When *guanxi* Fills Structural Holes: Promoting Tacit Knowledge Conversion in Scientific and Technological Achievements Transformation Team

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Abstract: Tacit knowledge conversion is the key to the transformation of scientific and technological achievements. However, tacit knowledge is highly personal, difficult to articulate, and subconscious, making it particularly hard to convert. Social network has been viewed as the main channel of tacit knowledge conversion, but its disperse structural holes can cause poor communication among sci-tech achievements transformation team members, leading to limited information mobilization. *Guanxi* can alleviate such disadvantages, because it pursues resource mobilization in the form of favor exchange, *renqing* accumulation and *mianzi* preservation. Therefore, this project puts forward a scientific hypothesis that strategically leveraging *guanxi* to buffer the negative impacts of structural holes can promote the effective conversion of tacit knowledge, so as to advance the sci-tech achievements transformation. The project attempts to adopt a mixed-methods research approach which involves quantitative surveys and social network analysis, as well as qualitative interviews、observation and case studies. This project aims to explore the dynamics of social networks for tacit knowledge conversion in sci-tech achievements transformation team, investigating the impacts of structural holes and *guanxi* on the transfer, acquisition, application and integration of tacit knowledge respectively. In addition, it intends to study the moderating effect of *guanxi* on structural holes, exploring how *guanxi*and structural holes coordinate beneficially to promote the effective conversion of tacit knowledge among sci-tech achievements transformation team members. It can hence be seen that this project has significant theoretical and practical implications for the transformation of scientific and technological achievements.

Keywords: *Guanxi; Structural Holes; Tacit Knowledge Conversion; Transformation of Scientific and technological Achievements.*

I. INTRODUCTION

The Transformation of Scientific and Technological Achievements (TSTA) to realistic productive forces is currently one of the most significant strategic tasks in China. In September 2018, the State Council made a request regarding "mass entrepreneurship and innovation" [1], of "enhancing the application ability of sci-tech achievements transformation". However, according to data [2], the transformation rate of sci-tech achievements in China is less than 10%, and that of the real industrialization is even less than 5%, which is far lower than the average level of 40% in the other countries. This reflects that there is a problem needing to be solved urgently in the field of TSTA in China.

In the era of knowledge economy, Liu et al. (2008) perceived TSTA as the whole process, in which intellectual goods are transformed into physical commodities that can be sold in the market, and through which knowledge conversion happens in every stage [3]. Sci-tech achievements are composed of explicit knowledge (in the form of patent, texts, etc.) and tacit knowledge (hidden in the brains of sci-tech achievements transformation team members) [4]. Taking the iceberg as an example: explicit knowledge is just the tip of the iceberg that emerges from the water, while tacit knowledge is the vast body of the iceberg hidden under the water [5]. At present in our country, when engaging in TSTA, people usually place most emphasis on explicit knowledge conversion, which reflects the technological contents of sci-tech achievements, but pay little attention to Tacit Knowledge Conversion (TKC) [4]. As Zheng (2017) pointed out, such a practice is exactly the main reason for the low rate of

TSTA in China [4].

In order to solve this problem, Dong & Deng (2010) proposed that social network could be a useful channel for TKC [6], because tacit knowledge can mainly be communicated by means of *guanxi* channels in social networks, and transformed through a series of implicit expressions such as emotion, body posture, language and so forth [6]. As the primary implementation body [7], the TSTA team is essentially a social network. The network members usually come from different research institutions, universities, enterprises or other professional institutions, with heterogeneous knowledge, expertise, skills, and experiences.

The gaps in social networks, or absence of connection, between two contacts who are both, nevertheless, linked to a common actor, are known as structural holes [8]. As structural holes theory attests [9], a hub actor who connects two or more otherwise disconnected individuals in a network, each with access to complementary information, has more advantages than an actor who does not occupy such a central position. Most studies highlighting the benefits that accrue to the 'brokers' occupying such structural holes have restricted their scope to Western contexts [8-12], but Xiao and Tsui (2007) highlighted that the collectivistic values of China can undermine the manner in which Chinese brokers gain such control and information benefits [13].

Being embedded in Confucian culture, the Chinese perceive these brokers as unethical, selfish and opportunistic, as they manipulate "accurate, ambiguous, or distorted information" strategically between the two sides to have a "disproportionate

say in whose interests are served" (p. 354) [10]. Thus, structural holes may expose the intermediary actors to conflicting allegiances, increasing their risk of diminishing collective interest and tarnishing their personal reputation. Besides attenuated control benefits, Chinese brokers cannot fully realise their personal information benefit either, as the communal-sharing values oblige them to attribute a more significant 'share of the pie' to the group contribution and a smaller proportion to that of the broker [13].

In addition, Batjargal (2007; 2010) further pointed out that structural holes in networks may slow down the communication process among distributed individuals who barely know each other, may trigger the creation of boundaries in the flow of information, leading to bottlenecks in knowledge diffusion, may create a further mismatch of strategies as a reflection of dispersed, vague and distorted information, may amplify incompatibilities in personal values and behaviours, and may exacerbate the dissimilarity in members' social and technical worlds, which prevents them from building shared understanding [14-15]. All of these problems may hinder the transfer, acquisition, deployment and integration of tacit knowledge among the network members, thereby impeding the TKC of the TSTA team.

Such disadvantages can be mitigated by *guanxi*, a system of influential relationships and social network dynamics in Chinese culture, when it is certain to have a unique influence on structural holes [16-17]. In China, every person is expected to observe *guanxi*, regardless of their age or profession, because it acts as the social standard when developing and maintaining a relationship among the Chinese. Scholars have studied the constraining effect of Chinese culture on structural holes [13-15], but, thus far, how *guanxi* moderates the negative impacts of structural holes on the TKC among the TSTA team members remains largely unexplored.

Rooted in the traditional Confucian culture, *guanxi* values *renqing* and *mianzi*. On the one hand, the word '*renqing*' combines '*ren*', referring to human being, and '*qing*', which means affection and sentiment, and is a lubricant for the emotional and economic exchange of favours in the pursuit of relational longevity. Once *renqing* is developed, a person can ask a favour from someone, with the obligation to return this favour in the future. Zhai (2004) highlighted that the other more significant aspect of *renqing* is *baoen* (repay kindness) [18]. Such favour return is sentimental, and the exchange behaviour may continue due to the creation of emotion [18]. In this way, such reciprocity allows the team members to exploit social capital that offers leverage in interpersonal exchanges among their network connections, fostering the mobilization and conversion of tacit knowledge resources [19]. On the other hand, refusing to return a previously received favour will severely damage personal creditability, resulting in not just an exclusion from ongoing *guanxi* maintenance, but also a humiliating loss of *mianzi*.

In China, *mianzi* as a social currency implies more than reputation. The Chinese have a strong sense of *mianzi*, hence they are willing to devote considerable effort to maintaining their face. Huang et al. (2011) suggested that people can earn *mianzi* by showing their advantages, and tacit knowledge conversion provides an appropriate way to demonstrate such

advantages [21]. This is because tacit knowledge is highly personalized and implies important skills and valuable experiences. Therefore, compared with more common, explicit knowledge [21], the conversion of tacit knowledge can reflect personal ability to a greater extent, so as to gain more respect, pride and dignity.

The development and maintenance of *guanxi* is a dynamic process, in which a gradual transition occurs from being treated as an outsider to becoming part of the in-group. During this process, structural hole owners tend to fill their structural holes and pull previously disconnected individuals together into a buffer zone, around which an abundant of cognitive and social resources flow in the form of favour exchange, *renqing* accumulation, and *mianzi* preservation, smoothly alleviating the negative issues that structural holes induce [16-17].

From the perspective of network structure, a network rich in 'filled' structural holes can reach a greater variety of persons with relevant expertise that individuals cannot obtain from their own experiences or customary personal contacts. By filling structural holes, and creating connections with previously unknown members of other network clusters, rich flows of non-redundant and unique information can be facilitated, which allow the network members to adequately transfer, acquire, deploy and integrate tacit knowledge for enhancing TSTA [16-17]. Simultaneously, the mutual commitment, trust and expectation embedded in *guanxi* provides a control mechanism that limits the risk of the opportunistic behaviour that is highly possible in a sparse network [16-17].

Therefore, through the lens of "*guanxi* fills structural holes", this paper considers the moderating effect of *guanxi* on structural holes as a starting point to study the TKC of the TSTA team. As such, the study addresses the research question: how do TSTA team members leverage *guanxi* and structural holes to enhance the conversion of tacit knowledge?

The rest of this paper is organised as follows: in the next two sections, diverse bodies of literature will be integrated to build the research model and develop relevant hypotheses. Then in the third section, a mixed-methods research approach will be adopted, where questionnaire surveys will be used to test the hypotheses, and qualitative interviews will be used to enrich quantitative results. Last, key contributions will be articulated along with their associated theoretical and practical implications.

II. LITERATURE REVIEW

2.1 The role of TKC in TSTA

In order to promote the TSTA, our party and state have issued a series of policies in the four decades of reform and opening. According to the Law of the People's Republic of China on the Promotion of Application of Scientific and Technological Achievements Transformation, promulgated in 1996〔30〕, "TSTA refers to a series of activities that have been done on sci-tech achievements with practical value produced by scientific research and technological development, including follow-up experiments, development, application, popularization and the formation of new products, new processes, new materials and new industries, in order to improve the level of productivity". Liu et al. (2008) pointed out that knowledge conversion permeates every stage of TSTA [3]. If knowledge conversion does not take place, the sci-tech achievements will

always be in an isolated state and cannot be transformed, let alone produce the value of transformation [3,31,32].

Knowledge consists of explicit knowledge and tacit knowledge [33]. Polanyi (1958) first proposed the implicit view of knowledge, highlighting that most of humans' knowledge exists in the form of tacit knowledge [5]. People know more than they can tell [34]. Nonaka & Takeuchi (1995), Nonaka and Krogh (2007) theoretically and empirically defined knowledge conversion as an interaction between explicit and tacit knowledge [35,37]. Zheng (2017) found that sci-tech achievements, as knowledge products in a highly condensed state, are composed of explicit knowledge and tacit knowledge [4]. During the process of TSTA, knowledge conversion continually happens, and TKC plays a critical role in promoting TSTA [4].

TSTA is a continuous and dynamic process, which requires the mutual conversion between tacit knowledge and explicit knowledge. In fact, knowledge can freely be converted between tacit and explicit states, through Socialization, Externalization, Combination and Internalization (SECI), according to the SECI model [33]. In general, prior research into TKC has taken one of two perspectives [21]. On the one hand, the first perspective focuses on transforming tacit knowledge into explicit knowledge. Such a process is called as externalization [33], and usually reflected in two ways. The first way is to express one's own tacit knowledge, such as thought, inspiration, or imagination in the form of explicit knowledge, using language, text, metaphor, analogy or model. The second way is to elicit others' tacit knowledge, translate it into a form that is easy to understand, and then disseminates it among members [36] [37].

Nevertheless, not all scholars agree that all forms of tacit knowledge can be converted into explicit knowledge [21]. One argument is based on the interpretation of Polanyi (1958) [5]. Specifically, Hildreth& Kimble (2002, p. 6) pointed out [38], "If we accept Polanyi's view of tacit (implicit) knowledge as being inexpressible, it cannot be converted into explicit knowledge because it can never be externalized and written down in an explicit form". In addition, Voelpel& Han (2005) implied that during the process of TKC, much of the richness and potential value of the content will be lost [39], and this loss of richness is called as "tacit-explicit paradox" [40].

On the other hand, the second perspective encourages tacit knowledge sharing [41] [42]. This process of transferring tacit knowledge between individuals via observation, imitation and practice is defined as socialization [22]. Socialization is an experiential process, during which people need to use all of their senses to communicate in a perceptual way, in order to share subtle ideas, acquire hidden skills and obtain implicit, common psychological patterns [22].

Liu et al. (2008) classified the tacit knowledge of TSTA into three categories [3]: (1) knowledge regarding the conception, design, trial production and production of sci-tech achievements; (2) knowledge regarding technology, know-how and experience; (3) knowledge regarding culture and management. This tacit knowledge is usually hidden in the minds of the TSTA team members, embodied in their organizational culture and values, or materialized in machinery and equipment; therefore, it is very difficult to externalize and socialize such tacit knowledge for promoting TSTA [3].

Drawing on the work of Dhanaraj&Parkhe (2006) [43], this study identifies tacit knowledge transfer, tacit knowledge acquisition, tacit knowledge application and tacit knowledge integration as the essential ingredients that constitute TKC. First, tacit knowledge transfer is predominantly referred to in the network literature as an 'asset' that carries value for a network [44]. Particular emphasis is placed on standardizing or establishing compatible methods of communication to facilitate the sharing of this form of intellectual capital across 'syntactic' boundaries [45]. Secondly, when the transferred tacit knowledge is complex and there is not commonality or clarity of purpose, the challenge shifts to the receipt and deployment of the knowledge, where a 'semantic' approach is needed to recognize the different ways in which each team member interprets, accepts and uses the disseminated message in TSTA settings [45,45]. Finally, tacit knowledge integration concerns the management of dependencies of member expertise in a team, involving "knowing where knowledge is located, where it is needed, and how to deliver it" [47]. Thus, a 'pragmatic' approach is needed for the team members to fully explore their unique local context without losing their ability to interrelate and transform different types of 'hard-won', practice-based knowledge into a novel innovation that transcends its customary pragmatic boundaries [45].

2.2 The influence of structural holes and *guanxi* on TKC in the TSTA team

According to the study of Wang et al. (2018) and Cao & Ali (2018), people are more willing to obtain knowledge from their social networks rather than texts [51] [52]. In these decades, social network has gradually played a dominant role in transferring tacit knowledge [53]. As Dong & Deng (2010) stressed [6], explicit knowledge can be transmitted and shared through information networks, while tacit knowledge can mainly be transferred and transformed via social networks. It is because that common life, work environment and day-to-day communication among relatives, friends, colleagues, superiors and subordinates can provide a large number of opportunities for individuals to transfer, acquire, deploy and integrate tacit knowledge [6, 54]. Generally, it is difficult to obtain personal tacit knowledge from formal channels; instead, tacit knowledge is usually transferred and converted through the relationship capital in social networks [6]. That is, people can realize the essence of implicit knowledge by means such as example [55], with the help of emotion, posture, language, demonstration and other subtle ways of expression.

As structural holes theory attests [8, 11], a hub actor who connects two or more otherwise disconnected individuals in a network has more advantages. Most studies highlighting the benefits that accrue to the 'structural hole owners' have restricted their scope to Western contexts, but the collectivistic values of China can undermine the manner in which Chinese brokers gain such control and information benefits [13]. In addition, excessive structural holes in networks may cause poor communication issues, limited information mobilization, a mismatch of strategies, exacerbated incompatibilities in personal values and behaviours, as well as increased dissimilarity in members' social and technical worlds [14] [15], all of which may impede the TKC of the TSTA team.

Drawing on the research [16, 17], such disadvantages can be mitigated by *guanxi*. The Chinese phrase '*guanxi*' is composed of two characters: the first character '*guan*' which represents a gate, and the second '*xi*', referring to a connection. Thus, literally, *guanxi* means "pass the gate and get connected" [56]. As a highly particularistic tie between two persons bonded by an implicit psychological contract [24], *guanxi* involves "the exchange of favours; the cultivation of personal relationships; and the manufacturing of obligation" (Yang, 2016, p. 6). Grounded in the traditional Confucian values of *renqing* and *mianzi*, *guanxi* is not merely an affection-based kinship relationship, but also involves a connection through which both parties exchange favours or valued materials. On the one hand, *renqing*is a lubricant for the emotional and economic exchange of favours in the pursuit of relational longevity [19]. Once *renqing* is developed, a person can ask a favour from someone, with the obligation to return this favour in the future [24]. An arrangement of taking turns to give favours is significant to obtain access to "a larger range, a greater diversity, and higher 'upper reachability'" (Bian, 2002, p. 277) of information, knowledge, and social resources [59, 19], thus promoting the transfer and conversion of tacit knowledge.

On the other hand, refusing to return a previously received favour will severely damage personal creditability, resulting in not just an exclusion from ongoing *guanxi* maintenance, but also a humiliating loss of *mianzi* [51]. As a social currency, *mianzi* is defined by Leung & Chan (2003) as "respect, pride and dignity as a result of his or her social achievements and practices" [20]. In China, there is a saying that face is just like the bark of a tree, without which the tree will die. Thus, the Chinese tend to make a great amount of efforts to protect and earn their *mianzi*, while the conversion of tacit knowledge provides them a suitable opportunity to demonstrate their advantages, because it is much harder to convert tacit knowledge than explicit knowledge [21]. Hence, by exchanging favours, accumulating *renqing*, and preserving *mianzi*, *guanxi* may promote the conversion of tacit knowledge among the team members.

Based on prior research [16, 17], this study assumes that through the influence of *guanxi*, structural hole owners tend to fill their structural holes and pull otherwise disconnected individuals together into an 'in-group' to inhibit personal controlling behaviours and enhance collective intelligence benefits [13], thereby promoting the TKC of the TSTA team. Specifically, within an interwoven social network, where prestige flows via word-of-mouth dissemination and where the controlling behaviours are perceived as unethical, those who have a higher concern for *renqing* and *mianzi* are less inclined to profit from the brokerage, a behavior otherwise regarded as "standing on two boats" (a Chinese proverb) and socially distasteful [14]. This is because unlike the West, which mainly operates on the basis of guilt, in Confucian culture the most primary deterrent to unethical behaviour is shame [60].

On the contrary in brokering situations, rather than acting as controllers, the Chinese are more willing to cultivate a social exchange relationship with key persons by playing the role of integrators. Through providing the favour of introducing unknown contacts to one another, integrators invest their *renqing*, which can extend through the network quickly, leading to a greater return because the Chinese tend to trust those who are introduced by their trustworthy sources [14]. Likewise, those who receive a favour tend to pull more new, useful individuals together in order to return this favour, as they follow the unwritten code of reciprocity.

The study assumes that a buffer zone emerges, around which an abundance of cognitive and social resources flow in the form of favour exchange, *renqing* accumulation, and *mianzi* preservation, smoothly alleviating the negative issues that structural holes induce in TSTA settings. From the perspective of network structure [9], a network rich in 'filled' structural holes can reach a greater variety of persons with relevant expertise that individuals cannot obtain from their own experiences or customary personal contacts. By filling structural holes, and creating connections with previously unknown members of other network clusters, rich flows of non-redundant and unique information can be facilitated, which allow team members to adequately convert tacit knowledge resources to enhance TSTA.

In addition, Fu et al. (2006) indicated that "brokering" (bridging) unique information to appropriate persons can not only provide team members with access to valuable resources, but also promote the cultivation and accumulation of *renqing* [57]. Thus, high levels of commitment, empathy and interdependence can be engendered to provide a control mechanism that prohibits opportunistic behavior by brokers and limits the risk of being cheated [58], thereby securing the sharing, acquisition, deployment and integration of tacit knowledge for improving TSTA.

III. RESEARCH MODEL AND HYPOTHESIS DEVELOPMENT
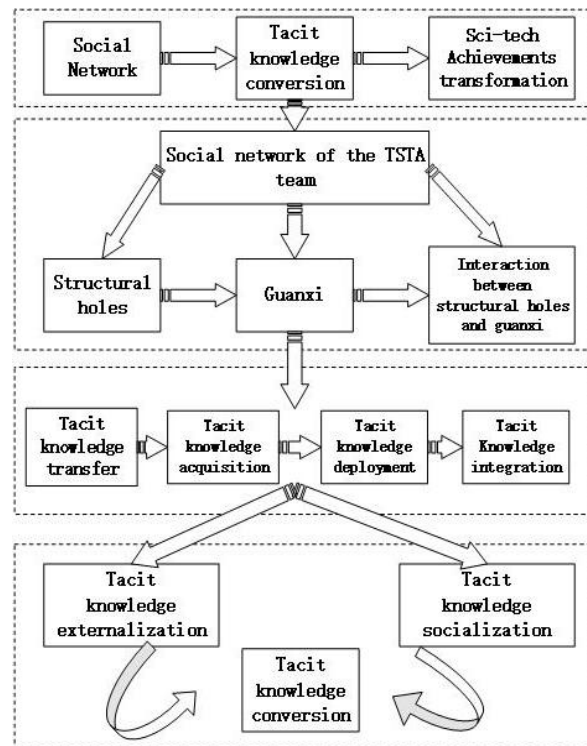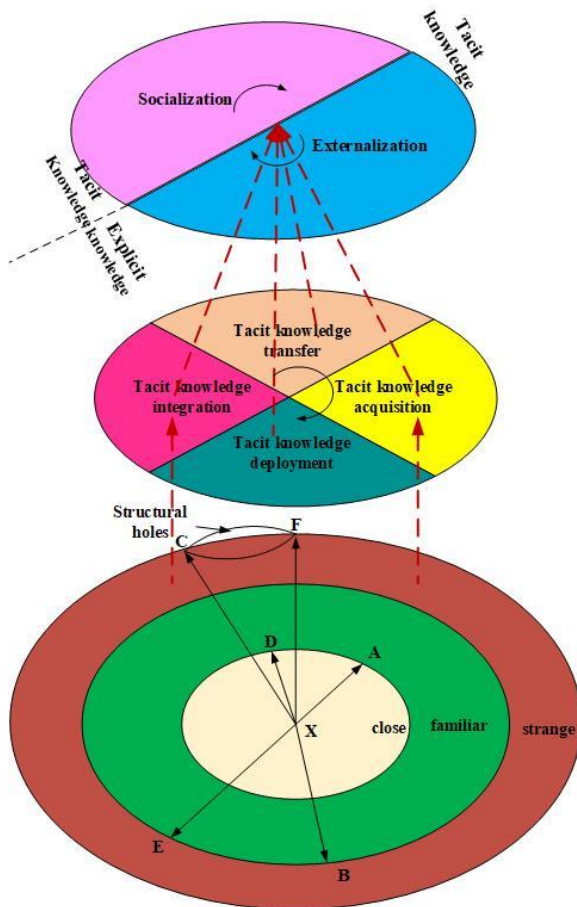
A. Research model

Fig. 1 Research flow chart

Fig. 2 Research model

B. Hypothesis development

Hypothesis 1. Structural holes will be negatively related to TKC in the TSTA team.

Hypothesis 1a. Structural holes will be negatively related to tacit knowledge transfer in the TSTA team.

Hypothesis 1b. Structural holes will be negatively related to tacit knowledge acquisition in the TSTA team.

Hypothesis 1c. Structural holes will be negatively related to tacit knowledge application in the TSTA team.

Hypothesis 1d. Structural holes will be negatively related to tacit knowledge integration in the TSTA team.

Hypothesis 2. *Guanxi* will be negatively related to TKC in the TSTA team.

Hypothesis 2a. *Guanxi* will be negatively related to tacit knowledge transfer in the TSTA team.

Hypothesis 2b. *Guanxi* will be negatively related to tacit knowledge acquisition in the TSTA team.

Hypothesis 2c. *Guanxi* will be negatively related to tacit knowledge application in the TSTA team.

Hypothesis 2d. *Guanxi* will be negatively related to tacit knowledge integration in the TSTA team.

Hypothesis 3. *Guanxi* will moderate the negative relationship between structural holes and TKC in the TSTA team, such that

structural holes will impede TKC less when *guanxi* is stronger.

Hypothesis 3. *Guanxi* will moderate the negative relationship between structural holes and TKC in the TSTA team, such that structural holes will impede TKC less when *guanxi* is stronger.

Hypothesis 3a. *Guanxi* will moderate the negative relationship between structural holes and tacit knowledge transfer in the TSTA team, such that structural holes will impede tacit knowledge trasnfer less when *guanxi* is stronger.

Hypothesis 3b. *Guanxi* will moderate the negative relationship between structural holes and tacit knowledge acquisition in the TSTA team, such that structural holes will impede tacit knowledge acquisition less when *guanxi* is stronger.

Hypothesis 3c. *Guanxi* will moderate the negative relationship between structural holes and tacit knowledge application in the TSTA team, such that structural holes will impede tacit knowledge application less when *guanxi* is stronger.

Hypothesis 3d. *Guanxi* will moderate the negative relationship between structural holes and tacit knowledge integration in the TSTA team, such that structural holes will impede tacit knowledge integration less when *guanxi* is stronger.

Hypothesis 4. The transfer, acquisition, application and integration of tacit knowledge will be positively related to tacit knowledge externalization in the TSTA team.

Hypothesis 5. The transfer, acquisition, application and integration of tacit knowledge will be positively related to tacit knowledge socialization in the TSTA team.

IV. EXPECTED METHODOLOGY

This study will adopt a mixed-methods research approach, which is generally used to establish a more systematic account of aphenomenon (Zachariadis et al., 2013). Specifically, the study will use quantitative surveys to test the hypotheses and estimate their impacts, which will then be discussed in conjunction with the qualitative results. In parallel, the qualitative analysis of the interviews will not only explain these hypothesized relationships but also make better sense of the quantitative results by reviewing the interview data.

A. Quantitative research

In the quantitative part of the research, a stratified random sampling approach will be used to select 500 persons. The sampling frame will include the Chinese who are engaging in TSTA or have such kind of experiences. To collect the most reliable data available, those key informants will be requested to respond to the surveys who have large *guanxi* networks, who frequently leverage their personal connections to obtain valuable social and cognitive resources, and who are able to make informed comment on the survey variables. In total, 500 questionnaires will be distributed. On the basis of Armstrong and Overton (1977) [61], t-tests will be conducted to evaluate non-responses bias in the quantitative surveys, and examine if there is any significant difference between early and late responses.

B. Quantitative measures

Structural holes (SH). In order to measure structural holes (SH), the study will refer to Xiao and Tsui (2007)'s name-generator approach [13], originally developed by Burt (1992) [8]. This approach will involve two steps. First, the respondent

(ego) will be asked to give the names of the members (alters) within their *guanxi* network. In a second step, the respondent will be asked to indicate the strength of all ego-alter ties and alter-alter ties in their network. Specifically, there will be eight questions, respectively, about supply information release of sci-tech achievements (1st), demand information release of sci-tech achievements (2nd), legal protection of TSTA (3rd), policy guidance of TSTA (4th),financial support of TSTA (5th), arbitration services of TSTA (6th), price assessment of TSTA (7th), and intellectual property protection of TSTA (8th). Thus, two sample questions will be "Can you nominate several persons who you choose to contact when you need financial assistance during the process of TSTA?" and "Can you nominate several persons who act as a significant source of supply information for your sci-tech achievements?"

For each question, the respondent will be asked to list a maximum of three names. Then, the names created by theeight name-generating questions will be put together to assemble the *guanxi* network of the respondent. Afterwards, the strength of relationshipon the basis of a 0–3 range will be measured, by reference to Xiao and Tsui (2007) [13]: "3=Very close: strong personal bond; 2=Close: aperson you get along with well; 1=Less close: the person is OK to get along with; 0=Distant: a person you don't know". Then the constraint, c, of Burt (1992) [8] and Xiao and Tsui's (2007) [13] will be used to measure SH.

***Guanxi* (GX).** Referring to the measurement scale developedby Yen et al. (2011) for measuring *guanxi*(GX) based on three Chinese relational constructs – *ganqing* (affection), *renqing* (favour) and*xinren* (trust) [62], the study will adopt the items designed for measuring the construct of *renqing* to measure GX.

These measures of the *renqing* construct are stronglyrelated to receiving and returning favours, and are also consistent with the items for measuring reciprocity developed by Mavondo and Rodrigo (2001) [63]. Specifically, the study will four items to measure to what extent respondents in their *guanxi* networks: (1) are happy toprovide a favour to team members of their network with different social status who are in need; (2) feel obliged to return a favourto those team members who have previously given them a favour; (3) believe that "calling in" a previous favour is part of doing cooperation with their team members; (4) believe that giving and receiving favours is critical in maintaining the relationshipbetween their team members and themselves.

In addition, two items will be adopted created by Hwang (1987) for measuring the construct of *mianzi* to measure GX [64], which will be presented as "I will feel '*meimianzi*' (embarrassed, loss of face) if I am unable to return a received favour to those favour providers",and "I will feel '*you mianzi*' (honoured) if I provide a requested favour to my team members and introduce unknown, key contactsto one another".

Tacit knowledge transfer (TKT). According to Dhanaraj and Parkhe (2006) [43], the study will measuretacit knowledge transfer (TKT) using theitems for measuring the constructs of ease of tacit knowledge transfer.Specifically, referring to Reagans and McEvily (2003) [65], two items for measuring the ease of tacit knowledge transfer from asource to a recipient will be used, which will be represented as "It is easy for me to explain to my team members a key idea, concept, or theory aswell as new developments in my area of expertise", and "It is easy for me to follow and disseminate other members' ideaseither orally or via information technologies".

Tacit knowledge acquisition (TKA). The study will measuretacit knowledge acquisition (TKA) using theitems for measuring the constructs of ease of tacit knowledge acceptance [43].The measurements of the construct of absorptive capacity will be adopted to measure the ease with which tacit knowledge isaccepted and assimilated by team members, by reference to the four-item scale designed by Seo et al. (2015) [66] for measuringindividual absorptive capacity, and the ten-item scale designed by Gluch et al. (2009) [67] for measuring the routines for acquiring tacit knowledge. Specifically, the study willuse two items to measure to what extent respondents recognise and accommodate the different ways inwhich each member interprets and accepts the disseminated implicit message, and to measure the degree to which respondents receive theshared information and tacit knowledge resources, increasing their existing knowledge base.

Tacit knowledge deployment (TKD). The study will measuretacit knowledge deployment (TKD) using theitems for measuring the constructs of ease of tacit knowledge deployment [43].Referring to the Levels of Use (LoU) scale of Hall et al. (1975) [68], designed for measuring eight levels of use of aninnovation, the study will adapt it to measure the ease of tacit knowledge deployment for TSTA. Specifically, two items will be used to measure to what extent respondents pay attention to day-to-day use of their expertise for addressing problems in TSTA, and to what extent respondents consolidate the applicationof their expertise to address problems in TSTA.

Tacit knowledge integration (TKI). By referring to the study of Schutz et al. (2009)[47], the study will use two items for measuring the construct of tacit knowledge integration (TKI): "I have established a full understanding of each member's expertise as well as how each member's knowledge should becoordinated"; "I have carefully interrelated practice-based expertise and actions to each other for strategic responses to technologicalchanges in TSTA".

Furthermore, the study will draw from the knowledge integration instrument developed by Liu et al. (2008) for measuring TKI [69]. We adoptedtwo items to measure to what extent respondents (1) understand how two or more ideas, concepts or theories from different specialtiesinteract in a digital platform context, and (2) recognise potential connections between ideas, concepts or theories fromdifferent specialties, and elaborate the nature of these connections in ways specific to a platform-based setting.

Control variables. Each of the items in the preceding sections will be measured with a seven-point Likert scale, ranging from Strongly Disagree to Strongly Agree. The study will also control for three factors that might be associated with the performance of tacit knowledge conversion. Thus, controls will be included for education and industry experience. Specifically, to capture education, three dummy variables will be developed as follows: 0 for a Bachelor's degree, 1 for a Master's degree, 2 for a doctoral degree. Then, the study will control for industry experience by the number of years the entrepreneur has worked in this industry.

In order to handle the potential common method bias, the study will refer to the study of Conway et al. (2015) [70]. Specifically, in the phase of research design, the anonymity of the survey and the confidentiality of the data will be ensured. In addition, prior to survey distribution, a comprehensive pretest will be conducted to increase the understandability of the survey items. Last, exploratory and confirmatory factor analyses will be performed to check the quality of the construct measurement and to establish the convergent and discriminant validity of the scales.

C. Qualitative research

In the qualitative part of the research, semi-structured interviews will be conducted to make sense of the quantitative results with supplementary evidence. Specifically, the study will conduct 50 interviews with persons who are directly involved in the processes of TSTA and have an intimate knowledge of the *guanxi*networks involved. In addition, these interviewees will be asked to evaluate the significance of *guanxi* and structural holes in relation to the transfer, acquisition, deployment and integration of tacit knowledge.

The qualitative analysis will involve coding the interview transcripts to identify key themes and categories. Specifically, the study will use initial codes based on dimensions of network dynamics as a guide to categorize the transcripts, assisted by NVivo. For this, the study will refer to the study of Guo and Miller (2010) [58] and code the transcripts in terms of three crucial dimensions of network dynamics: social structure, content, and governance mechanisms (Hoang and Antoncic, 2003) [71].

In terms of social structure, the study will code (1) the strength of the tie of a *guanxi* network as either strong tie or weak tie, and (2) the configuration of a given *guanxi*network as possessing or not possessing a 'filled' sparse structure. As for content, the study will code the qualitative data in relation to the importance of guanxi and structural holes for tacit knowledge transfer, tacit knowledge acquisition, tacit knowledge deployment or tacit knowledge integration.Regarding governance mechanisms, the study will code the interview transcripts to identify the interaction between *guanxi* and structural holes in converting tacit cognitive resources for TSTA. During the process of moving back and forth between original interview recordings and transcripts, the appreciation of the links between *guanxi* and structural holes, TKC and TSTA will progressively emerge (Nandhakumar and Jones, 1997) [72].

V. CONTRIBUTIONS AND CONCLUSION

A. Theoretical contributions

This study has three theoretical contributions. First, the study opens up a new research method of TSTA through the lens of *guanxi*filling structural holes. Liu et al. (2009) used the knowledge innovation mechanism to study TSTA [22]. However, it makes very difficult for empirical research to verify the theoretical framework, due to the abstract nature of such a mechanism. In addition, Zhou et al. (2013) took Nanchang University as an example [7] to model and analyze the knowledge network in university's TSTA team, through using the social network analysis method, which included node centricity measurement and agglomeration subgroup analysis.This method is novel and interesting. It can not only capture the in-group structure of knowledge network in TSTA team, but also recognize the essentiality of core nodes and their control over knowledge. Nonetheless, this method is based on a relatively static perspective, failing to reflect the dynamic changes of the TSTA team as a social network. From the perspective of *guanxi* filling structural holes, this paper studies the moderating effect of *guanxi* on the relationship between structural holes and TKC, thereby opening up the new research method of TSTA.

Second, the study enriches the research on the influence of social networks on TKC in Chinese Confucian culture. Heikkinen&Tahtinen (2006) put forward the view of "a hub in networks" [23], suggesting that an individual who holds a nodal position in their network tends to use prominence and power to perform a 'prime mover' role in the conversion of tacit knowledge. As structural holes theory attests, a hub actor who connects two or more otherwise disconnected individuals in a network has more advantages than an actor who does not occupy such a central position [8]. Most studies highlighting the benefits that accrue to the 'brokers' occupying such structural holes have restricted their scope toWestern contexts [8]-[12], but Xiao and Tsui (2007) highlighted that the collectivistic values of China canundermine the manner in which Chinese brokers gain such control and information benefits [13].

Being embedded in Confucian culture, the Chinese perceive these brokers as unethical, selfish andopportunistic, as they manipulate "accurate, ambiguous, or distorted information" strategically between the two sides to have a"disproportionate say in whose interests are served" [10]. Thus, structural holes may expose the intermediary actorsto conflicting allegiances, increasing their risk of diminishing collective interest and tarnishing theirpersonal reputation. Besides attenuated control benefits, Chinese brokers cannot fully realise their personal information benefiteither, as the communal-sharing values oblige them to attribute a more significant 'share of the pie' to the group contribution and asmaller proportion to that of the broker [13].

On the other hand, Yang (2016), Leung et al. (2016), Chen et al. (2018), Leung & Chan (2003), and Huang et al. (2011) have pointed out [24,25, 19-22], in Confucian culture, *guanxi*, which pursues resource mobilization by exchanging favours, accumulating *renqing* and preserving *mianzi,* may promote the flow of tacit knowledge in social networks. Scholars have studied the constraining effect of Chinese culture on structural holes [13, 15], but, thus far, how *guanxi* moderates the negative impacts of structural holes on TKC for TSTA remains largely unexplored. This paper takes the lens of social networks to study the effect of *guanxi* and structural holes on TKC, so as to explore the relationship among TSTA, TKC and social networks. By studying the moderating effect of *guanxi* on the negative relationship between structural holes and TKC, this paper reveals the mechanism of TKC, and provides a scientific basis for promoting TSTA.

Third, the study extends the literature on TSTA from the perspective of TKC. Existing literature on TSTA is mainly from the lens of knowledge [4], knowledge management [26]-[28], knowledge innovation [22], and knowledge transfer [29], while few research distinguishes the difference between explicit knowledge conversion and tacit knowledge conversion, and study the performance of the TSTA team through the angle of TKC. By exploring how *guanxi*and structural holes affect TKC

in the TSTA team, this study enriches the research on TSTA.

B. Practical contributions

In addition to theoretical contributions, this study also makes a practical contribution: providing a new strategy for promoting TSTA. Specifically, the TSTA team is a knowledge network [7] and simultaneously a social network. Members of the network may come from universities, research institutions, enterprises or other professional institutions, and have different expertise, skills, and experiences. Heterogeneous knowledge backgrounds and complex interpersonal relationship may affect the communication among team members and hinder the efficiency of TSTA. Therefore, it is significant for TSTA managers to encourage the flow of tacit knowledge among team members. Based on the perspective of buffer zone, this study suggests that hub actors in the network tend to fill their structural holes and pull previously disconnected individuals together, so as to facilitate the transfer, acquisition, deployment and integration of tacit knowledge for TSTA. Hence, the study provides a new strategy for promoting TSTA.

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