

文章编号:2095-6134(2023)02-0280-09

How does IT-business alignment influence digital innovation: the moderating role of digital business intensity*

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(Received 29 January 2021; Revised 19 April 2021)

Xu T, Wei S B, Yin J M. How does IT-business alignment influence digital innovation: the moderating role of digital business intensity[J]. Journal of University of Chinese Academy of Sciences, 2023, 40(2): 280-288. DOI:10.7523/jucas.2021.0064.

Abstract With the rapid development of digital business, digital innovation has become a critical source for firms to gain competitive advantage. Whilst previous studies have examined the impact of IT-business alignment on firm performance, few studies have explored its impact on digital innovation. Drawing on resource-based view, our study investigates how different types of IT-business alignment (i. e. intellectual and social alignment) affect digital innovation independently and interactively and explores the moderating role of digital business intensity (DBI) further. Using 143 match-paired questionnaires collected from Chinese firms, our results show that intellectual and social alignments are positively associated with digital innovation, and their interactions generate synergistic effects to promote digital innovation. Furthermore, DBI positively and negatively moderates the relationship between intellectual alignment and digital innovation and between social alignment and digital innovation, respectively. Our study also discusses the theoretical and practical implications of the research.

Keywords intellectual alignment; social alignment; digital innovation; digital business intensity
CLC number: C31; F270; F276.6 **Document code**: A **DOI**:10.7523/jucas.2021.0064

IT-业务联盟如何影响数字创新:数字业务强度的调节作用

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摘要 随着数字商业的快速发展,数字创新已成为企业获得竞争优势的关键来源。虽然先前的研究考察了 IT-业务联盟对企业绩效的影响,但少有研究探讨其对数字创新的影响。基于资源基础理论,考察不同类型的 IT-业务联盟(即知识联盟和社会联盟)如何独立和交互地

* Supported by National Natural Science Foundation of China (72071190, 71701194, 71731010, and 71921001)

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影响数字创新,并进一步探讨数字业务强度的调节作用。通过对143份中国企业配对问卷的调查研究发现,知识联盟和社会联盟与数字创新之间存在显著的正相关关系,知识联盟和社会联盟之间的交互能够产生协同效应,促进数字创新。此外,数字业务强度正向调节知识联盟与数字创新之间的关系,负向调节社会联盟与数字创新之间的关系。

关键词 知识联盟;社会联盟;数字创新;数字业务强度

Firms have digitized the key functions of their products in part or in whole to utilize digital innovation better to achieve superior performance^[1]. Digital innovation refers to a kind of innovation wherein employees use digital technology to change market products, business processes, and business models into new ones^[2] to help firms maintain their competitive advantage^[3]. Unlike traditional innovation, digital innovation is primarily achieved by the recombination of existing resources and knowledge to stimulate new ideas rather than investing large amounts of resources to achieve innovative results^[3]. Although information systems (IS) scholars have recognized the importance of digital innovation, existing research on the mechanisms that affect it is limited^[4].

Prior studies have mainly examined the antecedents of digital innovation from the perspective of organizational IT governance^[4]. However, in this process, digital innovation needs the reorganization of resources and knowledge of different departments to break the established innovation path^[3]. In particular, IT-business alignment, which refers to the matching degree between business and IT strategies and between business and IT infrastructure, has been a top concern of practitioners and scholars in recent years^[5]. IT-business alignment helps firms apply IT and business resources effectively and strengthen the cooperation between the IT and business departments^[6]. This integration helps promote the interaction of different knowledge structures, and the acquisition of this knowledge creates the conditions for digital innovation^[3].

Scholars have recognized the impact of IT-business alignment on organizational agility and performance^[7-8]. However, our knowledge about the effects of IT-business alignment on digital innovation

is limited. According to resource-based view (RBV), IT-business alignment refers to an approach that spans IT and business process management that enables IT to accelerate data processing and knowledge integration and results in business process improvement, efficiency, and innovation-related organizational growth^[6]. Moreover, existing literature proposed two types of IT-business alignment, namely, intellectual and social^[6]. Specifically, intellectual alignment refers to the degree of the alignment between interrelated IT and business plans^[6], whilst social alignment refers to the state of IT and business executives' understanding of each other's mission, objectives and plans^[6,9]. To provide a more comprehensive understanding, we further consider the effects of these two kinds of IT-business alignment on digital innovation independently and interactively.

Furthermore, previous literature has argued that a firm's external or internal environment can affect the function of organizational strategies, such as environmental dynamism and organizational culture^[10]. Thus, we further explore the moderating role of a mostly-related environment, such as the firm's digital business intensity (DBI)^[11]. The existing literature has argued that the firm's DBI, referring to a firm's IT investment intensity in business, plays an important role in utilizing the firm's IT^[11]. Following this notion, the impact of IT-business alignment on digital innovation might be influenced by the digital business environment of the firm^[11]. Thus, we posit that DBI can moderate the effect of different types of IT-business alignment on digital innovation in various manners.

Against this backdrop, drawing upon the RBV, we aim to solve three research questions through a field study conducted in China: 1) How do different types of IT-business alignment affect digital

innovation? 2) How does the interaction of intellectual and social alignment affect digital innovation? 3) How does DBI moderate the impact of intellectual and social alignments on digital innovation?

1 Theoretical framework

1.1 RBV

The RBV has been widely applied to explain how firms use limited resources to gain competitive advantage^[11]. The development of the firm depends on the utilization of resources, which may either lead to beneficial or harmful outcomes^[11]. According to the RBV, IT-business alignment regarded as a valuable resource that plays an important role in digital innovation. In addition, DBI can also be considered the firm's resource or capability, and a high level of DBI indicates that the firm has invested more in digital technology^[11]. The interaction of different resources may generate various effects.

1.2 Digital innovation

Digital innovation is defined as a significant change that combines digital technology with traditional products, business processes or models to form new products, business processes and business models^[1]. Digital innovation includes two aspects. Firstly, it refers to innovation results, new products, services and platforms, and these innovation results do not need to be digitized but can be realized through the use of digital technologies and programs^[2]. Secondly, it represents a series of digital tools and infrastructure, such as 3D printing, big data analysis and management information system^[1-2]. Considering the importance of digital innovation, understanding how to achieve digital innovation for firms is significant.

1.3 IT-business alignment

The alignment of IT and business strategies has been a research hot spot in the IS field for several decades, and IT-business alignment is a highly desired state, in which an organization can use IT to achieve its business goals effectively^[12]. In this study, following Reich and Benbasat^[9], we classify IT-business alignment into intellectual and social

alignment. Intellectual and social alignment affect business goals by influencing the formulation and implementation of strategies. Moreover, they can both directly determine the success or failure of business goals, which means a flawed strategy or plan (low intellectual alignment) will lead to the worse results. In addition, intellectual and social alignment can affect firm outcomes dependently.

1.4 DBI

DBI refers to the level of firms' strategic investment in emerging and innovative digital technologies to build their IT portfolios^[11]. Previous studies have confirmed that DBI is an important environmental factor for firms^[13] that is mainly manifested in three aspects. Firms with high DBI can 1) apply cutting-edge digital technologies in many aspects of their business operations, 2) improve the ability to use existing resources and 3) create and utilize ubiquitous inter-organizational digital connections between key agents (e. g. suppliers, trading partners and customers) effectively to improve performance^[11]. Therefore, firms with high DBI can respond to emergencies and seize growth opportunities effectively. On the contrary, firms with low DBI are not good at communicating digitally with the outside world, thereby hindering opportunities for further exploration and innovation^[11].

2 Research model and hypothesis development

Figure 1 shows the research model based on the existing literature and RBV.

2.1 Effect of intellectual and social alignment

Intellectual alignment is defined as a matching degree between the organization's IT and business strategies^[14]. From a strategic alignment perspective, we consider that intellectual alignment has a positive effect on digital innovation. This strategy alignment enables key IT resources, such as physical IT infrastructure components, technology and managed IT skills, to be aligned with business strategy^[14], thereby resulting in a structure that can

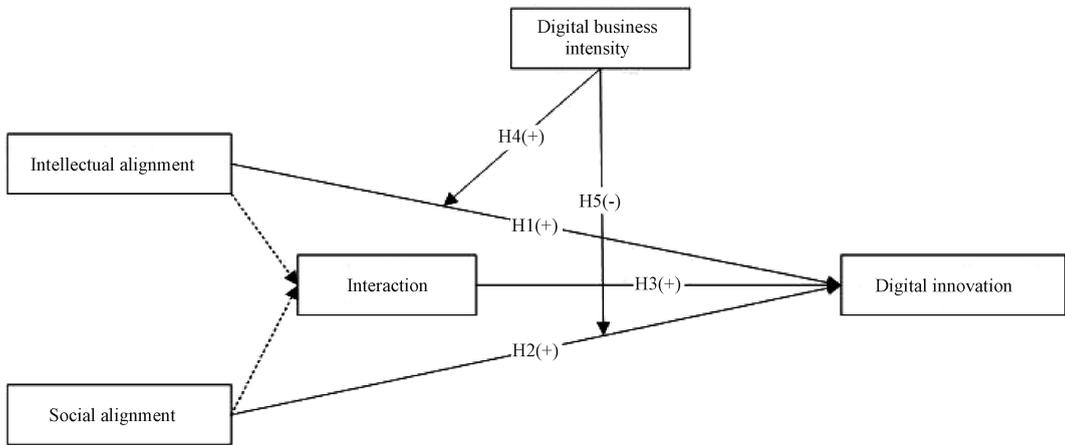


Fig. 1 Research model

monitor deployment and resource management and establishing a strong link between IT and business departments. In addition, digital innovation requires an alignment of a firm's IT infrastructure with the business process to help manage and coordinate different resources and enable the firm to deploy IT resources to support business strategies for digital innovation^[5]. Moreover, the alignment between IT and business strategies leads to the exploration of key organizational resources that promote innovation and adaptation^[15]. The integration of IT, business processes and other resources can promote the ability to exploit existing resources to deal with external changes and enhance digital innovation^[16]. Therefore, we hypothesize that:

H1: Intellectual alignment has a positive impact on digital innovation.

Social alignment denotes the state in which business and IT executives understand each other's mission, objectives and plans^[9]. On the one hand, social alignment influences digital innovation by promoting knowledge sharing and creative ideas exchanged between IT and business executives^[17]. Knowledge sharing promotes collaboration, enables executives to understand their resource needs and potential resource limitations better to motivate them to allocate resources efficiently to achieve digital innovation^[8]. On the other hand, higher social alignment indicates a higher level of communication and interaction that can strengthen trust and build good relationships between IT and business

departments^[17]. Trust and good relationships can help firms solve problems promptly through communication, move toward consistent goals, improve operational efficiency and increase the success rate of business goals^[18]. In a more complex environment, the communication between the IT department and the business unit helps to respond to changes quickly and seize opportunities to gain competitive advantage^[19]. Therefore, we expect that:

H2: Social alignment has a positive impact on digital innovation.

2.2 Interaction of intellectual and social alignment

Intellectual alignment is a formal way to match and integrate IT and business strategies, whereas social alignment is an informal way to help firms coordinate their operations through the communication between IT and business departments^[9]. A high degree of social alignment enables IT and business executives to share their knowledge and ideas with each other to form a consensus of strategic goals. Furthermore, the sharing of knowledge and perspectives can help decision-makers to obtain more comprehensive information, discover and solve problems, such as resource limitations and unreasonable plans, to make more rational strategic decisions^[18,20]. In the phase for strategic plan implementation, good plans (i. e. high intellectual alignment) hinge on good execution (i. e. high social alignment)^[6,9]. Specifically, the

communication between IT and business departments can improve the execution efficiency, that is, timely consultation can help the firm faced challenges adjust quickly and seize opportunities to ensure the success of strategic plans during the implementation^[19]. Therefore, we assume that:

H3: The interaction of intellectual and social alignment has a positive impact on digital innovation.

2.3 Moderating effect of DBI

According to the RBV, intellectual alignment ensures the consistency of the firm's IT and business strategies that facilitates the success of digital innovation. However, intellectual alignment is a long-term process of resource coordination and bundling, such alignment also creates path dependence and inertia to some extent^[6], leading to the fact that firms are not willing to change until they realize the value of existing resources and miss opportunities^[15]. Under this condition, DBI focuses on the strategic exploration of future resources and motivates firms to eliminate the inertia of intellectual alignment to support digital innovation^[11].

Moreover, high DBI reflects the firm's high investment in innovative emerging technologies to build its IT portfolio, which may have higher IT capabilities and digital connections^[11]. DBI provides IT infrastructure support for intellectual alignment, which helps firms utilize IT strategies better to align business strategies to achieve business goals for digital innovation^[12]. In contrast, a firm with low DBI might make IT capability more rigid^[11], and it's difficult to respond quickly to changes due to the inflexible IT strategies^[8], which inhibits the firm's ability to leverage intellectual alignment for generating digital innovation. Therefore, we hypothesize that:

H4: DBI positively moderates the effect of intellectual alignment on digital innovation.

Social alignment focuses on sharing knowledge and ideas through communication during the implementation of strategic plans^[20]. The functions of DBI can replace the functions of social

alignment^[11]. Firms with high DBI can help managers to make better choices, such as big data analytics, which can reduce errors and create more value in the formulation and implementation of strategic plans.

Moreover, digital technologies can support new ways to create and capture value, new exchange mechanisms and new forms of the cross-border organization^[21]. In addition to internal information, firms with high DBI can rely on digital technology to build a digital connection with external partners to obtain more comprehensive information (e.g. internal and external information)^[11]. Therefore, when the firm has a higher degree of DBI, it will use the new ways of information sharing and value creation instead of social alignment to achieve digital innovation, and we propose that:

H5: DBI negatively moderates the effect of social alignment on digital innovation.

3 Research method

3.1 Sampling and data collection

To test our research model and hypotheses, we conducted a field study in some firms located in the Yangtze River Delta region in China^[22]. We designed a match-paired questionnaire for IT and business executives to answer relevant questions. We sent questionnaires to 550 firms randomly and finally collected 155 questionnaires, with a response rate of 28.1%. Excluding 12 invalid ones for incomplete data, we finally obtained 143 valid match-paired questionnaires that met the research requirement. To test possible non-response bias, we conducted a Chi-square comparison between the first 25% and the last 25% of respondents and found no significant difference in control variables between the two groups, thereby suggesting that non-response bias is not a concern in our study^[23].

3.2 Measures

We designed a questionnaire using 7-point Likert scales with options that range from 1 ('strongly disagree') to 7 ('strongly agree') to measure all items^[20]. Intellectual and social alignment were measured by six items from Liang et

al.^[6]. We adopted four items to measure DBI from Nwankpa and Datta^[11]. Digital innovation was measured by four items from Huang et al.^[4]. We also controlled firm size, firm age, ownership dummy variable, region dummy variable and industry dummy variable that might affect firm digital innovation^[4,10].

3.3 Common method bias test

Common method bias is a common problem in questionnaire data research that directly affects the effectiveness of our research. Therefore, we adopted three methods to evaluate these biases. Firstly, we designed a match-paired survey for IT and business executives to answer questions about knowledge in their respective fields, which added credibility to the data from different respondents^[6,19]. Secondly, when we designed the questionnaire, we placed similar questions in different places to avoid the respondents who answer the corresponding questions for a long time tend to form conventional thinking^[24]. Thirdly, the results of Harman’s single

factor test showed that the most covariance explained by one factor was 30.68% , which is less than 40% , indicating that the common method bias was not a concern^[6,24].

3.4 Reliability and validity

As shown in Table 1, the Cronbach’s alpha and composite reliability were higher than 0.7 respectively, thereby indicating the good reliability of the measurements^[25]. We further tested construct validity by convergent and discriminant validity. The former was tested based on average variance extracted (AVE), which was greater than the recommended level of 0.5. Furthermore, all loadings were greater than 0.60, thus confirming the convergent validity of the measures. In Table 2, the square root of the AVE from a construct was greater than the correlation between that construct and all other constructs in the model, thereby supporting the discriminant validity of our measures. Table 2 displays the descriptive statistics and correlation of all variables.

Table 1 Results of confirmatory factor analysis

Constructs	Items	CR	Cronbach’s alpha	AVE	Loadings
Intellectual alignment (IA)	6	0.936	0.917	0.708	0.790~0.862
Social alignment (SA)	6	0.935	0.914	0.705	0.738~0.875
Digital business intensity (DBI)	4	0.941	0.915	0.798	0.866~0.920
Digital innovation (DI)	4	0.951	0.931	0.829	0.883~0.934

Note: AVE=average variance extracted. CR=composite reliability.

Table 2 Descriptive statistics and correlations

Variables	1	2	3	4	5	6	7	8	9
1. IA	0.841								
2. SA	0.681**	0.840							
3. DBI	0.582**	0.636**	0.893						
4. DI	0.526**	0.583**	0.623**	0.910					
5. Firm age	-0.148	-0.226	-0.135	-0.113	—				
6. Firm size	0.002	0.050	0.072	0.072	0.547**	—			
7. Region	0.191*	0.202*	0.229**	0.234**	-0.158	-0.064	—		
8. Industry	-0.166*	-0.135	-0.095	-0.178*	0.108	-0.107	-0.267**	—	
9. Ownership	0.055	0.145	0.077	0.140	-0.161	-0.165*	0.255**	0.072	—
Mean	5.131	4.878	4.772	4.949	3.09	3.51	2.09	4.57	1.76
S. D.	0.999	1.047	1.201	1.117	1.302	2.065	1.627	2.402	1.107

Note: The diagonal elements are the square roots of AVE. * $p < 0.05$, ** $p < 0.01$.

4 Hypothesis testing

We performed hierarchical regression to test our hypotheses using SPSS^[6]. To minimize the possibility of multicollinearity, we regenerated the

interaction terms with mean-centered independent variables, and the maximum variance inflation factor (VIF) was 3.080, which is less than 10, indicating that multicollinearity was not a problem. We showed the step-by-step analysis in Table 3, which provided

support for H1-H5. (H1: $\beta = 0.206, p < 0.05$; H2: $\beta = 0.393, p < 0.001$; H3: $\beta = 0.165, p < 0.05$; H4: $\beta = 0.176, p < 0.05$; H5: $\beta = -0.187, p < 0.05$).

Table 3 Results of regression analysis

	Digital innovation			
	Model 1	Model 2	Model 3	Model 4
Controls				
State	-0.057	-0.058	-0.070	-0.107
Privately	0.186	0.094	0.085	0.045
Foreign	-0.099	-0.132	-0.127	-0.159*
Anhui	-0.258*	-0.158	-0.154	-0.086
Jiangsu	-0.008	0.048	0.054	0.033
Zhejiang	-0.089	-0.007	-0.010	0.002
Shanghai	-0.228*	-0.154	-0.144	-0.107
Automotive	0.081	0.006	0.013	0.047
Machinery	-0.024	0.016	0.022	0.062
Electronics	0.128	0.034	0.031	0.147
Commodity	0.130	0.050	0.064	0.074
Steel	0.120	0.087	0.083	0.054
Financial	0.025	-0.030	-0.010	0.033
Firm size	0.175	0.066	0.087	0.042
Firm age	-0.061	0.088	0.075	0.091
Main effects				
IA (H1)		0.206*	0.260*	0.251*
SA (H2)		0.393**	0.342**	0.145
Moderator				
DBI				0.288**
Interactions				
IA * SA (H3)			0.165*	0.099
IA * DBI (H4)				0.176*
SA * DBI (H5)				-0.187*
R^2	0.199	0.499	0.474	0.562
Adjust R^2	0.102	0.372	0.395	0.483
F-value	2.042*	5.799***	6.004***	7.146***

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The two-way interaction amongst intellectual alignment, social alignment and DBI can be interpreted better through single-slope plots^[10]. Figure 2 presents the two interaction plots. In Fig. 2 (a), an increase in intellectual alignment led to greater digital innovation gains when DBI is high, thereby suggesting a positive moderating role of DBI on the relationship between intellectual alignment and digital innovation. However, in Fig. 2(b), an increase in social alignment led to greater digital innovation gains when DBI is low, indicating the negative moderating role of DBI.

5 Discussion

In previous research, IT-business alignment has been generally considered to have a positive effect on financial performance, agility and cost control^[8]. In this study, intellectual and social alignment positively affect digital innovation, and the interaction effect on digital innovation is positive, which is consistent with Liang et al.^[6] that social alignment can help intellectual alignment reduce inertia for superior agility. Moreover, our post-hoc analysis also finds a significant three-way interaction, which suggests that the interaction effect between intellectual alignment and social alignment on digital innovation can be also contingent upon the firm's DBI.

5.1 Theoretical implications

Our study contributes to the existing literature.

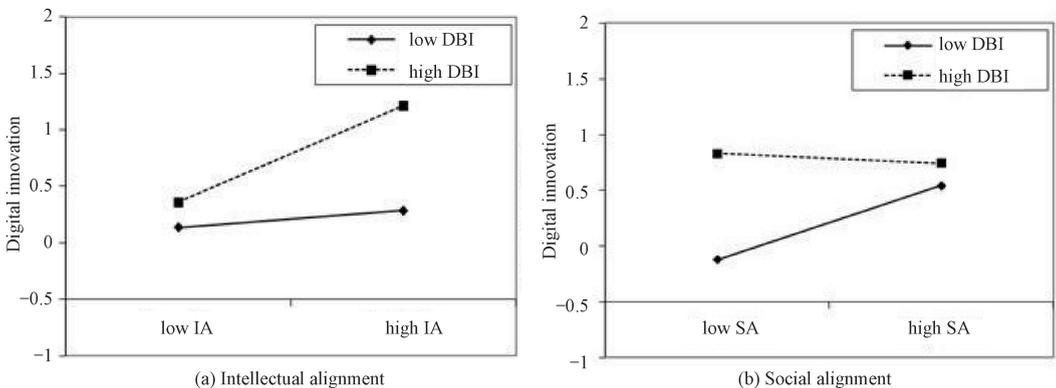


Fig. 2 Two-way interactions between intellectual alignment (a), social alignment (b) and DBI

Firstly, IT-business alignment has long been a research hot spot in the IS field, but ignored studying the impact on the firm agility from two dimensions, most previous studies have regarded it as a single construct^[10]. In the study, according to Reich and Benbasat, we decompose IT-business alignment into intellectual and social alignment^[9], we find both the two types are positively associated with digital innovation, which indicates that IT-business alignment, as a horizontal mechanism within a firm, can facilitate the integration of information and knowledge to provide impetus for digital innovation. Secondly, previous research related to digital innovation has only considered from a single mechanism from the IT governance perspective, the joint mechanism of IT and business strategies provides a new perspective for future studies. Our results find a significant complementary role in the interaction, which confirm that the two types of IT-business alignment have independent and interdependent effects on digital innovation. Thirdly, DBI strengthens the effect of intellectual alignment on digital innovation, while weakens the effect of social alignment on digital innovation, thus further enriching our existing research of DBI. The negative moderating effect of DBI suggests that interactions amongst different resources may be inhibiting, which reminds practical managers that the value of resources lies not only in themselves but also more importantly in the correct use of these resources^[11,13].

5.2 Managerial implications

Our research also has managerial implications for IT and business managers. Firstly, the two types of IT-business alignment can promote digital innovation, IT and business departments need to be aligned in strategy formulation and maintain communication during the implementation phase of the strategy that can help improve digital innovation^[10]. Secondly, social alignment can positively moderate the role of intellectual alignment on digital innovation, which indicates that IT and business departments should not only maintain consistency from strategic planning but also create a

good informal relationship between the two departments, which may help align IT and business strategy more quickly to achieve digital innovation. Thirdly, DBI differently moderates the relationship between intellectual, social alignment and digital innovation. Managers can reallocate resources and invest more resources to cultivate intellectual alignment when firms have high DBI. Likewise, managers should enhance social alignment to help align IT and business strategies when firms have low DBI. This also gives managers another insight that resources should be allocated according to the nature, the superposition of resources with similar functions can easily lead to waste during the implementation of digital innovation.

5.3 Limitations and future research

Limitations in our study are noted to be addressed in future studies. Firstly, we can send more questionnaires to the employees and perform a confirmatory analysis in future studies to avoid ‘acquiescence bias’. Secondly, we only consider DBI as the boundary factor (internal factors). Thus, future research can consider internal and external factors, such as industry and institutional factors, to make our study more comprehensive and realistic.

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