Understanding Competing Application Usage By Integrating Information System Success Model And Network Externality Theory

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ABSTRACT

The D&M IS Success Model has been widely applied to evaluate the information system now. Since the connections and communications among individuals tend to be closer, this study introduces network externalities to the existing model In addition, although previous studies view the information quality, system quality and service quality as independent variables without interactions, this research investigates the inter-relationships among them. Since there are so many applications with same functions in the competitive market, in this study we also try to understand competing application usage by integrating IS success model to see how individuals make a decision to select one from two choices, and analyze the theory in the relative evaluation by applying comparison by difference (e.g., "user's satisfaction towards A" minus "user's satisfaction towards B"). The result shows that network externalities have great significance on three dimensions of quality, and its effect on service quality actually exerts by the mediating effects of information quality and system quality. The service quality was also proved to be affected positively by information quality and system quality. Thus, the current study not only contributes to the current theory by extending the model, but also provides some practical implications.

Keywords: IS Success Model, network externalities, service quality, competing application usage

INTRODUCTION

For many years, the D&M IS Success Model has been widely used to measure the complex dependent variables in information systems and also evaluate the success of an information system. The D&M IS Success Model tends to be increasingly rich by researches that focus on many independent variables influencing the IS success, for instance, trust, user expectations, extrinsic motivation, IT infrastructure and task compatibility, etc [21]. Apparently, in our times, people communicate mutually easier and more frequent, and their action of using an IS can also be easily influenced by others. Therefore, we introduced the network externalities into the D&M IS Success Model, testing whether it puts effects on IS success, and if it does, how it works.

Moreover, researchers have long recognized that the three dimensions of quality, i.e., information quality, system quality and service quality have parallel effects on user satisfaction and use, but there is little research on the inner relationship of these qualities [34] . Several researches suggested that there are mediating interactions among the three types of quality [9] . Considering the prevalence of high technology, narrowing the gap of information quality among information providers and the gap of system quality among system operators, service quality is becoming more and more tangible for IS users and important for IS users as well as system owners and sponsors. Therefore, joint effects of system quality, information quality and service quality desire more attention.

Furthermore, as said before, in the competitive market, given that there are many information system with similar functions are available, such as operating systems (e.g., Linux, MacOS, and Microsoft Windows) and office software packages (e.g., Microsoft Office, StarOffice and IBM SmartSuite).Thus compared research that examines more than one similar information system is tends to be an interesting and significant topic to study which application would be chosen by individuals and what would affect them to select one from various choices. However, according to the prior IS success literature, studies have not shaded light on the issue of product selection .Therefore, in order to fill this gap, in this research, we choose WeChat official account and a mobile application, both providing weather forecast and related information (e.g., UV, the air quality and even advice on dressing) and service (e.g., share to SNS) as alternatives. Based on this context, the study examined the following features of the alternative: network externalities, information quality, system quality, service quality, user satisfaction and use. We conduct a special measurement of questionnaire by requiring subjects to answer each question for WeChat official account and mobile application respectively. Thus, when answering the questionnaires regarding the features and satisfaction of one information system, these subjects may compare their evaluations with the alternative. In this way, we suppose that the results would be more valuable and trustworthy. In fact, researchers in the field of psychology and marketing have widely acknowledged this issue [7] [25] [33] .

THEORETICAL BACKGROUND

IS Success Model

DeLone and McLean Information Systems Success Model (Figure.1) was first proposed by DeLone and McLean in 1992 which is based on theoretical and empirical IS research conducted by researchers in the 1970s and 1980s, being used as a model for measuring the complex dependent variable in information system research [8] .
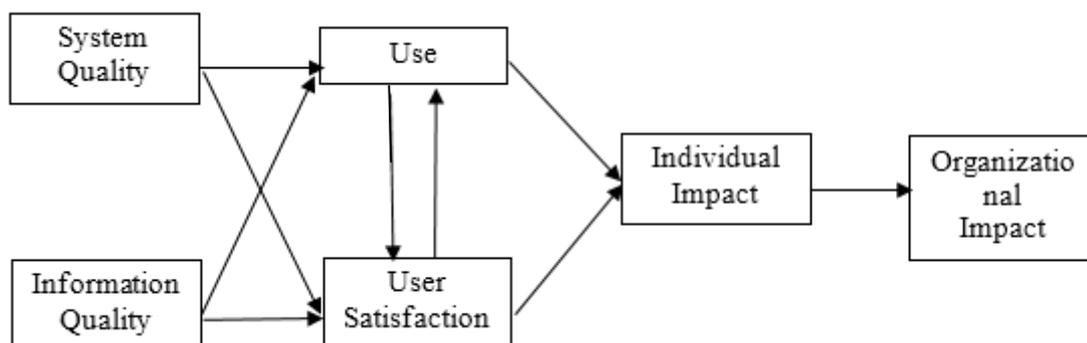
Figure 1. Information Systems Success Model (1992)

While with sequent researches, for instance Shannon and Weaver [24] and the information "influence" theory of Mason [20], the original IS Success Model was then updated by DeLone and McLean themselves in 2003 (Figure.2).
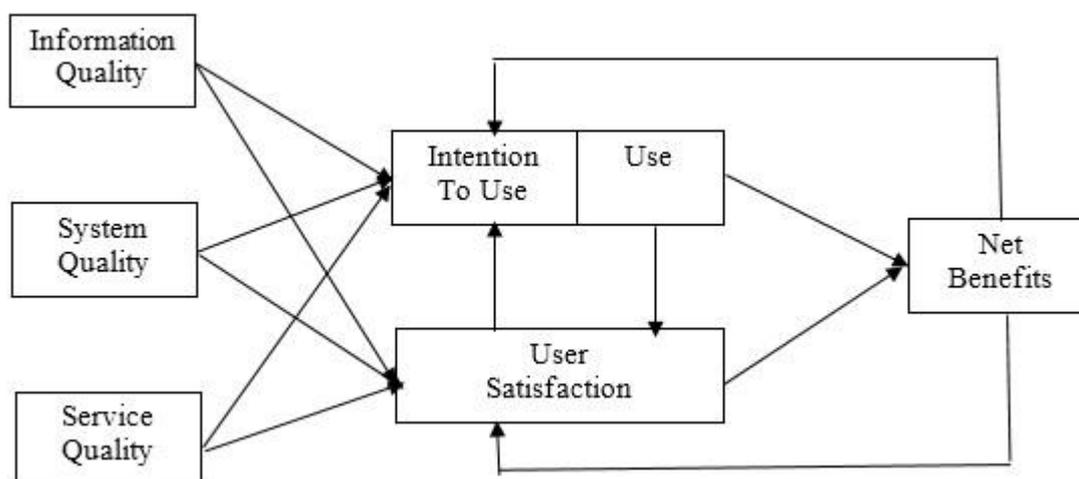

Figure 2. Information Systems Success Model [8]

In the updated IS Success Model, three dimensions of quality are measured or controlled separately to affect the subsequent "use" and "user satisfaction", namely "information quality", "system quality" and "service quality". In the D&M IS Success Model, "systems quality" measures technical success; "information quality" measures semantic success; and "service quality", added in 2003 measures whether the service providing for users is success (e.g., tangible, responsible, and reliable). According to DeLone and McLean [8] , "use" and "user satisfaction" are closely interrelated. "Use" must precede "user satisfaction" in a process sense, but positive experience with "use" will lead to greater "user satisfaction" in a causal sense. Similarly, increased "user satisfaction" will lead to increased "intention to use," and thus "use." Subsequently, "net benefits" from the perspective of the owner or sponsor of the system will be influenced by "user satisfaction" and "use", also, this "net benefits" will reinforce the future "use" and "user satisfaction" in return if the IS or service is to be continued.

DeLone and Mclean suggested that context plays an important role in evaluating the success. While measuring the success of a single system, "information quality" or "system quality" might be the most important quality component. Since these qualities are more measurable than service quality for individuals. However, for measuring the overall success of the IS department, as opposed to individual systems, "service quality" may become the most important variable.

Later, there are some researchers identified specific variables posited to influence the different dimensions of IS success. Petter et al. (2013),organize these success factors into five categories based on the Leavitt Diamond of Organizational Change(Leavitt, 1965): task characteristics, user characteristics, social characteristics, project characteristics, and organizational characteristics. Success factors such as trust, user expectations, extrinsic motivation, IT infrastructure, task compatibility, task difficulty, attitudes toward technology, user involvement, and relationship with developers have been found to influence IS success[21] .

Network Externalities

Network externalities was defined as "the utility that a user derived from his/ her consumption of a good would increase with the number of other users consuming this good" [15] . Once the scale of users reaches a considerable number, external benefit emerges and more users would be attracted to join[17] . Network externalities have been widely applied to explain the adoption of information system technology, especially for those computer-mediated communication applications. For instance, when the number of users of an instant messaging application reaches a critical mass, it would generate relative benefit, providing subsequent users with more correspondents, a wider scope of use, and attracting third-party businesses (e.g., a software developer) to join, which in turn attract more users by making the application use easier and more convenient [18] .

Although most early researches applied network externalities to explain the increase an individual's perceived economic value of a product or service [3] , later studies found that aside from economic value, individual's positive affective and cognitive beliefs toward a product or service come into being for the sake of the increase of users [18][29] . User's satisfaction and evaluation, for example, are two kinds of affective or cognitive belief towards product or service.

Katz and Shapiro (1985) in their work also identified two types of network externalities: direct and indirect. Direct network externalities directly derive value and benefit from the number of users consuming the same product or service. For example, when the users of a mobile SNS platform increase, individual user has the access to interact with more peers. In contrast, indirect network externalities arise when there are more complementary or compatible products and services available, rather than directly derive value from the number of users in a given network [16]. For instance, the wide adoption of Windows operation systems leads to rich software and applications running on them. But Linux has fewer available applications due to its limited number of users. Based on the viewpoints of prior researches, Lin and Lu (2011) concluded that direct network externalities are due to the demand side of the network, while indirect network externalities are the supply side. In this study, we focus only on the demand side of the network, concentrating on how users behave and affect each other, so we consider only the direct externalities here.

RESEARCH MODEL AND HYPOTHESES

Figure.3 presents this study's research model, developed based on D&M IS Success Model and network externality theory [23]. Specifically, the model considers that network externalities would affect the information quality, system quality, service quality, and user satisfaction. Then, both information quality and system quality might affect the service quality. Finally, as the IS Success Model indicates, the user satisfaction could affect use.
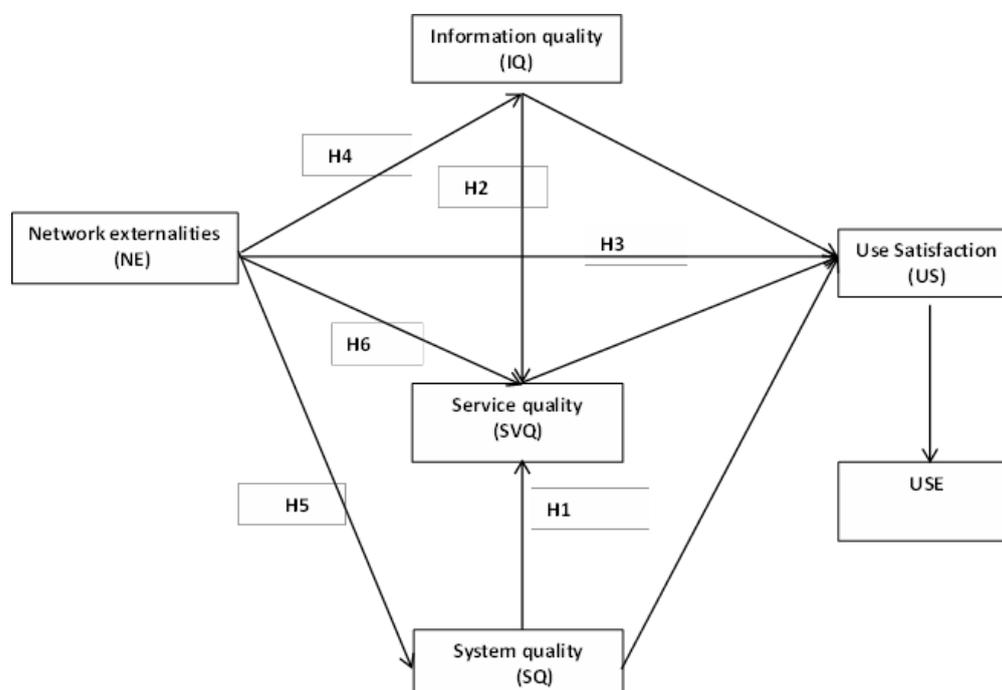

Figure 3. Research Model

IS Success Model

Based on the updated D&M IS Success model, earlier studies have increased our understanding of the parallel effects of these three dimensions of quality, viewing them as completely separated variables, but they have left unexplored the important

relationships among them. Although the service quality is significant nowadays, surprisingly few studies have examined the joint effects of system quality, and service quality e.g.[31][32] . Kafaji (2013) has tested that the service quality could mediate the relationship between system quality and user satisfaction in e-Government systems. The researchers [34] have also developed the 3Q model in an e-service context to theorize the relationships among the three types of quality, and finally made a conclusion that perceived system quality could influence perceived information quality and perceived information quality might influence perceived service quality in the e-service context.

We suppose that information quality and system quality are conceptualized as the overall evaluation of information and system, respectively, while service quality are more appropriately conceptualized as a consumer's overall evaluation of the service provision that contains considerations of both content and delivery [1][13][19][27][28] . Thus, when a user perceives a higher information quality (i.e., what content is offered) and a higher system quality (i.e., how it is delivered) in an information system, the user will perceive that its service quality is also be higher. It means if one system with higher information quality or system quality than the other, individuals would also bring it with better evaluation of its service, in other words better service quality than the other.

So, we hypothesize that:

H1: System quality positively influences service quality.
H2: Information quality positively influences service quality.

Network Externalities
Among all the current studies, researchers now tend to use the number of users to represent direct network externalities. Katz and Shapiro has defined network externalities as "the value or effect that individuals obtain from a product or service would bring about more values to other consumers with the increasing number of users, complementary product, or services."[5] . It indicates that with more users of the system, people would get more values and effects. And between the direct and in direct network externalities mention in the section of theoretical background, we only focus on the direct externalities, thus we use the number of users to represent the direct network externalities, like most current studies do.

Also, taking the social influence into consideration, many researches have confirmed that it might affect individual's overall judgment [4] . For example, some researchers indicated that network externalities would increase an individual's perceived value of a product or service[15] , including both the economic value [3] , and his/ her positive cognitive and affective beliefs toward the product or service [29] [17] .Thus, if individuals found that a number of people around him or her use the same application, they might feel satisfied without considering the real quality of the product or service ,since they might suppose they conformed to the mainstream of the society. For example, according to the prior research of SNS, some researchers believed that a user would use an SNS once its participants reach a significant number without further consideration about how the SNS platform really perform. So, we hypothesize that:

H3: Network externalities have positive effect on user satisfaction.

As far as we are concerned, network externalities not only exert effect directly on user satisfaction, but also have another mechanism: internalization. In sciences such as sociology or psychology, internalization involves the integration of attitudes, values, standards as well as the opinions from others into one's own identity or sense of self [6]. Individuals engage in internalization process are far more than just following others to adopt an information system and to be satisfied with, instead, they evaluate the performance of the information system. In our context, users notice that many people or most people around them are using the application, so they infer that it may have better information quality, system quality or service quality than other application with similar functions.

Herd behavior [2] or information cascade theory[10] may also provide an explanation of such mechanism: when a person on the street decides which of two restaurants to dine in, both look appealing, and he has no idea which one could serve with better food or better quality regarding other aspects, but he sees that restaurant A has several customers while B is empty, as a result, he chooses A on the assumption that having customers makes it the better choice. In this example, the person infers that the number of consumer can be seen as a signal to indicate a higher food quality or service quality or a competitive advantage against another on other things he care about. Therefore, in our context, network externalities may be viewed by individuals as a clue or evidence to evaluate the information, system and service quality of an application. When individuals find that application A has more users than application B, they may engage in an internalization process and infer that application A should be with better information, system and service quality, and finally feel satisfied. Thus, we hypothesize that:

H4: network externalities would show influence on information quality
H5: network externalities would show influence on system quality
H6: network externalities would show influence on service quality

METHODOLOGY AND RESULTS

This study analyzes the theory in the relative evaluation by applying comparison by difference (e.g., user's satisfaction toward mobile application – user's satisfaction toward WeChat official account).So, the participants would answer the same question twice, one for their attitudes towards the WeChat official account, the other for the mobile application, then we process data by subtracting the two scores for the same item. By using this method, we suppose the results would be more reliable and trustworthy, because when answering the questionnaires regarding the features and satisfaction of one information system, these subjects may compare their evaluations with the alternative.

Data Analysis

The research model described in Figure.3 is analyzed using partial least squares (PLS). Partial least squares analysis is a second-generation multivariate technique, which can assess a measurement model (i.e., reliability coefficients, factor analysis) and a structural model (i.e. path coefficients) simultaneously in one operation. Additionally, PLS is suitable for a small sample size, and is not sensitive to non-normal distribution[18].

Measurement Model

In PLS, composite reliability (_C) is the measurement for internal consistency. Despite the system quality ,information quality, service quality are the formative variables which do not need to consider its validity and reliability, other reactive variables including user satisfaction, use and network in the model all show high composite reliabilities ranging from 0.83 to 0.93 (Table 1). These numbers are higher than the acceptable 0.70 threshold for field research. For details, please see the row "Reliability" in Table 1 for all the constructs.

There are two criteria for validating discriminant validity in PLS. First, all loadings should be higher than cross-loadings (c.f. the requirement of the factor analysis is stricter, cross-loadings should not be larger than 0.5). Second, the square root of average variance extracted should be larger than the other construct correlations[5] Tables 1 and 2 also present discriminant validity of the constructs. Table 1 shows all loadings for reactive variables are higher than 0.70, except for the first item in USE which is lower than 0.70. However, all loadings on their own constructs are still higher than on other constructs, i.e., comparing the loadings in columns shows that each indicator in the block is higher than other indicators from other blocks.

Additionally, Table 2 shows the average variance extracted (AVE), in which all constructs share more variance with their indicators than with other constructs. Above all, the results confirm that the constructs have adequate convergent and discriminant validity.

Table 1. Loadings and cross-loadings for each construct

	IQ	NE	SQ	SVQ	US	USE
Reliability	NA	0.93	NA	NA	0.83	0.86
IQ1	0.598	0.107	0.230	0.465	0.359	0.156
IQ2	0.441	0.260	0.037	0.100	0.368	0.251
IQ3	0.676	0.432	0.343	0.372	0.321	0.315
IQ4	0.655	0.329	0.229	0.290	0.449	0.305
TQ5	0.765	0.276	0.225	0.538	0.410	0.236
NE1	0.333	**0.832**	0.434	0.323	0.413	0.423
NE2	0.424	**0.876**	0.364	0.160	0.456	0.501
NE3	0.358	**0.800**	0.412	0.212	0.411	0.431
NE4	0.302	**0.857**	0.396	0.230	0.445	0.565
NE5	0.434	**0.862**	0.459	0.284	0.501	0.577
NE6	0.384	**0.756**	0.377	0.336	0.430	0.482
SQ1	0.318	0.440	0.837	0.326	0.356	0.291
SQ2	0.142	0.336	0.518	0.133	0.215	0.085
SQ3	0.262	0.303	0.766	0.409	0.328	0.230
SVQ1	0.346	0.238	0.434	0.751	0.430	0.183
SVQ2	0.245	0.150	0.180	0.409	0.210	0.176

SVQ3	0.533	0.274	0.255	0.827	0.444	0.331
SVQ4	0.359	0.060	0.230	0.476	0.155	0.018
SVQ5	0.102	0.122	0.020	0.280	0.261	0.246
US1	0.453	0.262	0.192	0.414	**0.696**	0.360
US2	0.478	0.487	0.426	0.409	**0.859**	0.458
US3	0.452	0.478	0.353	0.434	**0.787**	0.487
USE1	0.330	0.509	0.300	0.279	0.507	**0.884**
USE2	0.270	0.382	0.239	0.337	0.453	**0.833**
USE3	0.372	0.590	0.219	0.138	0.403	**0.722**

Table 2. Average variance extracted

	IQ	**NE**	**SQ**	**SVQ**	**US**	**USE**
IQ	NA					
NE	0.451	**0.692**				
SQ	0.355	0.492	NA			
SVQ	0.583	0.312	0.427	NA		
US	0.586	0.534	0.424	0.533	**0.614**	
USE	0.393	0.599	0.311	0.313	0.560	**0.665**

Note: The bold typeface number on the leading diagonal are the square root of the variance shared between the constructs and their measures, while 'NA' indicates the formative constructs that do not need to consider its AVE. Off diagonal elements are the correlations among constructs. For discriminant validity, diagonal elements should be larger than off-diagonal elements.

Structure Model
Figure 4 shows the result of comparison by the difference for the WeChat official account and the mobile application.
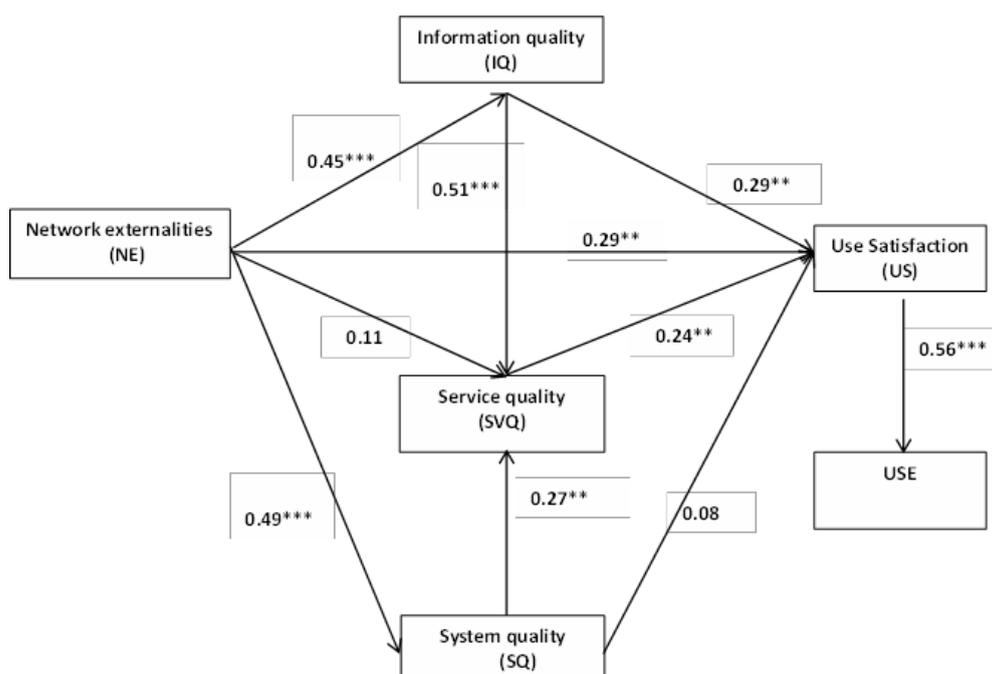

Figure 4. The Result of the Research

Note: *p<0.05, **p<0.01, ***p<0.001

Network externalities have significant effects on information quality(IQ), system quality(SQ) and user satisfaction(US),with (H4; path coefficient=0.45, t=4.17), (H5; path coefficient=0.49, t=6.11), （H3; path coefficient=0.29, t=2.45) respectively. However, Network externalities do not have significant effect on service quality as the results indicated, therefore, H6 is not supported.

Besides, both information quality and service quality show great significance on user satisfaction, with (path coefficient=0.29, t=2.09), (path coefficient=0.24, t=2.17) respectively, which partly confirms the IS Success Model. However, the system quality does not show significance on user satisfaction (path coefficient=0.08, t=0.18) as the success model said .But the results show that both information quality and system quality have significant influence on service quality, (H1; path coefficient=0.27, t=2.36), (H2; path coefficient=0.51, t=3.23).The user satisfaction also shows importance on use, (path coefficient=0.56, t=7.16) as the result has showed.

DISCUSSION

The purpose of the present study is to examine the users' satisfaction and use action of two similar information systems, whose function are basically the same but their other features are distinguishable. We chose the information systems with similar function in order to avoid the impact brought by the function on user's satisfaction and their use action. Additionally, there's a distinct contrast between the WeChat official account and mobile application concerning information and service provided, as well as the system operation mode, which are suitable for our research. As with the measurement, specially, we analyzed our model in the relative evaluation by applying comparison by difference (e.g., user's satisfaction toward mobile application – user's satisfaction toward WeChat official account).

With a total number of 6 hypotheses, despite one (H6), the rest of them are supported. We now elaborate below on key findings and limitations.

First, this study reveals that network externalities have a positive effect on information quality, and system quality of an information system. This finding confirms what researchers [15][18] concluded that network externalities affect user's perceived benefits, in other words, their perceived quality of an information system. If more users come in, sponsors are stimulated to enhance their product, leading to an improvement in information quality, system quality and then user satisfaction. To some extent, this impact can be viewed as a way that network externalities affect user satisfaction mediated by the two types of information system quality, i.e. the information quality and system quality.

However, as with the unsupported hypothesis (H6), the network externalities do not show significant positive influence on service quality. A possible explanation of this result may be that the network externalities do influence service quality positively, not a direct impact, but impact mediated by influencing the information quality and system quality. Actually, this explanation accord with previous conclusions mentioned in section 3 that information quality and system quality are conceptualized as the overall evaluation of information and system , respectively, while service quality are more appropriately conceptualized as a consumer's overall evaluation of the service provision, which contains considerations of both content and delivery. Because of the compounded feature of service quality, a direct improvement is difficult to achieve. IS owners and sponsors can almost only enhance their product by improving the information quality (e.g., using more advanced technology to attain more accurate information) and system quality (e.g., improving the system performance in response time and stability), so as to achieve an improvement on service quality.

Second, network externalities are also found to have a direct influence on user satisfaction. Unlike what was referred above, another way that network externalities put an effect on user satisfaction is a direct one. Users do not necessarily feel satisfied about an information system because of the improvement of information quality, system quality and service quality. It will also happen just for that there are plenty of people, especially people around them using the information system. We suppose that this results from the normative social influence, which indicates that once there were a number of people use the same application, the individual might find they conformed to the mainstream of the society, so they would feel satisfied.

Third, in terms of IS success, our study found that the impact of both system quality and information quality on user satisfaction are mediated by service quality. As was mentioned in section 3, information quality and system quality are conceptualized as the overall evaluation of system and information, respectively, while service quality should be more appropriately conceptualized as a user's overall evaluation of the service provided, including both content and delivery. There is, however, a noticeable difference between the mechanism of how system quality affects user satisfaction and that of how information quality works. Our results showed that system quality are almost completely mediated by service quality when posing an influence on user satisfaction, and its direct impact is marginal. When it comes to information quality, however, two paths are both found significantly. This can be explained that information quality is more tangible than system quality. Users can discriminate whether the information provided is accurate, adequate, timely, and reliable, but pointing out the discrimination of a system quality, for example, a clear guidance, a friendly interaction or intelligible steps to use is more difficult, especially when these features have been improved dramatically with the help of today's technology.

There are several limitations should be acknowledged here.

First, this study focuses on the network externalities perspective to understand the information quality, system quality and service quality, so several other independent variables such as extrinsic motivation, management support, developer's skills are not well addressed[21] . However, under current circumstances where people connect and communicate more frequently, we suppose the network externalities should be given priorities to investigate further. And this provides an opportunity for future studies to examine other independent variables for the IS Success Model.

Second, this study investigates one single function of the informational application (e.g., weather forecast) in one single culture (e.g., China). Applying the conclusions to other research contexts may be cautioned. Further, in different societies with various cultures, the power of network externalities may be different. Like in European countries where people behave more independently, individuals are less likely to change their attitudes or behaviors to conform to the mainstream of the society. So the network externalities might not have a direct influence on user satisfaction. But this provides an opportunity for future studies to examine the cross-culture issues of Is Success Model.

CONCLUSION

The present study extends research on D&M IS Success Model, which not only adds network externalities to the existing model but also shows the internal relationship among three constructs of the IS Success Model (information quality, system quality and service quality).

The research has made some theoretical contribution.

First, the study highlights the caution needed in considering network externalities under current environment where the connections and communications among individuals become more frequent and close. The result shows that network externalities have great significance on three dimensions of quality, and its effect on service quality actually exerts by the mediating effects of information quality and system quality.

Second, the study also highlights the relationship among information quality, system quality and service quality should not be ignored, where both system and information quality would affect service quality, considering system and information quality might be reflected through service quality.

Third, the method for processing data in this research has hardly been used, but it indeed could help gather more reliable and specific data from participants. We conduct a special measurement of questionnaire by requiring subjects to answer each question for WeChat official account and mobile application respectively. Thus, when answering the questionnaires regarding the features and satisfaction of one information system, these subjects may compare their evaluations with the alternative. Then we analyze the theory in the relative evaluation by applying comparison by difference (e.g., user's satisfaction toward mobile application – user's satisfaction toward WeChat official account).

The findings are also of practical importance. Since there are so many applications with same functions in the competitive market, so we suppose this study brings value to the owners or sponsors of the system. According to the results in the study, hey have to fully realize the importance of the network externality, since it can affect the information, system and service quality to some extent .Thus, in order to gain the success of one system, sponsors should strive to increase the number of the users, attracting them to use the system continuously.

APPENDIX

Constructs	Questions	Reference
System quality	1 System is easy to use 2 The procedure is clear when I use the system 3 The user interaction in this system is understandable	(Venkatesh and Davis, 2000)
Information quality	1 The system could provide me with accurate information 2 The system could provide me with abundant information 3 The information provided by the system could satisfy me need.	(Rai et al., 2002)
Service quality	1 The system provide me with sufficient training when I first use it 2 The system provide in-time service 3 I suppose the system is reliable 4 The system could provide right service 5 The system is friendly.	(Gefen and Keil, 1998, Shin, 2003)
USE	1 I use this system with a high frequency. 2 I use many functions in this system 3 I definitely rely on this system	(Gefen et al., 2003)

User Satisfaction	1 I am satisfied with the information provided by system 2 I am satisfied with the functions of the system 3 In general, I am satisfied with the system.	(Rai et al., 2002)
Network Externalities	1 I suppose that many people are using this system 2 I suppose that most people are using this system 3 I suppose many people will use this system in the future 4 I suppose many friends around me are using this system 5 I suppose most friends around me are using this system 6 I suppose many friends around me will use this system	(Lin and Lu, 2011)

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