Chinese Students' Behavior Intention to Use Mobile Library Apps and Effects of Education Level and Discipline

1. Introduction

In the last decade, in order to increase the use of library resources by university students, a significant segment of user groups in university libraries, thousands of universities in China have developed or provided mobile library (m-library) apps or services. Almost all the Ministry of Education's "Project 985" and "Project 211" universities, which are designated as elite universities in China, have been implementing this mobile service mode for students and academics (Li, 2013). According to the report by Tian (2014), with the exception of independent development of some m-library apps, a large proportion of universities choose to cooperate with an information system or database provider. This is an embedded approach by which a university library may then upload its collections to an m-library cloud platform and share or deliver resources to students, academics, or other university users.

A university m-library app may free students from temporal and spatial limitations, enabling them to acquire library resources and services anytime and anywhere via an authenticated library account (Chang, 2013). Because of the 100 percent smart phone adoption rate by university students in China and their needs for book retrieval, reservations, and information resources, university m-library apps may appear to have a high penetration rate based on the large number of initial downloads (Jia and Dong, 2014). However, the degree of university students' acceptance and adoption of m-library apps is relatively low at present, and even fewer university students continue to use them for library services (Tian, 2015). The benefits of using university m-library apps are greatly limited due to these low continuance usage and participation rates. Therefore, in order to encourage university users to continue use of m-library apps and promote the efficiency of library resources, it is critical to reveal the antecedents of continuance usage intention towards university m-library apps.

Another important fact that should be noted is that university students, regardless of educational level (e.g., undergraduate, graduate, etc.) and discipline (e.g., science, engineering, humanities, social sciences, etc.), are provided with uniform interfaces and functions in m-library apps. This may not meet the varied needs and preferences students with different backgrounds have of library resources and services.

Most previous research reported only the influence of some factors on the information behaviors of acceptation and adoption of m-library services. These include technology acceptance (Jin, 2014), user experience (Hu *et al.*, 2014; Zha *et al.*, 2015), service quality (Joo and Choi, 2015), usage performance (Gan *et al.*, 2015), students' cognition (Jia and Dong, 2014), satisfaction (Guo, 2014) and so on. To date, there are less clear understandings of the elements affecting Chinese university students' long-term behavior intention towards m-library apps, and much less of the moderating effects of education and discipline on the relationship between intention and antecedents.

This study seeks to capture the unique features and identify the factors which influence behavior intention towards m-library apps by Chinese university students by addressing two research questions:

RQ1. How factors affect Chinese university students' continuance usage intention towards m-library apps in light of system features and student perceptions?

RQ2. How education level and discipline may affect Chinese university students' continuance usage intention towards m-library apps?

Answers to these two questions will offer insight on university student m-library app use that will help libraries and service providers offer better and more targeted services to users.

2. Literature review

2.1 Services provided by the Chaoxing m-library app

In China, the Chaoxing m-library app, developed and promoted by Beijing Chaoxing Inc., is the most popular m-library tool in universities. This professional mobile reading platform/app integrates the OPAC system, digital library portal, cloud sharing service system, information exchange and interaction platforms, personalized services, *et al.*, and can run on smartphones, tablets, and other mobile devices. In addition to the local library resources, Chaoxing m-library also provides users with more than one million e-books and innumerable newspapers, as well as domestic and foreign literature metadata which can be shared in 78 industry alliances and areas and with 723 Chinese universities (Chaoxing, 2015).

As an example, the Chaoxing m-library app for Wuhan University (Wuhan University library, 2015) primarily offers four functional modules:

1) Retrieval of local library bibliography. Users can retrieve physical library

resources including books, journals, newspapers, dissertations, videos, and browse their account status and make reservations and renewals.

2) Retrieval of digital academic resources. The uniform interface enables users to retrieve digital resources, including e-books, journal articles, newspapers, dissertations, criterions, patents, and so on; browse their account details, and even access and display full texts within the app.

3) My subscription. Users can customize their reading content. Chaoxing m-library of Wuhan University provides a variety of content subscriptions, including books, news, newspapers, videos, audiobooks, and so on.

4) Personal center. Chaoxing m-library connects with the Wuhan University library OPAC system and provides borrowing, information checking, and renewal services; personalized favorites and subscriptions; and interactive and personal profile settings such as tagging, comments, browsing and retrieval history, customization of columns and keywords, and personal information.

Since launching its m-library service in April 2012, the Wuhan University library has been actively promoting use of the app among students by means of advertising, gamification using the m-library app, and so on. Although the promotion has resulted in a large number of downloads, fewer than 30% of students actually continue frequent use of the app according to a library internal assessment by surveying students from some schools and institutions in Wuhan University. It is imperative to reveal the influencing factors and underlying reasons of continuance usage intention towards m-library apps for researchers and library service providers.

2.2 Related research in university m-library services and users' behavior

Vassilakaki (2014) provided a comprehensive and in-depth review of the current status and trends of m-library service, summarizing and presenting the related peer-reviewed papers published between 2004 and 2014. The study found seven themes that have emerged, including mobile libraries, exploring users' perceptions of libraries' mobile services, presenting mobile technology use in libraries, reporting on current trends, presenting libraries' mobile services, reporting case studies, and reporting on evaluation on of libraries' mobile services. The majority of relevant literature mainly focused on raising awareness of m-library services. Literature related to exploring users' m-library behavior intention mainly concerned the acceptance intention and willingness to access library resources while using m-library apps (e.g.,

Vasudavan and Ravi, 2013).

Library services in universities are more credible and accurate (Lee *et al.*, 2012), and are more conducive for learning and research (Joo and Choi, 2015). In order to better understand behavior intentions and increase the usage rate of library resources, a few researchers explored the relationship between university m-library services and students' usage intention or behavior. Saravani and Haddow (2015) used a grounded theory to discuss the critical issues in m-library service usage, and considered that m-library service affects students' behavior to access and use library resources, which could be attributed to its more technical advantages. Finally, they stressed the need to identify the service quality as a crucial influencing factor on m-library usage intention. Pu *et al.* (2015) attempted to increase usage rates of university libraries by analyzing the factors influencing the level of user satisfaction in the context of m-library app systems developed for university students in Taiwan. The experimental results indicated that information quality, system quality, and work efficiency are the main factors influencing students' satisfaction with m-library apps, even further influencing their attitude towards the continuance usage. Zha *et al.* (2015) explored the flow experience in using digital library services and conducted the comparative analysis between web and m-library apps. Based on the investigation of students' usage behavior, they found students' flow experience of web digital library better than that of m-library apps at present in China. The study also emphasized that it is critical to examine university students' perceptions in the initial and subsequent stages of using m-library apps.

There has been research exploring the usage intention or behaviors. For example, Jaradat (2012) identified the factors influencing the acceptance and usage of library services in mobile phones with the aid of the extended technology acceptance model (TAM) (Davis, 1989, 1993) and the investigation of users in a Jordanian academic library. The results showed that social context, the perception of usefulness, and ease of use to be the main factors affecting users' acceptance intention and usage behavior. Vongjaturapat and Chaveesuk (2013) proposed a theoretical model based on the unified theory of acceptance and use of technology (UTAUT) (Venkatesh *et al.*, 2003), integrated with some variables from the task-technology fit (TTF) model, in an attempt to explore the factors affecting acceptance of m-library services in academic libraries. They believed that social influence, effort expectancy, m-library system features, et al. would be the direct effecting factors of m-library acceptance. Chang

(2013) explained student users' intention of using m-library apps in university libraries by integrating UTAUT and TTF. The results reveal that performance expectancy, effort expectancy, social influence, and facilitating conditions determine that intention. The moderating effect of students' perception of task-technology fit is also significant on the relationship between antecedents and usage intention. The study suggested further research to identify other factors that influence users' continued willingness to use m-library apps.

Deng and Yang (2014) utilized the extended expectation-confirmation model of IS continuance (ECM-ISC) (Bhattacherjee, 2001) to explore university students' intention towards using m-library apps. Based on the factor analysis, the study identified system quality, service quality, and information quality as the main factors affecting university students' intention to use m-library apps. Similarly, Zhao *et al.* (2015) conducted an analysis of Chinese users' continuance usage of mobile library apps, in which the examined variables were adapted from ECM-ISC and the theory of information system success. The participants of the study included the general public and a variety of user groups without a particular focus. The findings indicated that performance perceptions of systems, services, and information that m-library apps provide are more important for their improvement.

These studies show that research interest in m-library service and usage has increased, and the results serve as a foundation for further research. Particularly, behavior intention in the mobile context and with the major user population in the academic setting requires exploration. This study, built upon previous studies, aims to integrate theoretical models and corresponding variables to explore Chinese students' behavior intention of using university m-library apps, and reveals the relationship between antecedents and consequences in order to provide valuable insights and guidelines for the promotion and improvement of Chinese university library services.

3. Methodology

3.1 Research model and hypotheses

Based on the literature discussed above, the research model was designed to take into account both the function and utility of m-library apps and Chinese university students' usage perceptions, while also considering the simplicity and efficiency of the model. Students' perception of system performances would influence their perception of the usefulness of m-library apps and related cognitive perceptions (e.g.,

attitude). Meanwhile, these cognitive perceptions (e.g., self-efficacy, subjective norm) are also the main factors influencing their usage tendency or intention. On the one hand, the Delone & Melean IS Succcess Model (D&M ISSM) (Delone and Melean, 1992, 2003) and its three main variables, system quality (SyQ), information quality (IQ) and service quality (SeQ), was chosen to describe the system performance of m-library apps. This study also integrated perceived usefulness (PU) from TAM (Davis, 1989, 1993), subjective norm (SN) and attitude (ATT) from the Theory of Planned Behavior (TPB) (Ajzen, 1991), and self-efficiency (SE) from Social Cognitive Theory (SCT) (Bandura, 1977; Compeau and Higgins, 1995) to describe the students' behavior intention (BI) towards m-library apps. The conceptual model including these constructs and their relationships is depicted in Figure 1.

<Insert Figure 1 here>

System quality, Information quality and Service quality. In order to identify the factors that contribute to information system success, DeLone and McLean (1992, 2003) proposed an integrated view of IS success from the perspectives of system quality, information quality, and service quality. These three constructs were identified as the key initial antecedents of system usage. Recently, many researchers adapted the ISSM to investigate the usage behavior of mobile services. For example, Shen et al. (2012) found that both system quality and information quality significantly relate to a mobile word-of-mouth system, and further affect users' adoption and usage intention. In research on adoption intention towards mobile cloud services, Park and Kim (2014) investigated the contribution of service and system quality to perceived usefulness and found that service and system quality have notable effects on perceived usefulness.

In the context of m-library apps, system quality may be reflected in the form of the stability, reliability, response speed, and adaptability in mobile devices. Information quality is related to timely and accurate information, comprehensive and abundant library resources, display quality, and so on. Similarly, service quality of m-library apps could involve reasonable and accurate functionality, professional and personalized services, and so on. If university students perceive the high quality of system, information, and service from m-library apps, they will generate the perception of usefulness, which would in turn benefit their studies. Therefore, these

three constructs are likely having notable effects on the perceived usefulness; and the current study sets forth the following hypotheses:

H1a. System quality will have positive effect on Chinese university students' perceived usefulness of m-library apps.

H1b. Information quality will have positive effect on Chinese university students' perceived usefulness of m-library apps.

H1c. Service quality will have positive effect on Chinese university students' perceived usefulness of m-library apps.

Perceived usefulness and attitude. According to TAM, perceived usefulness is described as the main influence on usage intention of users. In this paper, the perceived usefulness of m-library apps is defined as the degree to which a user believes that it would enhance his or her learning and studying performance. Further, perceived usefulness affects a user's attitude towards using the information system, consistent with TPB (Lee, 2010).

The TPB theory proposed that an individual's intention to engage in specific behaviors is determined by his or her attitude (Ajzen, 1991). It presents attitude as the amount of effect for or against some objects or, simply, as feelings about using m-library apps to complete target tasks. It suggests that attitude determines an individual's intention to engage in some specific behaviors (Park and Kim, 2014). More importantly, attitude can better explain the internal and external cognition of users than other factors (e.g., satisfaction) (Hernandez-Ortega *et al.*, 2014). This in turn affects the actual behavior.

When Chinese students consider it useful, they will form a positive attitude towards m-library apps, which then affects their behavior intention. That is to say, they will have a stronger intention toward use. Previous related studies have also emphasized the relationship among perceived usefulness, attitude, and behavior intention (e.g., Park *et al.*, 2012; Booker *et al.*, 2012; Gan and Song, 2015). Therefore, the present study applies and extends these relationships based on TAM and TPB among perceived usefulness, attitude, and behavior intention:

H2a. Chinese university students' perceived usefulness will have positive effect on their attitude toward m-library apps.

H2b. Chinese university students' perceived usefulness will have positive effect on their behavior intention toward m-library apps.

H3. Chinese university students' attitude will have positive effect on their behavior intention toward m-library apps.

Subjective norm and self-efficacy. Chinese students tend to be predisposed towards being influenced by peers and individuals perceived to be important. In accordance with Ajzen (1991), subjective norm, as an external cognition, refers to the Chinese student's perception of social pressure and the influence of teachers, classmates, or trusted friends in performance of the usage behavior. One may also opine that subjective norm is related to the normative beliefs about students' expectations from others (Lee, 2010). In our paper, Chinese university students will choose to use m-library apps if their teachers, classmates, and trusted friends use and recommend them. In other words, recommendations and reviews from others and communication with them will change students' attitudes towards m-library apps and further influence their behavior intention. Park et al. (2012) identified the influential relationship of the subjective norm to attitudes and behavior intentions by university students. Hsu, Yu and Wu (2014) also found that the subjective norm has direct or indirect effects on users' attitude and behavior intention towards using information systems. Thus, we propose the following hypotheses:

H4a. Chinese university students' subjective norm will have a positive effect on their attitude toward m-library apps.

H4b. Chinese university students' subjective norm will have a positive effect on their behavior intention toward m-library apps.

Bandura (1997) defined self-efficacy as users' judgments of their capabilities to organize and execute the actions required to attain designated types of performances. This definition emphasizes one's self-judgments rather than actual skills. In this paper, self-efficacy reflects the degree to which a Chinese student feels he or she has the ability to succeed in performing the usage behavior regarding an m-library app. Those students with higher self-efficacy are more likely to attain better academic performance, as well as generate positive attitudes towards m-library apps and a stronger willingness toward continued usage, than those with lower self-efficacy (Tang *et al.*, 2014). Some scholars have posited that self-efficacy, as the internal cognition of users, plays an important role in affecting an individual's motivation, attitude, and behavior intention (e.g., Ajjan *et al.*, 2014; Hsiao and Tang, 2015). Thus,

we propose the following hypotheses:

H5a. Chinese university students' self-efficacy will have a positive effect on their attitude toward m-library apps.

H5b. Chinese university students' self-efficacy will have a positive effect on their behavior intention toward m-library apps.

Moderating effects of education and discipline. At present, both traditional and digital libraries provide different services according to the needs of students and academics in different educational levels and disciplines in China (e.g., Wang *et al.*, 2014; Zheng, 2015). It is unfortunate that m-library apps do not provide corresponding services. Some previous studies have proved that educational level and discipline will affect the degree of users' perceptions in using information systems. For example, Liu and Luo (2011) explored the different perceptions of undergraduate and graduate students in China using digital libraries. The results found that them quite different due to their differing emphases and expectations for library services. In addition, the study implied that students in various disciplines are not equally represented, and those disciplines may have different effects on library services. Therefore, in order to explore the difference in educational levels and disciplines, and provide beneficial guidelines for university libraries and app developers, we propose the following hypothesis:

H6. Chinese university students' education level and discipline have moderating effects on their usage of m-library apps.

3.2 Empirical methods

Questionnaire measurement. In this study, a questionnaire survey with two sections was employed to test the proposed model and hypotheses. The first section is designed to collect demographic information on the respondents, including their gender, age, education, discipline, and experiences using m-library apps. The second section is composed of the theoretical constructs discussed above to measure Chinese university students' perceptions regarding the behavior intention of using m-library apps.

To satisfy the content validity, the measurement items in the questionnaire are modified or expanded from relevant previous studies which had been validated. The constructs in this study are measured by a five-point Likert scale, ranging from

"strongly disagree" (1) to "strongly agree" (5). The list of these items is shown in Table I.

<Insert Table I here>

Sample plan and data collection. The sampling for this study was conducted on undergraduate and graduate students from various disciplines (Science, Engineering, Humanities and Social Sciences) in Wuhan University. First, the questionnaire was pilot-tested on five undergraduate and five graduate students experienced in using the m-library app. The survey was conducted from 3 Sep. to 3 Oct. 2015. 537 surveys in total were then distributed to students who use the m-library app at least once a week. Returned questionnaires with incomplete or invalid answers were eliminated, and a total of 466 valid questionnaires selected. Respondents' demographic information is shown in Table II.

<Insert Table II here>

4. Results

In order to analyze the collected data and obtain accurate results, we followed the two-step procedure of assessing the measurement and structural models respectively (Anderson and Gerbing, 1988). The widely-used SmartPLS was chosen for the structural equation modeling (SEM). The specific version used was SmartPLS 2.0.

4.1 Analysis of the measurement model

The response data was first evaluated the convergent validity of the measurements by applying the approaches proposed by Fornell and Larcker (1981). As shown in Table III, the Cronbach's alpha scores all exceed 0.7, which reflect the strong internal reliability of each construct. All standard factor loadings (λ) exceed 0.5 and are significant at $p<0.001$. The composite reliability (CR) of constructs range from 0.87 to 0.95, and the average variance extracted scores (AVE) range from 0.69 to 0.86. Therefore, all indices in this study are higher than the cutoff (Nunnally and Bernstein, 1994) indicating a good convergent validity.

<Insert Table III here>

In addition, Table IV shows the results of the discriminant validity testing, in which the values on the diagonal are the square roots of the AVE for each construct, and the correlation between each pair of constructs are the other values. It is evident that the square roots of the AVE are greater than the correlation coefficients in this study, indicating adequate discriminant validity. Some correlation coefficients are greater than 0.5, indicating limitations of the questionnaire. Possible remedies for this in future research may include using other sources of information for some of the key measures, collecting data pre- or post-survey, or mixing questions with different scale types.

<Insert Table IV here>

4.2 Analysis of structural model

The ten hypotheses, except the moderating effects presented above, were tested and the results summarized in Figure 2 and Table V. All hypotheses are supported and strongly significant at $p<0.05$, except for H5b between self-efficacy and behavior intention. The behavior intention of using an m-library app in this study was jointly predicted by attitude (β=0.603, $p<0.001$), subjective norm (β=185, $p<0.001$), and perceived usefulness (β=0.165, $p<0.05$). These constructs together contribute 78% of the variance in behavior intention. Attitude is significantly affected by perceived usefulness (β=0.506, $p<0.001$) followed by self-efficacy (β=0.332, $p<0.001$) and subjective norm (β=0.097, $p<0.05$), and they contribute 63.7% of the variance in attitude. Finally, system quality, information quality, and service quality all have positive and significant effect on the perceived usefulness, and they together explain 51% of the variance in perceived usefulness.

<Insert Figure 2 here>
<Insert Table V here>

4.3 Analysis of the hypothesized moderating effects

To examine the moderating effect, a two-step procedure was followed. First, the significance difference of education level (edu) was tested. Then, the significance difference of discipline (dis) was tested in the undergraduate and the graduate groups respectively (shown in Table VI). The results demonstrate support of majority of the

hypothesized moderating effects from education level, except for H2b, H4a, and H5b. This result suggests that there is a significant difference in perceptions and intentions between undergraduate and graduate students.

In terms of the effect of discipline, fewer than half of the hypotheses are supported: only four out of ten for undergraduates (H1b, H2a, H3, and H5a) and three for graduates (H1b, H3, and H5a). It can be said that discipline has some moderating impact on m-library app usage. The significance level is obviously higher in the graduate group than that in the undergraduate group, indicating the significance disciplines have on how their graduates use m-library apps, such as in their perceptions of usefulness, attitude and self-efficacy.

<Insert Table VI here>

Based on the results above, the path coefficients of relationships with significant difference are calculated by education level and discipline. Some interesting and meaningful results are found (shown in Table VII). From the perspective of different education levels, the relative strength of path coefficients is identical between the undergraduate and graduate groups. However, the differences within each education-level group between disciplines are more complex, which may reflect students' different focuses and purposes when using an m-library app.

<Insert Table VII here>

5. Findings and discussions

In this study, we have examined the effects of attitude, perceived usefulness, subjective norm, and self-efficacy on the behavior intention of using m-library apps, as well as the relationships among antecedents. Some meaningful findings and discussions could be demonstrated as follows.

5.1 Key findings

First, consistent with our hypotheses, the results reveal attitude to be the strongest predictor of Chinese university students' behavior intention towards m-library apps, followed by subjective norm and perceived usefulness. Meanwhile, perceived usefulness, subjective norm, and self-efficacy have an indirect influence on behavior

intention via attitude. Similar with other research (e.g., Park, Nam and Cha, 2012), the empirical research agrees with the findings of the TAM and TPB, and also illustrates that the constructs in this integrated model by TAM and TPB have both direct and indirect effects on Chinese university students' behavior intention to use m-library apps. In contrast, self-efficacy cannot be supported to significantly affect Chinese university students' behavior intention, unless via the influence on attitude.

Second, attitude is significantly determined by perceived usefulness, self-efficacy, and subjective norm ordered by the degree of influence, and plays an important mediating role between these three antecedents and behavior intention. Relative to the weaker direct effect on behavior intention (β=0.165) at a lower significance level (p<0.05), perceived usefulness has the strongest direct effect on attitude at a higher significance level (p<0.001), and further determines the behavior intention. The positive effect from self-efficacy to attitude is also identified here as consistent with earlier study (e.g., Ajjan *et al.* 2014). It is also an important determinant on attitude. Subjective norm as a social factor has a weak but positive effect on attitude in this empirical research, and it is even suggested that subjective norm does not much affect attitude in the process of determination on Chinese university students' behavior intention.

More importantly, in accordance with prior studies (e.g., Park and Kim, 2014), this study found the perceived qualities of system quality, information quality, and service quality significantly affect Chinese university students' perceptions of usefulness of m-library apps. In this empirical research, the effect of service quality is stronger than the other two system performances. The results reveal the D&M ISSM is applicable to exploring the quality of m-library apps.

Finally, the hypotheses of moderating effects from educational level and discipline are mostly supported in this study. From the perspective of different educational levels, 70% of the hypotheses are supported at significant levels. It is worth pointing out that the results show a high significant difference on the relationships of ATT→BI, PU→ATT, SE→ATT, and SyQ→PU between undergraduate and graduate students. However, the differences between the relationships of PU→BI, SE→BI, and SN→ATT are not significant. In contrast, most differences in each educational level subgroup (undergraduate and graduate) are not significant from the perspective of discipline. Obviously, the level of significant differences in the graduate group is higher than in the undergraduate group.

In addition, path coefficient of each relationship varies by education level and discipline. For example, path coefficients of IQ→PU in science and engineering are larger than that in the humanities and social sciences in both the undergraduate and graduate student groups. For undergraduate students, the path coefficient of SE→ATT is notably the largest in engineering compared to other disciplines; in contrast, the path coefficients of PU→ATT and ATT→BI are much smaller. Similarly, the path coefficient of SE→ATT is smallest in the humanities. For graduate students, path coefficients of ATT→BI do not greatly differ, except in the engineering subgroup, where it is the largest. However, the path coefficient of SE→ATT in engineering is the smallest.

5.2 Discussions

The goal of the present study was to empirically integrate D&M ISSM, TAM, TPB and SCT and examine factors influencing Chinese university students' behavior intention. Similar to previous research, this study confirmed the general structural model in helping to understand and explain behavior intention in using m-library apps.

Chinese students' attitude towards m-library apps is the most significant predicator of behavior intention, and the degree of determination is much larger than in other antecedents. In the process of usage, Chinese students will generate a positive or negative attitude towards the initial decision and in their satisfaction with m-library apps on the whole; which will then directly determine whether to continue use. It is a fact that students are easily influenced by social context in determining to use an m-library app. They will be more eager to use an m-library app when they find people around them use it or after receiving peers' recommendations.

The non-supported hypothesis of self-efficacy to behavior intention may indicate that current university students are confident in their technical abilities and well qualified in using m-library apps (Goh, 2011). First, it may be attributed to the speedy development and widespread popularity of mobile technology in China. Chinese university students accumulate rich experience using electronic products throughout their youth. Second, universities presently offer a broad range of information technology courses that enhance the necessary operating skills to rapidly learn and master a new electronic product. Therefore, mastering m-library apps could be straightforward for Chinese students due to their abundant experience using mobile

apps (Jia and Dong, 2014).

Meanwhile, we found that the perceptions of usefulness, subjective norm, and self-efficacy are the main factors affecting students' attitude. The usefulness that could assist students to accomplish learning and studying tasks will directly and significantly determine their attitude toward using m-library apps. That is to say, it will affect whether their initial decision proves wise. Perception of self-efficacy also contributes to Chinese university students' attitude. The higher their self-confidence in their ability, knowledge, and skill, the more positive their attitude. This conclusion is identified by the significance difference between different educational levels and among different disciplines. More notably, the level of significance difference is even higher in graduate student subgroups. It is evident that the influence of subjective norm is not significant because of Chinese students' relatively strong autonomy in learning and study. They are more inclined to form their own judgments or expectations of m-library apps, even though others' influence affects their usage.

In accordance with prior study, perceptions of quality from the perspective of system, information, and service significantly predict students' perception of usefulness. More importantly, compared with other perceptions of quality, service quality is the most important predicator in their view. At present, m-library apps provide information resources in amounts equal with traditional or digital libraries, and greater electronic resources through their cloud service platforms. The stable operating systems and mature mobile communication technology ensures the timely delivery of accurate information. In this context, it is understandable that quality, reflecting functional, professional, and personalized services, is the principal indicator of usefulness.

The moderating effects of education level and discipline are also identified in this empirical research. First, most perceptions of using m-library apps differ between undergraduate and graduate students. Education level affects perceptions of usefulness, attitude, and self-efficacy. A higher education level leads to more experience, knowledge, and proficiency, which will affect the final behavior intention. The differences among disciplines are not as significant for undergraduates as for graduate students. It can be concluded that there is less in-depth professional knowledge and fundamental learning during these undergraduate years. Thus, there are no significant differences in using m-library apps among disciplines. In contrast, it will require acquiring more professional knowledge and experience for graduates to

accomplish more complex learning and studying tasks using m-library apps. Finally, different disciplines require students have different focuses in using m-library apps, which generates a myriad of perceptions. This result suggests that m-library apps should provide different services or functions according to disciplines.

6. Conclusions, implications, and limitations

6.1 Conclusions and implications

This study explored the factors influencing Chinese university students' behavior intention to use m-library apps, and identified the relationships between pairs of factors as well as differences between educational levels and among disciplines. The findings of the study offer strong evidence supporting the proposed model integrated from D&M ISSM, TAM, TPB, and SCT.

This study adds to the findings from pervious related studies in revealing that external cognitive perceptions (subjective norm) more significantly influence Chinese university students' attitude and behavior intention towards m-library apps than internal cognitive perceptions. In addition, the moderating effects of educational level and discipline were identified, indicating students of varied education levels and disciplines differ in their perceptions of self-efficacy and the information quality of m-library apps.

For university libraries and app providers, understanding and discovering the factors affecting Chinese university student attitudes is helpful to increase and promote continuance usage of library resources via these apps. The effects of the subjective norm also encourage the creation of a positive context in which to increase the popularity of m-library apps. More importantly, university libraries and app providers may work together to improve the service quality of m-library offerings in accordance with different educational levels' requirements. In addition, the traditional library services specific disciplines require should not be neglected. It is necessary to develop more functions to meet their unique needs.

6.2 Limitations

Although the findings of this study offer some meaningful insights for the understanding of behavior intention toward m-library service apps, there were some limitations for future research to address.

This study was conducted using a one-time survey of one university as a sample.

For a better understanding of behavior intention of m-library service, longitudinal studies using more extensive samples should be explored. In addition, this study integrated several classical theories and models to explain and predict user behavior intention of m-library service by Chinese university students, and examined the moderating effects of education and discipline. Other factors, such as the purpose of m-library service, peer and social influence, and trust and privacy concerns should also prove important in understanding behavior intention and be considered in future research.

As mentioned above, there are several highly correlated variables, including attitude and behavior intention (0.59), and information quality and system quality. These may indicate an unreasonable measurement of the variables or possible additional pathways of causality in our model. A follow-up correction of measurement and detailed analysis on the direct and indirect relationships among these constructs should be part of future research efforts.

Finally, this study chose SmartPLS for structure equation modelling. It would be desirable to utilize various tools based on different methods and algorithms such as LISREL for analysis, comparison, and verification of results.

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Table I. Measurement of the variables

Variables	Model /Theory	Items	Source
System quality (SyQ)	D&M ISSM	SyQ1: M-library app always operates stably and reliably. SyQ2: M-library app always responds with a high speed under a good network situation. SyQ3: M-library app always well supports the university library services.	Delone and Melean 1992, 2003); Zhou (2014)
Information quality (IQ)	D&M ISSM	IQ1: Information provided by m-library app is timely and accurate. IQ2: Resources provided by m-library app are comprehensive and abundant. IQ3: Content provided by m-library app can perfectly display in an appropriate format in mobile phones.	Delone and Melean 1992, 2003); Park *et al.* (2012)
Service quality (SeQ)	D&M ISSM	SeQ1: M-library app provides reasonable and accurate functions. SeQ2: M-library app provides the professional and personalized services in accordance with my preference. SeQ3: M-library app provides the services that are able to meet my needs.	Delone and Melean 1992, 2003); Kim and Park (2014)
Perceived usefulness (PU)	TAM	PU1: Using m-library app enables me to gain the library resources effectively and accurately. PU2: Using m-library app enables me to use the library resources and complete tasks effectively. PU3: Using m-library app improves my efficiency of learning and studying. PU4: Overall, m-library app is useful for my learning and studying.	Davis (1989, 1993); Lee (2010); Gan and Song (2015)
Subjective Norm (SN)	TPB	SN1: People who are important to me think that I should use m-library app. SN2: People who influence me think that I should use m-library app. SN3: Using m-library app is a significant and necessary skill as a university student.	Ajzen (1991); Park *et al.*(2012); Hsiao and Tang (2015)
Self-efficacy (SE)	SCT	SE1: I am confident to use m-library app successfully. SE2: I can use m-library app successfully without others' help. SE3: I have enough knowledge and skills to use m-library app successfully.	Bandura (1997); Ajjan *et al.* (2014)
Attitude (ATT)	TPB	ATT1: Using m-library app is a wise idea. ATT2: Using m-library app is beneficial to my learning and studying. ATT3: On the whole, I am satisfied with m-library app.	Ajzen (1991); Booker *et al.*(2012)
Behavior intention (BI)	TAM; TPB	BI1: I intend to use m-library app on a regular basis in the future BI2: I will frequently keep using m-library app in the future BI3: I will continue using m-library app rather than any alternative tools in the future.	Ajzen (1991); Park *et al.* (2012)

Table II. Respondents' demographic information

Measure	Items (n=466)	Frequency	Percent
Gender	Male	217	46.51%
	Female	249	53.49%
Age	18-20	93	20%
	21-23	154	33.07%
	24-26	89	19.20%
	27-29	129	27.73%
Education	Undergraduate	252	54.18%
	Graduate	214	45.82%
Discipline	Science	119	25.58%
	Engineering Science	110	23.62%
	Humanities Science	105	22.47%
	Social Science	132	28.33%
Using experience (year)	(0, 1]	224	48.10%
	(1,2]	137	29.33%
	(2,3]	76	16.40%
	(3,+∞]	29	6.17%
Frequency	Once per week	193	41.42%
	2–4 times per week	113	24.33%
	Once per day	92	19.78%
	Several times per day	67	14.47%

Table III. Construct reliability and convergent validity

Constructs	Items	α	Factor loading	t-value	CR	AVE	Mean	SD
System quality	SyQ1	0.82	0.87	54.03	0.89	0.74	3.72	0.95
	SyQ2		0.88	53.07			3.76	0.98
	SyQ3		0.83	37.28			3.82	1.01
Information quality	IQ1	0.78	0.85	42.8	0.87	0.69	3.74	1.01
	IQ2		0.85	41.26			3.70	1.04
	IQ3		0.79	27.13			3.50	1.05
Service quality	SeQ1	0.84	0.88	67.54	0.9	0.75	3.63	0.93
	SeQ2		0.85	44.33			3.44	1.03
	SeQ3		0.87	56.4			3.65	1.00
Perceived usefulness	PU1	0.88	0.86	49.32	0.92	0.74	3.73	1.06
	PU2		0.86	35.56			3.73	1.02
	PU3		0.85	40.18			3.76	0.96
	PU4		0.87	50.6			3.91	0.99
Subjective Norm	SN1	0.79	0.82	29.47	0.88	0.7	3.32	1.22
	SN2		0.85	35.52			3.49	1.10
	SN3		0.85	43.49			3.58	1.08
Self-efficacy	SE1	0.92	0.92	75.91	0.95	0.86	3.94	0.95
	SE2		0.93	87.14			3.95	0.99
	SE3		0.94	103.59			3.99	0.97
Attitude	ATT1	0.87	0.92	79.33	0.92	0.8	4.10	0.93
	ATT2		0.91	78.72			4.08	0.97
	ATT3		0.84	37.62			3.89	0.95
Behavior intention	BI1	0.9	0.92	89.9	0.94	0.84	3.98	0.99
	BI2		0.92	66.18			3.80	1.05
	BI3		0.91	77.23			3.78	1.09

Table IV. Correlation matrices and discriminant validity

	ATT	BI	IQ	PU	SE	SN	SeQ	SyQ
ATT	***0.89***							
BI	0.59	***0.92***						
IQ	0.48	0.52	***0.83***					
PU	0.54	0.48	0.53	***0.86***				
SE	0.45	0.54	0.37	0.54	***0.93***			
SN	0.51	0.56	0.33	0.51	0.46	***0.84***		
SeQ	0.55	0.53	0.59	0.64	0.44	0.35	***0.87***	
SyQ	0.48	0.42	0.56	0.60	0.51	0.34	0.51	***0.86***

Table V. Summary of hypotheses tests on the whole

Hypotheses	Standardized coefficient	*t*-value	Supported
H1a (SyQ→PU)	0.273	5.07	Yes
H1b (IQ→PU)	0.246	4.72	Yes
H1c (SeQ→PU)	0.307	5.75	Yes
H2a (PU→ATT)	0.506	11.02	Yes
H2b (PU→BI)	0.165	2.14	Yes
H3 (ATT→BI)	0.603	10.63	Yes
H4a (SN→ATT)	0.097	2.46	Yes
H4b (SN→BI)	0.185	4.61	Yes
H5a (SE→ATT)	0.332	6.48	Yes
H5b (SE→BI)	*-0.026*	*0.50*	*No*

Table VI. Effects of education and discipline

Hypotheses	t-value (edu)	t-value (dis)	
		Undergraduate	Graduate
H1a (SyQ→PU)	3.33***	*1.03(ns)*	*0.49(ns)*
H1b (IQ→PU)	2.95**	2.53*	3.91***
H1c (SeQ→PU)	3.06**	*0.05(ns)*	*0.25(ns)*
H2a (PU→ATT)	6.14***	2.38*	*1.54(ns)*
H2b (PU→BI)	*1.25(ns)*	*1.68(ns)*	*0.66(ns)*
H3 (ATT→BI)	6.05***	3.07**	4.53***
H4a (SN→ATT)	*0.80(ns)*	*1.07(ns)*	*1.64(ns)*
H4b (SN→BI)	2.07*	*0.53(ns)*	*0.79(ns)*
H5a (SE→ATT)	3.97***	3.20**	5.81***
H5b (SE→BI)	*0.36(ns)*	*0.84(ns)*	*0.27(ns)*

Table VII. Path coefficients in different groups

Hypotheses	Undergraduate				Graduate			
	Science	Engineering Science	Humanities Science	Social Science	Science	Engineering Science	Humanities Science	Social Science
H1b (IQ→PU)	0.357	0.324	0.216	0.194	0.369	0.208	0.117	0.159
H2a (PU→ATT)	0.572	0.206	0.781	0.563	/	/	/	/
H3 (ATT→BI)	0.627	0.364	0.616	0.677	0.476	0.873	0.521	0.520
H5a (SE→ATT)	0.451	0.686	0.043	0.340	0.567	0.091	0.536	0.340

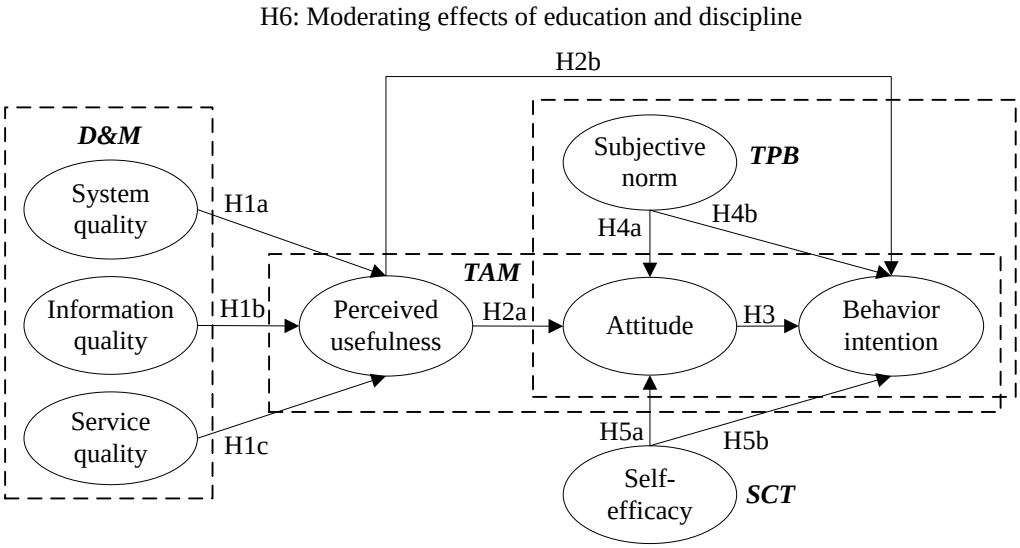

Figure 1. Proposed research model

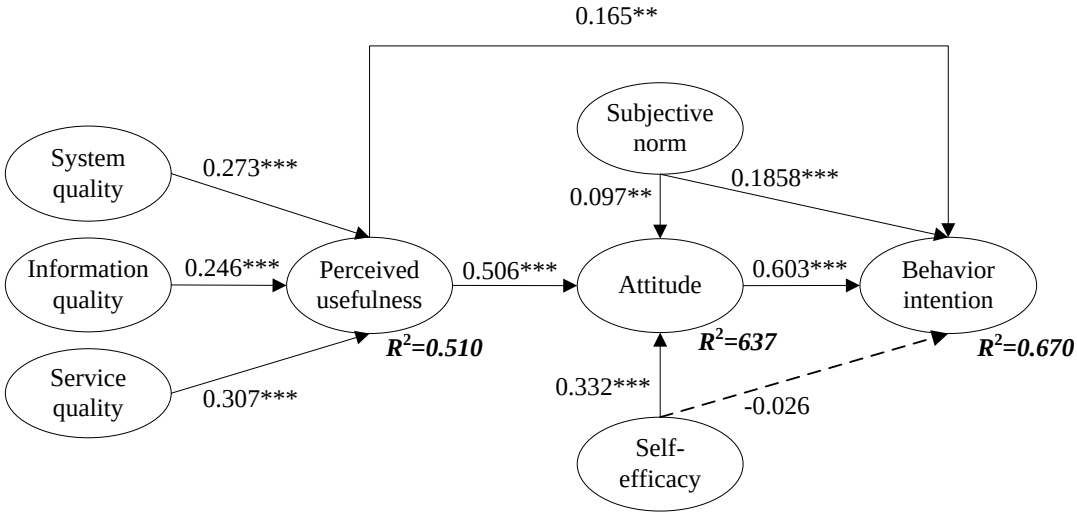

Figure 2. Results of structural modeling analysis (p*<0.05, p**<0.01, p***<0.001)