The Current State of Mobile Apps Development of Higher Education in Taiwan

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Abstract—**Mobile apps have had a large impact on many industries including higher education for many years since it emerged. The goal of this research is to deepen our understanding of the state of mobile apps development at higher education institutions in Taiwan, and it focuses on three major issues: (a) how many institutions are there in Taiwan adopting mobile apps; (b) what are the popular mobile services in higher education; (c) and whether mobile apps play a more important role than mobile webs in delivering the mobile service on campus.**

The research process was broken down into few phases. In the beginning, this research searched all the institution-related mobile apps on Apple App Store and Google Play, and determined whether it was owned by an institution based on the decision tree. Next, the classification of mobile services was proposed for analyzing the content of every official mobile app. Last, the institutions which had both mobile apps as well as mobile webs were sorted out, and the difference of mobile services between the two deliveries was compared.

The results indicates that less than half of the institutions in Taiwan have their own mobile apps, and the most popular mobile services on apps are general information as well as library services. And it also shows that the services delivered via mobile apps are more abundant than via mobile webs.

Keyword—**Mobile App, Development, Higher Education in Taiwan, Classification of Mobile App Services, Mobile Web**

I. INTRODUCTION

IN this research, the state of mobile apps development consists of the following three issues: (a) the mobile apps usage rate; (b) the popular mobile service; and (c) the main access to mobile service. Hence, the introduction would be given by the issues above.

A. *The Mobile Apps Usage Rate*

In recent years, mobile apps are more and more important in higher education. The NMC Horizon Report by 2012 indicated that mobile apps were the key technology that higher education would adopt within a year [1]. Besides, the relevant surveys showed that there were upward trends of using mobile apps at higher education institutions in the United States and in Taiwan (see Fig. 1.), and the proportion got to 83% [2] and 56.7% [3] in 2014 respectively.
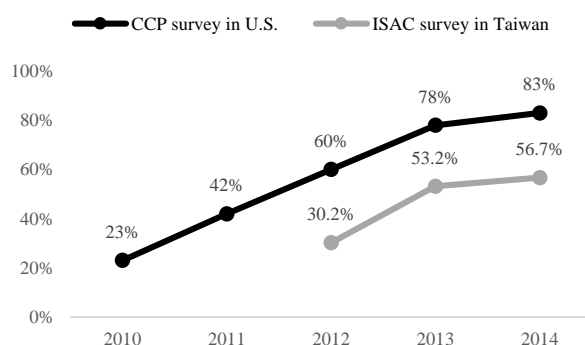

Fig. 1. The trends of adopting mobile apps at higher education institutions in U.S. and in Taiwan

Evidently, implementing mobile apps is an inevitable tendency for higher education in the future, and there would be more and more institutions starting to adopt it. In other words, the percentage of institutions adopting mobile apps in 2015 would be larger than in 2014.

As a result, it is necessary to investigate how many institutions provide its own mobile apps in 2015. The concern would be addressed specifically in Taiwan.

B. *The Popular Mobile Service*

The EDUCAUSE survey [4] showed that American universities and colleges tended to place high priority on student- and public-facing mobile services, and the top three of them were primary web presence, learning/course management services as well as library services.

In addition, when it came to the "killer mobile app" for higher education [4], most people regarded LMS (Learning Management System) and student services as top priority. Moreover, university libraries were moving toward the mobile web to deliver information access at the early stage of mobile enablement [5], so the library service was an important category for mobile services.

In this case, the research concerns what the most popular service is in higher education.

C. Mobile Apps vs. Mobile Webs

A mobile app is a program which is developed for small handheld devices [6] and installed directly onto it [7]. A mobile web is a website which is also developed specifically for mobile devices [8] but accessed through the mobile browser [7].

In most cases, mobile webs are more affordable than mobile app development [9], because it can be released in any form and any time without an approval by the app store or marketplace [7]. Moreover, mobile webs could be accessed by all types of platforms [10], and it is more flexible in the light of updating and changing content [9]. From the point of view of institutions, as a result, they prefer mobile webs rather than mobile apps.

However, students prefer to use mobile apps when they have the most mobile activities in their daily affairs (e.g. weather) as well as course-related tasks (e.g. access my course schedule) [11]. In addition, they consider that mobile apps have better performance in effectiveness of speed and ease of use than mobile webs [11]. Therefore, which access to provide is a major concern for institutions.

In light of these concerns, the assumptions of the research are listed below: (a) the mobile apps usage rate would be larger than the counterpart of the ISAC survey in 2014 [3] which is the researchers' previous study; (b) LMS and library services are the most popular categories of mobile services in higher education in Taiwan; and (c) mobile apps are the main access to mobile service base on the trend of using mobile apps in higher education.

II. RESEARCH DESIGN AND METHODS

The research was conducted during the period from January 25, 2015, through April 7, 2015. The content analysis was undertaken in this research and composed of five phases, which was summarized as follows:

A. Collecting Mobile Apps Related to Institutions

The related survey [3] suggested that the institutions in Taiwan preferred to publish their mobile apps for distribution via Android (100%) and iOS (70.8%). As a result, the search for mobile apps related to all the higher education institutions in Taiwan [12] would be limited to the two platforms, Google Play and Apple App Store, for this research.

Then, the researcher typed every institution's Chinese name as well as its English abbreviation sequentially in the search bar on the two platforms. Finally, around 670 apps associated with all the institutions in Taiwan were founded during the period from February 6, 2015, through February 10, 2015.

B. Determining Whether a Mobile Apps Is Official

The first issue of this paper is how many institutions are there in Taiwan adopting mobile apps. Therefore, it is necessary to justify whether an institution has its own mobile apps or not, and then the decision tree (see Fig. 2.) is developed for determining whether a mobile app is owned by an institution. The criteria was summarized as follows:

First, official mobile apps of institutions should be maintained properly, and its renewal should not be so long ago from now. As a result, if the mobile app was not updated in the past three years, it would not be regarded as an official

one.

Second, the use of an institution-owned mobile app should be widespread on campus. If the installs of a mobile app did not exceed 500 times, it would be regarded as non-official.
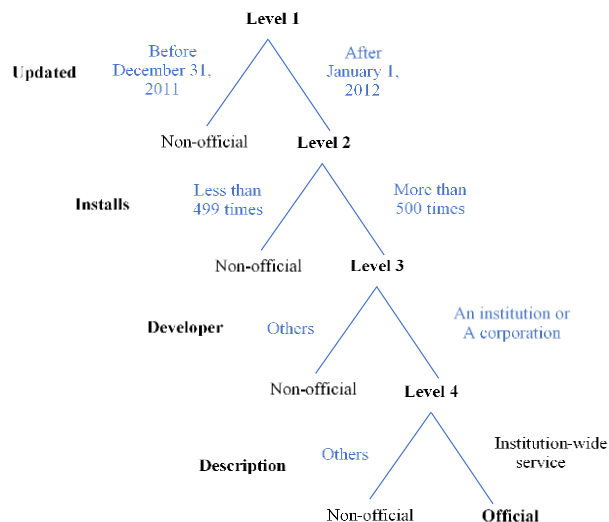

Fig. 2. The decision tree for determining whether a mobile app is official

Third, the official mobile apps should be introduced in the name of an institution or a corporation, or it would be considered as non-official. In the case of a corporation being the developer of the mobiles app, it was assumed that the institution outsourced their mobile apps to the corporation.

Forth, the services provided through an official apps should be institution-wide. If the mobile app's description did so, it would be regarded as official and would be downloaded to the researcher's mobile device.

Finally, the research got 177 official mobile apps associated with higher education institutions in Taiwan based on the decision tree.

C. Proposing the Classification of Mobile Services

In order to analyze what the content of every mobile app is, it is necessary to propose the classification of mobile services.

According to the category of the killer apps for higher education [4], the research drafted the classification of mobile services and then made use of it to examine the content of official apps in the analysis of pretest.

In the process of the pretest, the classification was adjusted and refined gradually and it became more mutually exclusive as well as collectively exhaustive. The revision of the classification of mobile services in higher education is showed on TABLE Ⅰ.

D. Analyzing the Content of Official Mobile Apps

Then, the researchers examined the content of every official mobile apps based on the classification (see TABLE Ⅰ) and recorded what services it provides. The frequency data was record by mobile apps initially, but it was converted into the statistics by institutions later.

For instance, the app 01, app 02 as well as app 03 belonged to the institution A, and the frequency of their services in sum was below: category A got three times, category B got two times, and category C got nothing. Then this research concluded that the institution A provided the service of category A and B, but not category C.

TABLE I
THE CLASSIFICATION OF MOBILE SERVICES IN HIGHER EDUCATION

Categories	Examples
Administration	Making Complaints Punch in/out
General Information	Directory Campus Maps Events Calendar
Personal Information	Push Notification Financial Services Inquiry Social Network
LMS	Learning Management System Courses/Grades Inquiry
e-Learning	e-Books Videos/Images
Productivity	Cloud e-Mail
Student Services	Reservations Emergency Call
Library Services	Library Catalog Renew Materials
Alumni Services	Events Information

PS. Each category is including but not limited to above examples.

E. Comparing Mobile Webs to Mobile Apps

The third issue of this research is to discuss whose service is more diversified, mobile apps or mobile webs. The research design of the section is as follows:

At the beginning, the researcher visited every institution's primary websites presence via a mobile browser and determined whether it was a mobile web or not (see TABLE II). Then it was filtered out that the institutions having both a mobile web and mobile apps, which amounted to 30 institutions.

Next, the mobile webs of these 30 institutions were categorized into two types, the general type and the special type. This research focused on the mobile webs belonging to the special type which included 16 institutions.

TABLE II
THE CRITERIA FOR ANALYZING MOBILE WEB

Issues	Criteria
Does the institution have a mobile web?	**Yes**, if the layout of the website on the mobile browser was a responsive design. **No**, if the layout of the website was like the page of standard websites on computer.
What the type dose the mobile web belong to?	**General type**, if the layout of the page would be automatically adjusted according to a device's screen size. **Special type**, if there were additional modular icons on the page in addition to the features of the general type.
Does a mobile web provide some kind of service?	**Yes**, if the icon of a service was linked to a page with responsive design **No**, if the icon of a service was linked to a standard website.

Third, what service the mobile web provided was analyzed. If the icon of a service on the mobile web was linked to a standard website instead of a page with responsive design (RD), then it was concluded that the mobile web did not provide this kind of service.

Finally, the services between mobile webs and mobile apps of the 16 institutions were compared.

III. RESULTS

A number of interesting findings emerged from this process, but this section focused on the three issues: (a) the mobile apps usage rate; (b) the popular mobile service; and (c) the main access to mobile services.

A. The Mobile Apps Usage Rate

Around 43% of institutions, which was 68 of 159, adopted mobile apps (see TABLE III) in Taiwan and they seemingly preferred to deploy their mobiles apps for iOS (82%) rather than Android (75%).

TABLE III
THE MOBILE APPS USAGE RATE

	For all institutions	For institutions adopting mobile apps	
	Mobile apps	For iOS	For Android
All institutions	42.8%	82.4%	75.0%
Universities & Colleges	47.9%	85.3%	88.2%
Technical Colleges	38.6%	79.4%	61.8%
Large institutions	77.8%	92.9%	92.9%
Medium institutions	49.4%	77.5%	77.5%
Small institutions	23.3%	85.7%	50.0%
Public institutions	45.1%	91.3%	73.9%
Private institutions	41.7%	77.8%	75.6%

According to the results, institution's size did matter in reference to the mobile apps usage rate. Large institutions were more likely than medium and small institutions to adopt mobile apps with the rate at 78 percent, as opposed to 49% of medium institutions as well as 23% of small institutions.

Generally speaking, institutions in Taiwan tended to publish their mobile apps on iOS instead of Android, and small institutions was the most evident example of that viewpoint because of its greatest difference of usage rate between the two platforms among all types of institutions. However, there was a result in the opposite direction. In relation to the type of institutions by education system, universities and colleges slightly favored Android.

Interestingly, such a few types of institutions as large institutions and medium institutions had the same usage rate between iOS and Android, but it did not mean that every institution deployed their apps for the two platforms simultaneously.

Approximately two thirds of institutions (68%) owned one or two mobiles apps, leading those who had three or four (19%) as well as five and more (13%). The average for those surveyed was 2.6 units, which indicated that only a third of institutions (32%) above the average (see TABLE IV).

TABLE IV
THE DISTRIBUTION OF MOBILE APPS AN INSTITUTION OWNED

Number of official app(s)	Pct. of institutions (n=68)	Cumulated pct. of institutions (n=68)
One	33.8%	33.8%
Two	33.8%	67.6%
Three	10.3%	77.9%
Four	8.8%	86.8%
Five	4.4%	91.2%
Six	2.9%	94.1%
Seven	2.9%	97.1%
Eight and more	2.9%	100.0%

B. The Popular Mobile Service

The most popular mobile service provided by institutions through their mobile apps was general information (75%), leading library services (62%), personal information (60%), LMS (54%), e-learning (52%), student services (50%), productivity (16%), alumni services (9%), and administration (6%) (see TABLE V). The number in the parentheses referred to the percentage of institutions which offered a certain kind of mobile service and was named "the supply rate" in this research. Consequently, the result showed that six of nine mobile services were offered by more than half of institutions while the others were furnished by less than 20% of institutions. In researcher's opinion, higher education institutions in Taiwan had a strong preference in some mobile services.

TABLE V.
THE STATISTICS ABOUT MOBILE SERVICES

	Pct. of institutions (n=68)	Pct. of mobile apps (n=177)
General Information	75.0%	57.1%
Library Services	61.8%	42.4%
Personal Information	60.3%	40.1%
LMS	54.4%	37.3%
e-Learning	51.5%	36.2%
Student Services	50.0%	33.3%
Productivity	16.2%	14.7%
Alumni Services	8.8%	5.1%
Administration	5.9%	3.4%

When it came to the most prevalent mobile service in institutions' mobile apps, the ranking of mobile services was identical to the order by the supply rate. However, only one of them, general information (57%), existed in more than half of institutions' mobile apps. Less than half of mobile apps were equipped with the following mobile services, including library services (42%), personal communications (40%), LMS (37%), e-learning (36%), student services (33%), productivity (15%), alumni services (5%), and administration (3%) (see TABLE V).

Besides, it was observed that institutions' preference for mobile services seemed to alter by control of school. For example, public institutions gave top priority to library services (74%) while private institutions put greater emphasis on general information (84%) (see TABLE VI). Second, e-Learning was one of the top three mobile services for private institutions but not for public institutions. Third, an ANOVA test showed that private institutions were more likely than public institutions to provide general information as well as e-Learning.

TABLE VI.
THE STATISTICS ABOUT MOBILE SERVICES BY CONTROL OF SCHOOL

	Pct. of public institutions (n=23)	Pct. of private institutions (n=45)
General Information	56.5%	84.4%
e-Learning	21.7%	66.7%
Personal Information	60.9%	60.0%
LMS	47.8%	57.8%
Library Services	73.9%	55.6%
Student Services	52.2%	48.9%
Productivity	21.7%	13.3%
Alumni Services	8.7%	8.9%
Administration	4.3%	6.7%

How many mobile services an institution offered was examined in this research. Less than half of institutions (47%) supplied three or fewer mobile services (see TABLE VII), and the average for those surveyed was 4 units. There was an obvious gap between six units (18%) and seven units (10%), which displayed that providing more than seven units of mobile services was a high threshold for higher education in Taiwan.

TABLE VII.
THE DISTRIBUTION OF MOBILE SERVICES AN INSTITUTION PROVIDED

Number of unit(s)	Pct. of institutions (n=68)	Cumulated pct. of institutions (n=68)
One	11.8%	11.8%
Two	14.7%	26.5%
Three	20.6%	47.1%
Four	13.2%	60.3%
Five	11.8%	72.1%
Six	17.6%	89.7%
Seven	5.9%	95.6%
Eight	4.4%	100.0%

Moreover, the researcher wondered how many mobile services an institution provided though a mobile app. The researcher set a value called efficiency and its formula was "the number of mobile services of the institution" divided by "the number of that institution's mobile apps. The value of efficiency presented the mean of mobile services per mobile app of an institution. The larger the value was, the more services a mobile app provided.

The institutions with value of efficiency between 1.00~1.99 accounted for 41 percent of the total, and those whose value of efficiency exceed 4.0 merely accounted 9 percent (see TABLE VIII). Interesting, there was roughly

10% of institutions with value of efficiency less than 1.00, which showed that their mobile services were overlapping largely. Briefly, the average for those surveyed was 2 units.

TABLE VIII.
THE DISTRIBUTION OF THE VALUE OF EFFICIENCY

Value of efficiency	Pct. of institutions (n=68)
5.00~5.99	2.9%
4.00~4.99	5.9%
3.00~3.99	19.1%
2.00~2.99	19.1%
1.00~1.99	41.2%
0.00~0.99	11.8%

There was a significant difference in the value of efficiency with respect to control of school: private institutions were more likely than public institutions to provide more mobile services with less mobile apps.

Next, the mobile services were focused again. In this research, two numbers, "the multi-app rate" and "the service multiple", were calculated in order to understand the degree of diversity or redundancy of a mobile service.

The multi-app rate was the proportion of institutions offering a certain kind of mobile service via two or more apps. The larger the multi-app rate was, the larger degree of diversity or redundancy a mobile service was. Among the mobile services, productivity had the highest multi-app rate (91%), leading e-Learning (69%), student services (68%) and so on (see TABLE IX).

TABLE IX.
THE DEGREE OF DIVERSITY OR REDUNDANCY OF MOBILE SERVICES

	The multi-app rate	The service multiple
Productivity	90.9%	2.36
e-Learning	68.6%	1.83
Student Services	67.6%	1.74
General Information	64.7%	1.98
Library Services	64.3%	1.79
LMS	62.2%	1.78
Personal Information	56.1%	1.73
Administration	50.0%	1.50
Alumni Services	50.0%	1.50

The service multiple was the division gained from the number of mobile apps furnishing a certain mobile service divided by the number of institutions providing the same mobile service. It displayed how many mobile apps was used to support a mobile service by an institution. The larger the service multiple was, the larger degree of diversity or redundancy a mobile service was. Among the mobile services, productivity also had the highest value (2.36), followed by general information (1.98), e-Learning (1.83), etc. (see TABLE IX).

The supply rate mentioned above stood for the degree of widespread of a mobile service because it presented "how many institutions offer the mobile service". On the other hand,

the multi-app rate and the service multiple represented "the degree of diversity or redundancy of a mobile service".

From the aspect of the supply rate, personal information was one of the top three mobile services, trailing behind general information and library services, yet it came in seventh place with respect to the degree of diversity or redundancy of mobile services. It showed that personal information was offered by most intuitions via just one or two mobile apps (see TABLE X).

However, the result of productivity was in the opposite direction: productivity had a quite low ranking by the supply rate but became the top one by the degree of diversity or redundancy. That was, once productivity was offered by an institution, it would be supported by relatively more mobile apps (see TABLE X).

TABLE X.
THE RANKING OF MOBILE SERVICES BY THREE CRITERIA

	By supply rate	By multi-app rate	By service multiple
General Information	1	4	2
Library Services	2	5	4
Personal Information	3	7	7
LMS	4	6	5
e-Learning	5	2	3
Student Services	6	3	6
Productivity	7	1	1
Alumni Services	8	8	8
Administration	9	8	8

C. Mobile Apps vs. Mobile Webs

Around 33% of institutions in Taiwan adopted mobile webs (see TABLE XI). Again, the institutions' size had much things to do with the mobile webs usage rate. For example, large institutions (56%) were more likely than medium (40%) and small institutions (17%) to adopt mobile webs.

Besides, among all types of institutions, the mobile webs usage rate was always lower than the mobile apps usage rate (see TABLE XI), which indicated that the institutions in Taiwan tended to focus their mobile enablement on apps instead of webs.

TABLE XI.
THE USAGE RATE: MOBILE WEBS VS. MOBILE APPS

	Pct. of institutions adopting mobile webs (n=159)	Pct. of institutions adopting mobile apps (n=159)
All institutions	32.7%	42.8%
Universities & Colleges	32.4%	47.9%
Technical Colleges	33.0%	38.6%
Large institutions	55.6%	77.8%
Medium institutions	39.5%	49.4%
Small institutions	16.7%	23.3%
Public institutions	37.3%	45.1%
Private institutions	38.1%	41.7%

For those institutions who adopted mobile apps and mobile webs simultaneously, a certain kind of mobile service might be provided by their mobile apps but not mobile webs, and

vice versa. The four possible situations were described in Fig. 3. A mobile service was placed in the corresponding quadrant according to the situation the majority of institutions belonged to. Frist, many institutions offered general information (88%) and library services (31%) via both their apps and webs. Second, three mobile services was provided via apps but not webs, including personal information (63%), LMS (56%) and e-Learning (38%). Third, most of institutions did not provide some kinds of mobile services via neither mobile apps nor mobile webs, such as alumni services (88%), administration (81%), productivity (69%), and student services (44%). Apparently, there was no mobile service offered via mobile webs but not mobile apps.
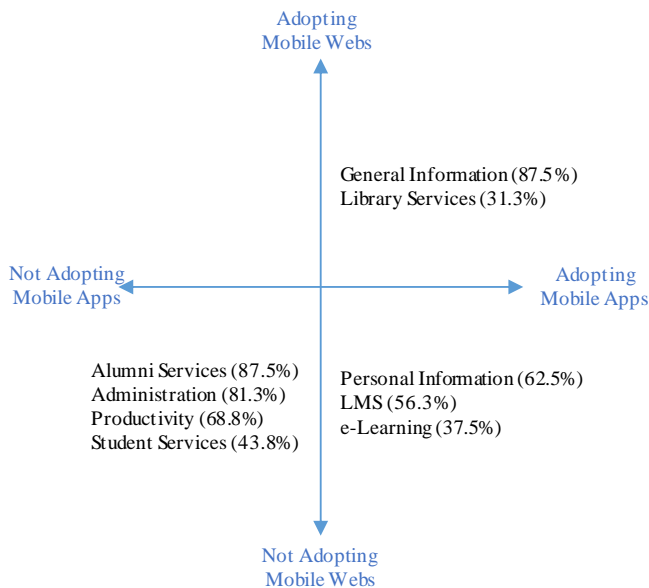

Fig. 3.   The situation the majority of institutions belonged to by mobile services

Furthermore, the detail of the percentage by mobile services was viewed. Among the services provided by both mobile apps and mobile webs, only general information exceeded 80% of institutions while the other night of ten were below 35%, even four of them were zero (see TABLE XII). It showed that there was no room for mobile webs to replace mobile apps.

Besides, there were four mobile services that mobile apps provided but mobile webs did not, including personal information (62.5%), LMS (56.3%), administration (18.8%) and productivity (18.8%). It specified that the mobile services delivered via mobile apps were more abundant than via mobile webs. Hence, the conclusion of this part was that the main access to mobile service for institutions in Taiwan was mobile apps instead of mobile webs.

IV.   CONCLUSIONS

The last two of the assumptions of the research are supported while the first one is not. There is an explanation for the result. Besides, four limitations of the research would be summarized.

A. Findings

The result indicates that the mobile apps usage rate of higher education institutions in Taiwan is 42.8%, as opposed to 56.7% of the ISAC 2014 survey, which rejects the first

assumption. There is a way to explain such a result. The criteria of this research for determining whether a mobile app is official is strict that the percentage of adopting mobile apps declined. For example, a mobile app whose developer is a person would be regarded as non-official even though its copyright belongs to an institution or a corporation.

TABLE XII.
CONTENT ANALYSIS ACROSS MOBILE APP AND MOBILE WEB

Does It Provide?	App does Web does (n=16)	App doesn't Web does (n=16)	App does Web doesn't (n=16)
Administration	0.0%	0.0%	18.8%
General Information	87.5%	12.5%	0.0%
Personal Information	0.0%	0.0%	62.5%
LMS	0.0%	0.0%	56.3%
e-Learning	25.0%	12.5%	37.5%
Productivity	12.5%	0.0%	18.8%
Student Services	12.5%	6.3%	37.5%
Library Services	31.3%	18.8%	25.0%
Alumni Services	0.0%	37.5%	0.0%
Others	12.5%	12.5%	12.5%

PS. The number is the percentage of institutions.

The most popular mobile services provided by institution in Taiwan via official apps are as follows: general information, library services, personal information and LMS. In addition, more than half of the institutions offer these services. Hence, the second assumption is supported.

The services delivered via mobile apps are more abundant than via mobile webs, which indicates that mobile app is the main tool for delivering mobile services for higher education in Taiwan. As results, it is concluded that the third assumption is supported and serving users takes priority over cutting cost in the consideration of the institutions in Taiwan.

TABLE XIII.
THE OUTCOMES OF THE RESEARCH

Assumptions	Results
The usage rate of the institutions of this research is larger than the counterpart of the ISAC survey in 2014.	The percentage of this paper is 42.8% as opposed to 56.7% of the ISAC 2014 survey.
LMS and library services are the most popular categories of mobile services in higher education in Taiwan.	In terms of frequency, library services and LMS are at top 2 and top 4 respectively, and both of them are provided by more than half of institutions in Taiwan.
The main access to mobile services for institution in Taiwan is mobile app instead of mobile web.	The services delivered via mobile apps are more abundant than via mobile webs

B. Limitations

First, if the name or the developer of an official app was irrelevant to the institution's name then researchers could not find it out, which may affected the usage rate.

Second, there was no information about the installs of an app on Apple App Store. If the installs of an app were less than 500 times then the researcher could not cross it out.

Third, it was impossible to analyze the content of some mobile services on the mobile app or the mobile web due to no user accounts to log in. If the researcher could not ensure that the institution did provide the service, then it didn't.

Finally, a concise method of analysis was taken because of the restriction of time. For mobile apps, the researcher regarded the app on iOS and Android as the same in case that its name, developer and user interface are the same. The analysis result of one of them would be applied to the other. For mobile webs, analyzing the institutions belonging to the special type of 16 were focused on instead of the general type of 30.

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Chia-Ming Li graduated with a degree in history in 2009 and earned his MBA in 2013 both from National Chengchi University (NCCU), Taipei, Taiwan. Now he is the RESEARCHER of WisdomGarden in Taipei, and takes responsibility for industry study of educational technology in higher education. Furthermore, he is in charge of collecting, organizing and carrying out complex data analysis in support of management as well as customer requests, and also involved in reporting statistical findings to developing data-driven strategies with senior managers.

Prior to the current position, Mr. Li served as a second lieutenant while fulfilling his compulsory military service in 2010. Besides, Mr. Li had an overseas internship for two months at Sinyi Realty in Shanghai, China, when he was an MBA student in 2012.
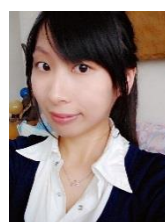
Yu-Jou Sun earned her MBA in 2014 from Feng Chia University, Taichung City, Taiwan, and Double Bachelor Commerce Degrees in 2012 in financial and economic law as well as finance from Chihlee Institute of Technology, New Taipei City, Taiwan. Now she is the ASSISTANT RESEARCHER of WisdomGarden in Taipei, and responsible for industry study of educational technology in higher education. Prior to the current position, she had an overseas internship for two months at ACE group International Management Consulting Co. in Dongguan, China, when she was an undergraduate in 2011.