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# Can Digital Transformation Promote Service Innovation Performance of Construction Enterprises? The Mediating Role of Dual Innovation

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**Abstract:** With the ongoing intensification of VUCA environment, enhancing service innovation performance has become a crucial choice for enterprises striving for sustainable development. The emergence of digital transformation offers construction enterprises an opportunity to bolster their service innovation performance. However, effectively leveraging digital transformation for this purpose remains a formidable challenge. Therefore, this study proposes a theoretical model from the perspective of Resource-Based View, named "Digital Transformation-Dual Innovation-Service Innovation Performance", to explore the impact of digital transformation on the service innovation performance of construction enterprises. This model proposes the impact path of digital transformation on service innovation performance, as well as a mediating role of dual innovation in this relationship. A questionnaire was designed and administered in China for collecting 291 valid responses. An analysis revealed that digital transformation exerts a positive impact on both dual innovation and service innovation performance, with the former proving to be more significant. Furthermore, dual innovation not only significantly enhances service innovation performance but also serves as a partial mediator between digital transformation and service innovation performance. The findings of this research clarify the internal mechanism by which digital transformation empowers service innovation in construction enterprises, offering insights for enhancing service innovation performance and achieving sustainable development.

**Keywords:** digital transformation; dual innovation; service innovation performance; sustainable development

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## 1. Introduction

Recently, the rapid development of the construction market has fueled economic growth, while simultaneously revealing issues such as extensive management and product homogenization [1,2]. These challenges have emerged as major obstacles to the sustainable development of many construction enterprises. Recognizing that relying solely on existing product technology limits market share growth and fails to meet changing customer needs, construction enterprises are increasingly aware that competitive advantages can only be achieved by increasing service innovation for existing product technology [3]. Meanwhile, the global construction industry has been severely impacted by the COVID-19 pandemic since late 2019. Governments, industries, and academia have all been actively exploring strategies to address this crisis. The industry is still steadily recovering from continued ongoing efforts [4]. Nevertheless, the post-pandemic era has ushered in a market environment characterized by volatility, uncertainty, complexity, and ambiguity. This dynamic environment is commonly referred to with the acronym VUCA [5]. In this VUCA era, enterprises must leverage innovation to establish novel driving forces for maintaining a sustainable competitive advantage [6]. This indicates that driving innovation and transforming from traditional construction contractors into comprehensive service providers has become an inevitable trend for construction

enterprises to achieve sustainable development. These comprehensive service providers are able to provide holistic solutions that encompass investment and financing, planning, design, construction, operation, and maintenance [7]. Thus, construction enterprises must focus on the efficiencies and effectiveness derived from engaging in service innovation activities, or what we call service innovation performance (SIP). It is imperative for these enterprises to urgently identify effective approaches to enhance SIP.

Existing research posits that digital transformation (DIT) serves as an emerging means for construction enterprises seeking a competitive edge in the digital economy era [8]. Concurrently, service innovation is recognized as a crucial competitive advantage that construction enterprises aspire to uphold [7]. DIT, when effectively implemented, has the potential to optimize and facilitate service innovation activities, leading to enhanced performance outcomes. Despite the acknowledged impact of DIT on financial performance [9,10], innovation performance [11,12], and new product development performance [13,14], limited attention has been given to its effects on SIP [15]. Moreover, current research on DIT predominantly focuses on traditional industries, manufacturing, and service sectors, leaving the DIT of the construction industry in its early development stages. This is evidenced by the McKinsey report, which shows that the global construction industry ranks second to last in digitization levels, only above agriculture [16]. Given this context, there is substantial theoretical and practical value in investigating the relationship between DIT and SIP in construction enterprises. Simultaneously, enterprises grapple with the challenge of balancing the utilization of existing resources and capabilities while establishing new ones that align with the evolving path brought about by DIT [11,17]. Dual innovation (DI), as referring to two distinct innovation methods that flexibly leverage enterprise resources and capabilities, emerges as a critical mechanism for effectively navigating the DIT dilemma. This approach aids in generating positive SIP outcomes through the synergy of both established and newly acquired capabilities. Building upon previous research, this study focuses on Chinese construction enterprises as the survey subjects, and employs DI as the mediating variable, exploring the mechanisms by which DIT shapes SIP.

The next section reviews the literature on the DIT, DI, and SIP. Section 3 proposes the research hypotheses. Section 4 introduces the research methods. Section 5 presents the obtained results. Section 6 summarizes the study's main contributions and further discusses some valuable results. The final section outlines key findings, management insights, and also highlights the study's main limitations along with potential future research directions.

## 2. Literature Review

### *2.1. Digital Transformation*

The concept of DIT was initially introduced by scholars such as Patel and McCarthy in 2000, but it did not garner widespread attention from practitioners and academics until 2014. Currently, there exists no unified definition of this concept in academia. Ilvonen et al. regarded DIT as a process whereby enterprises utilize digital technologies, such as big data, to facilitate changes and innovations in the way they operate their production services [18]. Vial believed that DIT is a fundamental change in strategy, architecture, process, and culture via digital technology, which enables enterprises to maintain competitiveness in the digital world [19]. Gong and Ribiere proposed that DIT is defined as the innovative use of digital technology by enterprises to leverage critical resource and capability, aiming to fundamentally reshape the value proposition of enterprises and their stakeholders [20].

Presently, as emerging digital technologies such as BIM, VR, and AI are increasingly integrated into the construction industry, the DIT of construction enterprises has become a major trend. However, it is essential to recognize that the DIT of construction enterprises entails more than merely applying technology, it encompasses a comprehensive integration of digital technology with the overall business, management, and business models of construction enterprises [21]. To achieve DIT and development, construction enterprises must develop a customer-centered, process-driven, data-centric, platform-supported organizational structure and ecosystem. Building upon the aforementioned research, this study posits that

DIT in construction companies is a form of change, in which digital technology is integrated to optimize and innovate business processes, management practices, and business models. Its essence lies in being a strategic business transformation driven by customer demand.

Existing research indicates that digital maturity serves as an indicator for assessing the DIT within enterprises [22]. Consequently, this study employs digital maturity as a proxy variable to measure the level and extent of DIT in construction enterprises. Additionally, scholars have explored various dimensions of digital maturity. Westerman et al. proposed that digital maturity encompasses both digital intensity and transformation management intensity [23]. Colli et al. identified five dimensions of digital maturity: digital governance, digital technology, connectivity, value creation model, and digital competences [24]. Building on Colli et al., Zouari et al. argued for four dimensions of digital maturity: digital governance, digital competences, value creation, and connectivity [25]. Drawing from these perspectives, this study aligns with the core essence of DIT and tailors it to the specific context of construction enterprises. Therefore, the measurement of DIT in this study will be focused on the dimensions of digital management, digital technology, and digital competences.

### *2.2. Dual Innovation*

Benner and Tushman introduced the dual concept into the field of enterprise innovation, categorizing it into two types: exploratory innovation (ERI) and exploitative innovation (EII) [26]. The simultaneous pursuit of both ERI and EII constitutes DI [27]. ERI entails R&D activities conducted by enterprises to explore new product markets and identify potential customers. Conversely, EII entails R&D activities where enterprises upgrade existing processes based on their current products or services to meet new customer needs [28]. Furthermore, EII, which is based on improving products and services by existing knowledge, technology, or structures, has the characteristics of relatively lower investment risks and shorter return periods [29]. ERI, which is based on developing new technologies, products, or services, has the characteristics of higher investment risks and longer return periods. Corresponding to this higher risk, the financial returns from ERI significantly exceed those from EII [30].

Existing research indicates that DI serves as a pivotal pathway for enhancing enterprise performance and achieving sustainable success when facing intensifying market competition [31]. Thus, advancing DI initiatives has become a vital strategic choice for construction enterprises in the unpredictable market of the digital era. Building on insights from the aforementioned studies and taking into account the unique characteristics of construction enterprises, this study proposes that ERI constitutes an innovative activity in which construction enterprises utilize new knowledge and technology to offer new products and services to meet emerging market and customer needs. Conversely, EII is characterized as an innovative activity in which construction enterprises employ their existing knowledge and technology as a basis to enhance their current products and services, thereby meeting existing market and customers.

Presently, there are three primary methods for measuring DI. The first method studies ERI and EII as separate dimensions [32,33]. The second method regards DI as a combination of ERI and EII, where the scores of the two types of innovations are either multiplied or added together to represent DI [34,35]. The third method considers DI as a balance between ERI and EII, and recommends using the absolute difference between these two as an indicator [36]. Current research indicates that successful enterprises simultaneously pursue both ERI and EII. The former maintains the enterprise's present viability while the latter secures future survival and growth potential [37]. This implies that ERI and EII have divergent objectives and exhibit unique interactions with other variables. In this context, it is essential to conduct separate analyses of the impacts of ERI and EII activities on enterprise performance. Accordingly, this study chooses to employ the first method in measuring DI.

### *2.3. Service Innovation Performance*

Betz initially introduced the concept of service innovation, contending its distinction from traditional product and process innovation as characterized by the introduction of

technology-oriented services to the market [38]. Building upon this, Menor and Roth proposed that service innovation involves delivering a novel service experience to customers, either by creating a new service product or enhancing an existing one [39]. Gustafsson et al. believed that service innovation is a new process or offering that can create value for stakeholders [40]. Given that the assessment of service innovation activities typically revolves around SIP, Den Hertog et al. argued that the performance generated by an enterprise through the provision of a new service experience or solution constitutes SIP [41]. Similarly, Mennens et al. emphasized that SIP is the capacity of an enterprise to establish a competitive advantage through conducting service innovative activities [42]. Sun and Zhao regard SIP as a kind of development of new services and the improvement of existing services in an enterprise, which meets the financial requirements of the enterprise, satisfies its customers, and achieves internal development [43].

Recently, faced with the evolving customer demands and the complex, changing market environment, an increasing number of construction enterprises have begun to recognize the necessity of service innovation. In construction enterprises, service innovation aims to cultivate new competitive advantages by introducing innovative services [7]. Unlike service innovation in manufacturing or the service industry, service innovation in construction enterprises focuses on construction and building as a foundation. It aims to achieve sustainable development by augmenting service elements in building planning, design, construction, and operation processes. Drawing from the aforementioned research, this study posits that SIP refers to the ability of construction enterprises to develop new services or improve existing ones to meet customer needs, thereby bringing multiple benefits to the enterprise.

Measuring SIP is challenging, mainly due to the inherent characteristics of service innovation, such as its intangibility. Consequently, there currently exists a lack of a standardized criterion for the dimensions of SIP. Avlonitis et al. advocated a comprehensive approach, asserting that SIP should encompass both financial and non-financial components [44]. Conversely, Storey and Kelly identified three key dimensions of SIP: financial indicators, customer indicators, and internal indicators [45]. Additionally, Hsueh et al. emphasized the consideration of both process and outcome in evaluating SIP [46]. Upon evaluating these perspectives, Storey and Kelly's classification appears to be more comprehensive, providing a holistic measurement of the improvements that service innovation brings to enterprises. This classification aligns with the scope of the sample objects of this study, leading to the decision to endorse and adopt this particular division.

## 3. Research Hypothesis

### *3.1. Relationship between DIT and SIP*

The Resource-Based View posits that an enterprise's unique resources and capabilities are critical in gaining a competitive advantage in the market [47]. This perspective is particularly relevant to construction enterprises, where DIT is essential for restructuring production and operational processes, as well as organizational structures. In doing so, it fosters the development of distinct resources and capabilities, thereby enhancing SIP. Despite its obvious relevance, the current literature is scarce in directly exploring the relationship between DIT and SIP in construction enterprises. Most studies focused on the broader impact of DIT on overall enterprise performance. For instance, the research conducted by Li and Jia demonstrates how DIT significantly improves product quality, optimizes sales channels, and fosters innovative business models. Collectively, these factors contribute to both the expansion of market share and the enhancement of enterprise performance [48]. Similarly, Abou-Foul et al. emphasize the positive impact of digitization on financial performance, noting that prioritizing service delivery during the digitization process can yield even greater financial benefits [49]. Conversely, a minority of scholars contend that digital technologies may induce conflicts between production and management systems, potentially diminishing enterprise performance [50].

The synthesis of the current research indicates a consensus among the majority of scholars that DIT exerts a positive impact on enterprise performance. This effect is particu-

larly pronounced in construction enterprises where SIP—a type of enterprise performance triggered by service innovation activities—is also influenced by DIT. The essence of DIT aims to achieve customer value propositions and enhance value addition through a comprehensive upgrade of the business process. Meanwhile, the essence of service innovation resides in the development of new service products driven by customer needs. DIT acts as a catalyst for service innovation activities, which, when executed effectively, yield tangible performance gains. Drawing on these insights, the following hypothesis is proposed:

**H1.** *DIT positively affects SIP.*

### *3.2. Relationship between DIT and DI*

During the process of DIT, the widespread application of digital technology has accelerated the flow, aggregation, and sharing of both internal and external resources, which enables enterprises to rapidly acquire and utilize market information, capture market opportunities, and engage in both ERI and EII [51]. When enterprises find themselves caught in the "dilemma" of DIT, they require digital empowerment to enhance their dual capabilities [52,53]. The exploitation capability formed through digital empowerment can enable enterprises to refine and expand existing capabilities and technology paradigms, aiding in optimizing existing business processes, and consequently improving efficiency. Given that path dependence hinders enterprises from undertaking innovative activities, the exploration capabilities gained through digital empowerment can assist in reducing path dependence, reshaping business models, and promoting breakthrough achievements in disruptive innovation.

Likewise, DIT is a pivotal tool for the flexible redistribution and utilization of resources among construction enterprises. It facilitates the restructuring and integration of complementary internal and external resources, thereby offering potential for both ERI and EII. During the transformation process, these enterprises can expand their product and technology scope. This expansion is driven by a keen awareness of the latest industry trends and market demands, coupled with the development of new products and services, creating fertile ground for ERI. Simultaneously, this process accelerates the transfer and sharing of resources across internal and external boundaries. It aids in consolidating and refining existing knowledge and skills, enhancing current products and services. This, in turn, motivates enterprises to pursue EII activities more vigorously. Based on these observations, the following hypotheses are proposed:

**H2a.** *DIT positively affects ERI.*

**H2b.** *DIT positively affects EII.*

### *3.3. Relationship between DI and SIP*

This study begins with an examination of the relationship between DI and enterprise performance, an area with limited existing research directly addressing the connection. Focusing on DI and enterprise performance, research has shown that ERI significantly impacts enterprise performance, particularly under the moderating effect of competitive intensity. This observation is supported by survey data from China's semiconductor and pharmaceutical industries [54]. However, contrasting findings emerge when considering Hong Kong's manufacturing enterprises, where it appears that only EII significantly and positively affects enterprise performance [55]. Providing an additional viewpoint, Osiyevskyy et al. found that distressed enterprises could enhance performance through both ERI and EII. This suggests that enterprise success relies on both exploiting existing and exploring new markets, knowledge, and skills [56].

The complex relationship between DI and enterprise performance remains a focal point for scholarly inquiry, inspiring deep contemplation and exploration. SIP, a type of enterprise performance, is directly influenced by DI, a critical tool for enhancing enterprise performance. In the context of construction enterprises, ERI plays a crucial role. It

leverages new resources and capabilities to develop innovative products and services, and to explore new markets, thus enlarging the enterprise's market share and boosting its SIP. Simultaneously, EII enables these enterprises to more effectively integrate existing resources and capabilities. By improving current products and services to more aptly suit the existing market, it further elevates the enterprise's SIP. Building on this understanding, the following hypotheses are proposed:

**H3a.** *ERI positively affects SIP*.

**H3b.** *EII positively affects SIP*.

### *3.4. Mediating Effect of DI*

DI is an effective strategy for addressing the "dilemma" faced by enterprises during DIT. It is also a crucial tool for attaining a competitive advantage and consistent success. An empirical analysis of Chinese manufacturing enterprises conducted by Su et al. demonstrated that DI serves as an indirect mediator between big data analysis capabilities and organizational performance [57]. Thus, this study suggests that DI provides an indirect transmission path in the DIT process, thereby influencing the SIP of construction enterprises. Additionally, DIT acts as a catalyst for two distinct types of innovative activities.

In the era of the digital economy, construction enterprises embark on DIT to adapt to the intricate and ever-changing market environment, thus securing a competitive edge. Successful DIT enables these enterprises to rapidly acquire and integrate information related to customer groups, upstream suppliers, and stakeholder enterprises. This enhances their ability to discern market opportunities and achieve precise market positioning. Furthermore, DIT empowers construction enterprises to efficiently integrate both internal and external resources through digital technology and other methods. This strategic allocation of limited resources to these two categories of innovative activities maximizes resource utilization value and fosters active engagement in DI. In this context, ERI is instrumental in creating new products and services and venturing into new markets to secure long-term competitive advantages. Simultaneously, EII focuses on refining existing products and services to align with current market demands, thereby maintaining the enterprise's market position [27]. Collectively, these two innovative activities are pivotal in driving the continuous and stable growth of SIP. On this basis, the following hypotheses are proposed:

**H4a.** *ERI mediates between DIT and SIP*.

**H4b.** *EII mediates between DIT and SIP*.

Based on the above hypotheses, a theoretical model in this study is proposed, as shown in Figure 1.

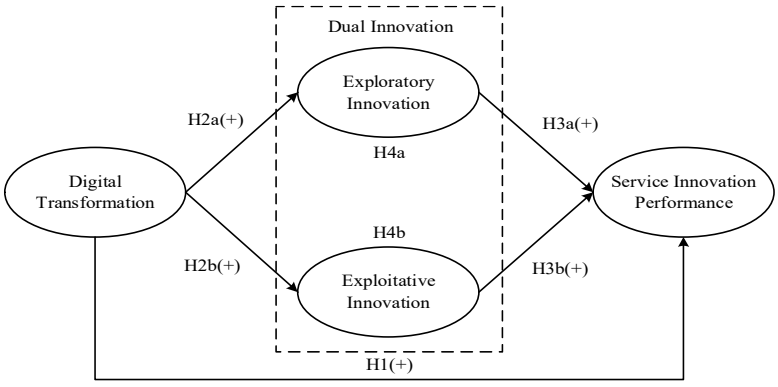


**Figure 1.** Theoretical model.

## 4. Research Methods

### *4.1. Questionnaire Design*

Data for this study were gathered via a survey questionnaire. During the questionnaire design phase, the instrument underwent multiple modifications and optimizations. These changes were based on the relevant literature and expert feedback, ensuring that the participants could fully comprehend the specific meanings of the measurement dimensions.

The formal questionnaire consisted of two parts: Section A comprised 3 questions regarding the basic information of the enterprise (e.g., year of establishment, scale, and ownership nature). Section B contained 24 questions covering various aspects from DIT, DI, to SIP of construction enterprises rated on a 5-point Likert scale, from 1 (completely disagree) to 5 (completely agree). The specific measurement items for each variable are listed in Table 1.

**Table 1.** Measurement items.

| Constructs | Items |
| --- | --- |
| DIT | Group 1: Digital Management |
| | DM-1 The leadership of the enterprise places significant emphasis on DIT |
| | DM-2 Enterprise has clear DIT strategy plans and understands its implementation steps and paths |
| | DM-3 Enterprise has invested a large amount of funds in digital construction |
| | Group 2: Digital Technology |
| | DT-1 Enterprise is able to independently build or introduce an online digital platform that can monitor project implementation in real time, thereby achieving visual management of projects |
| | DT-2 Enterprise is able to apply highly automated construction equipment and building robots in construction projects, thereby achieving effective human–machine cooperation |
| | DT-3 Enterprise can utilize digital technology to provide new solutions for construction projects to meet the needs of customers |
| | Group 3: Digital Competences |
| | DC-1 Enterprise can use digital platforms to coordinate information on personnel assessment, material allocation, safety management, and other aspects, thereby optimizing resource allocation, managing construction sites effectively, and minimizing resource waste |
| | DC-2 Enterprise can leverage online digital platforms to achieve internal information sharing and enhance internal cooperation capabilities |
| | DC-3 Enterprise provides regular training for its employees to cultivate their digital thinking, overall planning ability, and operational skills of digital platforms |
| DI | Group 4: Exploratory Innovation |
| | ERI-1 Enterprise regularly carries out comprehensive innovations in the production methods of construction projects or services |
| | ERI-2 Enterprise is brave enough to increase the variety of new construction projects or services |
| | ERI-3 Enterprise will attempt to grow into hitherto untouched market areas |
| | Group 5: Exploitative Innovation |
| | EII-1 Enterprise strives to improve the quality of existing construction projects or services |
| | EII-2 Enterprise endeavors to improve the adaptability of existing construction projects or services |
| | EII-3 Enterprise is committed to both consolidating and expanding its existing market size |
| SIP | Group 6: Financial Performance |
| | FP-1 Enterprise reduces project costs by developing new services or improving existing services |
| | FP-2 Enterprise brings profits to projects by developing new services or improving existing services |
| | FP-3 Enterprise increases investment return of projects by developing new services or improving existing services |
| | Group 7: Customer Performance |
| | CP-1 Enterprise boosts its market share by developing new services or improving existing services |
| | CP-2 Enterprise enhances owner satisfaction by developing new services or improving existing services |
| | CP-3 Enterprise establishes a good market image by developing new services or improving existing services |
| | Group 8: Internal Performance |
| | IP-1 Enterprise improves its operation efficiency by developing new services or improving existing services |
| | IP-2 Enterprise optimizes its internal workflows by developing new services or improving existing services |
| | IP-3 The enterprise enhances its overall development potential by developing new services or improving existing services |

Main Sources for DIT: Westerman et al. (2012) [23], Colli et al. (2019) [24], Zouari et al. (2020) [25], Main Sources for DI: He and Wong (2004) [32], Jansen et al. (2006) [58], Duodu and Rowlinson (2019) [59], Main Sources for SIP: Storey and Kelly (2001) [45], Hilman and Kaliappen (2015) [60].

### *4.2. Sample and Data Collection*

To ensure the validity of the questionnaire, its distribution was strictly confined to the management personnel of large and medium-sized construction enterprises, as well as top-ranked local leading enterprises. The electronic questionnaires were distributed among the surveyed enterprises through the QuestionStar platform. Over a three-month period, a total of 347 questionnaires were collected. Following the exclusion of samples that failed to meet the required criteria, such as excessively brief response times or identical answers, 291 valid enterprise samples were retained. This constitutes an effective response rate of 83.86%, which satisfies the criteria for structural equation analysis.

The basic information of the sample is detailed in Table 2. An analysis of this table reveals that state-owned enterprises represent 79.38% of the sample, private enterprises make up 17.53%, and other types of enterprises account for 3.09%. A significant portion of the enterprises, constituting 48.45% of the valid samples, have a workforce ranging from 100 to 1000 employees. Furthermore, companies that have been established for more than 16 years comprise 50.52% of the total sample. This diverse and comprehensive sample composition contributes significantly to enhancing the accuracy of the research findings.

**Table 2.** Basic information of the sample.

| Parameter | Category | Total | Frequency (%) |
|---|---|---|---|
| Years of establishment | 5 years and below | 63 | 21.65 |
| | 6–10 years | 41 | 14.09 |
| | 11–15 years | 40 | 13.74 |
| | 16 years and above | 147 | 50.52 |
| Employee size | Fewer than 100 people | 21 | 7.22 |
| | 100–1000 people | 141 | 48.45 |
| | 1001–2000 people | 40 | 13.75 |
| | 2001–3000 people | 6 | 2.06 |
| | More than 3000 people | 83 | 28.52 |
| Status of ownership | State-owned enterprises | 231 | 79.38 |
| | Private enterprises | 51 | 17.53 |
| | Other | 9 | 3.09 |

### *4.3. Statistical Technique*

Structural Equation Modeling (SEM) is a multivariate statistical technique that amalgamates factor and path analysis [61]. It is widely utilized in various fields such as economics, psychology, and sociology, primarily to examine hypothesized relationships between latent variables. Unlike other multivariate statistical techniques, SEM allows for measurement errors in both independent and dependent variables, incorporating these errors into the analysis to improve result accuracy. Consequently, this study employs SEM to validate the hypotheses of the theoretical model.

## 5. Results

### *5.1. Reliability Testing*

The study utilized Cronbach's alpha coefficient, calculated by SPSS 25.0, to evaluate the reliability of the samples. Initially, the overall Cronbach's alpha coefficient of the questionnaire was 0.893, indicating robust internal consistency within the questionnaire. Subsequently, the individual Cronbach's alpha coefficients for each variable exceeded 0.8, confirming their high reliability [62], as illustrated in Table 3.

**Table 3.** Results of reliability and validity testing.

| Variable | Items | Factor Loading | AVE | CR | Cronbach's α |
|---|---|---|---|---|---|
| Digital Management | DM-1 | 0.800 | 0.589 | 0.811 | 0.808 |
| | DM-2 | 0.747 | | | |
| | DM-3 | 0.755 | | | |
| Digital Technology | DT-1 | 0.755 | 0.577 | 0.804 | 0.802 |
| | DT-2 | 0.747 | | | |
| | DT-3 | 0.777 | | | |
| Digital Competences | DC-1 | 0.793 | 0.578 | 0.804 | 0.802 |
| | DC-2 | 0.723 | | | |
| | DC-3 | 0.764 | | | |
| Exploratory Innovation | ERI-1 | 0.737 | 0.667 | 0.857 | 0.854 |
| | ERI-2 | 0.854 | | | |
| | ERI-3 | 0.853 | | | |
| Exploitative Innovation | EII-1 | 0.873 | 0.631 | 0.836 | 0.826 |
| | EII-2 | 0.801 | | | |
| | EII-3 | 0.700 | | | |
| Financial Performance | FP-1 | 0.809 | 0.727 | 0.888 | 0.884 |
| | FP-2 | 0.928 | | | |
| | FP-3 | 0.816 | | | |
| Customer Performance | CP-1 | 0.792 | 0.648 | 0.847 | 0.842 |
| | CP-2 | 0.829 | | | |
| | CP-3 | 0.794 | | | |
| Internal Performance | IP-1 | 0.825 | 0.618 | 0.829 | 0.827 |
| | IP-2 | 0.750 | | | |
| | IP-3 | 0.781 | | | |

### *5.2. Validity Testing*

The measurement items employed in this study were adapted from established international scales, thus ensuring robust content validity for the questionnaire. The results of the Confirmatory Factor Analysis (CFA), conducted using AMOS 26.0 and presented in Table 3, reveal that all measurement items exhibit factor loading coefficients exceeding 0.7. Additionally, the Average Variance Extracted (AVE) values for each variable exceed 0.5, and the Composite Reliability (CR) values exceed 0.8, affirming strong convergent validity of the scales [62]. DIT and SIP are treated as second-order factor constructs in the final analysis, while the two dimensions of DI are considered as separate constructs to assess the discriminant validity of the scale. As illustrated in Table 4, the square root of the AVE for each variable is greater than 0.7 and exceeds the correlation coefficient, indicating excellent discriminant validity for the scale [63].

**Table 4.** Results of descriptive statistics and correlation coefficient.

| Variable | Mean | SD | DIT | ERI | EII | SIP |
|---|---|---|---|---|---|---|
| DIT | 4.156 | 0.530 | 0.754 | | | |
| ERI | 4.140 | 0.719 | 0.321 ** | 0.817 | | |
| EII | 4.179 | 0.639 | 0.238 ** | 0.272 ** | 0.794 | |
| SIP | 4.208 | 0.579 | 0.356 ** | 0.434 ** | 0.390 ** | 0.719 |

Note: ** indicates $p < 0.01$; diagonal values are square root of AVE.

### *5.3. Correlation Analysis*

Given that the maximum absolute value of skewness for all measurement items is 1.572, which is below 3, and the maximum absolute value of kurtosis is 4.529, also below 10, this indicates that the data essentially conform to a normal distribution [64]. Furthermore, since all variables are continuous [65], Pearson correlation analysis was employed. The

Pearson correlation coefficient (r) signifies a positive correlation when the value is positive, and conversely, a negative correlation when the value is negative. In the social science studies, an absolute value of r below 0.2 denotes a weak correlation, between 0.2 and 0.5 suggests a moderate correlation, and above 0.5 implies a strong correlation. The mean, standard deviation, and Pearson correlation coefficients of the variables were calculated using SPSS 25.0 in this study, and the results are detailed in Table 4. DIT exhibited a moderately positive correlation with ERI (r = 0.321, $p < 0.01$), EII (r = 0.238, $p < 0.01$), and SIP (r = 0.356, $p < 0.01$). Likewise, ERI demonstrated a moderately positive correlation with SIP (r = 0.434, $p < 0.01$), as did EII (r = 0.390, $p < 0.01$). These results provide preliminary support for subsequent hypothesis testing.

### *5.4. Hypothesis Testing*

Prior to hypothesis testing, it is essential to assess the overall model fitness indicators. Therefore, SEM was employed, with the assistance of AMOS 26.0. The results indicated the following: CMIN/DF = 1.186 < 3, RMSEA = 0.025 < 0.08, IFI = 0.986 > 0.9, TLI = 0.984 > 0.9, and CFI = 0.986 > 0.9. According to the research of Hair et al. [66], all of these indicators meet the specified criteria, indicating a good fit between the data and the model. The structural model for hypothesis testing is illustrated in Figure 2.

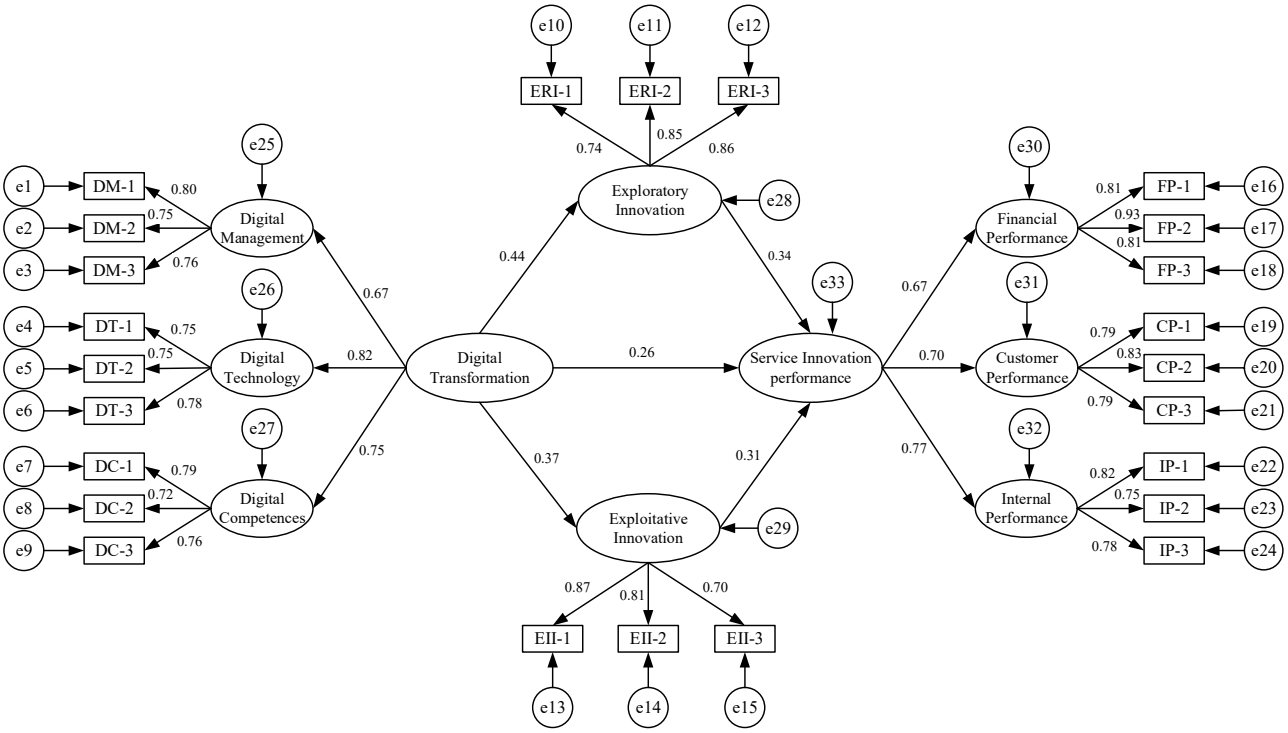


**Figure 2.** Hypothesis testing structural models.

#### 5.4.1. Path Analysis

According to the SEM framework, path analysis was conducted using AMOS 26.0. If the value of Critical Ratio (C.R.) is greater than 1.96 and the probability value ($p$) is less than 0.05, the path analysis result is considered significant and the hypothesis is supported [67]. A series of valuable results were obtained, as illustrated in Table 5. DIT exerts a positive impact on SIP, with a path coefficient of 0.257 (C.R. = 2.689 > 1.96, $p < 0.01$), confirming hypothesis H1. Similarly, DIT demonstrates a positive and significant impact on both dimensions of DI, yielding path coefficients of 0.438 (C.R. = 5.115 > 1.96, $p < 0.001$) and 0.370 (C.R. = 4.559 > 1.96, $p < 0.001$), supporting hypotheses H2a and H2b. Furthermore, ERI exhibits a significant impact on SIP, with a path coefficient of 0.340 (C.R. = 4.082 > 1.96, $p < 0.001$), validating hypothesis H3a. EII also demonstrates a significant effect on SIP, with a path coefficient of 0.307 (C.R. = 3.925 > 1.96, $p < 0.001$), confirming hypothesis H3b.

**Table 5.** Results of path analysis.

| Hypothesis | Path | Estimate | S.E. | C.R. | *p* | Result |
|---|---|---|---|---|---|---|
| H1 | DIT → SIP | 0.257 | 0.109 | 2.689 | ** | Pass |
| H2a | DIT → ERI | 0.438 | 0.135 | 5.115 | *** | Pass |
| H2b | DIT → EII | 0.370 | 0.122 | 4.559 | *** | Pass |
| H3a | ERI → SIP | 0.340 | 0.060 | 4.082 | *** | Pass |
| H3b | EII → SIP | 0.307 | 0.059 | 3.925 | *** | Pass |

Note: ** indicates $p < 0.01$, and *** indicates $p < 0.001$.

#### 5.4.2. Testing of Mediating Effect

The Bootstrap method has gained increased recognition in mediation effects testing [68]. Hence, this study employed the Bootstrap method to verify the mediating role of the dimensions of DI between DIT and SIP. The results are detailed in Table 6. The mediating effect value of ERI between DIT and SIP is 0.149, with a 95% confidence interval of (0.055, 0.276). As this interval does not include 0, it indicates the presence of a mediating effect, and the direct effect is significant. Consequently, ERI exerts a partial mediating role between DIT and SIP, supporting H4a. Similarly, the mediating effect value of EII between DIT and SIP is 0.114, with a 95% confidence interval of (0.031, 0.217), also excluding 0. This suggests the presence of a mediating effect, and the direct effect is significant, affirming that EII plays a partial mediating role between DIT and SIP, supporting H4b.

**Table 6.** Results of the mediating effect test.

| Hypothesis | Path | Effect Value | Bias-Corrected 95% CI | |
|---|---|---|---|---|
| | | | Lower | Upper |
| H1 | DIT → SIP | 0.257 | 0.073 | 0.489 |
| H4a | DIT → ERI → SIP | 0.149 | 0.055 | 0.276 |
| H4b | DIT → EII → SIP | 0.114 | 0.031 | 0.217 |

## 6. Discussion

Currently, research on DIT within the construction industry context remains relatively scarce. For construction enterprises, DIT serves as a crucial means to address challenges such as extensive management practices and severe product homogeneity. It is also an essential step towards enhancing their digitization level. Consequently, this study, focusing on construction enterprises, aims to broaden the scope of DIT research. Moreover, the impacts and mechanisms of DIT on SIP in the construction sector are remain thoroughly unexplored. Addressing this, our central research question delves into how construction enterprises can boost their SIP through DIT. Meanwhile, the study introduces DI as a pivotal mediating variable. This allows for a deeper examination of the interaction mechanisms between DIT and SIP, thus enriching the empirical research on service innovation driven by DIT.

Utilizing the SEM, this study successfully validated all seven proposed hypotheses. The following discussion centers on two principal outcomes derived from these validations.

Hypothesis H1 establishes a positive correlation between DIT and SIP, suggesting that DIT not only optimizes but also promotes service innovation activities. This result yields performance gains, equipping enterprises to navigate a complex and evolving market environment while meeting increasing customer demands. This finding aligns with Ferreira et al. [15], further enriching the body of research on the economic impacts of DIT. In their current phase of extensive development, construction enterprises are focusing on both service innovation and DIT simultaneously. Service innovation has emerged as a key strategy for gaining competitive advantages, while DIT provides the necessary technological support and a strong impetus for service innovation. This dual approach not only boosts internal efficiency and reduces operational costs but also motivates enterprises to continuously strengthen their core competitiveness and market positioning.

Hypotheses H4a and H4b examine the mediating role of DI in bridging DIT and SIP. The results reveal that DIT fosters both ERI and EII, thus providing support for service innovation. These results correspond with Su et al. [57], thereby broadening the scope of research on DI outcomes. Currently, a significant challenge for construction enterprises undergoing DIT lies in balancing the use of existing resources and capabilities while integrating new ones that align with their historical development trajectories. This highlights a crucial task for managers: overcoming resource constraints and further enhancing organizational capabilities amidst DIT. DI, characterized by its distinct innovation activities that flexibly utilize enterprise resources and capabilities, emerges as an essential mechanism. It effectively addresses the dilemmas of DIT in enterprises, thus playing a pivotal role in elevating SIP.

In summary, the research results presented above provide a novel perspective for construction enterprises aiming to boost their SIP in the digital economy era.

## 7. Conclusions

### *7.1. Key Findings*

This study develops a theoretical mechanism model elucidating how construction enterprises can enhance their SIP through DIT in the era of the digital economy and innovation-driven development. Employing SEM and the Bootstrap method, this research investigates the impact of DIT on SIP within construction enterprises, further examining the mediating roles of both ERI and EII. This study yields the following key conclusions:

Firstly, the DIT of construction enterprises significantly contributes to enhancing SIP. This transformation, akin to SIP, is fundamentally customer-centric. This shared focus on customer needs positions DIT as a vital driver in elevating SIP. Guided by the principle of customer value, DIT can reshape customer advocacy, streamline internal production and operational processes, and elevate service quality and customer experience. It empowers enterprises to meet customer needs more flexibly and offer more personalized, customized solutions. This extensive impact not only bolsters the core competitiveness of enterprises but also aids in expanding their market share, securing sustainable competitive advantages in a highly competitive landscape. Consequently, the positive influence of DIT on SIP is multidimensional, encompassing the refinement of internal processes as well as the differentiation and innovative enhancement of external services. DIT transcends mere technological change, it is a strategic move that propels enterprises toward maximizing customer value.

Secondly, both ERI and EII serve as partial mediators in the nexus between DIT and SIP. During DIT, construction enterprises employ tools such as digital technology not only to acquire new resources and knowledge but also to integrate existing ones. This synergy in resource utilization enables them to respond more agilely to market fluctuations, thereby enhancing the vitality of service innovation. In this context, ERI underscores the enterprise's capacity to develop new resources and knowledge. DIT facilitates broader channels for information acquisition, enabling enterprises to timely grasp market trends, customer demands, and industry developments. Leveraging this information, they can more effectively develop new products and services to meet emerging market needs. Concurrently, EII focuses on the enterprise's ability to amalgamate existing resources and knowledge. Through DIT, enterprises can more effectively harness internal information, experiences, and technologies. This integration aids in flexibly enhancing the quality of current products and services, aligning with existing market requirements. Therefore, ERI and EII collectively constitute a critical mediating mechanism in how DIT influences the SIP of construction enterprises. This mechanism provides substantial support for enterprises striving for competitive superiority in an increasingly complex market landscape.

### *7.2. Management Enlightenment*

Derived from the research conclusions outlined earlier, this study has formulated two critical managerial insights:

Firstly, actively promoting and executing DIT remains of paramount importance. Construction enterprises can use digital platforms and a variety of resources to actively promote the DIT of the enterprise, so as to provide support for service innovation. In the evolving digital landscape, it is essential for these enterprises to prioritize financial investment, as DIT necessitates substantial financial resources. The effectiveness of financial investment is key to realizing the various aspects of DIT. Moreover, elevating the application level of digital technology is critical. Enterprises should stay attuned to the latest digital technology trends in the industry and flexibly employ these technologies to refine their production and operational processes. Effective use of digital technologies facilitates the rapid and accurate acquisition of data, thereby enhancing strategic decision making. Equally important is the development of digital talent. Construction enterprises must emphasize nurturing and recruiting individuals with digital skills, which are essential for driving the successful application of digital technology and ensuring the quality and effectiveness of the DIT. By embracing DIT, enterprises can achieve information sharing and visualization, improve organizational operational efficiency and resource allocation, as well as continually upgrade the quality of their products and services. This transformation not only enhances the corporate image and attracts customers but also significantly elevates SIP.

Secondly, it is crucial for construction enterprises to actively engage in DI activities during DIT, thereby improving their service innovation capabilities. The core lies in the pursuit of synergistic development of both ERI and EII, which can effectively adapt to dynamic market changes. Therefore, during the DIT, construction enterprises should flexibly mobilize existing resources through digital means to improve their existing products and services. For instance, employing BIM technology for project management can better serve current customers and markets. Meanwhile, it is acknowledged that DIT cannot be achieved overnight. Senior managers are required to possess exceptional strategic resilience and foresight, coupled with the courage to break away from their path dependence, to foster organizational change and reshape business models. Digital means can help enterprises identify new market opportunities and develop new digital products and services. For example, developing customized software for specific construction projects can provide more personalized solutions. Next, it is vital for enterprises to provide greater organizational support to employees, thus stimulating their innovative potential through digital skills training and the sharing of successful experiences. Additionally, the current global investment in technology for the construction industry constitutes less than 1% of total revenue [16]. Hence, providing support at both the industry and government levels to encourage innovative activities in enterprises is of equal importance. Industry organizations can facilitate the dissemination of advanced knowledge and skills by conducting training sessions and seminars, thus supplying enterprises with high-quality talent. Governments can encourage enterprises to engage in technological research and development activities by implementing tax break policies and offering financial support. Naturally, different countries should adopt tailored strategies to encourage enterprise innovation activities, aligned with their local development conditions. Overall, by implementing a DI strategy, construction enterprises can not only maintain flexibility and adaptability in DIT but also enhance their SIP and strengthen their competitiveness in the ever-changing market environment.

### *7.3. Limitations and Future Prospects*

Despite its contributions to both theoretical and practical domains, this research is not without its limitations. Firstly, while it establishes DI as a key intermediary mechanism through which DIT enhances SIP in construction enterprises, it is possible that alternative pathways between DIT and SIP exist. Future studies should investigate other possible mediating mechanisms and examine the moderating effects within various contexts. Secondly, the study focuses on Chinese construction enterprises, drawing its sample data exclusively from China. This geographic specificity means that the findings are particularly relevant to Chinese construction enterprises, but could potentially limit their generalizability. Com-

parative studies with data from other countries could broaden the research scope in future investigations. Thirdly, this study employs cross-sectional data, which fails to account for the influence of time-related changes on the research outcomes. To further strengthen the validity of the relationships between variables, future research could incorporate longitudinal survey data, capturing the nuances of temporal variations. Lastly, future research could also consider conducting an objective statistical analysis of the construction industry from the perspective of the application of innovations and digital technologies and compare them with the research conducted in this paper.

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