

Social network influences on technology acceptance:
A matter of tie strength, centrality and density

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Abstract

This study examines social network influences on the individual technology acceptance. Since it is believed that individuals' trust, opinions and behavior are influenced by their network, an analysis of that network may help to provide some explanations on technology acceptance. However, since social network characteristics are group-level characteristics and the technology acceptance model (TAM) is grounded on an individual level, there is a need for a mediating variable that links group-level characteristics to individual-level characteristics. According to this research the subjective norm construct, as introduced in TAM2, can be used in this mediating, linking role. This research proposes three social network characteristics (tie strength, density and centrality) and examines their influence on the subjective norm construct. As a result, this research not only extends TAM with a social perspective by introducing three antecedents of subjective norm, but also reduces the potential tension that exists between models explaining behavior at the individual level (TAM) and models that explain behavior at the group level (social network). Theoretical and managerial implications derived from the model developed are also discussed.

Keywords: Social networks, Subjective norm, Technology acceptance model, Network ties, Network centrality, Network density

1 Introduction

Organizations utilize information systems (IS), among other aims, in order to make effective use of organizations' scattered knowledge and to create synergies (Schultze and Leidner, 2002). However, to make full use of such systems, system acceptance by users is critical for the successful adoption of the technology. If not, resistance to the introduction of a new information system can develop (Martinko, Henry and Zmud, 1996). In the past, many different theoretical approaches have been applied and designed to explain, predict and increase individual user acceptance of information systems (Tenkasi and Chesmore, 2003). The technology acceptance model (TAM) introduced by Davis (1989) and its extensions are being considered as the most influential within this research stream (Lee et al., 2003). However, TAM focuses on the individual psychological level of technology acceptance, with less attention for the social context such as social networks that surround the user (Sykes et al., 2009). As such, from an academic and practice perspective, little is known about the influence of these networks on the technology acceptance of individuals. Prior research already indicated that social networks can influence technology acceptance (Eckhardt et al., 2009). They do so, since social networks contain "a specific set of linkages among a defined set of persons, with the additional property that the characteristics of these linkages as a whole may be used to interpret the social behavior of the persons involved" (Laumann et al., 1978, p. 456).

Consequently, this research examines social network influences on technology acceptance. Within technology acceptance models, the concept of social influence indicates that individuals' acceptance behavior is being influenced by others. The main root construct of this social influence variable is the subjective norm concept (Venkatesh et al., 2003; Venkatesh and Bala, 2008). The subjective norm is the belief of the technology user that most of the important others believe (s)he should, or should not, accept the technology. Since the introduction of the subjective norm construct, scholars have taken it as a single construct (Lee, et al., 2003). However, previous research acknowledges the fact that "social norms need to be conceptualized in a more distinguishing manner to capture the nuances of the social environment" (Srite and Karahanna, 2006, p. 697).

As a result, this research enhances understanding of the antecedents of the subjective norm, by examining the influences of social networks and their characteristics on the construct, while reducing the theoretical tension that exists between models related to the individual level (TAM) and the group level (social network). In other words, this research presents a theoretical model where social network influences on individual technology acceptance are mediated through subjective norm. In order to do so, it suggests a social network approach to the technology acceptance process, focused on the subjective norm concept. By examining the social network characteristics, this study centers around the concepts of tie strength, centrality and density, since they are considered as the key principles of a social network, because of its core element (ties), the main individual measure (centrality) and main group measurement (density) (Cross

and Parker, 2004). This paper develops propositions concerning the influence of these social network characteristics on subjective norm.

This study provides the conceptual underpinning for extending TAM by including social network influences as antecedents of subjective norm at the individual level. This will offer new insights from a theoretical perspective, but can also lead to important managerial implications for implementing organization-wide technologies across and within business units.

2 Theoretical background

Information technology adoption and use in the workplace remains a central concern of information systems research and practice (Venkatesh and Bala, 2008). However, different approaches have been taken to explain the factors that influence the acceptance of a new technology by employees (Agarwal and Prasad, 1999). Limited attention has been devoted to the study of social networks in relation to technology within organizations (Sykes et al., 2009). Since it is believed that opinions and behavior of individuals are influenced by their network (Weimann, 1983), this paper suggests a social network perspective in order to provide additional explanations on the acceptance of a new technology. Prior research has indicated other social factors such as image (Venkatesh et al., 2003), roles and values (Thompson et al., 1991) and referents (Eckhardt et al., 2009) affecting the acceptance of technology within an organization. This research focuses on the three social network constructs of tie strength, density and centrality because they can be considered as social networks' key principles (Cross and Parker, 2004). Network ties are the core elements of a social network that are drivers of social exchange (Nahapiet and Ghoshal, 1998), while network density and network centrality channels these exchange patterns (Sykes et al., 2009). The following paragraphs provide the theoretical foundation for the proposed conceptual model.

2.1 Technology Acceptance Model

The Technology Acceptance Model (TAM) is derived from the theory of reasoned action from Azjen and Fishbein (1980) and addresses the issue of how users come to acceptance and use a technology (Davis, 1989). TAM suggests that when users are presented with a new technology, different variables influence the decision whether and how they will use it. Two causal linkages influence this decision: perceived usefulness (PU) and perceived ease of use (PEOU) of the relevant technology. Perceived usefulness explains the user's perception to the extent that the technology will improve his/her work performance and perceived ease of use relates to the user's perception of the amount of effort required to utilize the system or the extent to which a user believes that using a particular technology will be effortless (Davis, 1989). The model provides explanations of determinants of computer technology acceptance by tracing the impact of external factors on internal beliefs, intentions and attitudes.

Different researchers have extended or changed the original TAM by Davis (e.g. Segars and Grover, 1993; Venkatesh and Davis, 2000). These studies confirmed the model's validity and gave support for using it with different populations of users and different software choices (e.g. Szajna, 1994). Venkatesh and Davis (2000) proposed TAM2,

which includes all the original TAM elements but extended it by (among other constructs) social influences, since they increased the insights on perceived usefulness and usage intention constructs. Social influences were reflected in the subjective norm concept, which is defined as “the degree to which an individual perceives that important others believe he or she should use the new system” (Venkatesh et. al., 2003, p. 451). Although attention has been given to social influences, it is still acknowledged that “social norms need to be conceptualized in a more distinguishing manner to capture the nuances of the social environment” (Srite and Karahanna, 2006, p. 697). For instance, Davis et. al. (1989, p. 998) explicated the need for “more sophisticated methods for assessing the specific types of social influence processes at work in a computer acceptance context” while Venkatesh and Davis (2000, p. 200) suggest a repositioning where “the nature and role of social influence processes (both within teams and across teams) will need to be elaborated”.

This research provides an elaboration on our understanding of the subjective norm variable, which is an important extension of TAM because the subjective norm exerts a significant direct effect on usage intentions and PU (Venkatesh and Davis, 2000).

2.2 Social influences, subjective norms and social network theory

Social influence is defined as the perceived external pressure that individuals feel in the process of being informed about an innovation and decide to use it, and the degree in which an individual perceives that important others believe he or she should use the new system (Fishbein and Ajzen, 1975). People tend to adjust their beliefs according to the group they are in. Individuals are also influenced by the majority: when a large portion of an individual’s referent social group holds a particular attitude, it is likely that the individual will adopt it as well (Ash, 1951).

The original TAM presented by Davis (1989) ignored the aspect of social influence related to adopting and utilizing a new technology. Davis already observed that, in order to make a decision, individuals are influenced by their colleagues and that subjective norm was an important area for further research. Various scholars included social influence factors in their technology acceptance research approaches (e.g. Thompson et. al., 1991; Moore and Benbasat, 1991), but most consensus have been reached about the construct of subjective norm as main representation of social influences (Venkatesh et. al., 2003). Subjective norm is the perceived social pressure to engage or not to engage in a behavior (Fishbein and Ajzen, 1975). Much research in psychology theorizes subjective norm to be an important determinant of intention (Mathieson, 1991). Bandura (1977) suggested that one learns, and uses behaviors based upon what one sees in social groupings. Observed behaviors of others influence the observer to emulate those behaviors. The subjective norm reflects this, since it includes “the perceived opinions of referent others” (Mathieson, 1991, p. 176).

Previous studies have looked at the relationship between social ties and technology in areas such as exploitation of inter-organizational computer-mediated communication infrastructure (Pickering and King 1995); usefulness of electronic ties through broadcast messages (Constant et al., 1996); and electronic media usage for information exchange (Haythornthwaite and Wellman, 1998). However, so far a limited number of studies have been conducted on social influence and technology acceptance (Lee et al., 2003).

Social network theory can be described as the study of social networks and their influence on the social structure of relationships around a person, group, or organization, which can affect persons' beliefs or behaviors (Freeman, 1989). These relationships may comprise the feelings people have for each other, the exchange of information, peoples' influence on each other etc. Social networks can influence subjective norms, since information exposure, exchange and legitimization are being influenced by social network structures (Haythorntwaite, 1996) and network characteristics (Aral et al., 2007). For instance, two actors who have strong ties are more likely to trust each other, exchange knowledge more frequently and influence each other in the decision-making process (Wellman and Wortley, 1990), while network members can also influence decision makers by using their network positions in order to control, promote or restrain information (Burt, 2000).

3 Research model and propositions

Figure 1 presents our research model. This model aims at integrating elements from social network theory and the core elements from individual technology acceptance theory. In the remainder of this paragraph we will elaborate on this model and develop our propositions, which are deduced implications meant for theory development (Whetten, 1989).

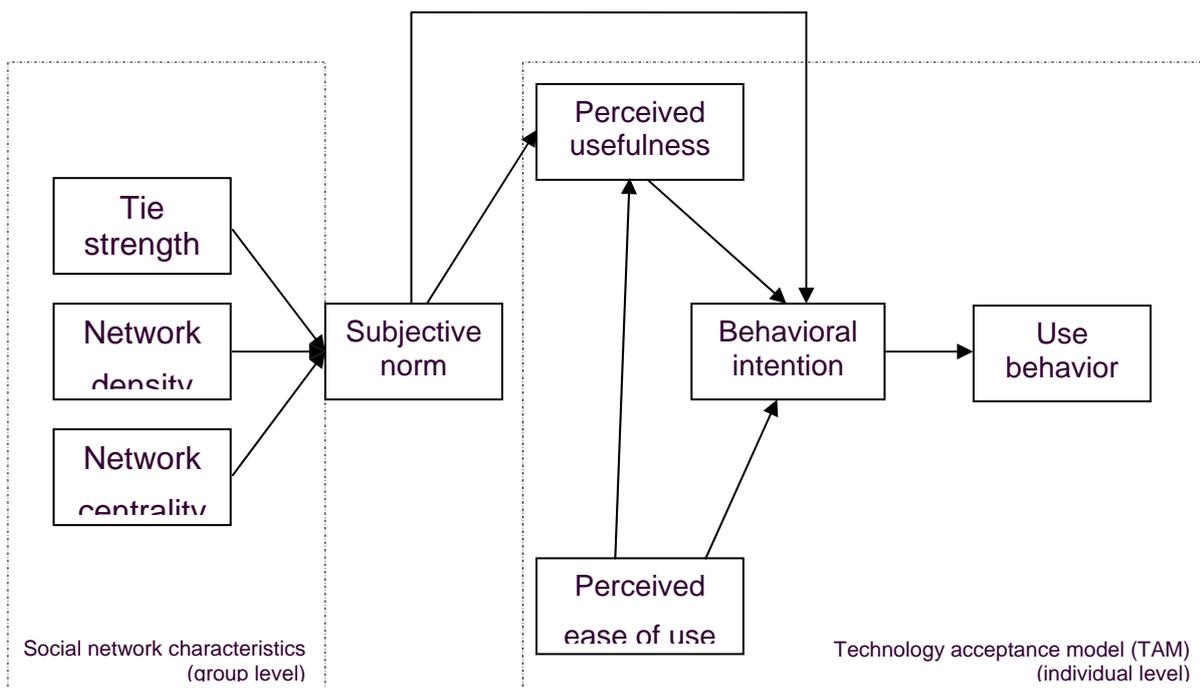


Figure 1: Social network influences on technology acceptance via subjective norm

3.1 Tie strength and subjective norm

Social ties refer to the links that connect individuals with others through the frequency and types of communications among them (Cross and Parker, 2004). The strength of a tie is “a combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie” (Granovetter,

1973, p. 1361). There are two different perspectives on social ties, namely strong ties and weak ties (Granovetter, 1973). Both types of ties are critical for the success of an organization because they provide access to different kinds of resources (Haythornthwaite, 2001).

When a company would like to implement a change, strong ties facilitate this change process and appear to be relevant for this change process as such (Krackhardt, 1992). They play a major role in achieving a shared understanding because they are based on trust and can reduce resistance and uncertainty. Actors who share a strong tie tend to influence one another more than those sharing a weak tie, share similar views, offer one another emotional support and help in times of emergency, communicate effectively regarding complex information and tasks, and are more likely to trust one another (e.g. Crona and Bodin, 2006).

On the other hand, weak ties can be more valuable than strong ties due to the diffusion of information. Weak ties are often characterized by less frequent communication where the actors share a distant and infrequent relationship that may be casual, less intimate and sharing, and nonreciprocal in nature (Granovetter, 1973; Haythornthwaite, 2001). According to McPherson et al. (2001) weak ties tend to exist between dissimilar others. Therefore, they offer access to diverse pools of new information and knowledge (which is preferable for innovation purposes). Weak ties draw a wider set of contacts and knowledge resources (Granovetter, 1973; Hansen, 1999). They do so primarily through performing bridging roles between otherwise disconnected segments of a network in the form of brokers or boundary spanners (Granovetter, 1973; Burt, 2000).

Actors who are connected through strong ties are most likely to trust each other (Putnam, 1993; Adler and Kwon, 2002). Trust is an important reason why strong ties tend to have more influence on technology acceptance through a process of knowledge sharing (Levin and Cross, 2004). Actors who are sharing a strong tie tend to influence one another more than those sharing a weak tie (Granovetter, 1973). Research has shown that people connected through strong ties are more accessible and willing to be helpful in sharing behaviors (Krackhardt, 1992). Organizational members who have a more extensive relationship with their colleagues would perceive greater social pressure for sharing their knowledge, because a good relationship results in high expectations of colleagues (Chow and Chan, 2008). Fishbein and Ajzen (1975) define subjective norm as the perceived social pressure to engage or not to engage in a behavior. As such, given the arguments before, tie strength can be expected to have a positive relationship with the subjective norm (whether it inhibits a positive or negative attitude towards the technology), since social pressures and influences will be primarily developed through stronger ties. This leads to the following proposition:

Proposition 1: Higher levels of tie strength positively influence subjective norms.

3.2 Network centrality and subjective norm

Network centrality refers to the position of an actor in the network structure and captures the individual's potential access to resources (Wasserman and Faust, 1994). When a network is characterized as highly central, one or a few individuals are presenting the majority of ties within the network. Previous research has characterized

central networks as being initial for the phase of forming groups and building support for collective action (Crona and Bodin, 2006). Coleman et al. (1957), for instance, found that individuals who are highly integrated into a social system are in general quicker to adopt than individuals who are isolated from the group. These isolated peripheral actors were less influenced by others and learned primarily about the innovation from outside sources. A central network on the other hand, provides the structure that connects individuals and gives them easy access to other network members. This can reinforce the current subjective norm considering technology acceptance. Therefore, it is much likely that in a highly central social network the group is more likely to adopt a new information system technology. Three centrality measures can be identified in order to explain the influence of network centrality on the subjective norm: degree centrality, betweenness centrality and closeness centrality.

Degree centrality is defined as the number of ties that are directly connected to each other (Cross and Parker, 2004). Looking from a group-perspective, network centrality is referred to as the connectivity of the actors in a social network (Coleman, 1990). Degree centrality is determined by individuals' frequencies of incoming and outgoing communications with others and measures how active or popular a particular actor is (Freeman, 1979). Central persons within a network often play a significant role when it comes to share information, influence others or bridging different communities (Chau, and Xu, 2005). Consequently, actors high in degree centrality can act as opinion leaders. An opinion leader can be considered as an informal leader who tends to influence others around them (Rogers and Kincaid, 1981). Hence, these actors could be effectively used to maximize social influence (subjective norm) within a social network.

Next, betweenness centrality refers to how many times a person lies in the shortest path between two others who are themselves disconnected (Freeman, 1979; Wasserman and Faust, 1994). Persons high in betweenness centrality often act as communication channels between different communities who transmit resources (Chau and Xu, 2005). As such, if an actor is the only bridge between two (sub-)networks, he/she acts as a broker who can jump in a structural hole (Burt, 2000). This implies a certain control of subjective norms, since it indicates a level of dependency of one actor to communicate with other actors.

In addition, closeness centrality provides a measure of a person's global centrality within a network (Scott, 2000). It is defined as the sum of the length of the shortest path between a particular actor and all other actors in a network (Freeman, 1979). In general, "persons highly central with respect to closeness tend to hear information sooner than others" (Cross and Parker, 2004, p. 157). This can indicate that these people are sooner influenced by social pressures, but can also mean that they have a certain control of these pressures by spreading that information or not. Summarizing the network centrality antecedent and considering the measures it consists of, high network centrality can be expected to have a positive influence on the subjective norm, which leads to the following proposition:

Proposition 2: Higher levels of network centrality positively influence subjective norms.

3.3 Network density and subjective norm

Network density is the degree to which the actors in a social network are connected to each other (Haythornthwaite, 1996). It can be measured by the number of existing contacts (ties) divided by the potential number of contacts among the network members (Cross and Parker, 2004, p. 159). Network density can also be referred to as the level of connectedness among the actors in a social network (Coleman, 1990). The stronger the connections between individuals in a network, the stronger the social norm is through mutual influence and reinforcement. This reduces uncertainties and creates a sense of belonging and is likely to enhance trust (Chua and Morris, 2006). Majumdar and Venkataraman (1998) propose that the density and variety of the user population will be positively related to levels of new technology adoption at all times.

These interconnections between actors inform and influence one another to create a shared meaning and a sense of common purpose (Tenkasi and Chesmore, 2003). A stronger density in a social network, as a result of strong ties, may help the actors to cope with change and ensuring that the change succeeds (Tenkasi et al., 1998). The larger the network becomes, the lower the density. As a consequence, the norms of a larger network will be more fragile than a smaller (denser) network. When the network becomes too large, the norms cannot influence the behavior of network participants (Burt, 1992). As such, it is expected that network density influences the subjective norm.

Network density enhances conformity and solidarity (Krackhardt and Hanson 1993) and increases the degree of trust, cooperation, commitment (Sparrowe et al. 2001) and the flow of information (Rowley, 1997). Further, ties that are interconnected tend to develop shared norms, behavioral expectations and promote interpersonal cooperation (Brickson, 2000). A dense network consisting of strong ties tends to share a majority view (Janis, 1983), reduces uncertainty, create meaningful information (Weick, 1995) and tend to produce homogenous evaluations and normative pressures (Friedkin, 1982), which can lead to a reinforcement of the subjective norm.

According to Hechter's (1987) theory of group solidarity, dense networks are more likely to be able to influence the behavior of members, because each individual is tied to another individual, where each member knows each other and interacts frequently. Dense networks tend to influence and control the behavior of the actors participating in the network and create social pressure towards conformity to the group's values (Wolf, 1966). Therefore, it can be expected that high network centrality has a positive influence on the subjective norm, which leads to the following proposition:

Proposition 3: Higher levels of network density positively influence subjective norms.

4 Conclusion and Discussion

4.1 Theoretical conclusion

The main purpose of this paper was to deepen our understanding of the social influence variable within TAM and extend it by taking a social network perspective. The conceptual research was grounded in literature on social networks, social influences and subjective norms and led to the proposition that social network characteristics such as tie strength, network centrality and network density have a positive influence on

subjective norm. As such, this paper proposes a more social view on technology acceptance. Although current technology acceptance models incorporate social influence effects on adoption decisions (subjective norms and image), they lack a further investigation of the influencing role of social networks. As social network characteristics are group-level characteristics and the TAM model is on the individual level, there was a need for a mediating variable in order to link group-level characteristics to individual-level characteristics. This link was found in the subjective norm concept as introduced in TAM2, since social norms and interpersonal communication networks play significant roles in affecting adoption decisions (Yi et al. 2006). Overall, this paper presents an enhanced theoretical understanding of people's social networks and their influence on technology acceptance decisions, in order to better understand the drivers behind the actual use and acceptance of a system of individuals.

4.2 Managerial implications

The theoretical findings of this study provide insights on the role of social influences within individuals' technology acceptance, which can lead to organizational adjustments in order to improve technology implementations. Mandatory approaches to introducing new systems or technologies appear to be less effective over time than the use of social influence to target positive changes in perceived usefulness (Venkatesh and Davis, 2000). Therefore, organizations need to investigate their social networks and make adequate actions based on the outcomes. A common approach to do so, is executing a social network analysis (SNA) with a socio centric (group) approach. "A typical social network analysis uncovers and tracks the number of links among individuals in (...) networks, the frequency with which people communicate, the relative significance of their communication, and the number of people through which a message passes." (Kleiner, 2005, p. 4). This approach offers great value, since it is a mature methodology with proven results within organizational settings (Cross and Parker, 2004). Organizations can use the findings on the core social network characteristics, in order to increase technology acceptance via the subjective norms within the organization. For instance, they can do so by focusing on promoting more network connectivity to increase tie strengths within and across all various existing networks in order to align subjective norms; using highly central persons to spread information about the technology around the network, given the fact that these persons support the implemented system; and increasing network density in order to enhance conformity and solidarity within a working group, stimulate trust, commitment and cooperation and increase the flow of information regarding a new technology. Via these applications, organizations can make effective use of segments of social networks, instead of convincing large amounts of employees, agents and/or customers to use technologies. However, organizations with strong social networks, must be aware of the strength of these networks when it comes to adoption of new technologies. A negative message in combination with a strong social network can result in "do not adopt" as social norm.

4.3 Limitations

The research presented has some limitations that should be addressed. First, the conceptual model presented is based on a literature study and as such, is not empirically tested yet. However, the objective of this study was to present a more in-depth conceptual understanding of the social influence factor within the technology acceptance model, by linking social network characteristics to the subjective norm concept.

Since the proposed model includes the fundamentals of the TAM, it is worthwhile to address some opinions about the model as well. There has been a streamlet that focused on its limitations and their arguments can be valid for this model as well (see Benbasat and Barki (2007) for an extensive overview). Lucas and Spitler (2000) argue that the model is not applicable on the whole range of technology possibilities. They concluded that TAM might not work in the case of a complex technology. Another important aspect is the cultural dimension. Cultural background of individuals influence the decision-making process and therefore, also the process of adoption and use of information systems (Myers and Tan, 2002). Gefen and Straub (1997) investigated the gender differences and concluded that it affects the IT adoption process as well.

4.4 Future research

Based on the limitations above, there are many possibilities for model validation and application. This model can be used as a backbone model for empirical research by, for instance, investigating the degree of social influence variance explained by the model. This can be achieved by a follow-up study where data will be collected via a combination of social network analysis and TAM survey methodology. A comparable methodology, yet with a different subject-matter and within an online context, was applied by Wasko and Faraj (2005). Another possibility could be implementing longitudinal studies, in order to examine influence developments over time. Future research can consider additional social network characteristics as well for investigating social pressures, such as network exposure (Valente, 1996). More specific research can focus on applying different factors that might influence the outcomes. The argument of Meyers and Tan (2002) that cultural background affects the behavior of individuals is a good starting point to deepen the research and look at different groups based on ethnicity, gender, or age. The complexity of technology can be addressed in a multi-case research comparing different social networks (different characteristics) with different levels of technology complexity.

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