, 2023). At the industry level, the high-quality development of the manufacturing industry indicates five core capabilities: economic creativity, scientific and technological innovation, energy efficiency, environmental sustainability, and social responsibility (Li et al., 2015), originating from the concept of high-quality development at the macroeconomic level. At the enterprise level, the connotation of high-quality development will become more specific. It can be summarized from scholars' research as improved quality, enhanced innovation capability, increased efficiency, supply chain synergy, and green manufacturing (Liu et al., 2023; Wang et al., 2020).

**3. The Relationship between Digitalization and High-quality Development**

Digital technology is the decisive force and underlying foundation for digitization, which can amplify and multiply the development of the manufacturing industry. From the perspective of business operations, digital technologies can enhance enterprises' research and development design capabilities, and the provision of products or services that are

inherently embedded with information technology capabilities (Xu et al., 2022). This thereby improves product quality. Digital technologies such as artificial intelligence and big data technologies can realize the intelligence and digitization of production processes; the use of robots and automated equipment can achieve production automation, thereby reducing labor costs and improving production efficiency (Liu & Chen, 2023). Especially for traditional manufacturing sectors such as textiles, clothing, footwear, toys, and furniture, digital technologies such as 3D printing, artificial intelligence, collaborative robots, and CAD/CAE/CAM algorithms could be applied in the design and production processes (Jimeno-Morenilla et al., 2021); these applications of digitalization will play a greater role in improving production efficiency. From the perspective of enterprise management, digital technologies can drive the transformation of enterprises' organizational modes toward platformization, connecting both the supply and demand sides, thereby reducing costs and improving supply chain synergy (Qi & Shen, 2024). It can also reshape production conditions (the addition of data production factors) and change production organizational methods (the collaboration of business and operational activities of enterprises) (Li, 2024).

Therefore, the following hypothesis can be proposed:

**Hypothesis 1 (H1).** Digitalization has a direct positive impact on the high-quality development of the pump and valve industry.

**4. The Impact Mechanisms of Digitalization on the Manufacturing Industry**

Digitalization can directly promote high-quality development of the manufacturing industry (direct effect), which can also empower high-quality development through the improvement of human capital, industrial upgrading, and technological innovation (mediatng effect) (Li & Qu, 2022; Xie & Ren, 2023). The non-physicality of the data factor, along with the replicability and interconnectedness of digital technologies (Hui & Yang, 2022; Yang et al., 2022), indicates that there exist mediating factors connecting digitalization and high-quality development. This means that digitalization will impact the mediating factors, which will further impact high-quality development of the manufacturing industry. Some studies have pointed out that digital economy can promote high-quality development through management empowerment, capital empowerment, operational empowerment, and labor

empowerment (Zhang & Hou, 2023). Others have summarized digital empowerment into four categories: resource empowerment, structural empowerment, platform empowerment, and ecosystem empowerment (Li et al., 2022). In the digital era, digital technology is both a means of production and a resource for production, with data being the tangible manifestation of this resource. Considering the penetration of digital technologies into the tangible resources of enterprises as well as their organizational and production models, this paper will focus on two mediating factors: resource empowerment and structural empowerment.

Therefore, the following hypotheses can be proposed:

**Hypothesis 2 (H2).** Digitalization indirectly promotes the high-quality development of the pump and valve industry through resource empowerment.

Hypothesis 2a (H2a). Digitalization has a positive impact on resource empowerment.

**Hypothesis 2b (H2b).** Resource empowerment has a positive impact on the high-quality development of the pump and valve industry.

**Hypothesis 3 (H3).** Digitalization indirectly promotes the high-quality development of the pump and valve industry through resource empowerment.

**Hypothesis 3a (H3a)**. Digitalization has a positive impact on structural empowerment.

**Hypothesis 3b (H3b).** Structural empowerment has a positive impact on the high-quality development of the pump and valve industry.

Based on the above literature review, the conceptual framework can be formulated, and hypotheses are also remarked, as shown in Figure 3

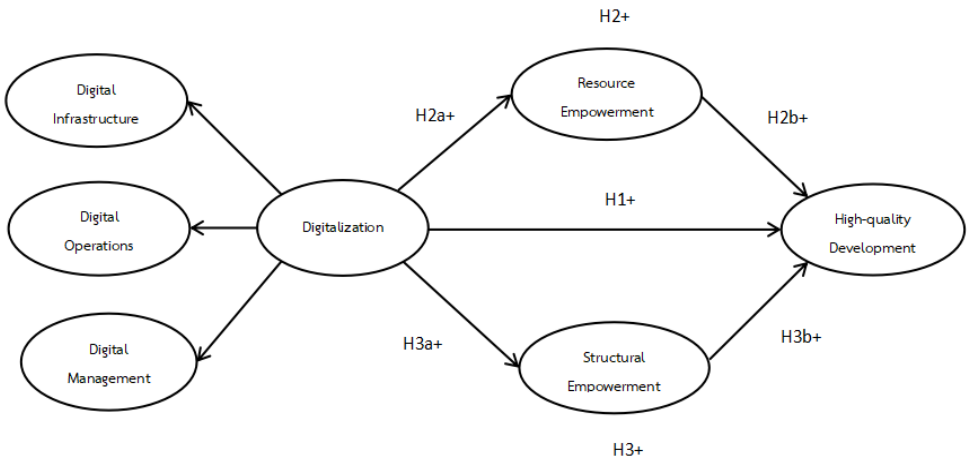



**Figure 3** The conceptual framework of the impact mechanism of digitization

## Research Methodology

### 1. Research Method

The empirical analysis method is a research approach based on the principles of positivism, which establishes and tests hypotheses by observing and analyzing existing experiences, objective facts, and primary data. It is widely used in the field of economics, utilizing statistical methods to reveal relationships between economic variables, helping researchers understand and analyze existing economic phenomena. The characteristic of empirical research is to transform the evidence and objective facts observed or collected in reality into quantifiable "data" to answer research questions. The research of this paper aims to reveal the relationships between digitalization and high-quality development. Following the process of the hypothesis-deductive model (Park et al., 2020), the research process of this paper should be as follows: (1) Research hypotheses are derived from insights of the literature review; (2) relevant variables and measurement indicators are identified; (3) data is collected to analyze and validate the related hypotheses; (4) it is assessed whether the results support the hypotheses, determining the need to update existing theories or revalidate them; and (5) ultimately, conclusions are drawn that provide reference for the high-quality development of other traditional manufacturing industries.

Structural equation modeling, or SEM, can be used to look at causal relationships between different variables. These can be direct, and they can include mediating effects (Sathyanarayana, 2025). SEM combines factor analysis and path analysis, encompassing both measurement models and structural models (Hair Jr et al., 2021). The measurement model is used to determine the relationships between observed variables and latent variables, which can be estimated using factor analysis. The structural model describes the causal relationships among latent variables. It normally involves two steps: (1) the test of the measurement model (reliability and validity analysis); and (2) structural modeling analysis, which mainly focused on the path analysis. It is used to simultaneously analyze relationships between multiple latent variables, identifying which variable influences others, the direction of influence, and whether the paths are direct or indirect (Lei & Wu, 2007). This method allows for the measurement and analysis of variables that cannot be directly observed and is suitable for analyzing complex models involving multiple independent and dependent variables. Therefore, this method is well-

suited for this paper, as it can be used for variable measurement and hypothesis testing.

**2. Measurement of Variables**

2.1 Independent Variable: Digitalization

Scholars typically construct indicators for measuring digitalization from a macro perspective. From the macro perspective, the level of digitalization can be measured from three aspects: digital infrastructure, digital technology application, and digital industry development (Li & Qu, 2022). A similar evaluation index system was built from three dimensions: digital foundation, digital production application, and digital technology innovation (Hui & Yang, 2022). It can be seen that most have selected digital infrastructure as one of the key indicators of digitalization, highlighting its importance and foundational nature as an indicator. From the micro perspective, the document "Digitalization Level Assessment Indicators for Small and Medium-sized Enterprises (2024 Edition)," issued by the government, provides three dimensions—digital infrastructure, digital operations, and digital management—to build a measurement system for the digitalization level of manufacturing enterprises (Technology, 2024).

Digital Infrastructure (DIGI). Digital infrastructure is a comprehensive system that includes hardware, software, standards, the internet, and platforms (Hustad & Olsen, 2021).

Digital Operations (DIGO). It mainly involves the digitalization of enterprise business processes, including research and development, production, and warehousing and logistics.

Digital Management (DIGM). Digital tools should be used to strengthen collaboration between different departments, facilitating cross-departmental and supply chain management.

2.2 Mediating Variables: Resource Empowerment and Structural Empowerment

Chinese scholars have designed and developed a digital empowerment scale for the high-end equipment manufacturing industry, which includes four dimensions: resource empowerment, structural empowerment, platform empowerment, and ecosystem empowerment (Li et al., 2022). The research validated the content validity and reliability of these variables through exploration and confirmatory factor analysis, ultimately establishing a digital empowerment scale that includes 24 measurement items. Based on the research of this paper, resource

empowerment and structural empowerment are selected as mediating variables.

2.3 Dependent Variable: High-Quality Development

Scholars have established various evaluation index systems for high-quality development that share similarities. Some assessed the high-quality development of manufacturing from four dimensions: economic efficiency, industrial innovation, industrial modernization, and green development, along with 14 corresponding sub-indicators (Zhao et al., 2023). Similarly, others have measured from the perspectives of efficiency, scale, innovation-driven growth, and green development (Li & He, 2023). Based on the research of the scholars, the five indicators of high-quality development can be extracted from the micro perspective: quality, efficiency, innovation, supply chain synergy, and green development (Li & He, 2023; Liu et al., 2023; Xie & Ren, 2023; Zhao et al., 2023). The measurement items are referenced from the scales developed and validated by scholars and are slightly adjusted according to the current situation of the pump valve industry to fit the research of this paper, as shown in Table 1.

**Table 1** The measurement of variables

| Variables | Index | Measurement Item |
|---|---|---|
| DIGI | DIGI1 | The proportion of annual digital investment. |
| | DIGI2 | The proportion of CNC rate of key equipment. |
| | DIGI3 | The degree to utilize communication networks. |
| | DIGI4 | The degree to utilize data automatic collection and analysis systems. |
| DIGO | DIGO1 | The extent to use 2D or 3D digital process design. |
| | DIGO2 | The extent to use digital technologies, such as Computer-Aided Design (CAD). |
| | DIGO3 | The extent to implement manufacturing systems. |
| | DIGO4 | The extent to implement warehouse systems. |
| DIGM | DIGM1 | The extent to implement Enterprise Resource Planning (ERP) systems. |
| | DIGM2 | The extent to which enterprises utilize identification technologies for quality management. |
| | DIGM3 | The extent to utilize ERP systems to achieve full lifecycle management of suppliers. |
| RE | RE1 | The extent of the enterprise's investment in digital technology resources. |
| | RE2 | The convenience to access relevant digital resources (such as data, technology, and expertise). |

| Variables | Index | Measurement Item |
|---|---|---|
| | RE3 | The situation regarding the sharing and utilization of digital resources (data, tools, platforms, etc.) among different departments within the enterprise. |
| | RE4 | The capability in integrating and comprehensively applying data resources (such as production data, market data, customer feedback, etc.). |
| SE | SE1 | The extent of organizational support provided by the enterprise to facilitate employees' use of digital resources. |
| | SE2 | The flexibility of the enterprise's organizational structure in adapting to market changes and the application of new technologies. |
| | SE3 | The extent to utilize digital tools or technologies to improve workflows and business processes. |
| | SE4 | The extent to which the enterprise utilizes digital technologies to obtain necessary information to support organizational decision-making. |
| | SE5 | The extent to which the enterprise has established a digital training and learning system to enhance employees' digital skills. |
| HQD | HQD1 | The product qualification rate. |
| | HQD2 | The production efficiency level. |
| | HQD3 | The innovation capability level. |
| | HQD4 | The level of collaboration with upstream and downstream enterprises in its industry. |
| | HQD5 | The green manufacturing level. |

**3. Data Collection and Sample Selection**

There is no uniform principle for determining sample size when using SEM for analysis, but scholars have provided some views. The ratio of sample size to estimated parameter should be at least 5:1, while a ratio of 10:1 can ensure the validity of the significance test (Kline, 2023). Some scholars believe that the ratio of sample size (N) to the number of parameters to be estimated (q) should be at least 10:1, and ideally 20:1 (Brown, 2015). Some scholars also believe that the sample size should be at least 200 to ensure the statistical power of the model (Memon, 2020). For complex models, a sample size of at least 300 is recommended (Kline, 2023). Therefore, there is no fixed number for the ideal sample size when using SEM analysis. Taking into account the research questions, model complexity, and variable types, the sample size of this paper should be at least 300, which also meets the requirements of the ratio of 10:1.

Quantitative research often uses methods such as surveys, questionnaires, and experiments to obtain quantifiable data. This paper will use questionnaires to collect primary data on the digitalization level and high-quality development of pump and valve enterprises. To ensure the reliability of the data, questionnaire respondents are required to meet the following criteria: i) They should be employees who are familiar with the company's digital transformation and development status; ii) they should come from different positions such as research and development, procurement, production management, and marketing, having a comprehensive understanding of the enterprise's digital application and operational situation. This study collected a total of 388 questionnaires. After eliminating unreasonable situations such as questionnaires that took no more than 60 seconds to fill out and questionnaire answers that had obvious regularity (filling in the same option for all questions), 349 valid questionnaires were finally obtained, with an effective response rate of 89.9%. The descriptive statistical analysis of the variables of 349 samples is shown in Table 2.

**Table 2** Descriptive statistical analysis of sample data

| Descriptive statistics of sample data (N=349) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Variables | Measurement items | Minimum value | Maximum value | Mean | Standard Deviation | Skewness | Kurtosis |
| DIGI | DIGI1 | 1 | 5 | 2.30 | 1.096 | -0.401 | -0.605 |
| | DIGI2 | 1 | 5 | 2.32 | 1.022 | -0.312 | -0.560 |
| | DIGI3 | 1 | 5 | 3.09 | 1.033 | -0.074 | -0.142 |
| | DIGI4 | 1 | 5 | 3.33 | 1.060 | -0.369 | -0.446 |
| DIGO | DIGO1 | 1 | 5 | 3.92 | 0.998 | -1.124 | 1.119 |
| | DIGO2 | 1 | 5 | 3.56 | 1.042 | -0.418 | -0.604 |
| | DIGO3 | 1 | 5 | 3.54 | 1.099 | -0.499 | -0.663 |
| | DIGO4 | 1 | 5 | 3.65 | 1.057 | -0.606 | -0.374 |
| DIGM | DIGM1 | 1 | 5 | 3.35 | 1.025 | -0.346 | -0.514 |
| | DIGM2 | 1 | 5 | 3.09 | 0.991 | -0.102 | 0.002 |
| | DIGM3 | 1 | 5 | 3.89 | 0.929 | -1.136 | 1.429 |
| RE | RE1 | 1 | 5 | 3.68 | 1.075 | -0.743 | -0.126 |
| | RE2 | 1 | 5 | 4.06 | 1.036 | -1.134 | 0.817 |
| | RE3 | 1 | 5 | 3.59 | 1.122 | -0.560 | -0.589 |
| | RE4 | 1 | 5 | 3.48 | 1.082 | -0.452 | -0.684 |

| Descriptive statistics of sample data (N=349) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Variables | Measurement items | Minimum value | Maximum value | Mean | Standard Deviation | Skewness | Kurtosis |
| SE | SE1 | 1 | 5 | 4.22 | 0.906 | -1.308 | 1.757 |
| | SE2 | 1 | 5 | 3.95 | 0.941 | -1.183 | 1.593 |
| | SE3 | 1 | 5 | 3.65 | 1.031 | -0.472 | -0.694 |
| | SE4 | 1 | 5 | 2.86 | 1.096 | 0.149 | -0.487 |
| | SE5 | 1 | 5 | 3.33 | 1.052 | -0.318 | -0.646 |
| HQD | HQD1 | 1 | 5 | 3.38 | 1.017 | -0.218 | -0.607 |
| | HQD2 | 1 | 5 | 4.15 | 1.010 | -1.167 | 0.757 |
| | HQD3 | 1 | 5 | 3.81 | 1.033 | -0.573 | -0.547 |
| | HQD4 | 1 | 5 | 3.69 | 0.972 | -0.897 | 0.469 |
| | HQD5 | 1 | 5 | 3.98 | 1.048 | -1.233 | 1.197 |

## Results

### 1. Measurement Model Results

The measurement model reflects whether the measurement items can accurately reflect the relevant latent variables. Therefore, it is necessary to do reliability and validity analysis first. The reliability of the scale can generally be measured by Cronbach's coefficient (Cronbach'α), Cronbach'α after item deletion, and the corrected item-total correlation (CITC), which can reflect the internal consistency of the scale. If the coefficient exceeds 0.8, the CITC is lower than 0.4, which indicates the model has good reliability (Maydeu-Olivares et al., 2010). The reliability of the measurement model was found to be good from the reliability results shown in Table 3.

**Table 3** Reliability analysis results

| Variables | Items | CITC | Cronbach's α after item deletion | Cronbach'α |
|---|---|---|---|---|
| DIGI | DIGI1 | 0.646 | 0.797 | **0.833** |
| | DIGI2 | 0.717 | 0.765 | |
| | DIGI3 | 0.681 | 0.78 | |
| | DIGI4 | 0.608 | 0.813 | |
| DIGO | DIGO1 | 0.712 | 0.774 | **0.836** |
| | DIGO2 | 0.637 | 0.806 | |

| Variables | Items | CITC | Cronbach's α after item deletion | Cronbach'α |
|---|---|---|---|---|
| DIGM | DIGO4 | 0.651 | 0.799 | **0.823** |
| | DIGM1 | 0.672 | 0.764 | |
| | DIGM2 | 0.655 | 0.779 | |
| | DIGM3 | 0.712 | 0.725 | |
| RE | RE1 | 0.719 | 0.806 | **0.855** |
| | RE2 | 0.754 | 0.792 | |
| | RE3 | 0.693 | 0.817 | |
| | RE4 | 0.625 | 0.844 | |
| SE | SE1 | 0.652 | 0.825 | **0.852** |
| | SE2 | 0.751 | 0.8 | |
| | SE3 | 0.65 | 0.825 | |
| | SE4 | 0.616 | 0.836 | |
| | SE5 | 0.666 | 0.821 | |
| HQD | HQD1 | 0.634 | 0.888 | **0.89** |
| | HQD2 | 0.782 | 0.855 | |
| | HQD3 | 0.712 | 0.871 | |
| | HQD4 | 0.756 | 0.862 | |
| | HQD5 | 0.784 | 0.855 | |

Discriminate validity analysis is to test the distinguishability of different factors in measurement. The analysis can be performed using Fornell-Larcker criterion (AVE square root method). If the value of the AVE square root of each factor on the diagonal is the largest, indicates that the measurement mode has good discriminant validity. Validity analysis is conducted through convergent validity and discriminant validity. Convergent validity can be analyzed by several indicators, such as factor loading coefficient, the average variance extracted (AVE), and composite reliability (CR). If the coefficient value exceeds 0.7, the AVE value exceeds 0.5, and the CR value is greater than 0.7, indicating that the measurement model has good convergent validity (Cheung et al., 2024).

As the discriminant validity and convergent validity results shown in Table 4 and Table 5, the measurement model of this paper was found to have good validity.

**Table 4** Discriminant validity results

| | DIGO | DIGI | DIGM | SE | RE | HQD |
|---|---|---|---|---|---|---|
| **DIGO** | 0.750 | | | | | |
| **DIGI** | 0.369** | 0.749 | | | | |
| **DIGM** | 0.499** | 0.458** | 0.783 | | | |
| **SE** | 0.302** | 0.243** | 0.433** | 0.739 | | |
| **RE** | 0.364** | 0.433** | 0.410** | 0.290** | 0.775 | |
| **HQD** | 0.416** | 0.241** | 0.423** | 0.375** | 0.357** | 0.791 |

** indicates that the correlation is significant at the 0.01 level (two-tailed).

**Table 5** Convergent validity result

| Convergent validity analysis | | | | |
|---|---|---|---|---|
| **Variables** | **Items** | **Standard Factor loading** | **AVE** | **CR** |
| DIGI | DIGI1 | 0.728 | **0.561** | **0.835** |
| | DIGI2 | 0.818 | | |
| | DIGI3 | 0.762 | | |
| | DIGI4 | 0.680 | | |
| DIGO | DIGO1 | 0.827 | **0.563** | **0.837** |
| | DIGO2 | 0.693 | | |
| | DIGO3 | 0.752 | | |
| | DIGO4 | 0.722 | | |
| DIGM | DIGM1 | 0.768 | **0.613** | **0.826** |
| | DIGM2 | 0.742 | | |
| | DIGM3 | 0.835 | | |
| RE | RE1 | 0.809 | **0.601** | **0.857** |
| | RE2 | 0.827 | | |
| | RE3 | 0.774 | | |
| | RE4 | 0.683 | | |
| SE | SE1 | 0.730 | **0.546** | **0.857** |
| | SE2 | 0.833 | | |
| | SE3 | 0.723 | | |
| | SE4 | 0.675 | | |
| | SE5 | 0.723 | | |
| HQD | HQD1 | 0.674 | **0.625** | **0.892** |
| | HQD2 | 0.845 | | |
| | HQD3 | 0.771 | | |
| | HQD4 | 0.809 | | |
| | HQD5 | 0.840 | | |

**2. Structural Equation Model Results**

This study used AMOS 28.0 to conduct hypothesis testing on the structural equation model. After running the model, the first step is to examine the overall model fit indices. The overall model fit index is to test whether the model constructed in this research can fit the observed data. The values of the model fit indices are shown in Table 6 (CMIN/DF=1.043<3, RMSEA=0.011<0.08, AGFI=0.93>0.9, NFI=0.938, CFI=0.997), indicating that the model fit is good. Therefore, the next step of analysis can be carried out.

**Table 6** Overall model fit indices

| Overall Model Fit Indices | | |
|---|---|---|
| **Fit Indices** | **Fit Criteria** | **Results** |
| **CMIN/DF** | <3 | 1.043. The model fits well |
| **RMR** | <0.05 | 0.042. The model fits well |
| **RMSEA** | <0.08 | 0.011. The model fits well |
| **GFI/AGFI** | >0.9 | 0.943/0.93. The model fits well |
| **PGFI/PCFI** | The closer to 1, the better. | 0.774/0.867. The model fit is accepted |
| **NFI/RFI/CFI/TLI/IFI** | >0.9 | 0.938/0.93/0.997/0.997/0.997. The model fits well |

The path coefficient represents the strength of the relationship between two variables and whether it is positive. The larger the value, the stronger the influence relationship between the variables. If C.R. is greater than 1.96, and p-value is lower than 0.05, it indicates that the significant correlation between the variables can be proved. It can be seen that H1, H2a, H3a, and H3b can be verified, while H2b is rejected, as results shown in Table 7.

**Table 7** Model path coefficient and hypothesis testing results

| Path | | | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| HQD | <--- | DIG | 0.467 | 0.169 | 4.138 | 0.000*** |
| RE | <--- | DIG | 0.629 | 0.169 | 7.051 | 0.000*** |
| HQD | <--- | RE | 0.064 | 0.062 | 0.823 | 0.411 |
| SE | <--- | DIG | 0.548 | 0.141 | 6.248 | 0.000*** |
| HQD | <--- | SE | 0.139 | 0.065 | 1.987 | 0.047** |

**3. Mediating Effect Analysis**

The mediating effect refers to the influence of the independent variable on the dependent variable through one or more mediating variables. According to the hypothesis testing results above, H2b is rejected; that is, resource empowerment has no significant impact on high-quality development. The scholar believed that if the independent variable has a significant effect on the mediating variable, but the mediating variable has no significant effect on the dependent variable, there may still exist a mediating effect (Wen & Ye, 2014). Hayes also pointed out that even if the mediating variable has no significant effect on the dependent variable, there may still exist a mediating effect (Hayes, 2013). The bootstrap method can be used to test whether the confidence interval of the mediating effect contains 0 to test the existence of the mediating effect. This paper uses the process plug-in of SPSS 27.0 to use the bootstrap method to test the mediating effects of resource empowerment and structural empowerment. This study sets the sampling number to 5000, and the 95% confidence interval calculated by the Bootstrap sampling. If the LLCI and ULCI intervals do not contain 0, then the mediating effect is significant (Hayes, 2013; Wen & Ye, 2014). The results of the mediating effect test are shown in Table 8; indicating that H2 and H3 are verified. That is, digitalization can indirectly promote the high-quality development of the pump and valve industry through resource empowerment and structural empowerment. The structural path diagram of the impact of digitization on the high-quality development is shown in Figure 4.

**Table 8** The results of the mediating effect test

| Path | Effect type | Effect | SE | LLCI | ULCI | Significance |
|---|---|---|---|---|---|---|
| DIG⟶RE⟶HQD | Total effect | 0.560 | 0.060 | 0.441 | 0.678 | **Yes** |
| | Direct effect | 0.448 | 0.069 | 0.313 | 0.584 | **Yes** |
| | Indirect effect | 0.111 | 0.043 | 0.034 | 0.203 | **Yes** |
| DIG⟶SE⟶HQD | Total effect | 0.560 | 0.060 | 0.441 | 0.678 | **Yes** |
| | Direct effect | 0.443 | 0.064 | 0.318 | 0.568 | **Yes** |
| | Indirect effect | 0.117 | 0.037 | 0.052 | 0.196 | **Yes** |

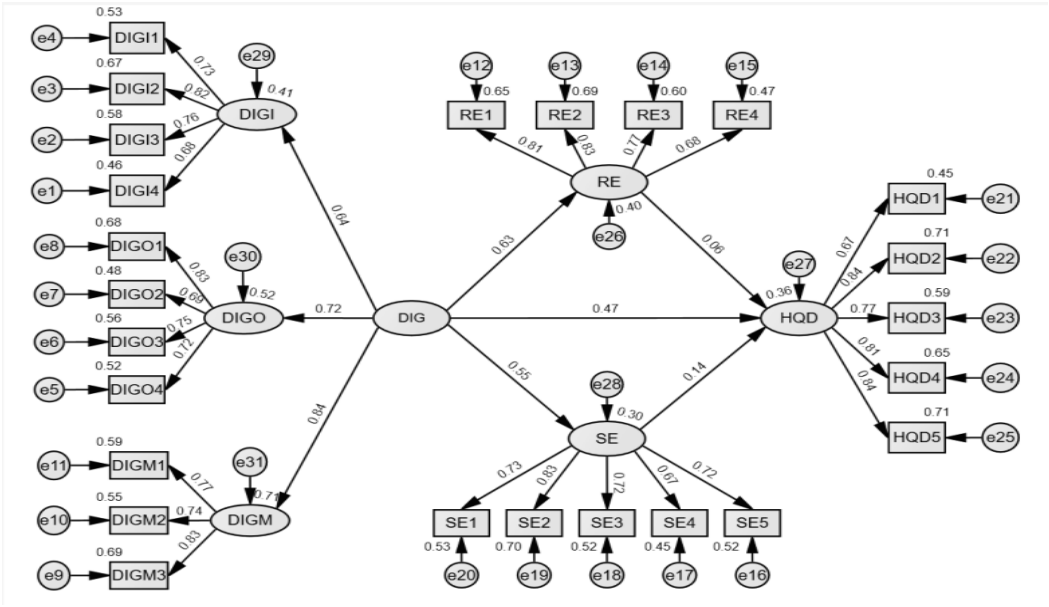



**Figure 4** Structural path diagram of the structural equation mode

## Discussion and Conclusion

### 1. Research Findings

The first objective of this paper was to analyze the role of digitalization in promoting high-quality development of the pump and valve industry. The findings imply that digitalization has a positive effect on high-quality development. The path coefficient of DIG⟶HQD is 0.467, indicating that for every unit increase in the digitalization level, the high-quality development level can be increased by 0.467 units accordingly. This conclusion means that those companies with low digitalization levels can achieve high-quality development by improving their digitalization levels. The finding is also consistent with scholars' research (Li & Qu, 2022). The path coefficients of DIG⟶RE and DIG⟶SE are 0.629 and 0.548, respectively, and all of them are significant at the 1% level, indicating that digitalization has a positive impact on both resource empowerment and structural empowerment. This is because the improvement of the digitalization level of the enterprise can improve the convenience of enterprise resource acquisition and realize cross-departmental and even cross-company resource sharing and transferring. The emergence of digital means has made the organizational structure of enterprises flatter, and enterprises can make more beneficial decisions based on digital tools. The path of SE⟶HQD also passed the testing ($\beta$=0.139, p-value=0.047<0.05). It can be seen that structural empowerment can also promote high-quality development,

which means that enterprises can make full use of the improvement of organizational efficiency and agility to bring about improvements in innovation, efficiency, quality, etc. However, the path of RE⟶HQD did not pass the testing ($\beta$=0.064, p-value=0.411>0.05), indicating that resource empowerment cannot promote the high-quality development of the pump and valve industry. This means, although the level of resource empowerment has been improved under digital empowerment, this has not been translated into high-quality products, green production, and innovation improvements for enterprises. Although this hypothesis has been overturned, it still has certain practical significance, indicating that enterprises still need to consider how to leverage resource empowerment to promote high-quality development.

The second objective was to clarify the impact mechanisms of digitalization on high-quality development. The indirect effects of DIG⟶RE⟶HQD and DIG⟶SE⟶HQD are 0.111 and 0.117, respectively, and the LLCI and ULCI intervals do not contain 0. It means that digitalization can indirectly promote high-quality development through resource empowerment and structural empowerment. The mediating role of resource empowerment lies mainly in the empowerment of traditional production factors by digitalization; that is, production factors such as labor, capital, land, and entrepreneurial talent can play a greater value after digital empowerment, or less input can be used to obtain the same value with digital empowerment. This role is not achieved by increasing the input of production factors (this is a direct way), but it affects the interaction of the original production factors and ultimately achieves higher output on the basis of the original (this is an indirect way). Therefore, this is an indirect impact, and this impact is positive. The mediating role of structural empowerment emphasizes the impact of digital technology on organizational structure, business processes, and organizational decision-making, thereby indirectly affecting high-quality development. The findings above also validate the scholars' research that there exist the mediating effects between digitalization and the high-quality development (Li & Qu, 2022; Xie & Ren, 2023).

In conclusion, this paper constructs a "digitalization-resource empowerment, structural empowerment-high-quality development" model based on literature review. Through model construction, corresponding research hypotheses are

proposed, the structural equation model is verified, and then the following conclusions are drawn (the summary of hypothesis test results can be seen in Table 9): Digitalization can directly and positively promote high-quality development; digitalization can directly and positively promote resource empowerment and structural empowerment; structural empowerment can directly and positively promote high-quality development; resource empowerment cannot significantly promote high-quality development, which does not mean that resource empowerment cannot promote high-quality development of other manufacturing industries; mechanism analysis shows that digitalization can indirectly promote high-quality development by improving resource and structural empowerment.

**Table 9** Summary of hypothesis test results

| Number | Hypothesis | Testing results |
|---|---|---|
| H1 | Digitalization has a direct positive impact on the high-quality development of the pump and valve industry. | Pass |
| H2 | Digitalization indirectly promotes the high-quality development of the pump and valve industry through resource empowerment. | Pass |
| H2a | Digitalization has a positive impact on resource empowerment. | Pass |
| H2b | Resource empowerment has a positive impact on the high-quality development of the pump and valve industry. | Not Pass |
| H3 | Digitalization indirectly promotes the high-quality development of the pump and valve industry through resource empowerment. | Pass |
| H3a | Digitalization has a positive impact on structural empowerment. | Pass |
| H3b | Structural empowerment has a positive impact on the high-quality development of the pump and valve industry. | Pass |

**2. Implications to Other Traditional Manufacturing Industries**

The third objective of this paper is to provide practical reference for other similar traditional manufacturing industries. The digitalization level and development stage of the pump and valve industry in Yongjia county and their impact mechanism of digital empowerment of high-quality development provide a highly representative and empirical research example for the development of other traditional manufacturing industries. At present, most traditional manufacturing

industries have similar problems to the pump and valve industry, with many small and medium-sized enterprises, a low overall digitalization level, and a low degree of integration with digital technology applications. Even after achieving a certain level of digitalization, some enterprises still cannot make full use of digital empowerment to effectively transform it into the outcomes of high-quality development. Therefore, traditional manufacturing industries need to improve the level of digitalization on the one hand, and on the other hand, fully utilize the empowering role of digitalization to promote high-quality development.

The effective measures can be as follows: (1) Intelligent production to boost efficiency: A realistic method is to configure some intelligent and CNC production lines in the workshop to maximize production efficiency. Especially for some industries with many product specifications and models and many non-standard customizations, the intelligent production line can give the optimal parameter combination of the production process and reasonably plan the production schedule and production progress. (2) Technological empowerment to stimulate innovation: All traditional manufacturing industries can be led by the leading enterprises in the industry to build the industry's "industry brain" and intelligent laboratories, share some basic research and technical experience accumulation in the industry, and jointly solve some common technical problems such as the research and development, design, and testing of high-end products, as well as "stuck neck" technical problems. (3) Intelligent monitoring to enhance quality: Product quality should be controlled throughout the process from product design to production until the final finished product is off the line and in the hands of customers. Digital twin technology and digital simulation can be used to simulate products and process flows, predict potential quality problems, and improve them in advance. (4) Platform empowerment to achieve synergy: Building an industry Internet platform to achieve collaboration between the procurement, production, and sales ends. Especially on the production side, establish a "cloud manufacturing" system to achieve collaborative production. If an enterprise can only complete part of the orders based on its own production scheduling, spare capacity, and equipment process requirements, it can allocate the remaining orders to other enterprises on the platform to complete together, realize cross-factory collaborative production, and meet the diverse order needs of customers. (5) Green

manufacturing to improve energy efficiency: In the production stage, enhancing resource allocation efficiency, reducing manufacturing and operation energy consumption, improving manufacturing enterprises' energy utilization technology and production processes, and developing intelligent manufacturing models that meet the requirements of clean production and circular economy. Using digital technology to make operational processes such as procurement, production, and sales collaborative and visual, and reduce unnecessary waste and energy consumption.

**3. Limitations and Future Research**

Despite its contributions, this study has several limitations. First, the research adopts a cross-sectional design with quantitative data, which restricts the ability to capture long-term causal dynamics of digitalization and high-quality development. Second, the focus on Yongjia's pump and valve industry may limit the generalizability of findings to other manufacturing sectors with different technological, organizational, or market conditions. Finally, the study emphasizes structural and resource empowerment but does not consider other potential mediators such as ecosystem empowerment, leadership practices, or organizational culture, which might also influence high-quality development. Therefore, future research can expand in several directions. First, longitudinal or panel studies could be employed to observe the dynamic evolution of digitalization's effects on high-quality development over time. Second, qualitative methods, such as in-depth interviews and case studies, should be incorporated to enrich the understanding of how managers and employees perceive and implement digital empowerment. Third, exploring additional mediating and moderating variables—such as enterprise size, innovation ecosystem, government policy support, or global supply chain integration—would further clarify the mechanisms at play. Finally, integrating sustainability indicators and circular economy practices into digital empowerment frameworks would strengthen the relevance of future studies in addressing the global green transition.

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