行政院國家科學委員會專題研究計畫 成果報告

建構企業組織之資訊科技關係品質與決定因素：一個線上服務之網路外部性觀點
研究成果報告(精簡版)

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計畫編號：NSC 98-2410-H-263 -001 -

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計畫主持人：蔡淵輝

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行政院國家科學委員會專題研究計畫成果報告

建構企業組織之資訊科技關係品質與決定因素：一個線上服務之網路外部性觀點

Modeling IT Relationship Quality and Its Determinants across Business Organizations: A Perspective of Network Externalities in E-Service

計畫編號：NSC 98-2410-H-263 -001 -
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主持人：蔡淵輝　致理技術學院財金系
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一、中文摘要

本計畫以資訊科技爲背景，應用網路外部性理論爲基礎著眼於關係品質的發展，本研究模式預測資訊科技之關係品質受到同步價值與自給價值的影響；同時，同步價值受到關係承諾與知覺關係多數的影響，而互補產品可及性受到知覺相容與整理建置基礎的影響。本研究模式使用台灣的多家企業收集的資料做爲實證，而實證發現與意涵也都於本計畫內做進一步地討論。

關鍵詞：關係品質、網路外部性、同步價值、自給價值。

Abstract

This project addresses the development of relationship quality in the service context of information technology (IT) based on the network externalities theory. The model predicates the IT relationship quality is influenced by both synchronization value and autarky value, whereby autarky value is influenced by the availability of complementary goods. At the same time, synchronization value is influenced by relationship commitment and perceived critical mass, while availability of complementary goods is influenced by perceived compatibility and overall installed base. The model is examined using data obtained from employees of different companies in Taiwan. The empirical findings and their implications are discussed herein.

Keywords: Relationship quality, network externalities, synchronization value, autarky value.

二、緣由與目的

IT relationship quality (e.g., human-computer relationship) evaluates the relationship strength or interaction between IT and its users (e.g., Lin and Ding, 2005) and also represents the extent to which IT meets the needs and expectations of the users involved based on a history of successful or unsuccessful encounters or experiences (Crosby et al., 1990). IT relationship quality can be conceptualized as involving users' trust on specific IT and their satisfaction with the IT. Collectively, IT relationship quality is regarded as a construct comprising at least two components: (1) user trust in the IT service (e.g., Swan et al., 1985) and (2) user satisfaction with the IT service (e.g., Crosby et al., 1990). Hence, this study assumes that improved IT relationship

quality is accompanied by increased IT satisfaction and trust. This study next briefly expands on these two important dimensions of IT relationship quality.

Satisfaction with IT in this study means IT users' emotional status occurs in response to an assessment of interaction experiences with their IT service (Preece, 2001). User satisfaction depends directly on managing and monitoring individual service encounters - namely, the periods of direct user interaction with IT service (e.g., Shamdasani and Balakrishan, 2000). Trust is usually considered necessary for a successful interactive relationship between IT and its users. More specifically, trust can be viewed as users' confidence in the reliability and integrity of IT service (Pavlou, 2003).

Katz and Shapiro (1985) described two types of network externalities: direct and indirect. There is quite a distinction between direct and indirect network effects. Direct effects occur as an immediate result of participation in a network, while indirect effects are due to an emergence of complimentary products and services (Gupta and Zhdanov, 2006). Whereas direct externalities result from the demand side of a network, indirect externalities stem from the supply side. These two types of network externalities are introduced in more detail below.

Direct network externalities are based on the number of participants in a given network. Typical examples include the number of sellers and the number of buyers in an online auction network such as eBay, the number of customers in a given cellular network like Verizon or T-Mobile, the number of gamers on an online gaming website like PartyPoker.com, or the number of Skype users online. As new participants enter these networks, existing users gain more choices for communicating, trading, and playing games, and thereby gain network utility. Direct network effects pertain to how properties of the customer network affect the perceived value of the service (Thorbjørnsen, Pedersen, and Nysveen, 2009). Such direct network effects are applied in both social network theory and industrial economics to explain the "bandwagon effect": the more existing customers there are for a service, the more attractive the service becomes even for potential customers (Frels et al., 2003). Previous literature argues that the adoption of information systems requires the participation of many individuals to create a sense of collective action (Lou et al., 2000).

Indirect network externalities are ancillary benefits accruing to network participants, such as the development of complementary goods, services, formation of standards, and the lowering of prices as a network grows, but they do not directly result from other network participants. A traditional instance of complementary goods is motor oil and gasoline: if gasoline consumption falls due to a price increase, the consumption of motor oil will fall as well, because motor oil and gasoline are used together (Chernev, 2005). Complementary goods can be extended to the idea that people seek products with characteristics that are different from and complement their own ones, also known as the idea that opposites attract (Ansell, Kurtz, and Markey, 2008; Dryer and Horowitz, 1997; Moskowitz and Ho, 2007). The theory of indirect network effects argues that the availability of a complementary product (or service) affects the perceived value of a networked product (or service). The prototypical example of indirect network effects is how the supply of software and the demand for hardware affect each other positively (Thorbjørnsen et al., 2009). For example, the value of a digital music (DM) player counts heavily on the availability of digital music, thus indirect network externalities have a significant influence on customer perceptions of the value of a DM player (Song, Parry, and Kawakami, 2009).

2.1 Research framework and development of the hypotheses

Network value is an important motivation

for using network IT (e.g., Internet, wireless network, or mobile network). This phenomenon allows, in principle, the value received by IT users to be separated into two distinct parts, including direct and indirect network effects (Liebowitz and Margolis, 1995, 1996). The direct effects, which are called synchronization value, represent the value derived from being able to interact with other users of the product (Liebowitz and Margolis, 1995, 1996) based on a perspective of social utility. Accordingly, the indirect network effects, which are labeled the autarky value, are the additional value generated by the product even if there are no other users (Liebowitz and Margolis, 1995, 1996) based on a perspective of technical utility.

The term "autarky" is originally Greek and means "self-sufficiency" (Bala and Long, 2005). The autarky value represents the value generated by the product itself even if there are no other users (e.g., the printing and copying functions of a fax/printer combo machine) (Ge, 2002; Stephenson and Sage, 2007). Distinguishing between autarky value and synchronization value helps IT firms develop their critical product strategies for future business growth (e.g., Lin & Kulatilaka, 2007). An autarky is often used to express an economy that is self-sufficient and does not participate in any international trade with others, or strictly limits trade with the outside world (Irwin, 2005). Likewise, the term refers to a social system that relies heavily on its own resources. Autarky value represents individuals' perceived value obtained without their social interaction with others (that is, to experience a product's benefit solely by themselves), whereas synchronization value represents the individuals' perceived value obtained through interaction (that is, to get no benefit without others). A typical example of synchronization value for users in instant messaging is that they experience joyful text chats with others online, whereas a typical example of autarky value for users is that they experience interesting video games disregarding their social interactions with others.

Empirical studies by Gandal (1994) and Brynjolfsson and Kemerer (1996) demonstrated that users who are satisfied with spreadsheets are willing to pay a higher price for spreadsheets with a larger number of participants such as Lotus (e.g., direct network effects), or those having great compatibility with Lotus (e.g., indirect network effects). This phenomenon suggests that those who turn to a specific IT service due to their satisfaction with and trust on the IT service are likely driven by synchronization value and autarky value. More specifically, the more IT users are able to interact with other users by using the same IT (i.e., synchronization value), the better the satisfaction and trust towards the IT they will have, leading to stronger IT relationship quality. Accordingly, the more fringe benefits that are generated by using specific IT without social interaction with others (i.e., autarky value), the better the satisfaction and trust they will obtain towards the IT, resulting in stronger IT relationship quality and implying a positive influence of autarky value on relationship quality.

Specific IT that helps users establish interpersonal ties with other people is likely to achieve emotional, instrumental, and informational communication (e.g., a form of synchronization value) for the users and thus can be a source of satisfaction (Denissen, Penke, Schmitt, and van Aken, 2008). Emmers-Sommer (2004) tracked research subjects' assessments of communication quality and quantity (e.g., a form of synchronization value) within either romantic relationships or friendships and found that both indicators (aggregated across 1 week) independently predict relationship satisfaction (Denissen et al., 2008), suggesting the potential influence of synchronization value on relationship quality. Consequently, this expectation leads to the next hypotheses.

H1: The synchronization value perceived by IT users is positively related to IT relationship quality.

H2: The autarky value perceived by IT users is positively related to IT relationship quality.

Relationship commitment can be seen as an individual's intrinsic motivation that boosts the expected persistence in a supportive relationship with others (Agnew, Van Lange, Rusbult, and Langston 1998). Network IT provides virtually a social system for online users to develop their social relationships with online others. Thus, relationship commitment should be effectively taken into practice in the service context of network IT.

Relationship commitment indicates a psychological and emotional attachment to a relationship between individuals and their specific friends or relatives (Rusbult, Martz, and Agnew 1998). The popularity of network IT provides confirming evidence that the expected communication of maintaining interpersonal relationships drives users' satisfaction and trust towards the IT service (e.g., Lin and Ding, 2005; Scott, 2001; Simon, 2006), implying a critical role of relationship commitment in network IT. More specifically, because one's relationship with others is the foundation of social interaction (Li et al. 2005), the commitment to maintaining the relationship is fundamental to the synchronization value that the IT users care so much about. To put it differently, the network IT is helpful particularly for users with a high commitment to cultivating relationships with friends or relatives, leading to a strong synchronization value of the IT perceived by the users. Thus, the hypothesis is stated as below.

H3: The relationship commitment of IT users is positively related to the synchronization value perceived by the users.

The importance of perceived critical mass has been indicated in previous research in that users may use IT according to a subjective perception of the critical number of current IT users in the market (Lou, Luo, and Strong 2000). Significantly applied to the diffusion of interactive communication media, perceived critical mass reflects individuals' perception about a small segment of the population that chooses to make big contributions to a collective action (Oliver, Marwell, and Teixeira 1985). Perceived critical mass is particularly important to network IT, because the IT often requires social interdependence collectively between two or more users simultaneously (Li et al. 2005), suggesting a positive relationship between perceived critical mass and synchronization value perceived by the users.

IT users often base their affections on how many of their friends, colleagues, or others in their social circle use a specific target IT, because this perceived critical group defines the universe of users with whom they can interact with while using the IT (Liebowitz and Margolis 1995). A case in point is Skype, which is an Internet telephony software allowing users to talk to other Skype users anywhere in the world without using expensive telephone connections, simply by using their computer and a Internet connection. Naturally, the attractiveness of Skype to a given user increases as more friends and acquaintances (i.e., the critical mass) adopt and use this software. In our particular instance, the larger a given user's perceived critical mass is, the more synchronization value she experiences from the IT, and consequently the greater is her motivation to use the IT. Hence, we propose the next hypothesis.

H4: The perceived critical mass of IT users is positively related to the synchronization value perceived by the users.

The availability of complementary goods for IT users is extended to the idea of the accessibility of products with characteristics that complement users' IT (Ansell et al., 2008; Dryer and Horowitz, 1997; Moskowitz and Ho, 2007), enhancing the value of IT usage in which social interaction is not required (i.e., autarky value). Many IT

products are heavily affected by the availability of complementary goods or services that enhance the value of the product. In many cases, the lack of sufficient availability of complementary products impedes the success of a product (Bhaskaran and Gilbert, 2005). Complementary relationships often arise in consumer IT products. For instance, the supply for online video games is highly dependent upon the availability of video-game websites - that is, with more video-game websites available on the Internet, it is more likely that consumers are able to obtain more online video games (i.e., the value increases). Many technologies are not desirable to customers without an associated set of complementary goods such as software for computers and memory cards for digital cameras, weakening their autarky value. Indirect network externalities are those that result from the availability of complementary goods and services that enhance users' benefit from being a part of the network. In other words, indirect network externalities that generate autarky value are ancillary benefits particularly due to the development of complementary services.

More and more complementary goods that are available for a specific target IT means that people who use the IT are likely to upgrade the functions of the IT easily by, for example, paying an inexpensive fee for complementary goods due to economies of scale, suggesting higher autarky value. Though indirect network externalities (i.e., autarky value) are commonly expected for network effects, goods such as online reservation systems and online auctions, many non-network and/or physical goods such as automobiles, videocassette recorders, and computer software still experience indirect network externalities in the form of complementary services, product standardization, and so forth. For example, Apple and Google have traditionally operated at different and complementary parts of the value chain in which Google's Android recently works to match iPhone Store's mobile software market (McLean, 2009).

The theory of network externalities suggests that the availability of complementary products ultimately influences users' perceptual benefit (or productivity benefit) from using interactive IT such as e-mail systems and online video games, and even many non-network IT such as operating systems and spreadsheets (Shapiro and Varian 1999). This further implies that the availability of complementary goods may affect users' perceived autarky value. Given that the autarky value represents the technical value generated by the service or product even without other users for mutual interaction (Liebowitz and Margolis, 1995, 1996), the availability of complementary goods that increase technical value is thus positively related with the autarky value of IT users. Specifically, a given user's IT usage depends heavily on the extent to which the user perceives the IT as having complementary goods, suggesting the importance of the availability of complementary goods. Users that perceive a given IT as having a higher available level of complementary goods and services generate greater network benefit from that complementarity than those who perceive it as being less complementary. This expectation leads to our next hypothesis.

H5: The availability of complementary goods for IT users is positively related to the autarky value perceived by the users.

Compatibility (e.g., interpersonal compatibility, compatibility between personality attitudes) is a concept that describes the long-term interaction between two or more subjects in terms of the ease and comfort of communication (Ackoff, Emery and Ruben, 2005). In this study, perceived compatibility refers to the degree to which a specific IT is perceived as being consistent with the existing values, needs, and past experiences of potential adopters during the interaction between the adopters and their IT (Moore and Benbasat, 1991). When the compatibility is perceived strongly by many

users in the market, it is likely that the invention and supply of complementary goods are driven by a large user demand, suggesting a positive relationship between perceived compatibility and the availability of complementary goods. Previous research indicates that IT users' benefits may increase with the number of users of the same good when compatibility is important (Schilling, 2002), implying the importance of perceived compatibility as an antecedent variable. Examples include the compatibility of memory cards with digital cameras and the compatibility of existing computer files with new software.

The proliferation of an incompatible product or service to users may prove detrimental, however, because it will likely cut up the market and create uncertainty among product or service providers (Van Hove, 1999). Without IT compatibility, users of network IT may be discouraged and may not achieve economies of scale, leading to a low availability of complementary goods. Consequently, this hypothesis is derived as below.

H6: The perceived compatibility of IT users is positively related to the availability of complementary goods for the users.

The first important contribution of the network externalities literature concerns formalization through the concept of an overall installed base. This means an equilibrium market for the goods is unlikely to exist unless the overall installed base is greater than a minimum level (Van Hove, 1999). When an industry is characterized by network externalities, the overall IT installed base and the availability of complementary goods likely play major roles in network effects (Schilling, 2002). For example, when bankers launch payment instruments, the bankers (or issuers) are faced with a 'chicken-and-egg' problem: merchants will be reluctant to invest in new equipment or software needed to accept such payments unless an amount of sufficient consumers show their interest. Consumers, on the other hand, will not use the new means of payment if they can only use it in a few places (Van Hove, 1999). When customers compare the value of a new technology to an existing one, they weigh a combination of subjective information (e.g. perceived technological compatibility, perceived information on the installed base and complementary goods). This process is captured in this study's proposed model (Dattée and Weil, 2005). In other words, an insufficient installed based in a society may result in a situation in which a firm finds itself unable to develop or competitively sell products in society. Products that have a large installed base are likely to attract more providers of complementary goods.

As more IT users join a network, a growing user base becomes increasingly attractive for IT providers to offer complementary goods of potential interest to the user base. For example, the number of CD titles available is likely driven by the installed base of sets of CD players (Gandal et al., 2000). The same phenomenon applies to such IT products as iPods. In other words, the user's network benefit from Skype depends in part on the total installed base of Skype users worldwide. Similarly, a large installed base of Microsoft Windows is often credited to the availability of a larger number of application tools and software on this platform, versus competing platforms such as Linux or Macintosh. A large installed base extends the range of a user's network, attracts more developers of complementary technologies, and thus increases the number of options available to the user, therefore enhancing the value of the user's IT usage (Choi, 1994; Cottrell, 1998). This phenomenon suggests that the complementary goods of a particular IT are likely provided in the market based on the overall installed base of the IT, leading to a new hypothesis as follows.

H7: The overall installed base is positively related to the availability of complementary goods for the users.

三、結果與討論

3.1 Subjects and measures

The research hypotheses described above were empirically tested using a usage survey of instant messaging (IM) technology among student subjects at an evening college of a large university in Taiwan.

A random set of classes from the management college at a university was selected for data collection purposes, with the requirement that participating subjects must have had experience with using at least one kind of IM (e.g., MSN, Yahoo IM, etc.).

Relationship quality is measured with four items modified from Lin and Ding (2005). While synchronization value with four items is modified from Lin and Bhattacherjee (2008), autarky value with four items is modified from Grewal et al. (2001). Relationship commitment with three items and perceived critical mass with four items are modified from Li et al. (2005). The availability of complementary goods with four items is modified from Lin and Bhattacherjee (2008). Perceived compatibility with four items is modified from Moore and Benbasat (1991) and Grewal et al. (2001). Finally, overall installed base was measured using four items that asked subjects to indicate their observation about what percentage of people, university students, working adults, and senior high school students used IM, on a ten-point scale with ranges such as 0-9%, 10-19%, 20-29%, and so forth. This scale was a modified version of Schilling's scale (2002) and was developed based on pre-test interviews of student subjects regarding their IM use.

3.2 Data analysis

The final survey data were analyzed (with the CALIS procedural of SAS software) using a two-step structural equation modeling (SEM) approach proposed by Anderson and Gerbing (1988).

After considering MI (modification index) used to examine indicator variables (Jöreskog and Sorbom, 1986), some indicator variables were removed from the model under the circumstance that the indicator variables were multidimensional (Hatcher, 1994). Consequently, every construct in the measurement model is measured using at least three indicator variables. The chi-square/df in this study meets the standard criteria, because a chi-square/df that is lower than 2.0 reveals a good fit according to the informal rule-of-thumb criteria (Hatcher, 1994). The goodness-of-fit of the CFA (confirmatory factor analysis) model was assessed using a variety of fit metrics. Although the normed fit index (NFI) and the adjusted goodness of fit index (AGFI) are both slightly lower than the recommended value of 0.9, the root mean square residual (RMR) was smaller than 0.05, and the root mean square error of approximation (RMSEA) was smaller than 0.08, while the comparative fit index (CFI), the non-normed fit index (NNFI), and the goodness of fit index (GFI) all exceeded 0.90. These figures suggest that the hypothesized CFA model in this study fits well with the empirical data.

Note that the above indices are important in SEM for evaluating an ideal fit for the measurement model. First, as an alternative to the chi-square test, Bentler and Bonett's (1980) normed-fit index (NFI) is regarded as the percentage of observed-measure covariation explained by a given measurement or structural model (Anderson & Gerbing, 1988; Hatcher, 1994). Second, Bentler's (1989) comparative fit index (CFI) is similar to the NNFI in which it offers an accurate assessment of fit regardless of sample size (Hatcher, 1994). Third, a variation on the NFI is the non-normed fit index (NNFI) which has been proved to better reflect model fit under all sample sizes (Bentler, 1989; Hatcher, 1994).

Convergent validity was examined and evaluated using three criteria suggested by Fornell and Larcker (1981). Collectively, the empirical data collected by this study met all

three criteria required to assure convergent validity. In SEM the chi-square difference test can be used to assess the discriminant validity of two constructs by calculating the difference of the chi-square statistics for the constrained and unconstrained measurement models (Hatcher, 1994). Since the chi-square difference statistics for every two constructs all exceed 12.74 in the model, discriminant validity is successfully achieved.

After the measurement model testing, the CFA model in the first stage was transformed to a structural model that reflects the hypothesized associations described in our research model for purposes of hypotheses testing.

Six out of our seven hypothesized model paths were validated at the $p<0.05$ significance level or better. Specifically, IT relationship quality is significantly influenced by synchronization and autarky value (H1 and H2 are supported), while synchronization is influenced by relationship commitment and perceived critical mass (H3 and H4 are supported). At the same time, autarky value is influenced by the availability of complementary goods, which is in turn influenced by perceived compatibility (H5 and H6 are supported). However, the influence of overall installed base on the availability of complementary goods is insignificant, suggesting that H7 is not supported.

3.3 Discussion

The role of users in improving relationship commitment and the role of suppliers in improving their service compatibility substantiate the fact that no individual enterprise in isolation can succeed in its drive to obtain IT relationship quality in the process of technological change. For example, customers are less likely to adopt a technology when they are not told of it by others in their social circle and/or perceive the technology is poorer than that of competing and complementary technologies. Famous examples of this situation can be seen in the failure of Sony's Beta video standard (Matsushita promptly licensed its VHS format to ensure the rapid production of VHS videotapes) and the uninteresting customer response to the PowerPC (for which only a few software programs were available) (Schilling, 2002). The failure of these goods (Beta video standard and Power PC) is not because their product quality is bad, but rather because their providers did not generate network effects through a positive psychological response of customers in general in society, leading to low network externalities.

The results of our study empirically establish the network externality hypotheses that users' perceived value, including synchronization and autarky values, is an important predictor of their IT relationship quality. By validating the network effect hypotheses using primary data collected directly from users, this study serves as an important complement to previous works that employed secondary data (e.g., market price information) from network providers to prove similar hypotheses.

It is important to note that network effects can be driven by variety or quality depending on technological or social change. Nintendo's prior dominance in the video-game market was mostly driven technically by the quality of the video games Nintendo and its licensees offered (i.e., technical change) (e.g.,, Markovich and Moenius, 2009). Similarly, iPhone successfully presents lock-in and network effects due to its superior quality and attractive functions (Dörr et al., 2009).

Given the significant direct and indirect network effects on IT relationship quality, marketers interested in widespread user diffusion of their IT services and/or management responsible for the implementation of interactive IT in their organizations should be cognizant of and stress the important role of network effects in their rollout plans. For example, the two strategic roles of adapting and shaping (Hagel, 1996) have the potential to generate

considerable value in the context of network externalities. Specifically, firms applying an adapting strategy (i.e., adaptors) endeavor to stay one step ahead of their competitors in response to changes in the e-commerce environment with network externality, while firms applying a shaping strategy (i.e., shapers) focus on the fluidity of events and on opportunities to affect outcomes in the environment (Hagel, 1996). Managers making good use of the two strategic roles can effectively achieve successful IT relationship quality.

四、計畫成果自評

This study provides an illustrative example of how the network externalities theory is extended to study IT relationship quality and represents such externalities as key factors in inducing social change in the contexts of IT relationship quality.

Besides, this project has been written as a journal paper submitted to a SSCI journal titled *Technological Forecasting and Social Change*.

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