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The Effect of Intellectual Leadership on Mass Customization: Moderated Mediation Effect of Customer Market Knowledge

MINGU KANG[1], TAEWON KANG[2], AND XIAOZHEN WANG[3]
[1]School of Management, Zhejiang University, Hangzhou 310058, China
[2]Department of Supply Chain and Logistics, College of Social Sciences, Kunsan National University, Gunsan 54150, South Korea
[3]School of Innovation and Entrepreneurship, Zhejiang University of Science and Technology, Hangzhou 310023, China

Corresponding author: Xiaozhen Wang (xzwang_mercury@163.com)

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ABSTRACT This study examines the relationship between intellectual leadership, the anticipation of new technologies, and mass customization. According to the knowledge management perspective, we explain how intellectual leadership influences mass customization via anticipation of new technologies. In addition, this study investigates the moderating role of customer market knowledge in this relationship. Our results suggest that customer market knowledge strengthened the direct effect of intellectual leadership on anticipation of new technologies and the indirect effect of intellectual leadership on mass customization via anticipation of new technologies. Theoretical and managerial implications and directions for future research are discussed.

INDEX TERMS Anticipation of new technologies, customer market knowledge, intellectual leadership, mass customization.

I. INTRODUCTION

Mass customization refers to the ability to quickly manufacture customized products on a large scale to meet customers' specific needs at a reasonable price [1]–[6]. The character of mass customization ability is represented as four components that are high volume customization, cost efficiency, customization responsiveness, and customization quality [1]. As an operation strategy, mass customization serves a company to achieve a competitive advantage by differentiating from other competitors [7]–[9]. Researches have been found that mass customization enhances operational performance [10], [11], product innovation, and firm performance [12], [13]. Given that the implication and development of mass customization are important to customers and companies, researchers concerned with the enablers of mass customization increasingly and found various organizational factors such as organization structure, process implementation, modularity, and information technology [2], [7], [14]–[17]. However, few studies have paid attention to individual-level factors, even though they are viewed as the importance of enablers [18]. Some scholars found that human capital [19] and individual competency [14] are important factors that improve mass customization, however, there is limited empirical evidence on the roles of leadership in mass customization development.

Therefore, this study attempts to narrow the gap in understanding of the individual enabler in mass customization development by exploring the role of intellectual leadership by drawing a knowledge management perspective. In this study, intellectual leadership refers to leadership which demonstrates leaders' intellectual practices based on data and analysis and also adopts careful listening and clear commands to communicate with employees. According to the knowledge management perspective, intellectual leaders who use information and knowledge not only understand differentiated customer needs for mass customization but also transfer their knowledge to employees to engage the development of mass customization.

Besides, this study presents that anticipation of new technologies (ANT) plays the mediating role through which intellectual leadership affects mass customization. ANT is referred to the extent of anticipating new technologies which are based on an organization's future needs [20]. Given that new advanced technologies are critical to mass customization, leaders have an important role that encourages new

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technologies development for mass customization. Up to this point, intellectual leadership may enhance the new technologies development by utilizing their information and knowledge and also encourage employees to develop new technologies by using clear two-way communication. In other words, intellectual leadership can facilitate ANT and in turn, affects mass customization.

Additionally, we also argue that the mediating effect of the ANT between intellectual leadership and mass customization is varied depending on customer market knowledge. Customer market knowledge refers to the knowledge about new market opportunities and the needs and characteristics of a product, which are obtained from the interaction with the customer [21]. Because customer market knowledge provides support to develop innovation and new technologies, the positive effect of intellectual leadership on anticipant of new technologies is likely to be stronger when the level of customer market knowledge is high. Therefore, this study proposes a moderated mediation model that examines the moderating effect of customer market knowledge on the relationship between intellectual leadership and mass customization via anticipant of new technologies.

Taken together, this study attempts to make several contributions to the literature on mass customization. First, this study enhances the understanding of the individual enablers that influence mass customization by focusing on intellectual leadership. Second, this research provides new insight into the mechanism underlying the relationship between intellectual leadership and mass customization by investigating the mediating effect of the ANT. Finally, by examining the moderating role of customer market knowledge, this study adds to the evidence on the boundary conditions under which intellectual leadership affects ANT.

II. THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

A. MASS CUSTOMIZATION AND INTELLECTUAL LEADERSHIP

Given that mass customization provides customization products to satisfy various customers' orders, it involves complicated and uncertain tasks. According to organizational information processing theory, task uncertainty requires the amount of information, thus the information processing capabilities are important to the implication of mass customization. Therefore, the application of information management [22], [23] and information technology [16], [24] provide better products to meet customer needs, thus enhancing mass customization.

Therefore, leaders have to understand differentiated customer needs and product variety, and also handle these tasks properly and quickly by using these intelligence applications. Given that there is the amount of collected information from market and product data, it is critical how leaders manage this information and think analytically to implement effective processes [14]. Since intellectual leadership is based on data and analysis, it increases the understanding of mass customization environments such as market, product, and purchasing information, and then identifies problems and solutions to develop the capability of mass customization. Also, according to knowledge management, intellectual leaders may play an important role to transfer and share knowledge by using careful listening and clear commands, which facilitates organizational learning and encourage employees to develop expertise and skills for mass customization. Besides, since intellectual leaders help the collaboration between the front office and back office by demonstrating a clear vision and common purpose, they are more likely to facilitate the efficiency of mass customization [18].

Taken together, since intellectual leadership demonstrates the intellectual competence of leaders and better communication skills, it promotes mass customization by using information flow and collaboration between stakeholders. Therefore, we propose:

Hypothesis 1: Intellectual leadership is positively related to mass customization.

B. THE MEDIATING ROLE OF ANTICIPATION OF NEW TECHNOLOGIES

Given that ANT is related to manufacturing capability which will provide organizational benefit and competitiveness in the future, it is critical to understand future customers' needs and have a clear vision and future goals to obtain the advanced new technologies [20]. Enhancing ANT requires strategic thinking and foresight which focus on knowledge about technologies that may be important to future success. In other words, ANT is the result of strategic management to develop organizational competitiveness in the market [25]. Undoubtedly, leadership may influence fostering ANT by sensing and seizing future opportunities which are relevant to new technology [26], [27]. Especially, intellectual leadership based on data and analysis not only understands future customers' needs and market environment but also handles complicated resources and specialization to make proper strategic decisions for organizational benefit. According to the knowledge management perspective, given that ANT involves complexity and uncertainty, leaders have to create, transfer and integrate knowledge from databases to develop ANT [28]. Intellectual leadership effectively transfers and shares information and knowledge by using communication such as clear command and careful listening [29]. Since intellectual leaders demonstrate a clear vision with a knowledge-based mind, they are more likely to encourage employees to develop new technologies [28], [30]. Since intellectual leadership implements the strategy about new technologies and stimulates employees' learning and expertise about new technologies, it may facilitate ANT.

On the other hand, given that the goal of mass customization is to satisfy differentiated customer needs with competitiveness, advanced technologies create opportunities for mass customization [31]. The capability to develop new technologies is crucial to achieving cost-efficiency in mass

customization [19]. Mass customization requires advanced manufacturing and technologies which provide the flexibility and responsiveness of operations, and rapid manufacturing [32]. The development of new technologies helps the company respond the customer requirements quickly and reduce costs and delivery times. Therefore, ANT facilitates mass customization by making effort to introduce new technologies.

Taken together, intellectual leadership has an impact on ANT, and further the impact of intellectual leadership transfer to mass customization through ANT. In other words, ANT mediates the relationship between intellectual leadership and mass customization. Therefore, we propose:

Hypothesis 2: Anticipation of New Technologies mediates the relationship between Intellectual Leadership and mass customization.

C. THE MODERATING ROLE OF CUSTOMER MARKET KNOWLEDGE

The purpose of customer market knowledge is to understand customer preferences. Customer preferences are critical to developing innovation which may increase the completive advantage of firms [21]. Given that customer market knowledge understands customer needs, it enhances the satisfaction of the customer by creating better products and services [33], [34]. Hence, customer market knowledge enables a firm to implement the proper market strategy through organizational learning. Customer market knowledge not only incurs learning about the current customer needs but also generates insights about the potential new market [34]. Several studies found that customer knowledge affects marketing results [35], [36].

In this study, we argue that customer market knowledge moderates the relationship between intellectual leadership and ANT. When intellectual leaders understand and learn about customer needs and potential new markets, they are more likely to make a decision and implement the strategy according to this knowledge. Given that customer market knowledge provides knowledge sharing and knowledge-creating, intellectual leaders may enable firms to develop a novel product and service for new generations. Since intellectual leaders are willing to utilize knowledge or information, they are more likely to respond to customer market knowledge and have a positive impact on ANT jointly. In other words, intellectual leadership can manage and choose knowledge about customers' current and potential needs and then incur new technology development to provide benefits for the company. Thus, customer market knowledge may amplify the effect of intellectual leadership on ANT through proper knowledge management [37]. Besides, customer market knowledge is more likely to motivate employees' orientation to innovation [36], thus in the case of a high level of customer market knowledge, the effect of intellectual leadership on ANT is stronger than a low level of customer market knowledge. Therefore, we propose:

Hypothesis 3: Customer Market Knowledge moderates the positive effect of Intellectual leadership on ANT, such that the positive relationship is stronger according to the extent to which the Customer Market Knowledge is implemented.

Further, assuming that customer market knowledge moderates the relationship between intellectual leadership and ANT, it is also likely that customer market knowledge can help intellectual leadership affect mass customization through ANT by providing customers with current and latent needs. Intellectual leaders with more information on customer needs are likely to make the proper strategy and implementation for mass customization by developing new and advanced technologies. Therefore, we can predict that the indirect effect of intellectual leadership on mass customization via ANT will be stronger with the high level of customer market knowledge than with the low level of customer market knowledge. Hence, we propose the following:

Hypothesis 4: Customer Market Knowledge moderates the indirect effect of Intellectual leadership on Mass Customization, such that the indirect effect is stronger according to the extent to which the Customer Market Knowledge is implemented.

Fig. 1 illustrates the moderated mediation model proposed in this study.

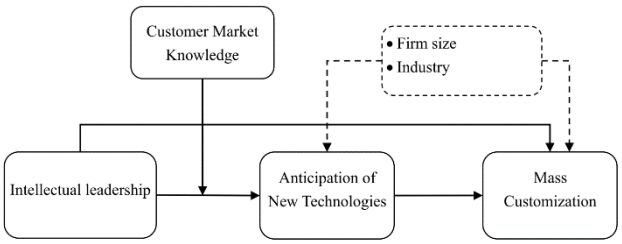

FIGURE 1. Conceptual research model.

III. METHOD

A. DATA SAMPLE AND MEASURES

To test our proposed hypotheses, the data set was collected from the fourth round of the High-Performance Manufacturing (HPM) project which is a worldwide research collaboration project and consists of a team of academic researchers, specializing in quantitative approaches to operation and supply chain management practices of manufacturing plants [38]. As shown in Table 1, data set was collected from manufacturing companies in 15 countries and regions (Brazil, China, Spain, Finland, Germany, Israel, Italy, Japan, Korea, Sweden, Swiss, Taiwan, UK, USA, and Vietnam) across three industries (machinery, electronics, and transportation) to provide a diversity of cultural and economic characteristics [38]. HPM survey questionnaires were developed in English, translated into local language by coordinators in each country, and back-translation was then conducted for cross-checking. The research team selected the sample randomly from a master list of manufacturing firms larger than 100 employees in each country to

arrive at a total sample frame of 320 responses. After dropping 31 responses (e.g., responses with over 30% missing data), the 289 responses were used for analysis.

TABLE 1. The overview of the sample.

Regions	Frequency	Industry	Frequency
Brazil	16 (5.5%)	Machinery	106 (36.7%)
China	28 (9.7)	Electronics	111 (38.4)
Finland	14 (4.8)	Transportation	72 (24.9)
Germany	26 (9.0)	Total	289 (100.0)
Israel	17 (5.9)		
Italy	27 (9.3)		
Japan	20 (6.9)	Size	Frequency
Korea	23 (8.0)	100~250	72 (24.9%)
Spain	24 (8.3)	215~500	73 (25.3)
Sweden	7 (2.4)	501~1000	91 (31.5)
Switzerland	8 (3.2)	1001~5000	48 (16.6)
Taiwan	29 (10.0)	over 5000	5 (1.7)
UK	13 (4.5)	Total	289 (100.0)
USA	12 (4.2)		
Vietnam	25(8.7)		

To measure intellectual leadership, 6 items were taken from the work of Clawson [39]. The items were rated on a five-point Likert scale from 1 (''never'') to 5 (''always''). Plant supervisors were asked to assess how often the leadership tools and techniques listed below are used in their plant: IL1) clear commands; IL2) data; IL3) careful listening; IL4) candor; IL5) clarifying vision; IL6) analysis.

We assessed mass customization with 6 items from Tu *et al.* [3]'s work, rating on a five-point Likert scale from 1 (''much below average'') to 5 (''much above average''). Process engineers in the plant were asked to assess the extent to which they agree with each of the following statements about their plant: MC1) we are highly capable of large scale product customization; MC2) we can easily add significant product variety without increasing cost; MC3) we can customize products while maintaining high volume; MC4) we can add product variety without sacrificing quality; MC5) our capability for responding quickly to customization requirements is very high; MC6) we can quickly elect individual customer's preferences.

To measure ANT, we employ Finger *et al.* [20]'s 4 items instrument, using a five-point Likert scale ranging from 1 (''strongly disagree'') to 5 (''strongly agree''). Process engineers were asked to indicate the extent to which they agree or disagree with each of the following statements about their plant: ANT1) we pursue long-range programs, in order to acquire manufacturing capabilities in advance of our needs; ANT2) We make an effort to anticipate the potential of new manufacturing practices and technologies; ANT3) Our plant stays on the leading edge of new technology in our industry; ANT4) We are constantly thinking of the next generation of manufacturing technology.

We used customer market knowledge as a moderator variable. The 4 items were used to measure customer market knowledge according to Tuominen *et al.* [40] and Swafford *et al.* [41]. Downstream supply chain managers were asked to indicate the extent to which they agree or disagree with each of the following statements about their plant: CMK1) in order to find potential new markets, we monitor economies around the world; CMK2) we are concerned about the needs of both our immediate customers and our ultimate consumers; CMK3) we understand the marketing strategies of our customers; CMK4) we are very familiar with our customers' product characteristics.

Additionally, we used control variables such as firm size and industry. The natural logarithm of the number of employees was used to measure firm size. To control the impact of industry heterogeneity, we used three dummy variables: industry 1 (coded as 1 for machinery industry, 0 for the other industry), industry 2 (coded as 1 for the electronics industry, 0 of for the other industry), and industry 3 (coded as 1 for the transportation industry, 0 for the other industry).

B. RELIABILITY AND VALIDITY

We conducted a confirmatory factor analysis to examine the reliability and validity of our construct. Our measurement model including all four constructs (i.e., intellectual leadership, ANT, mass customization and customer market knowledge) indicated good model fit with $\chi^2 = 313.583$, df $= 164$, χ^2/df $= 1.912$, IFI $= 0.91$, CFI $= 0.91$, RMSEA $= 0.056$. As shown in Table 2, the factor loadings of all items ranged from 0.46 to 0.78, showing the convergent validity. Cronbach's alphas of all constructs are greater than 0.72, demonstrating adequate item reliability. The average variance extracted (AVE) of each construct ranged from 0.45 to 0.57 and the composite reliabilities of all constructs were greater than 0.82, as shown in Table 2. Thus, the results of AVE and composite reliability showed an acceptable level of reliability for the constructs of our measurement model.

TABLE 2. Factor loadings and reliability.

Variables	Items	Factor Loadings	Construct Reliability	AVE	Cronbach's α
Intellectual leadership (IL)	IL1	0.59	0.89	0.57	0.80
	IL2	0.50			
	IL3	0.70			
	IL4	0.65			
	IL5	0.73			
	IL6	0.64			
Anticipation of New Technologies (ANT)	ANT1	0.65	0.82	0.53	0.77
	ANT2	0.68			
	ANT3	0.67			
	ANT4	0.72			
Mass Customization (MC)	MC1	0.68	0.83	0.45	0.80
	MC2	0.63			
	MC3	0.71			
	MC4	0.46			
	MC5	0.72			
	MC6	0.61			
Customer Market Knowledge (CMK)	CMK1	0.62	0.82	0.53	0.72
	CMK2	0.78			
	CMK3	0.68			
	CMK4	0.50			

C. HYPOTHESES TEST

Table 3 presented descriptive statistics and correlation. The variables were correlated with our expectations. To test our

hypotheses, we conducted a series of hierarchical regression analyses and bootstrapping tests with the PROCESS macro. Table 4 showed that intellectual leadership showed the positive impact on mass customization (Model1; $\beta = 0.314$, $p > 0.001$). Therefore, Hypothesis 1 was supported. Also, intellectual leadership was positively associated with ANT (Model 3; $\beta = 0.202$, $p > 0.01$). Besides, model 2 indicated that ANT demonstrated a significant impact on mass customization ($\beta = 0.426$, $p > 0.001$), and the effect of intellectual leadership on mass customization decreased ($\beta = 0.228$, $p > 0.01$). Taken together, the results revealed a partial mediation effect, supporting Hypothesis 2.

TABLE 3. Mean and correlations.

	Mean	S.D.	1	2	3
1.Intellectual leadership	3.832	0.518			
2.Anticipation of New technologies	3.752	0.676	0.155**		
3.Mass Customization	3.651	0.658	0.244**	0.470**	
4.Customer Market Knowledge	3.940	0.600	0.153**	0.255**	0.233**

NOTES) * P<0.05, ** P<0.01.

To examine the moderating effect of customer market knowledge, we mean-centered the independent variable (intellectual leadership) and moderator (customer market knowledge). We found that the interaction between intellectual leadership and customer market knowledge is positively related to ANT ($\beta = 0.255$, $p > 0.05$, Model 4). Fig. 2 illustrated the interaction effect between intellectual leadership and customer market knowledge. The result revealed that intellectual leadership is more positively related to ANT when customer market knowledge is high than when it is low. Hence, Hypothesis 3 was supported.

TABLE 4. Hierarchical regression analyses.

	MC	MC	ANT	ANT
	Model 1	Model 2	Model 3	Model 4
Constant	2.406	1.350	2.479	1.581
Firm size	0.034	-0.019	0.126**	0.110**
Industry 1	-0.073	-0.002	-0.167	-0.126
Industry 2	-0.171	-0.018	-0.360	-0.316
Industry 3	-0.337	-0.175	-0.380	-0.367
IL	0.314***	0.228**	0.202**	0.178*
ANT		0.426***		
CMK				0.265***
IL×CMK				0.255*
R^2	0.087	0.263	0.081	0.143
Adjusted R^2	0.071	0.247	0.065	0.121
F	5.386***	16.773***	4.972***	6.677***

Notes: n=931, ***p<0.001, **p<0.01, *p<0.05, +p<0.1
IL：Intellectual leadership, MC: Market Customization, ANT：Anticipation of New Technologies, CMK：Customer Market Knowledge

Also, we used SPSS macro to examine the conditional indirect effect of intellectual leadership on mass customization via ANT at three levels of customer market knowledge. As shown in Table 5, the indirect effect of intellectual leadership on mass customization via customer market knowledge was stronger and significant at the high levels of customer

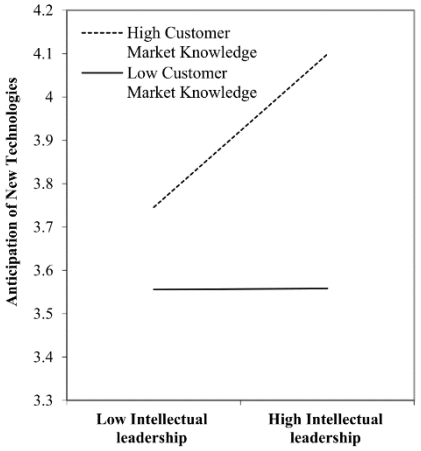

FIGURE 2. Moderation effect of customer market knowledge.

market knowledge (effect = 0.1413, 95% bias-corrected CI: [0.0424, 0.2602], not crossing zero), but the indirect effect was not significant at the low levels of customer market knowledge (effect = 0.0107, 95% bias-corrected CI: [−0.0696, 0.0924], crossing zero). Also, the results indicated that the moderated mediation effect was positive and had a non-zero probability (effect = 0.1087, 95% bias-corrected CI: [0.0147, 0.2154], not crossing zero), thus supporting Hypothesis 4. We plotted the conditional indirect effect of intellectual leadership on mass customization via ANT at three values of customer market knowledge. As shown in Fig. 3, intellectual leadership has a stronger indirect effect on mass customization via ANT at the higher levels of the higher level of customer market knowledge.

TABLE 5. Bootstrap results for conditional indirect effect at ANT = M±1 SD.

CMK: Moderator ANT: Mediator	Effect	SE	BC 95% CI	
			Lower	Upper
-1 SD	.0107	.0412	-.0696	.0924
M (0)	.0760	.0380	.0077	.1593
+1 SD	.1413	.0552	.0424	.2602
Index	.1087	.0507	.0147	.2154

Number of Bootstrap samples: 5000
SE: Standard error; BC CI: Bias-corrected confidence intervals

IV. DISCUSSION

Based on the knowledge management perspective [35], [42], [3], our study investigates how and when intellectual leadership enhances mass customization by examining ANT as a mediator and customer market knowledge as a moderator in this relationship. We found that intellectual leadership facilitated ANT, which further enabled to development of mass customization. Moreover, customer market knowledge moderated this mechanism, such that customer market knowledge strengthened the direct effect of intellectual leadership on ANT and the indirect effect on mass customization via ANT.

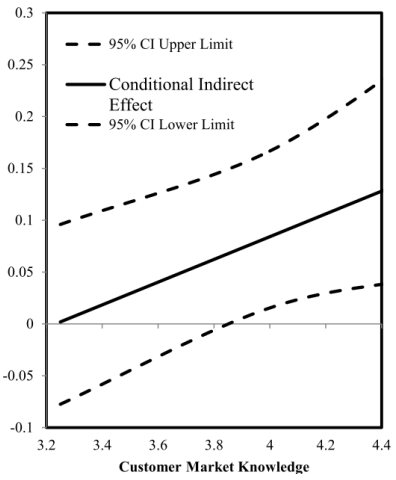

FIGURE 3. The conditional indirect effect of intellectual leadership on mass customization at values of the moderator customer market knowledge through ANT.

A. THEORETICAL IMPLICATIONS

Our findings reveal several insights that provide a better understanding of mass customization and intellectual leadership. First, this study examines the role of intellectual leadership as the key predictor of mass customization. Given the importance of mass customization, it is critical to identify the factors that may enable the development of mass customization [31], [44]. Although researchers have found the various organizational enablers of mass customization, few have studied the individual enablers of mass customization. Given that knowledge management is a critical factor to facilitate mass customization [2], [31], [32], [45], our study explored the relationship between intellectual leadership and mass customization based on a knowledge management perspective. Since intellectual leadership demonstrated knowledge management which involves information and knowledge sharing and transferring, it facilitated mass customization by adopting the proper strategy and guiding employees appropriately. Our findings enrich the mass customization literature by broadening the factors which enable mass customization. Second, this study suggests the underlying mechanism of how intellectual leadership influences mass customization by examining the mediating role of ANT in this relationship. Our findings revealed that intellectual leadership is related to ANT and in turn ANT further influence mass customization. According to the knowledge management perspective, intellectual leaders promote knowledge sharing which is essential to new technologies and also use information data to develop the market strategy appropriately [46], [47]. Also, emerging new technologies are important elements for mass customization [48]. Taken together, intellectual leadership influences mass customization via ANT by transmitting information and knowledge. Besides, since intellectual leaders make a decision depending on data and evidence, they are more likely to serve as role models for employees who engage in the development of new technologies and mass customization. Third, this study identifies the boundary condition under which intellectual leadership influences ANT. Customer market knowledge helps intellectual leaders to have the motivation and confidence to develop new technologies for customer needs, which leads to organizational benefits. Our findings revealed that intellectual leadership with high level of customer market knowledge is more likely to promote ANT. Since customer market knowledge provides knowledge and information for new market, it helps intellectual leaders to establish the targeted strategy effectively, thus it magnifies the direct effect of intellectual leadership on ANT [37]. The results in this study provide new insights to comprehend the boundary conditions on the relationship between intellectual leadership and ANT. Finally, this study suggests that the mediating effect of the ANT differentiates depending on the level of customer market knowledge by using a moderated mediation model. This study examined customer market knowledge strengthened the indirect effect of intellectual leadership on mass customization via ANT.

B. PRACTICAL IMPLICATIONS

Our findings provide several significant practical implications for practitioners. First, leaders' behavior is a critical factor to achieve organizational benefits. Although the design of organizational systems and investment for the development of technologies have been perceived as important to mass customization capability, these actions may be more effective when leaders deal with various information and share knowledge appropriately. Given that intellectual leaders have a positive impact on the development of new technologies and mass customization, organizations help managers display intellectual leadership practices by offering leadership training programs that involve how to deal with information and make proper decisions [49]. Also, the organizations should support for effective information process so that leaders utilize information to enhance the development of new technologies and mass customization [50], [51].

Moreover, the ANT has an important mediating role from intellectual leadership to mass customization. Therefore, organizations and managers should pay more attention to new technologies management and encourage employees to engage in developing new technologies.

Additionally, it is necessary to encourage collecting customer market knowledge to strengthen the effect of intellectual leadership. The influence of intellectual leaders can be increased by providing more proper knowledge such as customer needs or new market information. To enhance customer market knowledge, the organization should pay more attention to interaction with customers and achieve information about customer needs by adopting adequate policies [21], [36], [52].

C. LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

This study has several limitations and future research directions. First, this study adopts a cross-sectional design, thus may incur the reverse causality to some extent. Future research is needed to use a longitudinal design to ensure the

causality of the relationship in this study. Second, we investigated ANT partially mediated the relationship between intellectual leadership and mass customization, thus there may be another underlying mechanism that explains how intellectual leadership impacts mass customization. Future studies should explore other mediating processes of intellectual leadership. The culture or management system of the organization may transmit the effect from intellectual leadership to mass customization. Third, there may be various contexts that influence the effect of intellectual leadership. For example, employees' skills or training or interpersonal relationship between leaders and employees may maximize the effect of intellectual leadership. It may be beneficial to include these factors as moderators in the relationship between intellectual leadership and mass customization in future research.

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MINGU KANG received the bachelor's and master's degrees in mechanical design engineering from Hanyang University, Seoul, South Korea, and the Ph.D. degree from the School of Management, Zhejiang University, China. He is currently an Associate Professor with the School of Management, Zhejiang University. His articles have been published in the *Journal of Business Research*, *Production Planning and Control*, *International Journal of Physical Distribution and Logistics Management*, *Industrial Marketing Management*, *Ethics and Behavior*, and *Journal of Purchasing and Supply Management*. His research interests include outsourcing strategy, supply chain management, and strategies for managing technological innovation.

TAEWON KANG received the Ph.D. degree in management science from Zhejiang University, China. He is currently an Associate Professor with the Department of Supply Chain and Logistics, Kunsan National University, South Korea. His articles have been published in *Journal of Asian Finance, Economics and Business*, *Journal of Korea Trade*, *Journal of International Trade and Commerce*, *Journal of Distribution and Management Research*, *Korea Logistics Review*, *Asia–Pacific Journal of Business Venturing and Entrepreneurship*, *Korean–Chinese Social Science Studies*, and *Journal of China Studies*. His research interests include distribution management, e-retail, and cold chain management.

XIAOZHEN WANG received the Ph.D. degree in cartography and geographical information system from the School of Earth Sciences, Zhejiang University. She is currently a Lecturer with the School of Innovation and Entrepreneurship, Zhejiang University of Science and Technology, China. She once engaged in management of Esquel Group. Her research interests include innovation and entrepreneurship.