

Integrating Knowledge from Network: How Explorative/Exploitative Innovations are Balanced

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Abstract Despite consensus on the importance of balancing explorative and exploitative innovations, how organizations achieve so is unclear. This research argues that knowledge integration is the fundamental capability while organizations' networks put their oar in the process. In order to validate our inference, this research holds preliminary interviews on an innovative triangular cooperation then further generate a computer simulation analysis.

Keywords: *knowledge integration, ambidextrous innovation, computer simulation, exploration/exploitation*

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1. Introduction

Organizations are faced with various kinds of tensions in resources allocation, organizational design and other decision makings. One of the most critical kinds is that between exploitation and exploration. Considering both short-term efficiency and long-term survival, organizations need to reach balanced innovation between exploitation and exploration [1]. Despite multiple discussion regarding domains to achieve ambidextrous innovation, the mechanism through which firms can achieve balanced exploitation and exploration remains room for further investigation [2].

Based on different aspects to investigation into balancing exploitation and exploration, one important consensus is that "knowledge" plays a key role. In order to accomplish an innovation task, multi-dimensional knowledge is required and successful decomposing of the original knowledge as well as combining the decomposed knowledge to form the required (possibly new) knowledge is essential. Hereby, knowledge integration represents a particular mechanism to achieve balanced exploitation and exploration [3].

On the other hand, since knowledge variety is essential to fulfill balanced innovation task, the abundance of knowledge source becomes critical. Under resources constraint, some of the required knowledge may have already been possessed by the organization while some is to be found. In searching of the needed knowledge, the social network provides the most efficient source [4], especially efficient governance mode for tacit knowledge exchange [5] Because the embedded nature of tacit knowledge makes it either hard to be transacted through market mechanism or acquired through organizational hierarchy. Thus, social network cooperation provides the better means for tacit knowledge source.

Taking the intense market competition into account, organizations are required to respond to fluctuations within limited time. This has made the importance of both knowledge integration and access to network resources crucial [6]. To put it short, if an organization is better at exploitation work, gaining knowledge from other organizations to complement its exploration need would be more effective than other forms of transaction [3], and vice versa.

In the aspect, the social network resembles the resources bed for an organization. As such, the characteristics and features of the network will have influences upon the impact of knowledge integration on an organization's ambidextrous innovation.

In order to investigate how the process takes place, agent-based model is especially suitable for this research. Since computer simulation can assist us in understanding how the inter- and intra- organizational interactions take place, and the process of knowledge integration, also knowledge integration involves longitudinal and feedback effects, this research adopts agent-based simulation as the research methodology [1,7,8,9].

2. Literature Review

2.1. Balancing Exploration and Exploitation in Innovation

Organizations that are capable of balancing between two opposite elements of organizations are "ambidextrous" [10]. An organization is bounded to making decisions, thus involve making choices between alternatives. While some of these "choices" are mutually exclusive and have tension in nature. Taking corporate slack for example, having more slack is a means for organizations to be more

flexible but the idle resources harm the efficiency of the organization. As a result, an organization has to decide between flexibility and efficiency. Once the decision is made, it triggers resources and organization attention allocation because a single organization has only limited resources and attention compared to what it wants to achieve [11]. Dilemma as such kind is common to organizational strategy decisions. Interestingly, it has been pointed out that successful firms are capable of balancing the tensions [2,12,13,14,15].

Among the various and complex sets of opposite elements, March [1] has clearly elaborated the fundamental tension of exploration and exploitation which are two principle activities between which organizations divide their attention and resources [13]. Most successful firms think and act ‘ambidextrously’ by trying to attain high levels of both exploration and exploitation simultaneously [15,16].

March [1] connects innovation and knowledge management in his foundational work, he explicates that ambidextrous innovation is the tensions surrounding explorative and exploitative innovation. Explorative innovation leverages varied and dispersed knowledge in new ways, while exploitative innovation employs existing knowledge in well-understood ways and both forms entail integrating knowledge [17]. Nevertheless, it has been pointed out that excelling at both explorative and exploitative innovations are vital to long-term performance (e.g., [15]).

However, as a single organization has limited resources and attention, it has to divide its resources and attention between these two opposing elements which in term makes it a challenging task involving tradeoffs to keep optimal combinations [13,18]. Consequently, to assess and manage the proper emphasis on either side is also critical [12]. Quite some work has been done to probe into ambidextrous innovation through functional [19], structural [20], attribute domains, and other domains. However, there has yet been a consistent finding on how an organization can achieve ambidextrous innovation. Owing to the essential to excavate the mechanisms and the route to ambidextrous innovation, further research into cross-domain interplay should be carried out since both exploitation and exploration can affect one the domains and then affected the other indirectly [12].

Just as Levinthal and March [21] has further extended March’s [1] interpretation of exploration as associated with “a pursuit of new knowledge,” and exploitation as with “the use and development of things already known,” knowledge plays an especially important part in the pursuit of ambidextrous innovation. This is consistent with Grant’s [4] argument that knowledge has become the most strategically significant resource in current dynamic competitive markets.

2.2. Knowledge Integration as a Mechanism

Knowledge integration is “defined as the way in which different components of the knowledge base of a firm are combined in a complementary manner [3], pp.75.” In the hypercompetitive environment, knowledge integration is a critical organizational capability to gain competitive advantage [4]. In order to accomplish certain task, an organization needs to decompose knowledge from its source or original form and re-combine it into a new form

for the very need of the specific task. In the in-depth preliminary interviews on the cooperation between a private sector organization, a public relations agency and an NPO, the three organizations communicate with each other based on the shared knowledge and contribute each of their domain know-how to the cooperation work. The leader of the public relations agency team replied,

“... our role is to collect sufficient information for the sponsor, which is the decision maker of the project, to make proper decisions. Of course, we are also responsible for screening the information based on our professional judgment and the goal of the project...”

The PR agency first needs to understand what the customer expects, and judge whether the agency itself has the criteria to meet the expectation. If the agency needs more than what is already has, it has to collect information through different approaches. Then they decompose the knowledge collected, keep what they need. The last step is to re-combine the knowledge with the know-how of the PR agency so that they can provide possible solutions to the customer.

This is evident that even when two firms have equivalent knowledge stocks, they vary in their performance, because they have “differential ability to combine different pieces of knowledge coherently, that is, depending on their degree of knowledge integration” [3], pp.76].

However, organizations are heterogeneous regarding their knowledge asset, some are more inclined to explore while some are more inclined to exploit. Through knowledge integration, those are better at explore are able to gather exploitative knowledge to become better at both explore and exploit [11].

Organization structures and intervention mechanisms affect the degree of knowledge integration [22,23]. Because a task is usually carried out by groups of people who individually have their own knowledge base, it is the process of accomplishing the task that can spiral up the knowledge of individuals. With proper intervention along the process, the degree of knowledge integration can be improved [23].

Besides organizational factors, the inter-organizational dimension is also the key to high degree of knowledge integration. Because an organization is usually better in either exploitation or exploration, which means that is more endowed with certain type of knowledge, thus need to access the other type of knowledge through inter-organizational mechanisms. An organization can of course choose to access the knowledge they need through market, hierarchy or hybrid form [24-26], but as the specialized knowledge has so large tacit portion that it needs to be transformed in a day-to-day interaction. Thus, social network provides a better medium for knowledge to flow [2]. As the respondents of both PR agency and NOP says,

“...we want to cooperate with them (the NPO) because they have better connection to the communities and know how to handle the work with community universities. ...they (the NPO) say that it’s not going to work with the community universities based on their experience, and they explained to us. But we still wanted to try, ... and finally we know oh (expression of understand) this is how and why things can’t be done this way...” ~Ms. Tsou

“... the private sector (indicating the PR agency) is really good at scheduling and getting things done in time! ... I never knew professors can provide the teaching material ahead of the courses, it’s amazing (laugh) and I really want to know how they made it! ...”

In view of the above, this research argues that social network has critical impact on the quality and quantity of knowledge that an organization can access. Moreover, to achieve ambidextrous innovation, an organization’s access to complementary knowledge is further crucial.

2.3. Network as the Catalyzer

Meaningful units that are connected by ties such as formal relation (ie. alliance, ownership) or informal relations (ie. friendship, respect) form a network. These meaningful units include individuals, teams, organizations, communities, and so on. These units are connected so that resources can flow from one to another among them [27,28]. Whether they are physical resources like capital, assets, and machines or are virtual resources such as reputation, expertise, friendship, etc, they are important to an organization. For example, the ties connecting dyads of units are potential sources of learning and promote efficient skill transfer [29].

The resource flows contained in networks can generally be categorized into three types: asset flows, information flows and status flows. Asset flows refer to resources such as money, equipment, technology, and organizational skills that flow between connected firms [30]. Information flows represent the information and knowledge gathered from connected firms about their competitive intent, strategies, and resources, even in the absence of any asset flows [31]. And status flows are flows of legitimacy, power, and recognition from high-status firms to lower-status firms [32].

In general, innovation is a complex task that often requires knowledge flow between an organization and other actors. And it has been pointed out that when a firm invests more on the external knowledge network, it enjoys more innovation [33]. In our interview, the respondent said that,

“...we contacted The National Association for the Promotion of Community Universities (NAPCU) and tried to reach the community through community universities and found it, you know (shrugs her shoulder), they (the community universities) are very independent.... We had to try some other ways to reach the community.” ~ Ms. Tsou

“... It takes quite a lot of communication to begin the cooperation with PHLIB. Professor Chen has very high standards, ... when she (professor Chen) first had meeting with the PR Department Head, they have a common acquaintance, it had made the start of the cooperation a lot easier!” ~ Ms. Tsou

In our interviews, it is evident that when an organization lacks knowledge flow with its network, the chance of innovation is decreased. On the other hand, when knowledge can flow smoothly, such as a meeting, innovative way of cooperation is thus triggered.

When referring to inter-organizational networks, it is argued that the type and quantity of resources an organization can access to depends on below three inter-organizational network levels: firm-level [30,34,35],

dyadic-level [2,28,36] and network-level [2,37,38,39]. The characteristics of the networks affect the system-level performance [40].

As Simmel [41] suggests that research on cross-level analysis of social relations would lower intra- and inter-organizational complexity, this research takes into account that the network-level characteristic will affect both ego- and dyad- level behavior.

To sum up, knowledge integration is an important organizational capability for to achieve ambidextrous innovation, so that organizations will be equipped with better competitive advantage. Meanwhile, the interplay of multi-level networks has a moderating role on the access of knowledge. In order to better elaborate on above argument, followed is a simulation of the process of the scenario.

3. Research Model and Method

3.1 Research Model

Based on the literature, this research proposes that knowledge is a key mechanism to balanced exploitative and explorative innovation, while the social network the organization is embedded in has a moderating role. And the conceptual framework is shown as Figure 1.

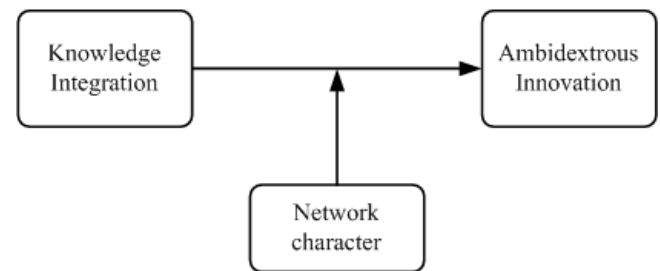


Figure 1. The conceptual framework

3.1. Simulation

Computer simulation is an emerging research method in strategic research to mimic and virtualize the dynamic environment with a set of equations and/or transformation rules for the description of certain context [18,42]. Among various types of simulations, such as agent-based models [1], systems dynamics models [43], NK fitness landscapes [44], cellular automata models [45], and others, agent-based simulation is particularly suitable for this research. The reasons include [8,46]:

1. Relevant theories are in emerging staging that needs further insights into the rationale.

Social network as the source for organizations to access knowledge has drawn much research effort in recent years [33], and cross-level concerns have drawn attention as well, especially the intervention of every level has caused research concern [2,47]. On the other hand, the relationship between knowledge integration and innovation has caught little yet critical insight in research. Thus further integration of these emerging theories is required.

2. Involves both intra- and inter-organizational cross-level issues that results to the difficulty in gathering correct empirical data [48].

Knowledge integration is a process taking place within an organization [3,4], but this research is investigating how the inter-organizational network condition affects the knowledge integration process. This involves both intra- and inter- organizational issues. This leads to great difficulty in collecting meaningful and precise empirical data.

3. Seeks to understand the “process” of knowledge integration, which computer simulation is more appropriate.

Since knowledge integration is a mechanism and represents the capability of an organization and the theme of this research is to find out “how” knowledge integration assists organizations to achieve ambidextrous innovation, simulation can provide a clearer picture of the course.

4. Both cross-sectional and longitudinal phenomena are investigated.

As this research seeks to understand how the multi-level network interaction will affect the process of knowledge integration leading to ambidextrous innovation, it involves both the characteristics of the network (cross-sectional) and the interaction process (longitudinal) phenomena. Thus, simulation is a better means for this kind of research.

3.2.1. Settings

The agent-based simulation model specifies the existing theories by taking agents as firms. In this research, an organization is represented by an “organization code” [1] that contains m dimensions. Every dimension of the organization code is represented by a series of 10 kinds of knowledge while every piece of knowledge is represented by one of integers of -1, 0 or 1. In short, an organization code is a set of knowledge, coded as m bit strings with 10 digits of -1, 0 or 1.

As Exploration means activities like search, variation, risk taking, experimentation, play and flexibility and exploitation is applying existing knowledge to existing implementation, exploitative innovation [1], and organizations tend to have both of them with different ratio [11]. In order to keep simplicity of the model, this simulation adopts integer -1 to represent that the knowledge is exploitative, 0 as neutral and 1 as explorative [8]. The initial status of the network ties will vary with different simulation runs.

Regarding the network, it is formed of 30 organizations, each having different knowledge bases. And with every simulation run, the initial status is randomly assigned by the system. To represent the characteristics of every level, this research adopts one outstanding characteristics of every level [2,6] so that the simplicity can also be taken into consideration into the simulation.

Table 1. Network Variables

Level	Variable
Firm	Centrality
Dyad	Bridging Tie
Network	Network Density

Every variable of the network level is measured with below rationale.

3.2.2. Degree Centrality

This refers to the number of ties that an actor has with others, which is the counting of the actor’s relationships.

Having many direct contacts with other actors represents enjoying high degree centrality.

$$\frac{T_i}{N} > 0.5 \tag{1}$$

T_i: Number of direct ties the actor actually has
N: Number of total actors.

3.2.3. Bridging Tie

Structural hole: the total amount of resources received and transferred is the same; on the tie information transmitted from structural hole is different from the targeted firm’s original information. The amount of one-way interaction can be counted in to test the level of bridging tie.

3.2.4. Network Density

Network density refers to the degree of interconnection among firms of the network. The greater the interconnectedness in the network, the higher density the network reaches. In the “closed” system, more ties existing among firms indicates denser network which facilitate the knowledge transferring in the network.

$$\frac{\sum_{i=1}^N T_i}{2} > 0.5 \tag{2}$$

When the agent encounters a task assigned by the system, it first examines internally to see if the required knowledge resides in its organization code. If the fill rate exceeds the threshold, it will start implement the task and generate certain degree of knowledge integration which updates some parts of the organization code. However, if the fill rate is below the threshold, the agent has to search knowledge from the network. Then it will imitate and internalize the knowledge by integrating it into the organization code.

4. Results

With above settings, the simulation model is implemented with NetLogo, and output data is analyzed with Microsoft Excel 2007.

Having high centrality in the network makes it easier for the organization to obtain homogeneous knowledge, leading to rapid growth in exploitative innovation. On the other hand, central position also enables the organization to obtain heterogeneous knowledge which will lead to explorative innovation. However, there’s distinction of degree shown as Figure 3.

Bridging ties enable the focal organization to gain high level heterogeneous knowledge while bringing difficulty for knowledge integration [2]. Innovation is improved because of bridging ties at the cost of unraveling other essential knowledge. For that reason, heterogeneous knowledge can be integrated by the focal organization to promote explorative innovation at the expense of hindering exploitative innovation because bridging ties load knowledge from too diverse sources.

Taking network-level characteristic into consideration, focal organization enjoys different benefits and bears different downsides.

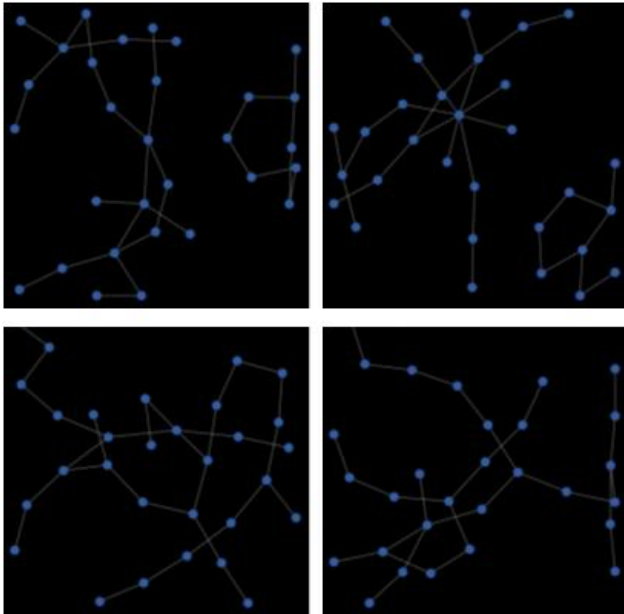


Figure 2. Different Initial State Network Examples

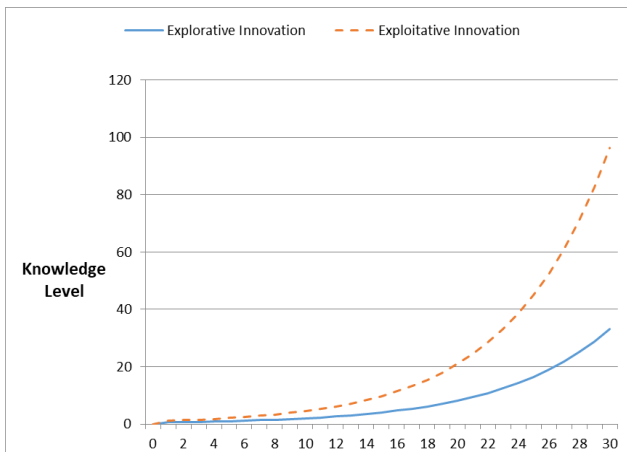


Figure 3. Simulation Result of Centrality and Ambidextrous Innovation

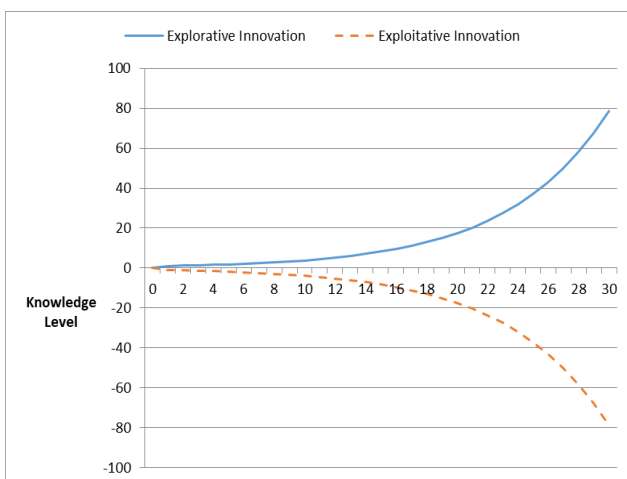


Figure 4. Bridging Tie and Ambidextrous Innovation

When centrality is coupled with high network density, total ties between central and non-central organizations increase, and even high degree of knowledge integration has mere impact on knowledge heterogeneity. Consequently, even if the focal organization has high centrality, it can only acquire homogeneous knowledge under this

circumstance. To put in another word, effects caused by high centrality diminishes as network density increases knowledge homogeneity among actors [30].

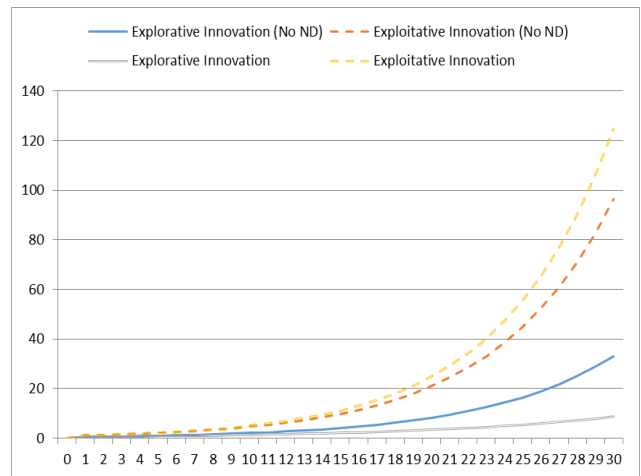


Figure 5. Centrality with Network Density on Ambidextrous Innovation

Bridging ties are supposed to load heterogeneous knowledge for the focal organization so that novelty can be kept. However, in a dense network, organizations are more linked with each other so that there are less bridging ties. Also, the organizations are more heterogeneous with regards to knowledge that hinders the transfer of novel knowledge. Thus result in better exploitative innovation.

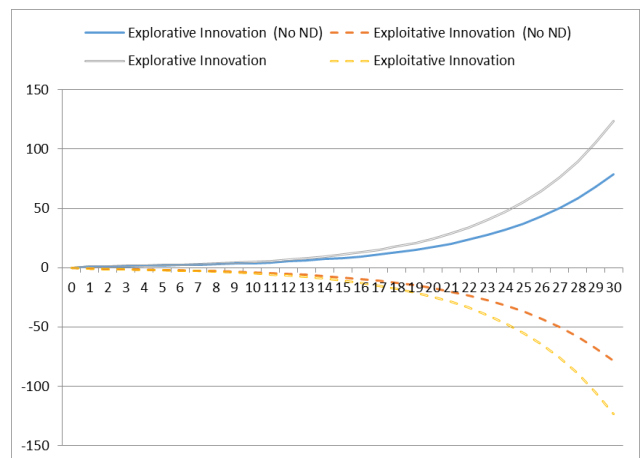


Figure 6. Bridging Tie and Network Density on Ambidextrous Innovation

5. Conclusion

As knowledge integration takes place on individuals within an organization [4], it will be more complete if this research can further delve into the intra-organizational process such as from individual level to the group level.

Besides, as simulation is a good research method for analyzing the emerging theories, it still requires further empirical testing to check the general situation.

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