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## **Innovation Quality, Customer Innovation, and Innovation Culture: The Relationship Mediated by Social Media**

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### **ABSTRACT**

Research on the relationship between innovation culture and innovation quality from the perspective of customer innovation is a hot topic in the field of innovation. This article, through the questionnaire survey to 65 innovative enterprises in China, using the structural equation model and hierarchical multiple regression analysis for validating the proposed hypothesis, discusses the relationship between the innovative culture, customer innovation, and innovation quality. The results show that there is a significant positive correlation between innovation culture and innovation quality, customer innovation and innovation quality, and innovation culture and customer innovation. Customer innovation partially mediates the impact of innovation culture on innovation quality, and social media strengthens the role of customer innovation in promoting innovation quality. Customer innovation in culture on enterprise innovation quality partial mediation effect in the process, the influence of the social media to strengthen the customer innovation role in promoting the quality of innovation.

*Keywords:* Innovation culture, Customer innovation, Innovation quality, Social media

### **INTRODUCTION**

Innovation quality is the sum of the quality of each aspect and every link related to innovation, including the product/service level, process level, and enterprise level, which can be reflected through the variables like amount, performance, effectiveness, feature, reliability, timing, costs, value to the customer, innovation degree and complexity, and many more (Haner, 2002). In the increasingly competitive business environment, innovation is the main way for enterprises to seek breakthroughs and maintain their core competitiveness, and innovation quality has become an important indicator and an effective guarantee of the competitiveness of enterprises. At present, most of the corporates in China are the original entrusted manufacturer (OEM), and they are laid in the subordinate status in the international division of labor, with a low-profit rate and low innovation ability. For instance, although the number of filed patents and authorized patents in China has been ranked No.1 in the world for eight consecutive years since 2010, the patents converted into productivity is fewer. Improving innovation quality is an important issue that needs to be solved in China's transformation from a huge to a strong manufacturing nation.

To improve the innovation quality, it's essential to understand clearly the key factors and their working mechanism influencing the innovation quality, and then take effective measures to strengthen the quality management to the innovation. Researches and practices show that one of the key factors influencing innovation quality is the innovation culture in a corporate. Enterprise innovation culture is a combination of both innovative spirit wealth and innovative material form created by the enterprise in innovation activities, with its own features, including innovative values, innovation standards, innovation systems and norms, and innovative material and cultural environment (Castro et al., 2013; Jing, Tang & Han, 2011; Merrill, 2017). Innovation culture fosters innovation and is the premise and the source of all innovations. It can enhance the cohesion of the enterprise and enable the enterprise to have a vigorous spirit of innovation, guaranteeing the continuous improvement of innovation quality. At the same time, it can transmit the innovation concept of the enterprise to the outside world and obtain the recognition and support of customers. To foster an excellent innovation culture is an inevitable requirement for an enterprise to carry out innovation (Dobni, 2013).

Another key factor influencing innovation quality is customer innovation which refers to the activities and patterns of customer-led innovation. With the emergence of the service-dominant logic and the theory of value co-creation, the open innovation mode in enterprises has been popularized (Chesbrough, H., 2003; Chesbrough, H. W., 2003; Gianiodis, Ellis & Secchi, 2010; Lichtenthaler, 2011; Rass et al., 2013), causing the changes of customer's role in innovation. Customers' participation or their independent innovation is common (Hippel, Ogawa & Jong, 2011; Hippel, 2005; Ma, Wang & Wan, 2013; Wang, 2011) and becoming an important factor affecting the innovation quality in enterprises. Studies have shown that customers' knowledge, experiences, and skills are some of the most important sources to improve the innovation ability in enterprises.

Customer innovation is a kind of enterprise innovation model which emerges from and develops with the development of social media technology. Social media, as a product of Web2.0, mainly through a new online platform, i.e., a kind of online interactive media or application programs based on the Internet (Kaplan & Haenlein, 2010), allow users to easily create, edit, and get access to content, with such characteristics as participation, openness, collaboration, interactivity, connectivity, and special clustering property that traditional media such as newspapers, televisions, magazines don't have (Jia & Chen, 2013). It is social media that provide a highly convenient interactive platform for enterprises and customers to exchange information and create value, provide the conditions for customer innovation, and promotes the development of customer innovation.

Some scholars have studied the influence of enterprise innovation culture and customer innovation on innovation quality, respectively (Amabile, 1997; Claver et al., 1998; Dobni, 2013; Hienerth, Hippel & Jensen, 2014), but there are still some deficiencies in the researches on the action path and mechanism between enterprise innovation culture, customer innovation, social media, and innovation quality.

According to the insufficiencies of existing researches and the new changes of enterprise innovation models, and based on the interaction environment on the social media by China's large and medium-sized enterprises, this paper focuses on the following three issues: Firstly, exploring the impact of innovation culture, customer innovation and social media on innovation quality by the empirical research; Secondly, investigating the interaction path and mechanism between innovation quality, customer innovation, social media, and innovation culture; Thirdly, by the analysis and discussion to the empirical results, providing the theoretical basis for enterprises to formulate innovative strategies, and the inspiration for enterprises to manage innovation activities.

## LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

### Literature Review

#### *Innovation quality*

The innovation quality can be measured by the degree to which the product/service provided by innovation meets the customer's requirements and the degree to which the defective products are avoided, i.e., innovation quality is concerned with not only the product/service but also the process directly related to manufacturing as well as the management of the customers of the end products (Yang, 2013). Based on the similarities between innovation quality and innovation performance, Sun (2015) suggested that innovation quality is the internal stimulation of innovation activities and is determined by the particularity of internal contradictions in innovation activities. But the innovation performance describes the scale, degree, and speed of innovation activities and is the arrangement of the permutations and combinations quantity of innovation elements in the space. The relations between innovation quality and innovation performance are essentially the two aspects of the quality and quantity of innovation activities. From the perspective of intellectual property rights, Zhang, Chen & Du (2011) argued that the innovation quality can reflect the innovation capability and can be measured by the authorization rate of the patent and the length of the pay period. Wei (2018) considers that the innovation quality can be measured by the patent rank from the CRIE patent database.

To sum up, innovation quality is a comprehensive concept based on the concept of 'big quality,' covering output quality, process quality, and management quality of the innovation.

#### *Customer innovation*

Under the traditional business model, most corporates used to adopt a relatively closed innovation strategy, and customers were only passive buyers and consumers. With the improvement of customer capacity and network technology, more and more enterprises systematically collect and integrate user information, based on which they conduct innovations (Franke & Piller, 2004), resulting in changes in the customer role, i.e., customer innovation has become an important form of open innovations in enterprises (Gianiodis et al., 2010). Customer innovation refers to enabling customers to participate in the innovation process by enterprises using special methods and strategies (Prahalad & Ramaswamy, 2004). The "customer" in customers' independent innovation is a broad concept, which is not limited to the individual customer but also includes the customer group or the customer community. From the theoretical origin, the concept of customer innovation is the further development and extension of interactive customer marketing and customer relationship management (Wang, 2011).

Hippel (2005) is the scholar who has systematically put forward the innovation theory earlier. He pointed out that in order to meet their own needs, customers suggest new ideas or improvements about the products or services, i.e., customers are the main body of innovation. In terms of the driving factors, on the one hand, the customer can obtain the functional value, the emotional value, the social value, and the economic value by innovation (Kuvykaite & Piligrimiene, 2014), therefore the innovation is a kind of value-driven behavior; on the other hand, customers carry a lot of knowledge and information required by enterprise innovation (Wang, Zheng & Peng, 2012), and their innovation behaviors can help avoid the information stickiness between enterprises and customers, which can effectively complement the enterprises' independent innovation.

In terms of the form of expression, some scholars believe that customer innovation includes two forms, i.e., customers' independent innovation and enterprise-customer cooperation innovation. Customers' independent innovation refers to the process during which customers conduct innovation activities independently in order to meet their own interests and needs (Ma, Wang & Wan, 2013). In this process, value creation is done independently by customers, while enterprises have no close

interaction with customers, similar themes are "customers' personal innovation behavior" (Feng, Lu & Peng, 2012), "customers' independent value creation" (Grönroos & Voima, 2013) and "customers' original value" (Zheng & Wang, 2015). Enterprise-customer cooperation innovation refers to an innovation model in which when enterprises cooperate with the customers whose innovation resources and ability can complement the enterprises, enhancing innovation performance by integrating scattered resources and capabilities (Feng, Li & Zhang, 2013). Some other scholars have enumerated the specific ways of customer innovation, such as sharing information, actively participating, inputting creativity, sharing experiences, suggesting new ideas, sharing risks with enterprises, interacting with other partners, etc. (Wang, 2011).

Although different scholars have different understandings on the connotation, the motive, and the form of customer innovation, by comparing and summarizing, it's found that customer innovation is actually a behavior that customers participate in innovation due to a certain kind of motive, mainly including customers' independent innovation and enterprise-customer cooperation innovation. Customer innovation activities are reflected not only in the feedback or solving problems in the product consumption but also in customers' innovating products through the network platform to achieve a win-win effect of both meeting their own needs and increasing the performance for enterprises.

### ***Innovation culture***

Innovation culture is a constituent part of the enterprise culture and gradually becomes its core. There are two kinds of understanding about innovation culture: One is that innovation culture represents enterprise culture on innovation, mainly referring to the willingness and openness of enterprises towards innovation (Hurt, Joseph & Cook, 1977). It's a culture that rewards innovation and encourages adventure (Dooley & Qsullivan, 2007), or a set of values of advocating, promoting, and protecting innovation behaviors, and an atmosphere of tolerating failures (Jing et al., 2011). Therefore, this is a one-dimensional definition. The other is that innovation culture is a complexion of internal spirits and external manifestations of enterprises, which covers the spiritual, institutional, physical, and behavioral aspects of enterprise culture, specifically including values, codes of conduct, purposes of innovation, infrastructure, and market environment, which supporting innovation (Dobni, 2013; Shui & Xu, 2005). So it's a multi-dimensional definition.

At present, there are few reports on the enterprise innovation culture from the perspective of the customer as a new innovation body. Based on the research paradigm and results about innovation culture, this paper argues that the multi-dimension definition of innovation culture is beneficial to the construction and implementation of enterprise innovation culture, particularly when customers become the main body of innovation. Enterprises should support the innovation resources flowing across the border, encourage customers to actively carry out information feedback, and take the initiative to participate in or carry out independent innovation. From customer innovation, enterprise innovation culture should be composed of two levels, i.e., internal level and external level. The former refers to the spiritual aspect of innovation culture, such as a view, philosophy, or value formed by enterprises towards customer innovation. The latter refers to the institutional, material, and behavioral aspects of innovation culture, in which the institutional aspect contains a series of participation rules, incentive mechanisms, work codes, etc., adopted by enterprises to encourage customers to innovate and guarantee their innovation behaviors. The material aspect refers to the resource supports such as WeChat, microblog, community, customer experience center, maker platform, etc. provided by enterprises to facilitate the co-innovation with customers; and the behavior aspect refers to the actions that enterprises take for customer innovation, such as maker competitions, creative design contest, customer return visit, customer salon, etc.

### ***Social media***

Social media support people's interpersonal communication through the Internet platform and redefine the communication between the enterprises and customers, or customers and customers. Relevant researches indicate that social media have become a major factor affecting customers, including their awareness, information acquisition, opinions, attitudes, purchases, after-sales communication, and evaluation (Mangold & Faulds, 2009). Especially in today's highly competitive market environment, the use of social media can enhance customer participation and significantly affect the performance and the value creation for the corporate (Trainor, 2012), such as through the establishment of online brand communities to make customers an effective source of enterprise innovation (Zhao, Tao & Jing, 2016). The survey shows that in 2010, Fortune 100 companies had an average of 20 different forms of social media for interaction with customers, corporate partners, end-users, and other stakeholders (Rapp et al., 2013). In addition, social media has a positive effect on innovation results, especially the proliferation of new technological achievements (Homburg, Wieseke & Kuehn, 2010).

In summary, social media influence the innovation mode and process of enterprises by promoting interaction between enterprises and customers or within customer groups, which have become an important factor affecting corporate performance.

## **Hypotheses Development**

### ***Innovation culture and innovation quality***

Many studies have confirmed that the innovation atmosphere has a positive impact on innovation behavior and innovation quality (Amabile, 1997). Innovation culture lays a foundation for organizations to seek technological innovation and innovation quality (Apostolos, Panagiotis & Panagiotis, 2017; Claver et al., 1998). To achieve rapid innovation progress, enterprises must pay much attention to the innovation culture according to the principles of behavioral economics (Yan, 2015).

The innovation culture based on customer innovation is a kind of atmosphere, which encourages and supports customer innovation, and is beneficial to improve the innovation quality in the enterprise (Hienerth et al., 2014). Studies have shown that customer authorization as a spiritual incentive has a positive impact on customer innovation (Zhang et al., 2013). Therefore, an excellent innovation culture is a prerequisite for enterprises to improve their innovation capability and innovation quality. Based on the above, the following hypothesis is made:

*H1: Innovation culture has a significant and direct positive impact on innovation quality*

### ***Innovation culture and customer innovation***

The innovation intention and behaviors of the customer are influenced by not only the internal factors such as their perception, demand, evaluation, trust, etc., but also the external factors such as atmosphere, environment, incentive system, platform building, material support, cooperation and mutual benefit, and interaction behavior in the innovation (Wang & Li, 2014). The customer-based innovation environment can encourage customers to interact with each other, solve problems, create value, take risks and make decisions together with enterprises. Qian (2014) found by studying the user communities that the user community with a good innovation atmosphere can exchange various information and knowledge, encourage each other, and make progress together. And the higher the tolerance of the community to innovation is, the more active the users are. Incentive system is an important factor that induces the innovation behaviors of customers because incentives can bring value to customers and stimulate their innovation intention (Chen & Zhang, 2014). Material support also affects customers' willingness to conduct innovation because it provides platforms and ways, as well as resources and technologies for customer innovation. The higher the information level and technical ability of the enterprise are, the more active the customer innovation activities should be (Yao, Jin & Wang, 2013). By stimulating the participation sense of customers, the interactive behaviors on the information platform can promote their emotional contact with enterprises and enhance their trust and recognition to the enterprises, thus, driving them to try to translate their innovative ideas into real products/services and then turn this innovation behavior into a program by repeated experiments and improvement (Gianiodis et al., 2010).

The above shows that innovation culture can directly affect the innovation willingness and behaviors of customers. Since there are both enterprise-customer cooperation innovation and customers' independent innovation, the following hypotheses are proposed:

*H2a: Innovation culture has a significant and direct positive impact on enterprise-customer cooperation innovation.*

*H2b: Innovation culture has a significant and direct positive impact on customers' independent innovation.*

### ***Customer innovation and innovation quality***

Customer innovation can promote the cross-border flow of information, reduce development costs and risks, bring enterprises more innovation sources, and help them achieve the innovation with high efficiency and high quality (Khan & Naeem, 2016; Leavengood, Anderson & Daim, 2014; Zheng, 2010). Focusing on the manufacturing enterprises, Yao & Wang (2011) found that providing information, participating in the design, and co-developing and co-innovating by customers have a significant positive impact on the innovation quality. By investigating the service industry, Feng et al. (2012) claimed that customers' participation in innovation could make innovation specific, reduce the uncertainty of innovation activities, and ensure that innovative services can meet customers' needs better. Moreover, customers' participation in innovation can greatly shorten the development cycle, reduce customers' complaint rate, improve market adaptability of new services, and improve process and result performance of innovation (Yuan, Liu & Li, 2015). To sum up, either as a co-developer or as an independent innovator, customer participation has a positive impact on the product/service innovation of enterprises.

#### ***1) Enterprise-customer cooperation innovation and innovation quality***

Studies have confirmed that enterprise-customer cooperation innovation has a positive effect on the innovation quality in enterprises. For example, the literature on market positioning, relationship marketing, user innovation, and open innovation have shown that, based on customers, by establishing a real-time interaction mechanism and a sharing platform with customers in all aspects, full time and all media, the stability of innovation quality in the planning and the implementing stages can be effectively improved, the success rate can be increased and high-quality innovation results can be produced (Lee, Lanting & Rojdamrongratana, 2017).

Studies have also shown that the main reason for the failure of innovation in many enterprises lies in their inability to understand their customers' needs accurately (Ulwick, 2002) because it's hard to ensure the correctness and integrity of information in the transmission process. Enterprise-customer cooperation innovation can promote the timely cross-border flow of information, and overcome the time delay and the content distortion in the transmission process, thus, ensuring the validity and innovation quality (Vestal, 2014).

In the process of cooperative innovation, enterprises can obtain the information needed for innovation directly from customers. By learning the relevant knowledge from customers, enterprises can improve their innovation capability, reduce innovation risk and improve innovation quality (Wang et al., 2012). Since customers are both the users and developers, enterprise-customer cooperation innovation can not only make the innovative products/services more easily accepted by the market and customers but also shorten the cycle and reduce the cost (Zheng & Xie, 2014). Moreover, customers' participation in

innovation enables them to have fun and feel satisfied, conduct self-realization; and thereby enhance the image perception and brand value of enterprises, which can, in turn, improve the innovation performance (Kuvykaite et al., 2014).

Based on the above discussion, the following hypothesis is proposed:

*H3a: Enterprise-customer cooperation innovation has a significant and direct positive impact on innovation quality.*

## **2) Customers' independent innovation and innovation quality**

Studies have shown that cooperation between customers can bring about high-quality innovation (Qian, 2014). In terms of the innovation quality input, customers, as the users of products/services, are more aware of the functional needs of products/services, so the information input for innovation from them is more effective. In terms of the innovation process, through social media, customers can exchange their experiences in using products, discuss existing problems, share expertise related to products, publish their own innovative achievements, and enjoy cooperation innovation with other customers (Zhang, 2010). In terms of innovation efficiency, the efficiency of customers' independent innovation is generally 2.4 times as high as that of enterprises' innovation alone, but the cost is only 42% of that (Fuchs & Schreier, 2011). The products/services resulting from customers' independent innovation can better satisfy their actual needs, and customers tend to buy the products/services which they have participated in developing. Therefore, it can reduce customer complaint rates and improve the retention rate, increase the market share for products/services and the income of enterprises, and ensure sufficient innovation funds and sustainable and efficient innovative activities.

It can be seen from the above that customers' independent innovation can improve the innovation quality inputs, process, and output. So the following hypothesis is proposed:

*H3b: Customers' independent innovation has a significant and direct positive impact on innovation quality.*

## **The mediating effect of customer innovation**

According to the existing researches, it can be concluded that innovation culture and customer innovation have a direct positive effect on innovation quality, respectively. However, the internal relationship model among the three concepts has not been built yet.

This study makes a further inference on the relationships between innovation culture, customer innovation, and innovation quality, believes that innovation culture has an indirect influence on the innovation quality through customer innovation as the intervening variable, and proposes the following hypothesis:

*H4: Customer innovation plays a mediating role between innovation culture and innovation quality.*

## **The moderating effect of social media**

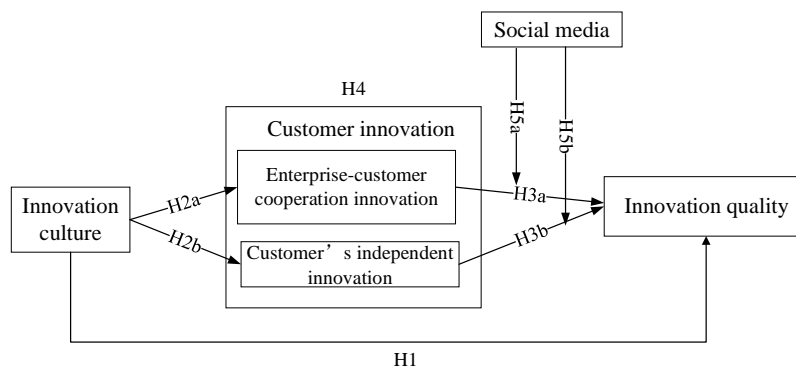
The rapid development of social media has generated a large number of forums and communities, the platform for customers to communicate and learn from each other and innovate together (Zhang, 2010). Social media have become a bridge between enterprises and their customers or customers and customers (Mangold et al., 2009). Many new media platforms, especially the application programs based on mobile intelligent terminals, i.e., mobile phones, have provided customers with channels to learn, cooperate and innovate, and enterprises have more and more interactions with their customers. Enterprises can transmit information to customers by creating social media, and customers can also actively get to know enterprises better. Social media allow customers to freely express their ideas, or let them create together with enterprises, and let them participate in collaborative marketing so that customers become both producers and sellers and transfer the originalities, innovative functions, feedbacks, and so on from offline to online (Chen, Weng & Huang, 2018; Grönroos et al., 2013; Iyer & Katona, 2016; Martini, Massa & Testa, 2013). Interactive behaviors can stimulate customers' participation, and frequent and high-quality interactions can promote customers' input in time, energy, and knowledge and then guide customers to innovate. Social media can help not only in the creation of good suggestions and ideas but also in the sharing and transmission of customers' innovation outcomes between customers and enterprises, which is conducive to the improvement of innovation quality (Yuan et al., 2015).

Thus, the following hypotheses are proposed:

*H5a: Social media have a significant moderating effect on the relationship between enterprise-customer cooperation innovation and innovation quality.*

*H5b: Social media have a significant moderating effect on the relationship between customers' independent innovation and innovation quality.*

Based on the above theoretical hypotheses, a research model on the relationships between innovation quality, customer innovation, social media, and innovation culture is established, as shown in Figure 1.



Source: This study  
Figure 1: Conceptual Framework

**RESEARCH METHODOLOGY**

**Samples**

The innovative enterprises in China were chosen to investigate. The upper-middle managers of these enterprises were chosen as the respondents of our questionnaire because they understand the innovation culture, the innovation quality, and the customer innovation better. The surveyed Chinas' enterprises are mainly private and state-owned, involving machinery manufacturing, automobile manufacturing, metallurgy, Internet, electronics, communications, etc. The variables in the questionnaire were chosen mainly based on the mature scale used in the mainstream literature and modified according to the survey about the enterprises and the experts. Each variable was measured by Likert's 5-point scale.

The variable, innovation culture, based on the scales (Amabile, 1997; Dobni, 2013; Sun & Tian, 2006), was modified into four aspects, i.e., Creative spirit (CS), incentive system (IS), material support (MS) and interactive behavior (IB), with 12 items. Customer innovation, based on the research results (Gianiodis et al., 2010; Kuvykaite et al., 2014; Ma et al., 2013; Wang et al., 2012), was modified into enterprise-customer cooperation innovation (CI) and customers' independent innovation (II), each with 4 items. Social media (SM) was based on the scales (Kaplan et al., 2010; Rapp et al., 2013), with 4 items. And based on analyzing the connotation of innovation quality and the research results( Brown, 2013; Denti, 2013; Yang, Miao & Zeng, 2007);, innovation quality was measured in terms of innovation input quality (IIQ), innovation process quality (IPQ) and innovation output quality (IOQ), with 12 items.

The initial questionnaire was responded to by MBA students at Hohai University and then based on the results and experts' advice, it was modified to form the final questionnaire. In order to avoid the homologous variance, each variable of the questionnaire was distributed and collected several times within certain time intervals. Totally 246 questionnaires were distributed, and 212 of them were taken back. After the screening, 199 valid questionnaires were retained, and the effective recovery rate was 80.9%.

**Validity and reliability**

In this paper, the Cronbach's  $\alpha$  coefficient and the combined reliability (CR) are used to verify the reliability of the scale. The reliability of the scale was evaluated, as shown in Table 1, and the results show that the  $\alpha$  values of the variables are all higher than 0.7, which indicates that the scale has good reliability.

The validity test of the scale consists of convergence validity and discriminative validity. The convergence validity refers to the correlation degree among the items for the same factor and is tested by the average variance extraction value (AVE). If AVE is larger than or equal to 0.5, it is considered that the measure of the variable has convergence validity. The discriminant validity reflects the uniqueness and specificity of the items of each factor and the degree of uncorrelation with other items. The determination of the discriminative validity requests that the AVE of each variable be larger than the square of the correlation coefficient between pairwise variables. (Fornell & Larcker, 1981).

The results (see Table 1) show that the AVE values are larger than 0.5, indicating that the scale has a good convergence validity. By calculating the correlation coefficient between variables, it is found that the R2 values among the variables of the innovation culture are all less than 0.5 and all less than their AVE values. Regarding innovation quality, the R2 value of input quality and process quality is 0.549, the R2 value of process quality and output quality is 0.563, and the R2 value of input quality and output quality is 0.520, also all less than their AVE values, which shows that the scale has good discriminative validity. Customer innovation and social media don't have sub-dimensions. Their discriminative validity is not discussed here. The fitting indexes of each variable of 2 /df, SRMR, RMSEA, TLI, CFI are all within the acceptable levels.

Table 1: Results of validity and reliability test.

Variable	Cronbach's $\alpha$	CR	AVE	$\chi^2$ /df	SRMR	RMSEA	TLI	CFI
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	CS	0.814	0.824	0.612					
Innovation culture	IS	0.767	0.771	0.529	1.822	0.0484	0.064	0.946	0.960
	MS	0.840	0.844	0.644					
	IB	0.802	0.805	0.579					
Customer innovation	CI	0.859	0.859	0.604	0.500	0.0088	0.000	1.009	1.000
	II	0.821	0.823	0.542	2.855	0.0271	0.097	0.961	0.987
Innovation quality	IIQ	0.806	0.811	0.588					
	IPQ	0.883	0.882	0.714	2.683	0.0441	0.092	0.924	0.942
	IOQ	0.889	0.892	0.583					
Social media	SM	0.812	0.824	0.548	2.241	0.0418	0.063	0.897	0.966

Source: This study.

### Correlation analysis

To verify the hypotheses preliminarily, Pearson correlation analysis is used to test the hypotheses of the relationship among the latent variables, and the results, as shown in Table 2, show that significant positive relations exist among all the variables, laying a foundation for afterward verification of the hypotheses.

Table 2. Variable correlation coefficient matrix.

	mean value	standard deviation	CS	IS	MS	IB	CI	II	IIQ	IPQ	IOQ
CS	3.51	0.798	1								
IS	3.01	0.805	.466**	1							
MS	3.03	0.941	.355**	.571**	1						
IB	3.30	0.734	.318**	.318**	.393**	1					
CI	3.38	0.783	.068	.429**	.360**	.235**	1				
II	3.29	0.725	.264**	.541**	.466**	.351**	.616**	1			
IIQ	3.43	0.932	.137	.458**	.425**	.330**	.612**	.617**	1		
IPQ	3.29	0.965	.144*	.489**	.452**	.233**	.682**	.651**	.621**	1	
IOQ	3.42	0.790	.234**	.560**	.470**	.312**	.687**	.708**	.604**	.664**	1

Notes: \*\*, \* Indicates significant correlation at 0.01 and 0.05 level, respectively

Source: This study

## DATA ANALYSIS AND RESULTS

### Hypothesis Test

Statistical analysis software AMOS21.0 was used to test the conceptual model. The fitting results show that the TLI, CFI, SRMR, and RMSEA value is 1.838, 0.891, 0.902, 0.0645, and 0.065, respectively, all within acceptable levels. It indicates that the conceptual model has a good fitting degree. Based on this model, the significance level (P-value) of the path coefficient is used as an indicator of theoretical hypothesis verification. The test results are shown in Table 3. Based on the research model verified above and taking the significance level (P-value) of the path coefficient as the index to verify the theoretical hypotheses, the results are shown in Table 3.

It can be seen from Table 3 that: (1) the T value of the path “innovation culture-> innovation quality” is greater than 1.96, statistically significant at P = 0.05 level, which means that innovation culture has a significant and direct positive impact on innovation quality, so H1 is true. (2) The T values of paths “innovation culture-> cooperative innovation” and “innovation culture-> independent innovation” are both greater than 2.58, statistically significant at P = 0.01 level, which means that innovation culture has a significant and direct positive impact on customer innovation, so H2a and H2b are true. (3) The T value of the path “cooperative innovation-> innovation quality” is greater than 2.58, statistically significant at P = 0.01 level, and the T value of the path “independent innovation -> innovation quality” is greater than 1.96, statistically significant at the P=0.05 level, which means that customer innovation has a significant and direct positive impact on innovation quality, so H3a and H3b are true.

Table 3. Results of the hypothesis test.

Hypothesis	Path coefficient	T	P	Result
H1: innovation culture-->innovation quality	0.156	1.968	0.049	Supported
H2a: innovation culture--> cooperative innovation	0.577	4.407	***	Supported



H2b: innovation culture--> independent innovation	0.447	3.949	***	Supported
H3a: cooperative innovation--> innovation quality	0.669	6.343	***	Supported
H3b: independent innovation--> innovation quality	0.264	2.549	0.011	Supported

Note: \*\*\*  $p < 0.001$

Source: This study

### Mediating Effect Test of Customer Innovation

In order to test the mediating effect of customer innovation, N1 is defined as an initial model, which is a partial intermediary model, and means that the innovation culture has both direct and indirect effects on innovation quality; N2 a complete intermediary model, means that innovation culture can only influence the innovation quality through customer innovation; and N3 means that innovation culture cannot affect the innovation quality through customer innovation. Then the fitting degrees of N1, N2, and N3 are analyzed and compared to identify the optimal model, as shown in Table 4. The significance of  $\Delta 2$  and  $\Delta df$ , as well as the relative simplicity of the model together, determine if the model is optimal. The simplified model can increase the degree of freedom and decrease the fitting degree, but when the 2 value increases very small, the simplified model can be accepted. Table 4 shows that by comparing N2 with N1,  $\Delta 2/\Delta df = 13.736 > 3.84$ , the difference between N2 and N1 is not significant, so the more complex model, N1 is selected; by comparing N3 with N1,  $\Delta 2/\Delta df = 65.362 > 3.84$ , the difference between N3 and N1 is not significant, the more complex model, N1 is selected. Therefore, N1 is the optimal model among the three models, which means that customer innovation plays a mediating role between innovation culture and innovation quality, so H4 is true.

Table 4. Collocation degree of each model.

Model	$\chi^2$	df	RMSEA	SRMR	TLI	CFI	IFI
N1	833.526	449	0.066	0.066	0.889	0.900	0.901
N2	860.999	451	0.068	0.068	0.882	0.893	0.894
N3	898.888	450	0.071	0.079	0.871	0.883	0.884
Result	$\Delta \chi^2$	$\Delta df$					
N2-N1	27.473	2	$\Delta \chi^2/\Delta df = 13.736 > 3.84$ , accepted model N1				
N3-N1	65.362	1	$\Delta \chi^2/\Delta df = 65.362 > 3.84$ , accepted model N1				

Source: This study

The path coefficients in Table 3 show that the direct influence coefficient of an innovation culture to innovation quality is 0.156; the coefficient of an innovation culture to innovation quality through enterprise-customer cooperation innovation is  $0.577 \times 0.669 = 0.386$ , and the coefficient of an innovation culture to innovation quality through customers' independent innovation is  $0.447 \times 0.264 = 0.118$ . The total influence coefficient of an innovation culture to innovation quality is  $0.156 + 0.386 + 0.118 = 0.66$ , while the mediating effect coefficient is  $0.386 + 0.118 = 0.504$ , accounting for 76.36% of the total influence coefficient. It shows that to obtain high innovation quality, enterprises should not only have an excellent innovation culture but also integrate their spiritual culture, system culture, and material culture with customers so as to stimulate customers' innovation enthusiasm, standardize customer innovation behaviors and provide various resources for customer innovation. It also shows that innovation culture by enterprise-customer cooperation innovation has a more significant impact on innovation quality than by customers' independent innovation, and therefore, enterprises should pay more attention to the impact of innovation culture on enterprise-customer cooperation innovation.

### Moderating Effect Test of Social Media

Multiple regression analysis is used to test the moderating effect of social media with enterprise-customer cooperation innovation and as the independent variables, social media as the moderating variable, and innovation quality as the dependent variable. To avoid the multi-collinearity of customers' independent innovation caused by the interactive items generated directly, the independent variables and regulatory variables were standardized. The impacts of variables such as the industry involved, enterprise nature, enterprise size, etc., were controlled when carrying out the data analysis. The analysis results are shown in Table 5.

Table 5. Multiple hierarchical regression analysis—regulatory effect.

		Innovation quality				
		Model 1	Model 2	Model 3	Model 4	Model 5
Control variable	Industry involved	-0.147	-0.007	-0.076	-0.023	-0.044
	Enterprise nature	0.006	-0.023	-0.031	0.039	0.030
	Enterprise size	0.342	0.172	0.175	0.176	0.192
Main effect	Cooperative innovation		0.682	0.063		

	Independent innovation				0.690	0.657
	Social media					
Interactive Effect	Cooperative innovation×Social media			0.116		
	Independent innovation×Social media					0.109
Index	F	9.731	66.251	58.488	73.130	64.172
	$\Delta F$	9.731	56.52	7.763	63.399	8.958
	R2	0.130	0.632	0.646	0.655	0.667
	adj R2	0.117	0.622	0.635	0.646	0.657
	$\Delta R2$	0.130	0.502	0.015	0.524	0.013

Source: This study

Model 3 in Table 5 shows that after introducing the interactive item, enterprise-customer cooperation innovation×social media,  $\Delta R2 = 0.015$  ( $p < 0.05$ ), indicating that social media play a moderating effect between enterprise-customer cooperation innovation and innovation quality, so H5a is true. Similarly, model 5 shows that after introducing the interactive item, customers' independent innovation×social media,  $\Delta R2 = 0.013$  ( $p < 0.05$ ), indicating that social media play a moderating role between customers' independent innovation and innovation quality, so H5b is true.

The moderating effect of social media between customer innovation and innovation quality is apparent. Before social media appeared or before enterprises adopted social media, it was difficult for enterprises to interact with users, the users did not understand the enterprises, and the enterprises could not obtain the opinions of the users. So, it's very difficult to conduct enterprise-customer innovations. Without social media, the independent innovation by cooperation between customers and customers is more difficult. It is because of the development of social media technology and the fact that enterprises pay attention to and conduct integration with social media that the model of customer innovation can come into being and develop.

Whether the enthusiasm and the capability of customer innovation can be fully brought into play is closely related to the development of social media technologies and how enterprises pay attention to social media. Although customer innovation has a spontaneous motivation if the interactive technologies of social media are not convenient or unconstrained, or enterprises are not open enough on social media, i.e., enterprises cannot show customers their correct values, lofty missions, and reasonable policies and systems, then, the enthusiasm of customer innovation will be suppressed, and the energy of customer innovation will not be fully brought into play. The emergence and development of new social platforms of customer innovation in the future will greatly promote the quantity and quality of customer innovation.

### Robustness Test

In order to verify the validity of the research results, robustness was tested. The tail-cutting mean method was used for the customer innovation scale (Huber, 1972), and by means of a cutting rate of 25%, i.e., removing the 25% maximum value and the 25% minimum value, the regressive analysis was made again for the remaining 50% data. The regression results show that the regression coefficient changes slightly, and the significance of the key coefficients does not change. Among them, regarding the moderating effect of social media between enterprise-customer cooperation innovation and innovation quality, the regression coefficient for the original overall sample is 0.116 ( $p=0.006$ ), and the value of F, R2, and  $\Delta R2$  is 58.488, 0.646, and 0.015, respectively; The regression coefficient for the tail cutting sample is 0.134 ( $p=0.007$ ), and the value of F, R2 and  $\Delta R2$  is 26.388, 0.615 and 0.029 respectively. While regarding the moderating effect of social media between independent innovation and innovation quality, the regression coefficient for the original overall sample is 0.109 ( $p=0.007$ ), the value of F, R2, and  $\Delta R2$  is 64.172, 0.667 and 0.013, respectively; The regression coefficient for the tail cutting sample is 0.124 ( $p=0.007$ ), and the value of F, R2 and  $\Delta R2$  is 20.427, 0.553 and 0.059 respectively. All of these show that the robustness of the research results is good.

## CONCLUSIONS AND IMPLICATIONS

### Conclusions

Based on related literature, this paper proposes and validates the theoretical hypotheses and the model regarding the relationships between innovation quality, customer innovation, social media, and innovation culture. The main conclusions are as follows:

- 1) Innovation culture has a significant and direct positive impact on innovation quality, while it has a significant and indirect positive impact on innovation quality through customer innovation. Establishing an excellent innovation culture is the basic condition for the enterprise to carry out customer innovation and improve innovation quality.
- 2) Innovation culture has a significant and direct positive impact on customer innovation, including Enterprise-customer cooperative innovation and customers' independent innovation. An excellent innovation culture can stimulate customers' willingness to innovate and promote the emergence of customer innovation behaviors.
- 3) Customer innovation has a significant and direct positive impact on innovation quality and plays a part of an intermediary role between innovation culture and innovation quality. Customer is an important resource for enterprise innovation. To improve the innovation ability of enterprises, the participation of customers is indispensable.

- 4) Social media play an important regulatory role between customer innovation and innovation quality. They can promote customer innovation and improve the efficiency and quality of innovation.

### Management Implications

Based on the above conclusions, the following management implications can be obtained:

- 1) Innovation culture is the foundation for the creation and development of enterprise innovation, especially customer innovation, as well as the guarantee of innovation quality. Enterprises should pay full attention to the important role of an innovation culture and further explore the general characteristics and the changing trend of contemporary innovation culture according to people's requirements on quality, as well as ideology and moral, social economy, science and technology, management methods, and the development trend of the market environment in the new era. They should conform to the open innovation model, establish the concept of "big quality," and build up innovation value and ideas from the perspective of customers. They should take innovation as the lifeline of their sustainable development and pursue high-quality innovation by establishing a multi-interaction innovation mechanism and a comprehensive evaluation system of innovation. And they must create a cultural atmosphere of advocating, supporting, and developing innovation in terms of organizational system, management system, incentive system, evaluation system, code of conduct, talent introduction and cultivation, achievement transformation, intellectual property protection, and so on.
- 2) Customer innovation is an increasingly important open model for enterprises to carry out innovation activities and an important way to improve innovation quality. Enterprises should strengthen the awareness of and attention to customer innovation, enhance the management of customer innovation, and provide resource support for customer innovation. They can establish incentive mechanisms for customer innovation, create a platform for customers to submit ideas and collaborate on innovation, or establish brand experience stores to collect customers' creativity and suggestions offline. They should provide customers with information, software, consultations, and other supports needed for innovation, and make some techniques and knowledge explicit and simplify the complex procedures in the developments.
- 3) Cooperation and innovation between enterprises and customers are essentially an information interaction behavior. Social media are indispensable technology platforms for customer innovation. The advancement of social media technology continues to promote innovation activities. Enterprises should make full use of social media to enhance their relationship with customers. Nowadays, the emergence of various social networking sites and new media has transformed the traditional binary relationship such as B2C and C2C into a three-way Internet relationship among customers, enterprises, and potential customers. Social media play an important regulating role in customer innovation and innovation quality. Therefore, enterprises should create their own corporate websites, official Weibo, official WeChat, customer forums, and other social platforms by focusing on creating, maintaining and updating, and constantly improving the conditions for an interaction.
- 4) The innovation activities, especially in small and medium-sized enterprises, cannot be separated from the guidance and support of the governments, just as they support the joint innovation of enterprises with universities and scientific research institutes. The governments should guide and support customers to participate in the innovation activities of enterprises by formulating laws and regulations, breaking monopolies, and standardizing market order, especially in intellectual property protection, independent innovation project approval, and achievement transformation.

### Limitations

This paper does not examine the impact of the industry nature on the research results and only studies the moderating role of social media between customer innovation and innovation quality, but not between innovation culture and customer innovation. It merges the spiritual, institutional, physical, and behavioral culture of innovation into a second-order variable of an innovation culture and fails to reflect the impact of different levels of innovation culture on customer innovation and innovation quality. It cannot consider the endogenous problem of enterprise culture, i.e., the reaction of customer innovation and innovation quality to innovation culture and the reaction of innovation quality to customer innovation. It fails to consider the endogenous problem of enterprise culture, i.e., the reaction of customer innovation and innovation quality to enterprise innovation culture and the reaction of innovation quality to customer innovation—all of these need to be made up in future researches. In addition, it also has great theoretical and practical significance to study the impact of innovation culture on innovation quality by taking employee innovation and supplier innovation as intermediate variables, and the impact of customer's own factors, such as customer demand, customer perception, and customer preference, on customer's innovation intention, innovation behavior and innovation quality. Studying customers' own factors, such as customer demand, customer perception, and customer preference, will further deepen the research on the relationship between customer innovation and innovation quality and comprehensively understand the impact of customer innovation on innovation quality. These can be used as future research topics.

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