Accelerating Individual Innovation: Evidence from a Multinational Corporation

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Abstract. With the understanding that individual innovativeness plays an important role in organizations, both practitioners and researchers are interested in finding ways to promote individual innovation. Based on the theoretical lens of Structural Holes Theory and Social Cognitive Theory, we examined the impact of network positions, degree of participation and social interaction on individual innovativeness based on the archival data of an organization's online system. The results reveal that individuals who have more structural holes contribute more innovative ideas in the online community, and more responding from peers encourages more future innovation contribution. Implications for research and practice are discussed.

Keywords: individual innovation, structural holes, social interaction, network position.

1 Introduction

The organizational innovation capability is viewed as the key tacit resource for organizational competence [1]. To unveil which factors can drive such capability and to what extent by each factor, increasing number of studies covering different topics can be found in current literatures. Such works can be broadly summarized into two approaches by the characteristics of the driving factors. One side, the organizational innovation capability was assessed via examining the interplays with other organizations, such as inter-organizational collaborations [2, 3] or the pressure from the competing firms[4, 5]. Such literatures attempted to explicate the question, "How do the extrinsic factors affect the innovation process of an organization?" Differing from such approaches concentrating on the extrinsic forces accelerating innovation, another perspective elucidated how the intrinsic factors like organizational capability, influence the innovation capability. For instances, Eisenhardt and Tabrizi [6] investigated the role of organizational structure and team composition affected the innovation paces in computer industry; the organizational learning capability was also found to be conductive to the organizational innovation capability [7]. In sum, most previous works accentuated the impact of the determinants in the institutional level, such as organizational structure or inter-organizational relationships, on driving the organizational innovation

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capability, but ignored the power of talents [8], namely the managerial employees. However, the innovation process has been studied as an active combination of diverse resources, such as people and their possessed knowledge [9-12]. Thus, as the basic component of any organization, the consequence of inspiring each individual's innovation ability is conductive to the overall organizational innovation.

After surveying the existing literatures, several studies delving into individual innovation ability in a scope of organization and business research have been found. For instances, Rao and Drazin [9] used the resource-based approach for arguing that constant metabolism of talents from outside organizations or rivals could result in increasing organizational competitiveness on product innovation. Another article by Kickul and Gundry[13] found organizational innovation could be reinforced in terms of improving the talent management like recruitment or rewarding mechanism for e-commerce firms. Although such works have accentuated the importance of individual ability for the organizational innovation, however, the individual innovative capability was somewhat viewed as whole, like a type of resource, rather than articulating how organization leverages individual ability on innovation to achieve the firm's innovative competitiveness. Such insufficiency was improved with the emergence of SNA (Social Network Analysis), where increasing amounts of researchers attempted to shed light upon facilitation of individual innovation from the network approaches, like weak ties or structural holes theories [11, 12, 14, 15].

Although the individual innovation ability can be facilitated in terms of their network position from the structural holes approach, we do not think it is substantial to interpret individual innovation mechanism by purely deploying network theory with two reasons. First, the structural holes theory depicts a fatalistic tone somewhat, where the individual innovation capability is determined by his/her superior position in the whole network. Nevertheless, people may not be easily aware whether they are positioned in superior or inferior network positions in the reality. Second, the network analysis deployed in structural holes theory can only depict the role of positions in leveraging individual innovation ability, but the extent or strength of interaction between individuals is not well elucidated. However, previous literatures have indicated individual's behavior is constantly evolving in terms of social interactions and experiences with others [16, 17], which is called social influence. In this regard, social cognitive theory can serve as an appropriate supplementary basis to consolidate our understanding of the factors influencing individual innovativeness, which is also confirmed in the subsequent empirical analysis.

The rest of this article is organized as follows. First, a comprehensive extent of literature reviews on theoretical basis is presented with the proposed hypotheses in Section 2. In Section 3, we will elaborate the research design, methodology, and data analysis. The overall discussion and conclusion are discussed in Section 4.

2 Theoretical Basis and Hypotheses Development

In current literature, innovativeness associated with network structural positions have been widely discussed. For instances, Perry-Smith[18] studied the network constructed by research scientists and found individual creativity was significant influenced by structural positions in the networks, and such relationship was patricianly

mediated by their background heterogeneity; Cattani and Ferriani [19] verified the network positions affected individual creativity and innovativeness in the Hollywood actor networks, but such positions are cohered at the interstices in lieu of prominent holes in the network; After empirically investigating a network constituted by R&D scientists from one multinational corporate, Tortoriello and Krackhardt [20] found the bridging ties affecting individual innovativeness is contingent upon the nature of the ties, and the significant influence only works across the Simmelian ties[1]. In general, such works found the individual innovativeness was achieved from their network positions providing superior access to the unique information. These findings echo the argument of structural holes theory, where the innovativeness is driven by the accessible information from the structural holes. In this regard, we adopted structural holes theory as the key theoretical basis for this study.

Consistent with Burt [21], we used constraint measure to depict the degree of structural holes. Such constraint measure depicted the extent to which individual depends upon others in his/her network and his/her access to the unique and non-redundant information, and the higher access to novel information confers the greater opportunity for innovation [21]. In the ego-network, the extent to which a vertex j has direct ties with another vertext i and vertex j has other ties q which is located in i's network. The mathematical expression of constraint measure is presented below.

$$c_{ij} = \left(p_{ij} + \sum_{i \neq j \neq Q}^{Q} p_{iq} p_{qj} \right)^2 \quad (1)$$

where $p_{ij}$is the proportion of i's relations invested in vertex j, and $\sum_{i \neq j \neq Q}^{Q} p_{iq} p_{qj}$ is the extent of triadic closure among i, j, and third parties q. The value of constraint measure is in inverse proportion to the number of structural holes. In line with the argument of structural holes theory, we can reach that the individual with lower value of constraint measure indicates the higher innovational ability. Thus, we propose our hypotheses as that:

Hypothesis 1: The degree of structural holes in an individual's social network positively influences his/her innovativeness.

As depicted previously, individual innovativeness is not only facilitated by the located network positions, but the extent of social interactions and experiences between each other as well. Previous literatures solely elaborated the effectiveness of structural positions, but understated the role of social interactions. To bridge such gap in the existing literatures, we refer to Social Cognitive Theory (SCT) to understand how the consequence of individual innovativeness could be promoted by the social interactions.

According to SCT, a person's behavior is shaped by the influences of social systems and the person's cognition [16]. A lot of prior studies emphasize the role of a person's cognition, specifically, the importance of self-efficacy and outcome expectations [22]. This view has been adopted in the IS studies to improve computer usage or Internet behaviors [17]. However, the other perspective, the influences of social systems, should not be neglected. SCT suggests that an individual's behavior is related to

[1] The basic element of a clique (with three connected vertexes).

observing others within the context of social interactions and experiences [16]. The social interactions serve as the environmental factors that influence an individual's behavior. Virtual community is treated as a place to meet others, to seek support and belongingness [23]. Research in knowledge sharing and participation in virtual communities has shown the importance of the social supports provided by the interaction environment. In understanding knowledge sharing in virtual communities, social influences, such as community ties, social interactions in the network, are suggested to play an important role. For example, satisfaction with member-member interactions and organizer-member interactions positively impact member's participation [24]. The sense of community could also enhance members' contribution and participation in a virtual community [25]. Thus, we proposed the following hypothesis:

Hypothesis 2: The degree of participation in online commutative platform positively influences individual innovativeness.

In the online community of our context, social influences mainly come from the interactions among members, the commenting behaviors. If an individual shares a new idea for product innovation, others can provide comments to the ideas shared. The more social interactions undertaken by each other, the greater the intensity, frequency, and breadth of knowledge exchanged. We propose that the social influences from the interactions would promote an individual's sharing of new ideas. To measure the extent of interaction, number of words is used in this study. This measurement has been traditionally used in studies of social influence in computer-mediated communication [26]. The more words responding to an individual's idea, the stronger the tie and social influence is. Such social interactions builds more connected social network, which encourages more sharing of new ideas. Therefore, we propose:

Hypothesis 3: Amount of responding to an individual contribution has positively influence individual innovativeness.

3 Research Methodology and Data Analysis

This work was collaborated with a leading consumer electronic company headquartered in Western Europe, and we name this firm as Blue in the subsequent paragraphs. In order to improve the product design and innovation, Blue attempted to encourage their own staff to contribute innovative knowledge to operate the business. Thus, a new internal online system was implemented on April 2009. After a trial round for six months by several key firm members, the system was officially launched. All managerial employees of Blue distributed in different countries have access to it. This system was designed for helping the decision-makers to read and select the innovative ideas and suggestions generated by the staff in terms of their posting and commenting content, and the adopted knowledge like ideas or suggestions might be applied to the different sectors of Blue's business and operations. In this regard, users' participation, namely posting innovative knowledge and commenting others' knowledge, plays a key role in the whole innovation process.

3.1 Data Description and Model Specification

The longitudinal sectional data was collected from October 2009 to April 2010. As depicted previously, only the managerial staffs were offered the access to the system. In the end, 63 people have been observed in the system logs during that period. To longitudinally observe the social interactions among the users, we constructed the social network by each month. Eventually, there were five [2] social networks constructed for further analysis. Thus, the dependent variable (DV) and independent variables (IVs) were measured with time lags. In particular, the DV, the extent of innovation contributed by individual, was measured by the amounts of suggestions or ideas at time t+1 along with the values of three IVs at time t for each observation. As mentioned previously, we used the constraint proposed by Burt [21] to depict the structural holes. For measuring the extent to which individuals were involved in this system, we used the frequency of visits to systems, as an indirect measurement rather than a relatively direct measurement as most of the self-reported studies adopted. To elucidate the extent of such interactions, we counted the words of each comment under the posted content to represent the extent of responses to each piece of contribution. In addition, we controlled for numbers of factors that might be associated with the social interactions and individual performances, including in/out-Closeness centrality, amounts of suggestions or ideas at time t, and individual gender. The descriptive statistics are shown in Table 1. Referring to the suggestion by Gelman [27], we normalized the abnormally distributed variables in terms of logarithmical and inversed transformation. From Table 1, we can find the DV, number of ideas/suggestions contributed by individual, is a counting variable.

Table 1. Descriptive Statistics (130 observations)

Variable	Description	Mean	Std.Dev.	Min.	Max.	VIF
$N\_o\_I_{i(t+1)}$	Number of ideas/ suggestions contributed by individual *i* at time *t+1*	0.362	1.251	0	10	
$constraint_{it}$	Index of structural hole for individual *i* at time *t*	0.949	0.368	0.292	1.837	1.18
$involvement_{it}$*	Number of visits to the platform for individual *i* at time *t*	0.767	0.385	0.004	1	1.13
$S\_o\_W_{it}$**	Number of words responding to individual *i*	0.649	1.768	0	6.616	1.09
$gender_i$	Gender of individual *i*	0.915	0.279	0	1	1.06
$inclose_{it}$	Indegree of closeness centrality of individual *i* at time *t*	4.284	1.862	2.439	7.722	1.19
$outclose_{it}$	outdegree of closeness centrality of individual *i* at time *t*	4.262	1.872	2.439	8.386	1.15
$N\_o\_IT_{it}$*	Number of ideas/suggestions contributed by individual *i* at time *t*	0.827	0.297	0.033	1	1.07

*Inversed transformed; ** Logarithmically transformed

[2] The network on March 2010 was dropped because we attempted to use the social metrics at time t to predict their behaviors at time t+1, thus including the social metrics of last month makes nonsense.

From the descriptive statistics, the mean of N_o_Ii(t+1) is not equal to its variance, thus the Poisson regression is not proper to be used here. Thus, we applied the negative binomial regression (NBR) model to test our proposed hypotheses and estimate the coefficients of the formula presented below. To control the heterogeneity of individual observation and time lag, we used the pooled, random effect, rather than simple linear NBR model. Notably, the μi and εit is the individual specific unobserved effect and panel error term respectively.

$$N\_o\_I_{i(t+1)} = \beta_0 + \beta_1 constraint_{it} + \beta_2 engagement_{it} + \beta_3 S\_o\_W_{it} + \beta_4 gender_i + \beta_5 inclose_{it} + \beta_6 outclose_{it} + \beta_7 N\_o\_IT_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

We present the correlation matrix in Table 2, where we can find all the values between each pair of inputting variables are less than 0.6. Besides the correlation matrix, we diagnosed the multicollinearity by computing the VIF values (in Table 1). Suggested by Greene (2003), if the VIF exceeds10, it is often thought the existence of multicollinearity. It is obvious that the VIF values of the inputting variables are low enough to avoid the concern of multicollinearity.

Table 2. Correlation Table

	constraint	**involvement**	**gender**	**S_o_W**	**inclose**	**outclose**	**N_o_IT**
constraint	1.000						
involvement	0.197	1.000					
gender	-0.022	-0.114	1.000				
S_o_W	-0.236	-0.074	0.008	1.000			
inclose	0.083	-0.230	-0.089	0.073	1.000		
outclose	-0.178	-0.106	-0.050	0.089	0.272	1.000	
N_o_IT	0.098	-0.001	-0.164	0.102	0.041	-0.110	1.000

3.2 Results

The results of the estimated coefficients are presented in Table 3. We have tested all models, from the baseline model including all control variables to the full model. Model 1 is the baseline model, where none of the control variables influences on individual innovation contribution. Although previous literatures on both information systems and organizational management [28-30] have indicated the gender differences in using the IT artifact in the organization and innovation, such difference was yet unfound in our empirical results. It is not that the current findings are contradicting to the previous works, but our research context restrained to highlight the gender difference. As a consumer electronics company, it is intuitive to be understood that the males predominate the whole employee population. Based on the descriptive statistics, our speculation can be affirmed, where most of the users are males (mean value is 0.915). The (in/out) closeness centrality is not significant across all models, which indicate the network position does not affect the results. In addition, the amounts of innovative ideas/suggestions contributed by individuals are not affected by that in pre round, which indicates the inexistence of unobserved heterogeneity due to the time lags.

Model 2 presents the results after the involvement, indicating the frequency of visits, was entered. The coefficient is not significant, indicating the extent of individual involvement does not influence them to subsequently contribute their knowledge to the system for innovation. Such insignificant results could be resulted from the characteristics of the system that we are studying. Differing from conventional IT-artifact, the system implemented by Blue is a kind of knowledge aggregator. Thus, there are at least two purposes for employees to use such system, namely contributing knowledge (posting and commenting) and seeking knowledge, from previous literatures [31]. In this research context, how individuals seek knowledge in terms of using this system is unknown due to the limitation of our dataset. Thus, we are only able to empirically investigate the relationship between the extent of involvement and one dimension of system usage, namely knowledge contribution, which could be an alternative explanation why the involvement of system usage did not conduce to the dependent variable.

We entered the variable *S_o_W*, representing the extent to which each individual received the responses from others, into Model 3. The coefficient of *S_o_W* is significant and in the expected direction in our proposed hypothesis, indicating the stronger extent of social interaction to individual who have posted content can motivate him/her to subsequently contribute more. Model 4 is the full model with all independent focal variables and the control variables. The coefficient of constraint has significantly negative impact, which implies more structural holes in the communication network are conductive to the individual innovation. Remarkably, the estimated coefficients of other inputting variables in full model are consistent with those presented in previous models, which suggests the results from our empirical investigation are solid and convincing.

Table 3. Results of Negative Binomial Regression Models

Variables	**Base model**	**Model 1**	**Model 2**	**Full Model**
	Coef. ***(Std. Err.)***	***Coef.*** ***(Std. Err.)***	***Coef.*** ***(Std. Err.)***	***Coef.*** ***(Std. Err.)***
$constraint_{it}$	--	--	--	-1.815**
				(0.894)
$S\_o\_W_{it}$	--	--	0.321***	0.282***
			(0.106)	(0.091)
$involvement_{it}$	--	-0.582	-0.231	-0.349
		(0.673)	(0.581)	(0.651)
$gender_i$	-0.015	-0.141	-0.455	-0.852
	(0.625)	(0.634)	(0.666)	(0.637)
$inclose_{it}$	-0.025	-0.037	-0.036	0.033
	(0.147)	(0.151)	(0.132)	(0.173)
$outclose_{it}$	-0.084	-0.088	-0.093	-0.102
	(0.153)	(0.156)	(0.137)	(0.180)
$N\_o\_IT_{it}$	0.604	0.529	0.562	2.215
	(0.860)	(0.876)	(0.795)	(1.673)
Log Likelihood	-109.599	-109.224	-107.287	-69.035
df	4	5	6	7

*p<0.1; **p<0.05; ***p<0.01

4 Discussion and Conclusion

In this article, we empirically investigated how the network positions and external factors, i.e. degree of participation and social interaction, influence the individual innovativeness. In particular, our results echoed the argument of structural holes theory that the individuals having more structural holes show the stronger involvement of innovations, i.e. contributing more novel ideas or suggestions in the online platform. Different from previous studies, the higher extent of participation in the platform does not affect individual subsequent innovation activities. Interestingly, consistent with social cognitive theory, the higher extent to which the individuals obtained the responding from his/her peers will encourage his/her future innovation contribution. This work serves as the first study jointly adopting the notions of structural network positions and extent of social interactions to articulate the individual innovativeness. In the IS literatures, previous works studying social cognitive theory only unveiled the social interactions do influence on the adoption or usage of online community. We extended such findings, and initially applied such theoretical framework in the organizational context. Besides the theoretical contribution, the findings from this work are conductive to the practitioners. We provided two solutions for managers to leverage their employees' intelligence for future innovation, namely 1) manually regulating the position of the individuals in communicative, and 2) encouraging staffs to increase their social interactions to maximize their individual innovativeness. Furthermore, the individual employee can also attempt to locate him/herself in the brokerage positions achieve higher extent of innovation ability, which may benefit for his/her future career development.

Like all studies, our paper has several limitations, which serves as suggestions for future research. First, we only used the archival data to empirically investigate our proposed hypotheses. Future studies may adopt multiple sources like self-reported or interviewed data to have a holistic understanding. Second, although the panelists in our dataset come from different nations, the proportion of Asians are not high. One alternative explanation could be that the oriental people are relatively restrained comparing with the western people. Thus, they may not be used to share their ideas in terms of such open environment. Last but not least, future studies are encouraged to continue to investigate the survivability of the contributed ideas. Although numerous ideas covering from product innovation to corporate governance can be found in the idea pool, this study is not able to foresee the consequence of such contributed ideas. Understanding how decision-makers refined such ideas for future usage will be very imperative.

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