

A Study on the Influencing Factors of Employees' Digital Competence in S Water Supply Company

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Abstract

Digital technology is reshaping the capacity requirements of the water industry, and employee digital competency has become a bottleneck restricting the digital transformation of county water enterprises. This paper takes S water company as a case, based on the “individual-organization-post” three-dimensional analysis framework, combined with industry data and enterprise data, systematically analyzes the key influencing factors and action modes of employee digital competency interpreted from the case. The research shows that within this case, learning motivation, training incentive and digital operation intensity are the most prominent influencing factors, and the combination of the three forms three types of promotion modes: individual-led, organizational complement and comprehensive coordination. According to the different characteristics of the transformed older employees and the young employees of the enterprise, county water enterprises should implement a hierarchical classification strategy, and finally realize the coordinated development of employee ability and digital transformation.

Keywords

Digital Competency, County Water Enterprises, Transformation of Public Institutions, Influencing Factors, Case Study

1. Introduction

At present, the scale of China's smart water market has exceeded 80 billion yuan, and the county market accounts for more than 40%, which is the core battlefield of the digital sinking of the industry (China Water Network Research Institute, 2025). However, in the case of rapid landing of technical systems, the ability of

employees to control digital systems cannot keep up with the development of the system, which directly affects the actual effectiveness of digital investment.

County water enterprises are mostly reformed from the original water supply and drainage institutions, and the staff structure is generally characterized by differentiation: the personnel of the business transformation have rich practical experience, but the digital foundation is weak; the technical foundation of young employees in the company is good, but they lack knowledge and experience in water affairs. S Water Company operates the county urban-rural integrated water supply and the second sewage treatment plant project. The design water supply scale is 58,500 tons/day, the service covers more than 300,000 people, and there are 138 employees, about 30% of which are transformed from the original institutions. The employee team presents the dual differentiation characteristics of “old employees are experienced and young employees are skilled”. The problem of ability adaptation faced by S Water Company is highly representative in county water enterprises. In this context, whether employees’ digital competence can meet the operational requirements of the smart water system is directly related to the actual effect of S company’s digital transformation. Therefore, it is necessary to clarify its core influencing factors as soon as possible in order to adopt corresponding strategies to improve employees’ digital competence.

However, the existing digital competency research mostly focuses on the Internet, manufacturing and other industries, and there are few targeted research on county water enterprises. This paper combs the core factors affecting the digital competence of employees in county water enterprises from the three dimensions of “individual-organization-post”. Combined with the case of S company, it aims to provide practical reference for the construction of digital competence of employees in county water enterprises.

2. Digital Competency Analysis Framework

The conceptual system of digital competence originates from the DigComp framework of the European Union. The core covers five dimensions: information and data literacy, communication and collaboration, digital content creation, security awareness and problem solving (Ferrari, 2013). Follow-up research further expands seven core competencies such as technical operation, critical thinking, and professional quality (Van Laar et al., 2017). In the early stage, domestic research focused on teachers and civil servants, and gradually extended to the scene of state-owned enterprises, and constructed a competency model suitable for domestic enterprises. The existing research generally agrees that digital competency is the result of multiple factors, which can be summarized into three perspectives: individual, organization and environment. From the individual perspective, age, education, technical experience and learning motivation are the core variables; from the perspective of organization, the training system, performance appraisal and incentive mechanism have significant external driving effects. From the perspective of environment, the ease of

use of technical systems and the degree of digitization of the industry will also have an impact on the level of capacity.

In the relevant research of the water industry, Tang Kaidi built a competency model for the digital operation and maintenance personnel of the water supply network, and summarized six core competencies such as tool application, data analysis, diagnosis and decision-making (Tang, 2026). Zhao Huan believes that the implementation of intelligent water affairs forces grassroots employees to improve their ability, and the training and incentive short board restricts the capacity building (Zhao, 2024). With the help of SWOT analysis, it is found that there are some problems in the water group, such as the aging of talents and the imperfect digital training system (You, 2025). Yu Liguang et al. proposed that the cultivation of intelligent water compound talents is the key to industry transformation (Yu, Chen, & Ji, 2020); Wang Jiaying et al. and Guo Liang et al. From the perspective of practical teaching and integration of production and education, it is pointed out that the training of water talents does not match the actual needs of enterprises (Wang et al., 2026; Guo et al., 2024). These studies provide an important theoretical basis for this article.

Combined with the business characteristics and personnel characteristics of county water enterprises, this paper constructs a three-dimensional analysis framework of “individual-organization-post”. The individual level covers age, educational background, technical experience and learning motivation, which is the internal basis of ability formation. The organizational level covers training support, institutional incentive and organizational atmosphere, which is the external guarantee of ability improvement. The post level covers digital operation intensity and work autonomy, and is a scene carrier of ability solidification. The three levels of factors are combined and matched in different ways, which together affect the formation and improvement of employees’ digital competence.

Table 1. Core dimensions and elements of the analytical framework.

Analysis Level	Core Elements	Element Description
individual level	Age	Reflects the knowledge renewal cycle and learning adaptability
	Education	Reflects cognitive foundations and learning ability
	Technical experience	Familiarity with digital tools and prior usage experience
	Learning motivation	The intrinsic motivation and drive to actively acquire new skills
Organizational level	Training support	The frequency, quality, and format of training provided by enterprises
	Institutional incentives	The extent to which performance appraisal and promotion systems guide learning
	Organizational atmosphere	A culture of learning and mutual support within the team
Job Level	Digital Operation Intensity	The extent of reliance on digital tools in daily work
	Job autonomy	Employees’ autonomy in making work-related decisions

Operational definition and assessment of digital competence in S Company To support comparative analysis within the case, this study operationalizes employee digital competence into three hierarchical levels with observable behavioral indicators:

1) Basic operation: Able to complete standard data entry, simple system query and basic interface navigation under step-by-step guidance; observable indicators include the completion rate of routine digital tasks, frequency of operational errors, and degree of reliance on on-site technical guidance.

2) Proficient use: Able to independently operate the full functions of the smart water system, solve common operational faults, and adjust work processes according to system functions; observable indicators include independent task completion rate, fault self-resolution rate, and operation speed of standard business processes.

3) Data-based judgment: Able to identify abnormal data trends, conduct preliminary cause analysis, and propose targeted disposal suggestions based on system output; observable indicators include accuracy of anomaly identification, rationality of disposal opinions, and frequency of data-driven work optimization.

3. Analysis of the Influencing Factors of S Company's Employee Digital Competency

3.1. Hierarchical Identification of Core Influencing Factors

This paper adopts the single case study method and takes S water company as the analysis object. The reasons are as follows: First, as a typical representative of county water enterprises transformed from public institutions, S company has obvious binary differentiation of employee structure, which is highly consistent with the research problems in this paper. Second, after the company applies the smart water system, the digital competency differences between different positions and different groups are more significant, which is convenient to observe the interaction of multi-level factors.

The field research was conducted over a month observation period from August to September 2026. The research data mainly comes from three aspects:

First, internal documentary data of the enterprise, including S company's organizational structure, job description, training records, performance appraisal documents, etc. Documentary evidence was selected according to two criteria: 1) directly related to digital system operation or competency training; 2) covering all front-line and functional departments to ensure cross-departmental representativeness.

Second, industry public data, including relevant statistics from the [Blue Book on County Water Development \(2024\)](#), [Investigation Report on Smart Water Construction and Talent Development \(2025\)](#) and other authoritative industry reports, which were used for industry benchmarking and comparative reference.

Third, on-the-spot non-interventional observation records. We observed typical work processes across four departments: comprehensive department, cus-

tomer service marketing department, pipe network management department. Data for the engineering technology department comes from on-site observation of project operation and maintenance processes as well as internal work log documents, to supplement the sample of technical front-line positions.

The framework analysis procedure followed three standardized steps:

1) Coding: Two researchers independently coded all text materials and observation records, using the “individual-organization-post” three-dimensional framework as the pre-set coding scheme. Each factor element in **Table 1** was used as a primary code, and specific behavioral performance and event descriptions were coded as secondary codes.

2) Theme identification: We aggregated secondary codes under each primary code, compared the frequency and performance intensity of each factor across different employee groups and departments, and identified high-frequency and high-impact themes as key candidate influencing factors.

Based on the above procedure, we classified and sorted the data, identified key influencing factors at each level, and compared the differences in the role of different employee groups.

3.1.1. Individual Level

The “Blue Book on County Water Development (2024)” shows that the county water enterprises as a whole are characterized by “old age and low education.” The proportion of employees over 40 years old is generally more than 60% (*Department of Rural Water Resources and Hydropower, Ministry of Water Resources, 2024*). The first degree is mainly technical secondary school and below, and the individual level ability is more prominent. The employee structure of S company is better than the industry average. The proportion of employees under 40 years old is more than 60%, and the first degree is more than 50% in college and above, but it has obvious group differentiation characteristics. The transformed old employees are generally over 45 years old, and have more than 10 years of first-line business experience, but the digital technology foundation is weak; young employees have a good educational background and technical foundation, but lack of knowledge and experience in water affairs.

Age and education directly determine learning efficiency. Young employees adapt to the new system faster than older employees in this case. Observation records show that employees aged 45 and above generally take more than twice as long as employees aged below 30 to independently master all core system functions. This finding is a descriptive result of the case sample, based on on-site tracking of training adaptation cycles.

At the same time, at the technical experience level, employees with computer office experience or deep smartphone use experience have a noticeably shorter system adaptation cycle; employees who can only complete basic mobile phone operations need to build system operation cognition from scratch.

Within this case sample, learning motivation shows the strongest association with digital competence level among individual-level variables. According to in-

dustry survey data from [China Urban Water Supply and Drainage Association \(2024\)](#), the knowledge retention rate of digital operational skills among employees who actively participate in digital training is 1.67 times that of passive participants. Employees who are willing to take the initiative to learn will independently consult the operation manual, ask technical personnel for advice, and even explore the advanced functions of the system; for employees with low learning initiative, it is difficult to form stable competence even after repeated training.

3.1.2. Organizational Level

The digital training of county water enterprises generally has the problem of “emphasizing theory over practice, emphasizing form over effect”. Industry statistics show that under the traditional centralized theory training mode, the average pass rate of employee assessment is about 55%, and the operation forgetting rate is more than 50% after 3 months ([Department of Rural Water Resources and Hydropower, Ministry of Water Resources, 2024](#)).

In terms of training support, the content, form and frequency of training directly affect the efficiency of employees’ ability acquisition. The previous training of S company is mostly theoretical learning and online answering, which is separated from the front-line business scene, and lacks follow-up practical guidance, resulting in low employee acceptance and high forgetting rate. The pipe network maintenance adopts the “hand-to-hand guidance” mode, and the training effect is noticeably improved in this case, which confirms the important influence of training form on ability transformation.

In this case, institutional incentives also show a notable positive association with learning engagement. If digital ability is directly linked to assessment, salary and promotion, it will greatly enhance employees’ learning motivation. S company has not incorporated digital operation performance into the formal assessment system, and employees generally lack external driving force for digital learning.

The potential value of organizational climate is prominent. According to [Investigation Report on Smart Water Construction and Talent Development \(2025\)](#), in water enterprises with formal internal mutual assistance mechanisms, employees’ system problem-solving efficiency is improved by about 60% and the competence improvement cycle is shortened by about 30% ([National Water Enterprise Management Association, 2025](#)). At present, S company has not yet established a formal knowledge transfer system, and system problems can only be solved remotely by manufacturers, which is time-consuming and inefficient. However, some employees have spontaneously formed mutual assistance pairs: young employees guide digital operations, while older employees share business logic. Comparative observation within the case shows that this informal mechanism has brought observable improvements in work efficiency and problem-solving speed.

3.1.3. Post Level

Among post-level factors in this case, digital operation intensity shows the most

direct positive correlation with digital competence level. The higher the dependence of daily work on digital tools, the more adequate practical exercises employees have, and the faster their competence solidifies. The overall digital competency of employees in the comprehensive department and engineering technology department of S company is the highest, and the core reason lies in daily high-frequency system operation; some employees in low-digital positions, even if they have participated in training, will gradually lose their skills due to long-term non-use.

The impact of work autonomy is relatively limited. The water industry has strong safety constraints, high requirements for post operation standardization, and limited space for independent optimization. Therefore, its explanatory power for digital competency differences is noticeably lower than that of digital operation intensity in this case.

To sum up, no single factor can independently determine employees' digital competence level in the context of county water enterprises. Within this case, internal learning motivation is the most fundamental prerequisite among all influencing factors. In the absence of active learning willingness, the effect of external organizational support will be greatly reduced.

3.2. Combination Effect and Typical Model of Influencing Factors

The influencing factors of the three levels do not work in isolation, but form differentiated ability improvement paths through specific combinations, corresponding to different employee groups.

3.2.1. Individual Dominant Type

This model is driven by individual learning motivation and technical experience, supplemented by high job autonomy, which is typical for young and highly educated new recruits. With strong endogenous motivation and technical foundation, even if the enterprise training system is not perfect and the digital operation intensity of the post is limited, such employees will take the initiative to explore digital tools in combination with their work needs, and integrate digital means into traditional work processes through autonomous learning.

3.2.2. Tissue Complement Type

This model is driven by organizational training support and institutional incentives, and makes up for the lack of individual conditions of employees through external institutional design, which corresponds to the group of transformed employees with rich business experience but weak digital foundation. When enterprises adopt on-the-job counseling, skill assessment and other methods, these employees can gradually master the core system operation, and combine digital tools with their own business experience to realize the transformation from "not using" to "using valuable".

3.2.3. Comprehensive Synergy

In this mode, individual motivation, organizational support and job strength play

a positive role at the same time, forming a joint force, focusing on the core digital employees such as comprehensive department and engineering technology department. This kind of post itself has high-frequency digital operation requirements. The enterprise supports special training and skill assessment. The on-the-job employees generally have a strong willingness to learn. The three conditions are superimposed on each other to promote the employee's digital competence to a higher level. It can not only operate skillfully, but also make preliminary judgments and disposals based on data anomalies.

3.3. Differences in Influencing Factors among Different Groups

For employee groups with different characteristics, there are significant differences in the influence weight and mode of action of each factor. The individual level factors play a leading role in the young employee group, and the organizational and job factors play a more accelerating and amplifying role; the weight of organizational factors is the highest in the group of older employees, and training and motivation are the core breakthrough of ability improvement. Core digital positions are indispensable at three levels. Job strength is the foundation, organizational support is the guarantee, and individual motivation determines the upper limit. This difference means that enterprises cannot adopt a "one-size-fits-all" plan to improve employees' digital competence, and must adopt differentiated management strategies.

4. Conclusion and Prospect

Based on the case of S company, this paper systematically analyzes the current characteristics, core influencing factors and promotion path of digital competence of employees in county water enterprises. The study found that the digital competency of employees in S company has the characteristics of group differentiation and job stratification. The employees of high-frequency digital operation positions such as comprehensive department and engineering technology department have been able to use the intelligent water system skillfully, and have the ability to make preliminary judgment and disposal based on data anomalies; most of the employees in some positions such as customer service marketing and pipe network management stay at the level of basic query, entry and simple operation, and the ability of digital judgment and disposal in complex business scenarios is insufficient. The digital foundation of the transformed older employees is weak, and the young employees lack experience in water business. Their existing digital competencies have not fully met the job requirements. On this basis, this paper further analyzes the three core influencing factors that affect the digital competence of employees in county water enterprises, namely, learning motivation at the individual level, training incentives at the organizational level, and digital operation intensity at the post level. Among them, intrinsic learning motivation is the most basic prerequisite. Through different combinations, the three types of factors form three promotion modes: individual-led, organizational complement and compre-

hensive coordination, which correspond to young and highly educated employees, transformed older employees and core digital positions, respectively. Therefore, county-level water enterprises should implement a hierarchical classification strategy based on the shortcomings of employees' digital competence, which not only stimulates the innovation vitality of young employees, but also revitalizes the business experience of transformed employees, and promotes the coordinated improvement of employees' digital competence and digital transformation.

There are some limitations in this study. First, the analysis at the industry level is mainly based on publicly reported data, and the data fineness of some subdivision dimensions is insufficient; the second is to use a single case to verify, and the universality of the research conclusions still needs more case tests; the third is a horizontal study, and there is no follow-up study on the long-term effects of various influencing factors. Future research can be further deepened from the following aspects: first, expand the scope of cases, select county water enterprises with different employee structures and different development stages to carry out multi-case comparison, and examine the differences of influencing factors in different situations; secondly, combined with semi-structured interviews and questionnaires, the core influencing factors identified in this paper are quantitatively tested to clarify the influence weight and causality of each factor. The third is to carry out a longitudinal follow-up study to observe the dynamic evolution of the influencing factors of employees' digital competency in different stages of digital transformation.

Author Contributions

Conceptualization, Lei Chai and Jianhong Tao; methodology, Lei Chai; formal analysis, Lei Chai; investigation, Lei Chai; resources, Lei Chai; data curation, Lei Chai; writing—original draft preparation, Lei Chai; writing—review and editing, Lei Chai; supervision, Jianhong Tao. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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