Knowledge Sharing through Social Networks

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Abstract—**We suggest that a lack of understanding of the social and human factors in the design process may lead to the failure of knowledge sharing or KS in most organizations. The basis for KS in organizations is embedded in participants' action and experience. We propose that successful KS initiatives require (1) attention to communication patterns of individuals or groups working in different divisions of an organization and (2) the development of IT systems that support both strong and weak ties between participants. Specifically, a distinction between different network structures as they relate to the concept of structural holes is drawn for highlighting how types of network structures effect sharing of explicit and tacit knowledge. Additionally, strong and weak tie theories are applied to develop a framework for potential IT-based initiatives aimed at addressing structural holes of communication. A set of propositions is proposed with their implication for designing KS systems in organizations. This paper concludes that sociological perspective in achieving a balance between the different types of ties (i.e., strong and weak ties) could assist in the maintenance and ongoing creation of new knowledge without having the networks to be redundant.**

Keywords- knowledge sharing; transfer systems; social networks; tie diversity; structural hole.

I. INTRODUCTION

Social networks or SN is an interdisciplinary behavioral approach for the study of human actors, their relationships and interdependencies. SN draws theoretical and methodological foundations from areas such as communication, sociology, social psychology, psychiatry, organizational science and graph theory. It involves theorizing, model building, and empirical studies, which focuses on uncovering patterns of communication among actors, organizations, states etc. Therefore, uncovering the communication practices among members from different organization, which would result in detecting cliques, isolates and brokers and their role in the network forms the basis for application of SN to study the knowledge sharing in organizations.

Social ties, a critical aspect for understanding the formation of cliques, isolates and brokers and their role in the network can be seen from two perspectives: (i) strong ties, and (ii) weak ties. Social network literature suggests strong ties or close and frequent interactions among people from different organizations are likely to lead to redundant information because they tend to occur among a small group of actors in which everyone knows what the others know. Contrary to strong ties, weak ties or distance and infrequent relationships provides access to novel information by bridging the disconnected groups and individuals in organizations [7, 46]. The usefulness of strong or weak relationships among people in different organization for effective coordination needs further investigation and especially in the context of knowledge sharing [3, 4, 5]. Furthermore, the relationships among strong and weak ties and computer mediation for successful knowledge sharing context have yet to be explored [7, 8, 9]. Also, the use of SNA and its outcome in improving communication flow and its process as a measure for developing effective knowledge sharing systems is yet to be explored.

The transfer of knowledge between individuals, groups, communities or systems is regarded as Knowledge Sharing (KS) in organizations [1, 2, 3]. Research suggests that understanding social interaction between different interest groups within an organization is a critical component of effective KS [4, 5, 6]. The relevance of a social interaction approach has been debated in areas such as systems design, organizational process redesign, process improvement and artificial intelligence *per se* [7, 8, 9]. The social approach for designing KS is based on the argument that communication between individuals, teams, groups, and communities is critical to the development and sustainability of a knowledge-creating organization [10,

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11, 12, 13]. It is also suggested in studies that an appropriate structure of KS is essential for facilitating effective sharing in organizations [1]. Specifically, we suggest that KS is dependent on the structure of the social communication network at play in an organization.

Organizational science literature also highlights that communication network structure provides insight about the communication patterns of individuals working in an organization [7]. Therefore, an understanding of the communication network at play needs to be viewed as an essential part of the design of KS systems in organizations. There is also a tension in the organizational structure, strategy and process literature when applied to KS in organizations. Studies suggest that organizations should not start with structure but with a task-and-person based foundation that incorporates both authority and responsibility [14]. Therefore, the design of the KS structure should be based on the study of the existing communication structure. Communication networks may suggest how individuals, groups, communities or systems interact in an organization and can be used as a basis for KS process of an organization [1, 2, 3].

In this paper, we first provide a background to organization as a network o people. A person or a group of people united for some purpose is considered to be a form of organization [15, 16]. Cyert and March [15] suggest that organization needs to be viewed as a form of coalition. That is, an organization is considered to be a coalition of individuals, some of them organized into sub-coalitions. Arrow [16] highlights that formal organizations, firms, labor unions, universities, or government, are not the only types of entities that represent the term 'organization'. For example, the market system has elaborated methods for communication and collective decision-making and, therefore, can be interpreted as an organization [16].

It is further suggested by Mintzberg [17] that organization structures have both a formal and informal structure. Formal organizational structure is usually represented by the organization chart and widely accessible by the internal and external members. It is also suggested in the organizational science literature that every organization is a network of people [15, 18, 19, 20]. An analysis of the communication network can help us in understanding the information exchange, patterns, coalition and power of the individual members in an organization [7, 21]. The distinction between formal and informal organization structure can be drawn by looking at the types of interactions, or links, between individuals or agents in an organization. For example, the legitimate network refers to formal structure and the shadow network refers to the informal structure of an organization [20]. In the legitimate network, interactions or links are either (i) formally and intentionally established by the powerful members of the organization or (ii) established well-understood, implicit guiding principles, which is accepted by the members of the organization [20]. On the other hand, the shadow network consists of links that are spontaneously and informally established by the individuals among themselves during the interaction process in the legitimate system [20].

It is also evident that the shadow system does not coincide with the rigid boundaries of the legitimate system. Shadow system is classified to have porous boundaries and therefore considered to the principal route for interaction between individual agents in an organization or in an inter-organizational network [20]. We argue that the KS system needs to be designed by conducting a thorough requirement analysis of both the legitimate and shadow network. This is important as the legitimate network may provide a normative view of how individuals should share knowledge while the communication network analysis of shadow network will assist KS system designers in understanding the descriptive view of individual agents' communication patterns. This information could later be used to directly address issues of *structural holes* that may or may not exist in an organization or in a department [20].

In this paper, we first highlight that successful KS initiatives require (1) attention to communication patterns of individuals or groups working in different divisions of an organization and (2) the development of IT systems that support both strong and weak ties between participants. In particular, we provide a distinction between different network structures as they relate to the concept of structural holes. We also highlight how types of network structures effect sharing of explicit and tacit knowledge. Additionally, strong and weak tie theories are applied to develop a framework for potential IT-based initiatives aimed at addressing structural holes of communication. A set of propositions is proposed with their implication for designing KS systems in organizations.

II. DESIGNING KNOWLEDGE SHARING SYSTEMS

KS systems design evolved from the traditional structured systems design literature. Scientists, engineers, technicians, and programmers initially performed the design of technology-based systems in the 1950s and 1960s [22, 23]. Kling highlights that design flaws were the major impeding factor for ensuring the optimal use of computer-based information systems in organizations [23, 24, 25, 26]. The design of computer systems for supporting collaborative work requires careful attention in five key areas--planning, analysis, design, implementation and support [27, 28]. The importance of careful examination of these phases for ensuring the success of systems implementation has been addressed in organizational design literature as well [17, 29, 30].

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Previous studies suggest that systems design is essentially a social process [23, 24, 25, 26]. Therefore, the social role of systems analyst is one of the critical success factors for the successful design and implementation of the system [1, 31, 32, 33]. This social role is essential for the collection of relevant information from different disciplines and people during the requirements analysis phase of the systems development [23]. Therefore, the design of technology-based products has to be in line with social and organizational dynamics [23]. In fact, there is a danger of systems failure or not receiving high rate of user acceptance if systems design issues are considered separately from the organizational issues. This is a common problem for the implementation of multi-module software systems such as enterprise resource planning [23].

Studies suggest that the social systems design approach by Mauro Mauro Design Inc. improved the performance of the New York Stock Exchange trading systems. The systems analyst from Mauro Mauro Design Inc observed the traders at the Stock Exchange for six months prior to start coding new software together with 30 iterations in testing their new systems [34]. Kling and Star [34] highlights that analyses that cover the complexity of social organization and the technical state of the art is critical to the design or use of human-centered computing. This analysis can provide the systems designers with insights both the technological characteristics of a computerized system and the social arrangements under which the system will be used [35].

For example, it is highlighted in studies that understanding the distinction between the legitimate and shadow network structure is an important first step towards the design of the KS in organizations. Understanding the shadow network structure requires a communication network analysis so that the patterns of exchange between agents in a network can be understood. It is highlighted in previous studies that a successful knowledge creation process requires an established communication network. Communications network structure deals with individual communication pattern in an organization or in a unit of work. KS design can be viewed as a social process because it requires interaction between all parties moving through developmental phases together in order to produce a system that is efficient and effective. It creates ownership in a system, which alleviates many of the problems traditionally associated with implementing a new system, resistance to change, resistance to imposed authority, training, etc. This serves as a basis for the development of a conceptual model of KS in organizations [36].

Nonaka [37] and Brown and Duguid [38] also support that knowledge creation is essentially a social process. It is suggested in case studies such as Nucor Steel and Buckman Labrotaries [39] that understanding the interaction of individuals, groups, teams and communities in knowledge networks leads to a successful KS in organizations. Therefore, it can be seen that there is a growing interest among social scientists to view KS as socially constructed and embedded in social networks and communities of practice [11]. These findings clearly highlight that the dichotomy of KS systems design can be seen from three perspectives—technological determinism, systems rationalism, and socio design. In the following section, we provide a brief overview of the systems design literature as it relates to the design of KS in organization.

III. SOCIAL DESIGN OF KNOWLEDGE SHARING SYSTEMS

Social design refers to joint design of both the technological characteristics of a system and the social arrangements under which it will be used [35, 40, 41]. Bijker [40] argued that the development of technological systems should be viewed as a social process, not an autonomous occurrence where relevant social groups will be the carriers of that process. Kling et al [23] further highlights that these social choices are considered to be an integral part of computerization, even though they are not formally decided or completely within the control of any one person. For example, company A is adopting portable computers so that they can improve the flexibility of people's work situations and relationships. However, company A still insists that their employees report to work daily during the regular working hours. Therefore, employees of company A have very little flexibility to work from a remote location even though they have access to the technology infrastructure provided by the company. In contrast, the underlying operational philosophy of company B is to allow its employees to work from remote location so that it provides maximum flexibility and optimal use of portable computing. This example illustrate that it is not only the technology that guide successful operation, but the guiding principles or social design of work practices that organizations decides to pursue.

Managers, therefore, must address the cultural side of change when implementing software systems such as ERP as it increases fear among managers that the availability of company wide information may challenge their authority [42]. The biggest impediment to knowledge transfer is corporate culture and the biggest difficulty in managing KS is changing people's behaviour. Therefore, organizations need IT infrastructure to make progress or to provide the facilitation of knowledge networks, but the use of ICT for managing KS activities should be supported by introducing proper organizational processes, people and content. There is also a growing interest in considering a social network approach to understand the KS design in organizations. Social network analysis refers to the method of analysing social structures and relational aspects of structures that exist in a communication network. It is highlighted in the previous section that communication network structure

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can be viewed as a legitimate or shadow network. That is, an organization's structure may suggest how the legitimate communications network should work and the shadow network structure may suggest how the communication flow occurs at an organization. Therefore, social network analysis is continuing to play a significant role in developing a deeper understanding of the actual process of communication flow between individuals [18]. Additionally, one can conclude from all of the above that social network analysis has the potential to play a significant role in the design and implementation of knowledge management systems.

IV. BUILDING INFO-CULTURE FOR KS

Socialization, externalization, internalization, and combination can be seen as a mechanism for the creation of knowledge in organizations [37]. Here, the socialization in organization refers to the conversion of tacit knowledge to new tacit knowledge through social interaction and shared experiences [3]. The combination mode deals with the creation of new explicit knowledge by merging, categorizing, reclassifying and synthesizing existing explicit knowledge. Both the externalization and internalization mode refers to interactions and conversation between tacit and explicit knowledge where externalization deals with the conversion of tacit knowledge to new explicit knowledge and internalization deals with the creation of new tacit knowledge from explicit knowledge. Table 1 provides an overview of four modes of knowledge creation.

TABLE 1. FOUR MODES OF KNOWLEDGE CREATION

Modes of Knowledge Creation	**Characteristics**	**Examples**
Socialization	Conversion of tacit to new tacit knowledge	Apprenticeship, user training
Combination	Creation of new explicit knowledge	Survey reports
Externalization	Conversion of tacit to new explicit knowledge	Lessons learned
Internalization	Creation of new tacit from explicit knowledge	Learning and understanding from reading and discussion

It can be seen from Table 1 that knowledge sharing and creation is dependent on the modes of knowledge creation. Here, socialization is seen as an important aspect for the conversion of tacit knowledge into new tacit knowledge. For example, the development of an "*infoculture*" is the first essential step for creating knowledge-based organizations [39]. The study of Nucor Steel highlights that three essential elements—superior human capital, high-powered incentives and a high degree of empowerment guide the knowledge creation process [39]. Nucor Steel used a *group-based incentive* mechanism to encourage people to start sharing knowledge that in fact lead to the development of an *infoculture* in their organization. This incentive mechanism was introduced at all levels of the organization so that Nucor could only reward group-based performance.

Social network analysis is increasingly used to develop a better understanding of the shadow system network that is considered to be a true representation of the communication patterns that exist in an organization. Social networks can be defined as an individual's relations and contacts with others [21, 42]. Social network analysis can be seen as a method that allows us to analyse social structures and relational aspects of the structures that exists in a communication network between individuals, teams, groups and communities. The argument advanced in this paper is that once the IT-based KS systems put into practice or implemented in organization, it becomes a social network. Therefore, the social design of this IT-based KS should be established through a thorough analysis of both the formal and informal social networks that may exist in an organization. It is argued here that the design of IT-based KS should be able to accommodate the facilitation of the communication patterns or flow process that exists in a department or in an organization. Therefore, the social dimensions of KS can be described from two perspectives—the first is the role of socialization and community building as a backbone social infrastructure for KS, and the second is the IT-based KS systems. IT-based KS systems are also considered as social systems as this KS systems link people as well as machines.

Wellman [43] suggests that computer supported social networks help sustain strong, intermediate and weak ties which provide information and social support in both a specialized and broad-based relationships. It is also important to note that there are direct and indirect ties exist between agents or the participating agents engaged in KS. It is clear that these ties are embedded in both the legitimate and shadow network of an organization. This, when combined with what is known about computer supported social networks mentioned above, may provide valuable insights for the effective design of IT-based knowledge management systems. This is discussed further in the following two sections.

A. KS through Strenghts of Ties

It is indicated earlier that organizations can be viewed as a network of people. In particular, we discussed two types of networks—legitimate and shadow and its implications for the design and sustainability of KS provided. These networks consist of individuals working

in an organization and can be seen as redundant or non-redundant. A structural hole is referred to as a relationship of non-redundancy between two or more contacts [21]. Non-redundant contact between individuals can be seen as disconnected either directly or indirectly. Here, the disconnected direct non-redundant contacts suggest that there is no direct contact with one another and the indirect contacts suggest that one has contacts that exclude the others. Burt [21] further suggests that the two contacts provide network benefits as a result of the structural holes. Here, we discuss the concept of structural holes together with the strong and weak ties metaphor as it relates to KS systems design in organizations.

Burt [21] suggests that two criteria—cohesion and structural equivalence can be used as an indicator for detecting structural holes. Cohesion criterion refers to direct connection between the contacts. For example, two contacts A and B are redundant to the extent that a strong tie connects both A and B. Here, this strong tie between contacts A and B indicates the absence of structural holes (e.g. the relationship between father and son, or people who frequently connects with each other for social occasions). However, structural equivalence concerns indirect connection by mutual contact. For example, both A and B are structurally equivalent to the extent if they both have same contacts.

This nature of the contacts between the executives and persons in their network is referred to as strength of ties [44]. Intense, emotion-laden, and reciprocal relationships that require time and energy to create and maintain can be a reflection of strong ties. Weak ties on the other hand, reflect loose networks and are best explained by the concept of a bridge [44]. The strength of the tie has traditionally been viewed as bearing on the overall amount and content of information associated with the contact. It is however suggested in previous studies that novel and non-redundant information is available through weak ties more than through strong ties [44, 45]. Strong ties can be seen as advantageous because they allow for quick flow of information and social support. Furthermore, strong ties are reliable, easily available, and important when dealing with conflicts, crises, and uncertainty [46].

Granovetter's [44] theory of strong and weak ties highlights the importance of weak ties in providing information. A weak tie is defined as a "casual acquaintance" and a strong tie is a formal relationship defined by a high-shared knowledge base and multiple interactions [45, 46, 47]. Burt [21] further suggests that weak ties provide a useful mechanism for understanding the strength of structural holes in a communications network. We believe that both these types of ties offer unique opportunities for developing a theoretical base for the design of KS systems in organizations from both a theoretical and an applied perspective. Studies suggest that weak relationships such as casual acquaintances, do not take as much time and effort to cultivate as friendships or community of practice. It is therefore easy to have more acquaintances than friends. A larger number of acquaintances can provide access to information about more out-groups. Most importantly, acquaintances offer the potential for (1) a relationship that takes limited time and effort and (2) offers the most potential for non-redundant and, thus, valuable information and knowledge. Specifically, Burt [21] proposed a direct relationship between the number of structural holes and the rate of return on player's investment in terms of time and energy and social capital (Figure 1). Here, the shape of the curve is to indicate the general relationship between structural holes and human capital as opposed to any validated and specific function.

B. Supporting KS through Social Capital

We propose above that the value of social interaction and social exchanges needs to be taken into consideration by a designer of an IT-based KS system. We further propose here that the design of an effective IT-based KS system should allow for an economic use of time and energy in the growth of social capital.

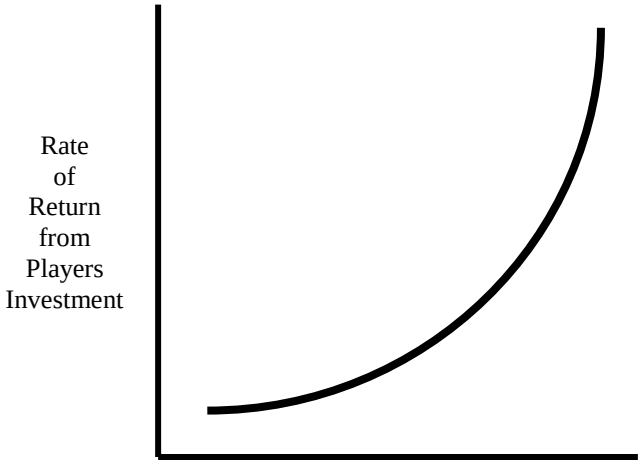

Figure 1. Relationship between Rate of Return and Structural Holes [21]

To discuss the specific effects of an IT-based KS system on social capital we will illustrate how one can increase capital by acting on the following five t propositions:

1. Maximizing weak ties in one's network increases the potential for innovation and/or market penetration [44].
2. IT-based KS systems are an effective means for establishing and maintaining weak ties [43].

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3. Maximizing the number of structural holes in one's network increases the potential for innovation and/or penetration [21].
4. A finite number of strong ties can be maintained [21].
5. Minimizing the number of strong ties allows for more allocation of resources to the application and creation of new knowledge.

Assume "Entrepreneur A" (E.A.) has lived and worked in city "Home" for a number of years. During this time, E.A. has established a number of strong ties due numerous in-person exchanges (Figure 2). E.A. soon realizes that both new ideas and/or potential markets for his product have become too redundant and that a larger network is required for further growth. E.A. decides to explore some potential new contacts via various forms of IT (Figure 2).

After establishing a number of loose contacts, E.A. decides to strategically strengthen ties with those who offer the greatest number of resources. The inherent communication barriers associated with numerous forms of IT motivate E.A. to invest time and energy into more face-to-face interactions with one of the selected new contacts. E.A. spends weeks (or, perhaps, longer) on-site with new contact E.B. who resides in Home2 and begins to strengthen their tie. E.A. also spends times with some of E.B.'s contacts and establishes a number of new relationships. During this time, E.A. maintains his ties back home by using IT channels. The maintenance of these ties requires (1) relatively little effort given the established shared knowledge base and (2) a strategic approach as to which contacts from Home make the most "economic" sense to maintain. E.A. maintains other new contacts by using the same methods used while at home. E.A. takes special care to maintain a weak tie, or no tie, between E.B. and other new contacts (Figure 3).

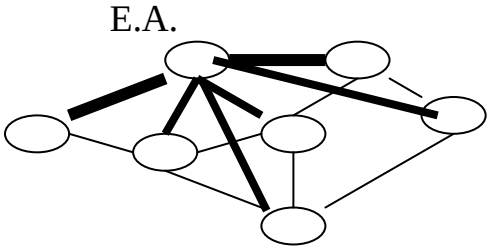

Figure 2. Social Network with proximal, strong ties

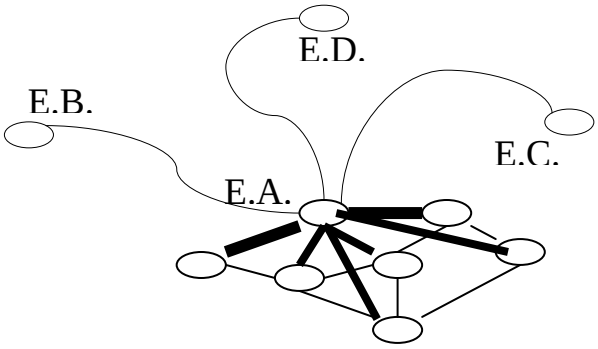

Figure 3: Social Network with proximal, strong ties, and new "distal", weak ties

Once the required shared knowledge base is established, E.A decides to move to Home3 to establish a stronger tie with E.C. E.A. maintains strong ties with Home and E.B. through efficient use of IT. Most importantly, E.A. maintains the structural holes between Home, E.B., E.C., and E.D. (Figure 4).

This process continues until E.A. reaches a maximum number of strong ties that can be maintained without having to "fill" in, or bridge, important structural holes due to a limited number of strong ties that can be maintained. E.A. eventually shows a significant amount of growth in social capital (see Figure 3) and invests more time in managing the flow of knowledge and information rather than actively searching for more capital (Figures 5 and 6).

One can better understand the demands of a system designer by combining an understanding of cognitive demands and limitations with the social behaviors and needs of end users like E.A. That is, for example, E.A. potentially realizes his cognitive capacity with the development and maintenance of 6 strong ties and the knowledge and information flow resulting from the increase in social capital. With every developed strong tie the demand imposed by the maintenance and utilization of a growing—and, thus, more complex—social network increases. Therefore, the ultimate requirement of an IT-based KS system is to minimize cognitive demand in the maximization and utilization of social capital. From this perspective, the IT-based KS system complements the individual and increases the potential for innovation and knowledge creation.

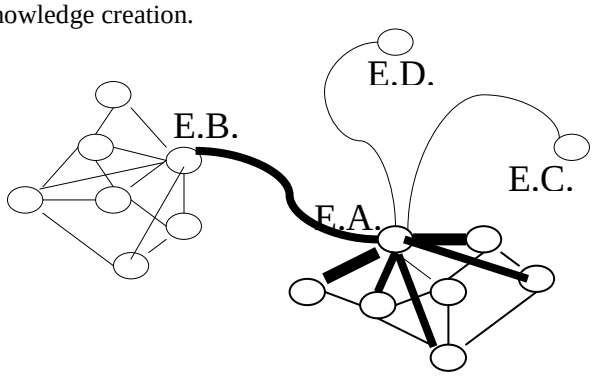

Figure 4. Example of Social Network with proximal, strong ties, distal weak ties, and a new distal strong tie

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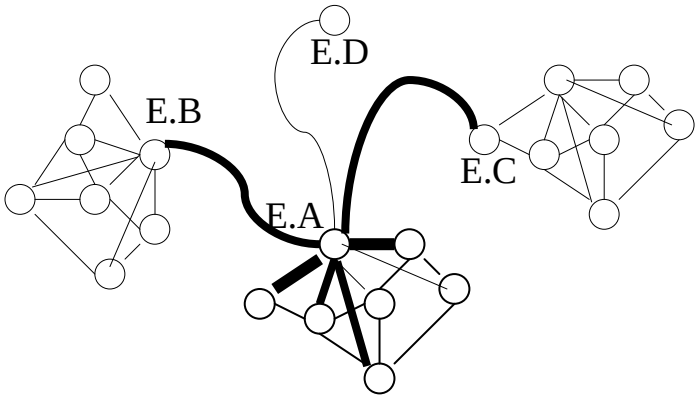

Figure 5. Example of Social Network with proximal strong ties, new distal weak ties and strong ties

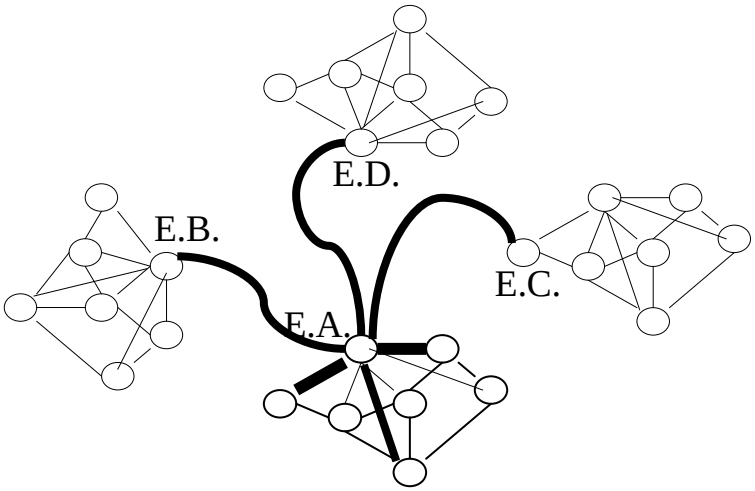

Figure 6. Example of Social Network with the same number of strong ties as shown in Figure 4, but with a significant increase in the amount of social capital

V. CONCLUSIONS

It is concluded that complex systems design such as knowledge sharing systems requires careful attention to the social context for which is systems is developed. Therefore, we suggest here that the designer of KS systems is required to develop the systems based on observations of the social interaction and social exchange needs of the individuals working in an organization. We further highlight that the design of KS should be based on an understanding of both the legitimate and shadow network structure of an organization. We recommend that social network analysis is a useful methodological paradigm for the purpose of eliciting the communication patterns for understanding the shadow network structure. It is suggested here that structural holes provide network benefits for developing social capital among participating members in knowledge sharing and conclude that strong and weak tie is a useful metaphor for fitting the structural holes. In conclusion, the following propositions can be used to develop a better understanding about how to effectively and efficiently leverage information technology for the development of social capital which help support knowledge sharing in organisations

1. Maximizing weak ties in one's network increases the potential for innovation and/or market penetration [44].
2. IT-based KS systems are an effective means for establishing and maintaining weak ties [43].
3. Maximizing the number of structural holes in one's network increases the potential for innovation and/or penetration [21].
4. A finite number of strong ties can be maintained [21].
5. Minimizing the number of strong ties allows for more allocation of resources to the application and creation of new knowledge.

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