Mediating effects on the relationship between perceived service quality and public library app loyalty during the COVID-19 era

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ABSTRACT

The demand for using library apps to search for information has been increasing after the COVID-19 outbreak. To look into how the pandemic affects the users' perception of the loyalty of using library apps, we designed this research by amalgamating the updated IS success model and S–O–R model to evaluate the service quality of a public library app under the Hong Kong Government mobile applications initiative. A third-order model is established to demonstrate the multi-faceted aspects of service quality and mediating effects of perceived brand image, satisfaction, and e-word of mouth. Using structural equation modeling, data collected from Hong Kong, a metropolis where mobile services empower its citizens, showed the interrelationships among service quality and possible outcomes (i.e., perceived brand image, user satisfaction, e-word of mouth, and user loyalty). Findings also indicate that the influence of perceived service quality on user loyalty could only be achieved through perceived brand image and user satisfaction. This is a timely study during the COVID-19 pandemic, as the lockdown and social distancing arrangements created challenges for citizens to search for information in public libraries in person. Our findings and suggestions reiterate the importance of considering the usability concepts when analyzing the service quality of each unique app. They also provide insights for practitioners in developing the next generation of apps for smart public information services and call for further investigation into the proposed hierarchical model and other potential factors related to service quality.

1. Introduction

In recent decades, the use of mobile devices has been widespread and increasing. From 2010 to 2020, the mobile device market share has rapidly increased from 3% to 52% (Statcounter, n.d.). Meanwhile, in Hong Kong, smartphones have become the most used device for Internet connections, particularly for information search (Census and Statistics Department, 2019). The increase of information search through mobile devices has created a challenge to the local public library system, Hong Kong Public Libraries (HKPL), as it faces a drastic change in patrons' needs: From 2012 to 2014, the number of physical visits has declined gradually, whereas the number of online visits has tremendously increased (Legislative Council of Hong Kong, 2016). As a result, the HKPL developed the "My Library" app (see Fig. 1) to provide better mobile services for citizens (GOVHK, 2014). This app provides various types of public library services via the mobile platform, including (i) transaction history; (ii) library materials search, renewal, and reservation; (iii) overdue fines and reservation fees payment; (iv) personalized alert services for reserved items pick-up and loan renewal; (v) links to electronic resources and social media platforms; and (vi) libraries location and contact. HKPL has won the Merit Award at the Asia Pacific ICT Awards 2015 in recognition of its popularization of mobile public information services (HKPL, n.d.). "My Library" has also become the primary tool for citizens to library information search and e-reading, particularly during the COVID-19 pandemic. It is because the HKPL, similar to other businesses and organizations, was ordered to shut down occasionally to minimize virus spread (HKPL, 2021).

Even before the COVID-19 pandemic, the HKPL planned to optimize "My Library" as a one-stop access mobile app to adapt to the new "Smart Library System" by the end of 2022 under the Hong Kong Government mobile applications initiative.[1] Hence, HKPL has been keen on collecting the public's opinions through surveys these years. The questionnaires, however, paid little attention to the service quality of "My Library," and the findings lacked transparency due to confidentiality issues

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[1] https://www.gov.hk/en/about/govdirectory/mobileapps.htm.

(Legislative Council of Hong Kong, 2018). Along with the ongoing consultations to the Public Library Advisory Committee members, HKPL staff members, and the public, it is vital to understand further how "My Library" can provide a better user experience and service quality by evaluating the app openly under a robust conceptual framework (Heo et al., 2017).

This study investigates users' perceived service quality of "My Library" during the COVID-19 period, particularly how perceived service quality influences users' loyalty to the app with the mediating effect of perceived brand image, satisfaction, and e-word of mouth (eWoM). While these three constructs, perceived brand image (Alam and Noor, 2020), satisfaction (Tan et al., 2017), and eWoM (Purwanto et al., 2020), have been shown to influence loyalty, scant research has studied how these constructs interact with the relationship between service quality and loyalty. Therefore, this research is designed to fill this gap with the following objectives:

(i) explore relevant and adequate dimensions and sub-dimensions to develop a service quality model for a public library mobile app;
(ii) apply the Mobile Library Service (MLS) Evaluating Model as the research procedure;
(iii) understand users' perception of "My Library" to ascertain the service quality of the app;
(iv) verify the relationships among the five constructs; and
(v) provide several suggestions to enhance the overall service quality of "My Library".

2. The development of the research model

2.1. Literature on service quality

Service quality is the output of the service delivery system perceived by its users (Martínez and Martínez, 2010). Therefore, mobile service quality can be interpreted as customers' judgment about the condition of service delivery in the mobile computing environment. To better understand service quality based on customer perceptions, Parasuraman et al. (1988) developed the SERVQUAL model to conceptualize their relationships. SERVQUAL models customer expectation as the perceived benefit or value that customers seek when receiving a service or purchasing a good, and customer perception is a concept that encompasses customers' positive or negative feelings concerned. Therefore, the goal of evaluating the service quality of a particular service is to identify the gap mentioned above and to close the gap by finding possible solutions (Alfalah, 2017). Based on the SERVQUAL model, Cronin and Taylor (1992) developed the SERVPERF model, a performance-based approach model, to measure customer perception towards a service.

Service quality is not only a concern for the private sector but also the public sector. Prior research has investigated e-government service quality using a multi-dimensional framework (Jansen and Ølnes, 2016; Sá et al., 2016), as well as for mobile government service (Al-Hubaishi et al., 2017; Shareef et al., 2014) (see Fig. 2). Concerning library services, Cook et al. (2001) also developed the service quality measurement for traditional library services, i.e., LibQUAL+, based on the SERVQUAL model. Tsui (2015) further improved the LibQUAL + by replacing "Affect of Service," "Information Control," and "Library as Place" of LibQUAL+ with "Service and Functions," "Usage and Operation," and "Appearance and Design," respectively. On the other hand, Zhang et al. (2016) assessed the quality of m-library apps in two aspects: hardware quality based on input function, resolution, and screen size of the user's mobile device; and software quality focused on measuring the format, layout, and presentation of the content of the m-library app. Fig. 3 summarizes the dimensions and sub-dimensions developed by Tsui (2015) and Zhang et al. (2016).

As the research on user experience and service quality in MLS is still emerging, researchers consider collecting ideas from the usability tests to assess MLS. According to the previous studies, *effectiveness, presentation, and efficiency* are the primary usability indicators (ChanLin and Hung, 2016; Fu et al., 2020). On top of that, to enrich the instrument, several ideas of Nielsen's usability heuristics clarified by Abulfaraj and Steele (2020) will also be adopted as the sub-dimensions.

2.2. The IS success model and the S–O-R model

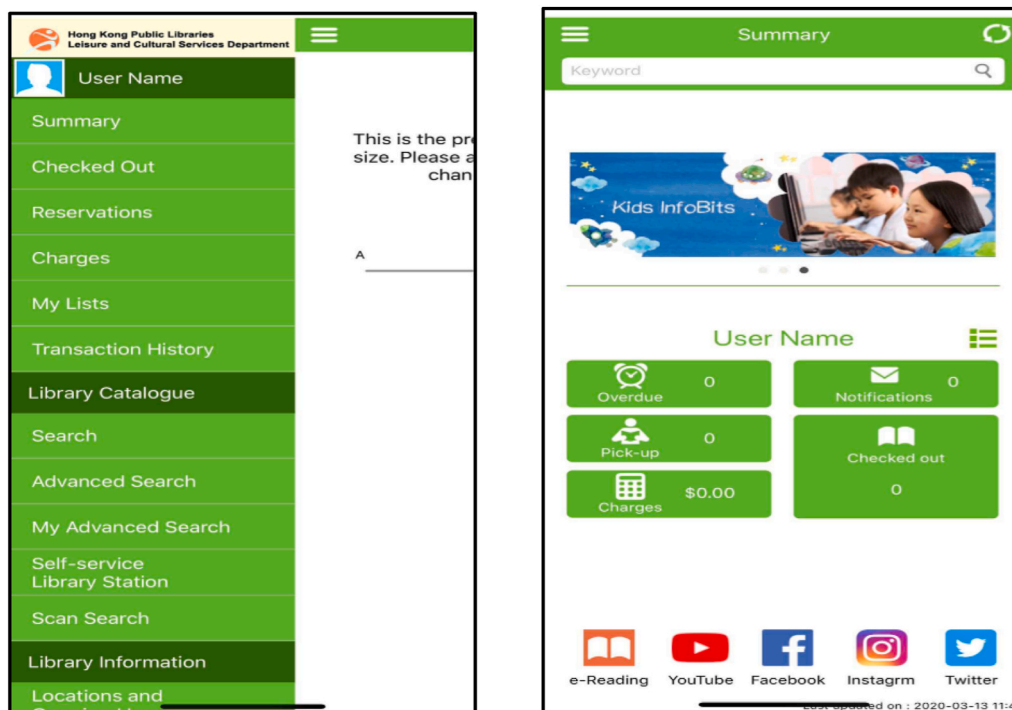Previous studies were based on the SERVQUAL model, which mainly

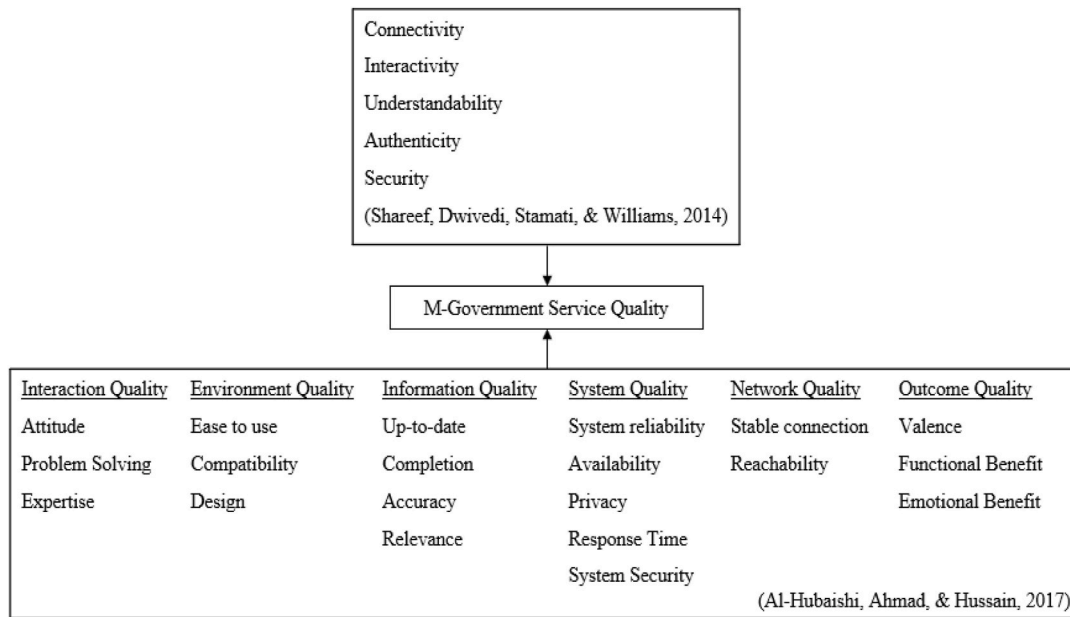**Fig. 1.** Screenshots of the "My Library" app.

Fig. 2. Dimensions and sub-dimensions from mobile government services.
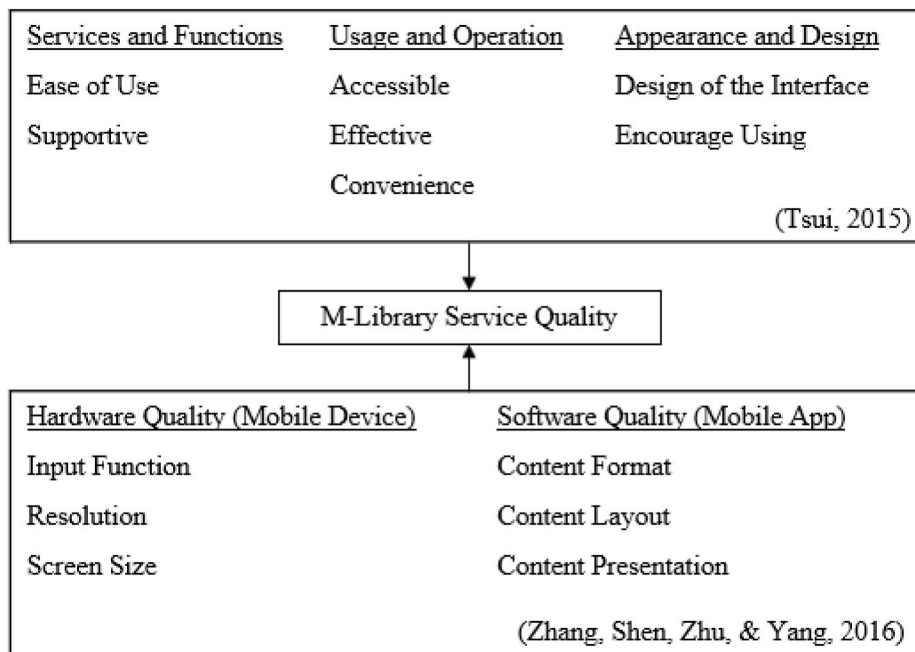

Fig. 3. Dimensions and sub-dimensions from mobile library services.

demonstrated the application of different service quality concepts in different environments, and then specifically reviewed the service quality gap. Yet, they rarely explore the possible impact of service quality from a broader perspective. To fill the research gap mentioned, this research not only continues to explore the application of service quality in a mobile information service setting. It also tries to integrate with other models to draw a more complete picture of service quality and its related constructs.

Here, we amalgamated two existing models into a single model to study the service quality of the "My Library" app. The first model is the information system (IS) success model, which is established to evaluate the effectiveness of an information system (DeLone and McLean, 2016). The model consists of six constructs, i.e., system quality, information

quality, service quality, user satisfaction, the intention of use, and net impacts (see Fig. 4). We selected the IS success model as one of the models incorporated in our final research model because it has been a commonly used model to study the adoption of e-government services (Alruwaie et al., 2020). The second model is the Stimulus-Organism-Response model (S–O–R model), in which stimulus (S) is the appraisal process that affects the emotional states of individuals, known as the organism (O). The organism, in turn, elicits several coping responses (R) (Mehrabian and Russell, 1974) (see Fig. 5). Alam and Noor (2020) also used this model to study the impact of service quality and corporate image on customer loyalty. We believe that by amalgamating these two models, we can explore how service quality and other related constructs, to be presented in the following
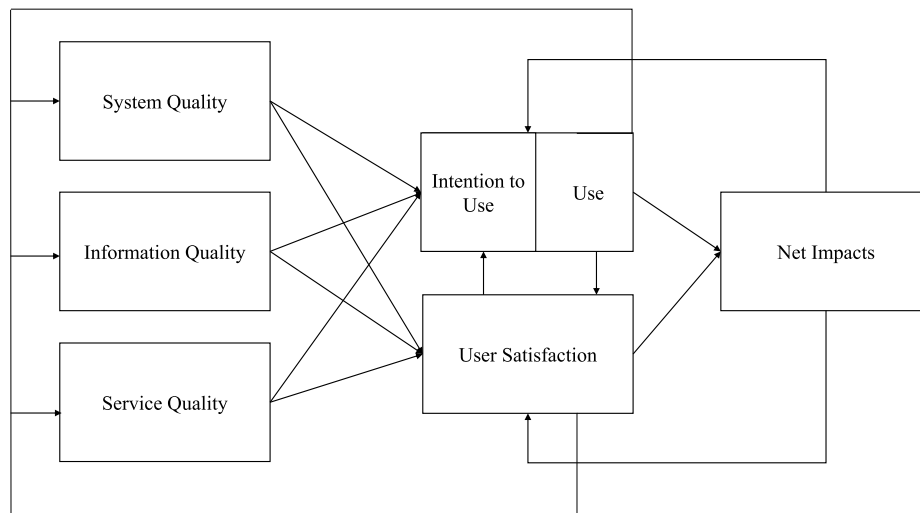
Fig. 4. The Updated DeLone and McLean 2003 is success model (DeLone and McLean, 2016).
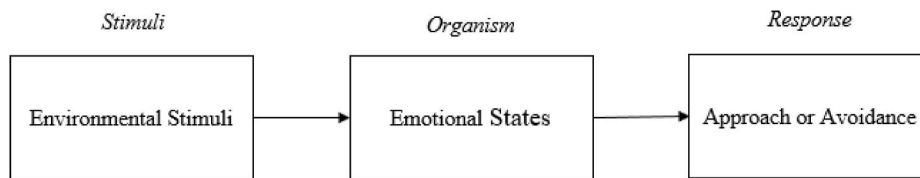

Fig. 5. The Stimulus-Organism-Response model (Mehrabian and Russell, 1974).

sub-sections, influence user loyalty in a public library app during the COVID-19 pandemic.

2.3. Research model and hypotheses development

2.3.1. Perceived quality and user loyalty

Under the S–O-R model, a stimulus would trigger the emotional state of individuals. Following Alam and Noor (2020), who consider service quality a stimulus, we use the perceived service quality of the library app (PSQ) as our stimulus. According to the findings of Alam and Noor (2020), service quality would have a positive impact on a user's loyalty act as a response. Tan et al. (2017) also found that service quality positively impacts loyalty in the library context. Therefore, we propose:

H1. Perceived service quality of library apps (PSQ) positively impacts the user's loyalty (LOY).

2.3.2. Perceived quality and satisfaction

The first emotional state that we are concerned about, i.e., organism, is satisfaction. In the library app context, we define satisfaction (SAT) as the degree to which the services offered by the "My Library" app meet users' expectations (Grigoroudis and Siskos, 2009). Recent research shows that perceived service quality on home delivery service of online purchase positively impacts user satisfaction (Uzir et al., 2021). We also know that service quality positively impacts satisfaction (DeLone and McLean, 2016), and the library information systems literature reported similar findings, such as Kiran (2010) and Tan et al. (2017). Therefore, we propose:

H2. Perceived service quality of library apps (PSQ) positively impacts the user's satisfaction (SAT).

2.3.3. Satisfaction and loyalty

According to the S–O-R model, O would impact R. Therefore, we anticipate that user satisfaction would have a positive impact on user loyalty. Prior studies showed that user satisfaction with the service

positively impacts the user's loyalty for mobile food-ordering apps of restaurants (Dirsehan and Cankat, 2021) and mediates the effect of experience on loyalty (Monlinilo et al., 2022). Research in library information systems setting (Tan et al., 2017) also observed satisfaction could positively predict loyalty in the public library. Therefore, we propose:

H3. The user's satisfaction with library apps (SAT) positively impacts the user's loyalty (LOY).

2.3.4. Perceived brand image

Perceived brand image (PBI) is related to an individual's impressions, beliefs, and knowledge of an institution (Jara and Cliquet, 2012), stimulating customers' satisfaction and maintaining a loyal relationship with a business. Prior research (Fu et al., 2018) verified the service quality-satisfaction-loyalty relationships and the positive impact of corporate image on satisfaction and loyalty. Under the S–O-R framework, Alam and Noor (2020) discovered that service quality positively influences brand image, and brand image positively affects loyalty in a retail superstore app. Meanwhile, PBI was used as a moderator in explaining the effect of service quality and customer satisfaction on customer loyalty in previous research (Nyadzayo and Khajehzadeh, 2016). These previous findings showed that perceived brand image is notable for further investigation. Therefore, we have the following three hypotheses related to perceived brand image developed:

H4. Perceived service quality of library apps (PSQ) positively impacts its perceived brand image (PBI).

H5. Perceived brand image of library apps (PBI) positively impacts the user's satisfaction (SAT).

H6. Perceived brand image of library apps (PBI) positively impacts the user's loyalty (LOY).

2.3.5. Electronic word-of-mouth

Electronic word-of-mouth (eWOM) refers to casual online

communication between a non-commercial communicator and a receiver regarding the perception of a brand, a product, or service and its quality (Krishnamurthy & Kumar, 2018). Nowadays, it has become vital as people spend a lot of time exchanging and discussing ideas online, particularly during the COVID-19 pandemic. It can influence people, especially the millennials, and quickly change their loyalty towards a brand by receiving online reviews (Purwanto et al., 2020). Furthermore, Khoo (In Press) found that both corporate image and user satisfaction positively impact users' word of mouth in the Karaoke television industry from Malaysia. Based on these findings, we developed the following four hypotheses:

H7. Perceived service quality of library apps (PSQ) positively impacts electronic word-of-mouth (eWOM).

H8. Perceived brand image of library apps (PBI) positively impacts electronic word-of-mouth (eWOM).

H9. The user's satisfaction with library apps (SAT) positively impacts electronic word-of-mouth (eWOM).

H10. Electronic word-of-mouth (eWOM) positively impacts the user's loyalty (LOY).

2.3.6. Mediating effects

Prior research (Kiran and Diljit, 2011) found that satisfaction explained perceived web-based library service quality effects on patron loyalty. In addition, Bakti and Sumaedi (2013) applied the SERVQUAL measurement scale to demonstrate that service quality indirectly affects reader loyalty through their satisfaction in the academic library context. However, scant studies have investigated what other mediating variables can interact with service quality to affect loyalty. Inspired by Karim (2020) and other studies, we see possible mediating effects of brand image, satisfaction, and e-word of mouth on service quality to loyalty. Therefore, we propose the following hypotheses to investigate the possible mediating effects:

H11a. Perceived brand image of library apps (PBI) mediates the relationship between perceived service quality of library apps (PSQ) and the user's loyalty (LOY).

H11b. User's satisfaction with library apps (SAT) mediates the relationship between perceived service quality of library apps (PSQ) and the user's loyalty (LOY).

H11c. Electronic word-of-mouth (eWOM) mediates the relationship between perceived service quality of library apps (PSQ) and the user's loyalty (LOY).

H11d. Perceived brand image of library apps (PBI) and the user's satisfaction with library apps (SAT) jointly mediate the relationship between perceived service quality of library apps (PSQ) and the user's loyalty (LOY).

H11e. Perceived brand image of library apps (PBI) and electronic word-of-mouth (eWOM) jointly mediate the relationship between Perceived service quality of library apps (PSQ) and the user's loyalty (LOY).

H11f. The user's satisfaction with library apps (SAT) and electronic word-of-mouth (eWOM) jointly mediate the relationship between perceived service quality of library apps (PSQ) and the user's loyalty (LOY).

H11g. Perceived brand image of library apps (PBI), the user's satisfaction with library apps (SAT) and electronic word-of-mouth (eWOM) jointly mediate the relationship between perceived service quality of library apps (PSQ) and the user's loyalty (LOY).

2.3.7. Final research model

With the growing trend of mobile technologies, information service

providers have started to introduce mobile apps in their services. However, a paucity of studies has assessed the service quality of the mobile library app. Meanwhile, a timely service quality scale has not been fully developed to systematically assess the MLS of public libraries and explain the relationships between service quality and its possible consequences. We developed a third-order service quality model to study the perceived service quality of the "My Library" app. While the second order of the model is developed based on the three dimensions proposed in "e-sq of MLS" (Tsui, 2015) are employed, the first-order latent variables, the sub-dimensions, are developed supported by extensive reviews on the service quality and usability literature. The final reflective-reflective-formative research model is presented in Fig. 6.

3. Methodology

3.1. Survey instrument

In this study, we use the mixed methods approach as it can provide us with a more holistic way to understand how our users view the service quality of the app (Cresswell, 2009). We developed a bilingual (English/Chinese) survey instrument with 53 items based on Tsui (2015) (see Table 1), plus some open-ended questions to collect qualitative feedback. We established the consistency between the English and Chinese versions of the survey and the content validity through the "translation and retranslation method." The survey consisted of four parts. Part A consisted of questions asking participants about their daily usage of the "My Library" app during the COVID-19 pandemic. Part B asked participants about their perceptions of the "My Library" services in terms of three dimensions (i.e., SF, UO, and AD) of service quality and their overview of "My Library" services (i.e., PSQ, PBI, SAT, eWOM, and LOY) using seven-point Likert scale (1 = "Strongly Disagree"; 7 = "Strongly Agree"). In part C, participants could optionally provide feedback for "My Library" to improve in the post-pandemic world. Those ideas were collected to facilitate the strategic action plan of the study. The last part collected the participants' demographic information and their feedback on the apps. The average time for completing the survey was about 10 min.

3.2. Data collection

Before our data collection process, we performed an *a priori* sample size calculation for SEM to determine the number of participants needed for this study (Soper, 2017). With a medium effect size, 0.9 statistical power, and 0.05 probability level, the minimum sample size required was 243.

We recruited our participants through face-to-face and online methods. For face-to-face recruitment of participants, one of the co-authors with mobile devices connected to the online data collection site randomly recruited patrons of the HKPL on site to fill in the survey with mobile devices. We also recruited participants online via WhatsApp and Telegram, two of the five most popular downloaded apps in 2021 (SensorTower, 2021). The snowball sampling method was applied as a supplement to boost the response rate. We also provided incentives to encourage people to participate in the survey, of which eligible participants would receive HK$3 (around US$0.38) in cash or via online payment after completing the questionnaire.

A total of 267 local residents participated in this survey, and their demographic data are presented in Table 2. 60.3% of the participants were male, with 44.2% earned a bachelor's degree. They were evenly distributed among different age groups, except for the 50–59 group (3.7%) and the 60+ group (0.7%).

4. Results

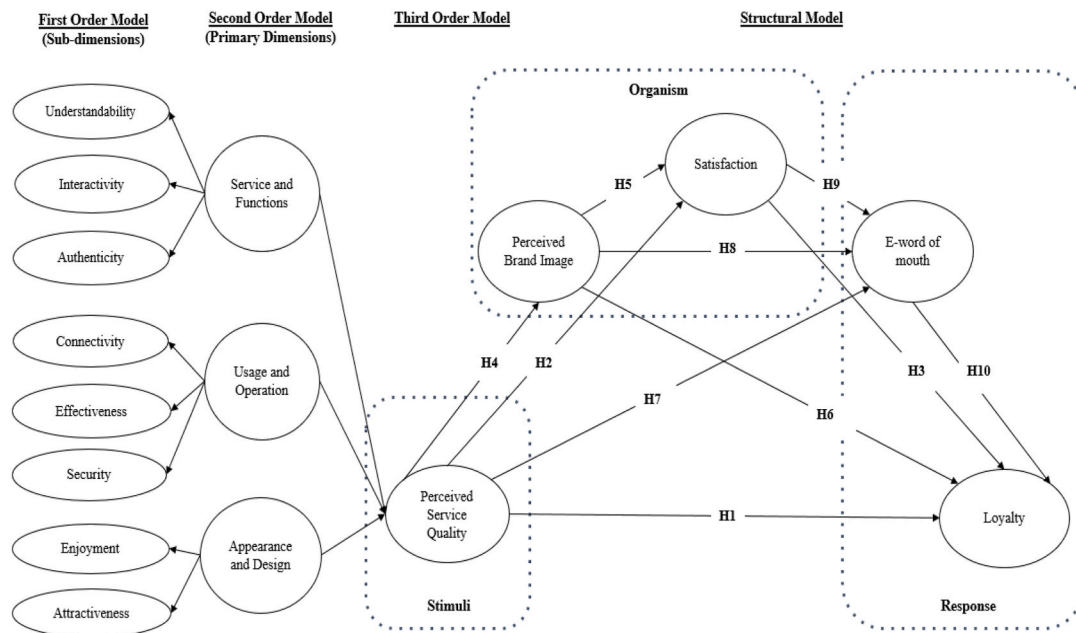This section first presents the findings on the general user behavior,

Fig. 6. Research model.

followed by the analysis of our research model using SmartPLS, and then the analysis of open-ended questions regarding the service quality of the app.

4.1. General user behavior – time spent and usage on "My Library" app

Table 3 shows the descriptive statistics of how our respondents spent their time and how they used the app. Regarding the average weekly use of "My Library" app, 68.9% of the respondents tended to spend less than once per week, and 28.8% claimed to spend 1–2 times a week. Only 2.2% of the respondents spent 3–4 times per week, and no respondent spent more than 4 times on "My Library" a week, indicating that the weekly usage rate of "My Library" is relatively low. Besides, respondents mainly spent 11–20 min (40.1%) and 5–10 min (27.7%) on "My Library" every time, followed with the option "more than 20 min" (19.5%) and then "less than 5 min" (12.7%).

In terms of the used resources, only 21 respondents (7.9%) explored all services of the app. The top three services used by the respondents were: search library catalog (89.1%), renew library materials (77.2%), and reserve library materials (74.9%), while the utilization rate of other services is less than 50%. To a certain extent, the patrons' commonly used functions help explain the short usage time of "My Library." HKPL has set the reserve limit for each user, and the loan period of each renewal is 14 days. Hence, the public is not expected to access the library app every week. Besides, HKPL opened irregularly during the pandemic, and some of the services were suspended and postponed. Based on the evidence in Table 3, we can consider that due to the impact of COVID-19, the public reduced the need to use the public services, thus decreasing the use of "My Library."

4.2. Quantitative results – structural equation modeling

4.2.1. Evaluation of measurement model

Data collected from the questionnaire were analyzed using SmartPLS 3.3.3 to obtain partial least squares structural equation modeling (PLS-SEM). PLS-SEM is more suitable for this study because it works efficiently with small sample sizes, non-normal data, reflective and formative measurement models (Hair et al., 2021). Besides, PLS works better if the model is relatively complex (i.e., a large number of latent and manifest variables, and higher-order model), the theoretical

objective of the study is "prediction," and the phenomenon under study is novel or changing (Chin and Newsted, 1999). Hair et al. (2017) also suggested that PLS-SEM is appropriate to apply in exploratory research, in which the theoretical framework is not yet fully crystallized. Overall, PLS-SEM shows high efficiency in parameter estimation and high accuracy in higher-order constructs estimation (Hair et al., 2021).

Several methods can estimate the higher-order constructs, such as the repeated indicator approach and the two-stage approaches. The repeated indicator approach is not suggested to adopt in this study as it works best when the lower-order constructs have an even number of indicators, or else the weight of the lower-order constructs on higher-order constructs will be biased (Ringle et al., 2012). Regrading two versions of the two-stage approaches (i.e., the embedded two-stage approach and the disjoint two-stage approach) led to similar study results (Sarstedt et al., 2019), we adopted the disjoint two-stage approach.

This study used self-report data, which is susceptible to common method bias, so we used Harman's single-factor test (Podsakoff et al., 2003) to assess the potential threat to our data collection. Results showed common method bias did not exist in this study (with total variance = 29.7% < 50% cutoff value). We also checked all first-order constructs' reliability and convergent validity (see Table 4). According to Hair et al. (2019), to reach good item reliability, the outer loadings of items should score 0.708 or above. Six items, i.e., IN1, IN2, IN3, AU4, AU5, and AT5, were removed because of the low factor loadings. To assess the lower bound and upper bound of internal consistency reliability of our constructs, we calculated Cronbach's α and Composite reliability (CR) of our constructs. We noted that all scores from both tests were >0.7, indicating acceptable reliability. Also, the average variances extracted (AVE) of all items surpass 0.5 and reveal good convergent validity. Discriminant validity was checked by comparing if the square root of the AVE of each construct is larger than the correlations between constructs (Fornell and Larcker, 1981). Our result showed that the discriminant validity was achieved (see Table 5). The second-order the third-order constructs were also examined using a similar method, and the results are presented in Tables 6 and 7. These second-order and third-order constructs were also achieved reliability and validity.

To examine the formative measurement model of the third-order constructs, three criteria were checked (see Table 8). Variance inflation factors (VIFs) were investigated to detect collinearity issues, and the results showed that all VIF values were well accepted as they are lower

Table 1

Survey items.

Construct/Sub-Dimension	Item
Service and function (SF)	
Understandability (UN) (Shareef et al., 2014; Tsui, 2015)	UN1. The instructions for using the service are understandable. UN2. The information organization is clear. UN3.The contents and actions presented follow a logical order. UN4. The outcome of the service is understandable.
Interactivity (IN) (Shareef et al., 2014; Tsui, 2015)	IN1. I can smoothly perform my tasks. IN2. I can easily use this app through the instructions of the "Help" function. IN3. The app remembers my preferences. IN4. I can receive instant help from the app when I face trouble. IN5. I can undo and redo any actions that perform.
Authenticity (AU) Shareef et al. (2014)	AU1. The process of the service is reliable. AU2. Any transactions conducting the service are reliable. AU3. The information provided is appropriate. AU4. The information provided is accurate. AU5: The information provided is complete.
Usage and operations (UO)	
Connectivity (CO) (Shareef et al., 2014; Tsui, 2015; Al-Hubaishi et al., 2017)	CO1. The service is available at any time through my mobile device. CO2. The service is accessible from anywhere through my mobile device. CO3. The app is compatible with my mobile device. CO4. It is stable to use the service.
Effectiveness (EF) Tsui (2015)	EF1. It is efficient to use the service. EF2. I can obtain my search results quickly. EF3. The app meets my needs for accessing information in a timely manner. EF4. I can achieve my goal in a reasonable time. EF5. Any tasks in the app are performed in the simplest way possible.
Security (SE) Shareef et al. (2014)	SE1. Disclosing personal identity during the process of the service is safe. SE2. Disclosing financial information during any transactions are safe. SE3. The service has adequate security features. SE4. Confirmation is requested before proceeding to ensure that I want the action to occur. SE5. Notification is sent when any changes in the app occur.
Appearance and design (AD)	
Enjoyment (EN) Tsui (2015)	EN1. The interface design makes me feel comfortable. EN2. Using the app to search for information is enjoyable. EN3. Using the app encourage me to learn. EN4. Using the app to search for information is entertaining.
Attractiveness (AT) Zhang et al. (2016)	AT1. The screen layout is aesthetically pleasing to me. AT2. The graphic interface is attractive to me. AT3. The app presents no extraneous content. AT4. The content is well-formatted. AT5. The displayed icons are related to the intended functions.
Perceived brand image (PBI) (Alam and Noor, 2020)	PBI1. The app deserves a good reputation. PBI2. I have always had a positive impression of the app. PBI3. In my opinion, the app has a good image in the minds of users. PBI4. I believe that the app has a better image than its competitors.
Satisfaction (SAT) (Shareef et al., 2014)	

Table 1 (*continued*)

Construct/Sub-Dimension	Item
	SAT1. I am pleased that the services of the app fulfill my needs. SAT2. I feel contented with the services provided by the app. SAT3. The services provided by the app have met my expectations. SAT4. I did the right thing when I choose the app to search for information.
e-Word-of-Mouth (eWOM) (Karim, 2020)	EWM1. I say positive things about the app online. EWM2. I point out the positive aspects of the app online if anybody criticizes. EWM3. I write good reviews on social media about the app. EWM4. I talk more about "My Library" than other similar apps on the Internet.
Loyalty (LOY) (Alam and Noor, 2020; Soares-Silva et al., 2020)	LOY1. I will be using more services provided by the app in the future. LOY2. I will recommend the app to my friends and relatives. LOY3. The app is my first choice when I want to search for library materials. LOY4. I intend to continue using "My Library" to get information services.

Table 2

Demographics (n = 267).

Demographics	Frequency
Gender	
➢Male	161 (60.3%)
➢Female	106 (39.7%)
Age	
➢18-23	63 (23.6%)
➢24-29	70 (26.2%)
➢30-39	72 (27.0%)
➢40-49	50 (18.7%)
➢50-59	10 (3.7%)
➢≥ 60	2 (0.7%)
Education Level	
➢Primary school	3 (1.1%)
➢Secondary school	58 (21.7%)
➢Associate degree	88 (33.0%)
➢College or above	118 (44.2%)
Employment status	
➢Employee	123 (46.1%)
➢Employer	7 (2.6%)
➢Self-employed	15 (5.6%)
➢Unpaid family worker	0 (0.0%)
➢Unemployed	0 (0.0%)
➢Home-maker	29 (10.9%)
➢Student	84 (31.5%)
➢Retiree	9 (3.4%)
Mobile device used	
➢Andriod phone	83 (31.1%)
➢iOS phone	186 (69.7%)
➢Tablet	46 (17.2%)

than 3 (Hair et al., 2019). In addition, the significance of weights was measured via the Confidence Intervals Bias Corrected approach (0.95) (CI_BC0.95). After bootstrapping 5000 subsamples in a one-tailed test, the confidence intervals of all weights did not include zero, revealing the significance of all outer weights. In other words, all indicators were retained in the formative measurement model. In terms of the relevance of the indicators, results indicated that all indicators had a median positive relationship with the third-order construct, and the influence of each component was fairly equal. More precisely, UO exhibited the highest relevance (0.473), followed by AD (0.457) and SF (0.334).

Table 3
Descriptive statistics on time spent and usage of "My Library".

Category	Frequency
Average usage per week (fequency) on the apps	
➢Less than 1 time	184 (68.9%)
➢1 to 2 times	77 (28.8%)
➢3 to 4 times	6 (2.2%)
➢More than 4 times	0 (0.0%)
Average time spent on using the apps per week	
➢Less than 5 min	34 (12.7%)
➢5–10 min	74 (27.7%)
➢11–20 min	107 (40.1%)
➢More than 20 min	52 (19.5%)
Resources used in "My Library"	
➢All	21 (7.9%)
➢Search library catalog	238 (89.1%)
➢Reserve library materials	200 (74.9%)
➢Renew library materials	206 (77.2%)
➢View the collection highlights	47 (17.6%)
➢Fill in a book suggestion form	27 (10.1%)
➢Pay fines and fees	97 (36.3%)
➢Identify the location of a book in the library	96 (36.0%)
➢View transaction history	104 (39.0%)
➢Save materials in MyLists	59 (22.1%)
➢Search for e-reading materials	101 (37.8%)
➢View special notice	117 (43.8%)
➢View library opening hours	112 (41.9%)
➢View library contact information	75 (28.1%)
➢Search for the library's social media	58 (21.7%)
➢Access to multiple library accounts	30 (11.2%)
➢Locate the nearest libraries via GPS	20 (7.5%)

4.2.2. Structural model

Our results of the structural model are presented in Tables 9 and 10. Before the analysis, inner VIF values were examined to ensure the collinearity would not bias the PLS results. As all VIF values were the threshold of 3 (see Table 9), we concluded that collinearity is not a critical issue. In addition, the SRMR of the model is 0.051, which is less than 0.10, indicating that the model has an adequate model fit.

Bootstrapping of 5000 subsamples (one-tailed test) was performed for analysis. Table 10 shows the results of the hypothesis assessment. For the four constructs that we predicted would affect LOY, we noted that PSQ and eWOM did not impact LOY, and thus, H1 and H10 were not supported. We also found that our data support the two and one hypotheses that we predicted their effects on SAT and PBI, respectively. However, our data did not support two out of three of the hypotheses related to eWOM: We noted that both PSQ and SAT did not impact eMOW, and therefore, H7 and H9 were not supported.

Prior research discussed the drawbacks of using Baron and Kenny (1986)'s approach to examine the mediating effect using PLS (Hair et al., 2021; Nitzl et al., 2016; Zhao et al., 2010). So, this study used the method proposed by Hayes and Scharkow (2013) to assess the significance of indirect effects using the bias-corrected bootstrap confidence interval. This method involves two steps to determine the type of mediation: (i) assessing the significance of the indirect effect and (ii) assessing the significance of the direct effect as proposed by Hayes and Scharkow (2013) and Nitzl et al. (2016).

With a 95% bootstrap confidence interval, our data supported three out of seven proposed mediating effects: (i) PSQ exerted an indirect effect on LOY through PBI, and therefore, H11a was supported; (ii). Besides, PSQ also had an indirect effect on LOY through SAT and supported H11b; and (iii) PSQ indirectly affected LOY through PBI and SAT and supported H11d. Considering that the direct effect of PSQ on LOY (H1) was statistically insignificant, we can conclude that the impact of the PSQ on LOY is completely transmitted with the help of PBI and SAT (i.e., full mediation).

On the other hand, the indirect effect between PSQ and LOY through eWOM was insignificant (i.e., H11c), as well as the indirect effect of PBI and eWOM (i.e., H11e) and SAT and eWOM (i.e., H11f) on LOY, and the

full path model (H11g) were not significant. Overall, our data supported that the influence of PSQ on patrons' LOY can only be achieved through brand image and patrons' satisfaction.

4.3. Qualitative results – suggested improvements for the "My Library app"

4.3.1. Suggestions for "service and function"

From the feedback of the open-end questions, we noted that "My Library" provided insufficient remote supports during COVID-19. Apart from updating the library's latest news, the services offered were similar to those before the pandemic. Indeed, various online learning methods, including asynchronous tools (e.g., threaded discussion) and synchronous tools (e.g., live streaming), can be arranged to facilitate community communications when physical activities are prohibited (Rafique et al., 2021). As an information disseminator, "My Library" should also take the role to combat misinformation by sharing reliable health resources during difficult times (Au et al., 2021; Wang and Lund, 2020).

Specifically speaking of services and functions, interactivity is a significant element that "My Library" should be concerned with. We noted a participant claimed that:

> *"After I enter the book name into the search bar, my record will be deleted if the catalog cannot match any item. It would be great if I could edit it."*

Under the Big Data environment, it is noted that a recommendation system can be designed to solve this issue. That is, user preference can be obtained by tracking historical visiting records (Huang, 2020) and social networking (Zhao, 2021) of the users. Even if the desired book is unavailable, the system should list similar reading contents that the users may feel interested in. In addition, imitating the New York City Public Libraries, "My Library" can build a thematic book recommendation system that meets current social issues, such as sharing credible COVID-19 resources and anti-epidemic related books to their library users (Alajmi and Albudaiwi, 2021).

Furthermore, "My Library" users also unimpressed the "Help" function as noted from our respondents' comments:

> *"Real-time online assistance."*

> *"Voice and video assistance (especially for the elderly)."*

The current version of "My Library" provides text and image formats guidelines. However, the elderly and some users with special needs may feel difficult to follow the instructions, thus requesting instant help. Despite providing video demonstration on how to control the library app, Augmented Reality (AR) is a prominent technology suggested to include in the next-generation public information services. AR technology can capture the physical service environment into the mobile app, enabling users to navigate the relevant locations and service areas visually. Romli et al. (2020) praised that this interactive function can enhance user experience, attracting users to use the app service and eventually visit the physical venue.

4.3.2. Suggestions for "usage and operation"

Based on the feedback from our respondents, "My Library" should pay more attention to the app's effectiveness, as some of them requested to:

> *"Directly enter to the e-database, not (no) need to download another app again."*

At this moment, users will be forwarded to the library website or another e-reading app when they want to access an e-database. As various third parties offer e-databases, some users may feel annoyed to log in to multiple accounts when switching to different systems. Considering this common issue from diverse libraries, cloud computing can be deployed to provide a one-stop centralized service for users in the

Table 4
Assessment of reflective measurement model of the first-order constructs.

First-order construct	Item	Mean	S.D.	Loading	Cronbach's α	CR	AVE
Understandability	UN1	5.51	0.717	0.809	0.796	0.865	0.616
	UN2	5.55	0.715	0.784			
	UN3	5.03	0.903	0.710			
	UN4	5.54	0.684	0.832			
Interactivity	IN4	4.58	1.156	0.895	0.717	0.876	0.779
	IN5	5.06	0.880	0.870			
Authenticity	AU1	5.39	0.724	0.877	0.795	0.879	0.707
	AU2	5.17	0.705	0.860			
	AU3	5.37	0.705	0.784			
Connectivity	CO1	5.85	0.776	0.882	0.870	0.908	0.711
	CO2	5.87	0.764	0.838			
	CO3	5.87	0.872	0.783			
	CO4	5.76	0.748	0.868			
Effectiveness	EF1	5.60	0.700	0.809	0.851	0.892	0.623
	EF2	5.46	0.742	0.769			
	EF3	5.43	0.749	0.830			
	EF4	5.48	0.727	0.757			
	EF5	5.50	0.796	0.778			
Security	SE1	5.05	0.837	0.846	0.877	0.910	0.669
	SE2	5.08	0.771	0.803			
	SE3	5.15	0.782	0.833			
	SE4	5.04	1.022	0.830			
	SE5	4.79	1.079	0.775			
Enjoyment	EN1	4.62	1.139	0.808	0.879	0.917	0.735
	EN2	4.37	1.242	0.896			
	EN3	3.85	1.256	0.853			
	EN4	3.91	1.228	0.869			
Attractiveness	AT1	4.22	1.207	0.905	0.847	0.896	0.685
	AT2	4.17	1.262	0.891			
	AT3	4.93	0.997	0.786			
	AT4	5.16	0.918	0.712			
Perceived brand image	PBI1	4.89	0.842	0.834	0.894	0.927	0.759
	PBI2	5.09	0.992	0.886			
	PBI3	4.55	1.055	0.877			
	PBI4	4.60	1.080	0.887			
Satisfaction	SAT1	5.29	0.908	0.900	0.936	0.954	0.840
	SAT2	5.39	0.874	0.923			
	SAT3	5.32	0.954	0.929			
	SAT4	5.46	0.814	0.913			
e-Word-of-Mouth	eWOM1	3.48	1.293	0.956	0.958	0.970	0.889
	eWOM2	3.46	1.352	0.952			
	eWOM3	3.24	1.305	0.957			
	eWOM4	3.14	1.333	0.906			
Loyalty	LOY1	5.59	0.787	0.892	0.916	0.941	0.799
	LOY2	5.10	1.188	0.870			
	LOY3	5.28	1.160	0.902			
	LOY4	5.52	0.990	0.912			

Table 5
Correlation matrix of the first-order constructs.

Construct	AT	AU	CO	EF	EN	eWOM	IN	LOY	PBI	SAT	SE	UN
AT	**0.827**											
AU	0.381	**0.841**										
CO	0.267	0.436	**0.843**									
EF	0.349	0.516	0.671	**0.789**								
EN	0.717	0.284	0.144	0.257	**0.857**							
eWOM	0.161	0.176	0.012	0.069	0.226	**0.943**						
IN	0.225	0.546	0.159	0.262	0.228	0.294	**0.883**					
LOY	0.434	0.442	0.281	0.399	0.349	0.345	0.284	**0.894**				
PBI	0.464	0.433	0.169	0.389	0.423	0.420	0.377	0.671	**0.871**			
SAT	0.481	0.537	0.345	0.468	0.405	0.347	0.369	0.739	0.739	**0.916**		
SE	0.355	0.486	0.327	0.524	0.315	0.268	0.363	0.473	0.548	0.500	**0.818**	
UN	0.264	0.605	0.389	0.392	0.253	0.131	0.415	0.288	0.226	0.313	0.271	**0.785**

Note. The square root of AVE of each construct is bold.

future. Other related services, such as open access resources, e-materials, and a personal knowledge base, can then be interconnected through single registration and logon anytime and anywhere (Zhang et al., 2020). With the help of cloud computing technology, government information apps can break through the boundaries of time and place to maintain services at all times.

Apart from boosting efficiency, our findings suggested "My Library" to ensure service security. Our findings revealed that users questioned whether notifications would be sent when any changes were made to the app. Based on our observation, the updated details of "My Library" are

Table 6
Assessment of reflective measurement model of the second-order constructs.

Second-order construct	Item	Loading	Cronbach's α	CR	AVE
Service and Functions (SF)	UN	0.769	0.766	0.863	0.679
	IN	0.796			
	AU	0.901			
Usage and Operation (UO)	CO	0.720	0.755	0.853	0.660
	EF	0.875			
	SE	0.835			
Appearance and Design (AD)	EN	0.917	0.835	0.923	0.858
	AT	0.936			

Table 7
Correlation matrix of the second-order constructs and the first-order endogenous constructs.

	AD	eWOM	LOY	PBI	SAT	SF	UO
AD	**0.926**						
eWOM	0.207	**0.943**					
LOY	0.425	0.346	**0.894**				
PBI	0.481	0.42	0.672	**0.871**			
SAT	0.480	0.348	0.739	0.740	**0.916**		
SF	0.363	0.244	0.421	0.436	0.510	**0.824**	
UO	0.390	0.174	0.492	0.498	0.553	0.557	**0.813**

Table 8
Assessment of formative measurement model of the third-order construct.

Third-order construct	Item	VIF	Outer Weights	CI_BC0.95	*p*-value
Perceived Service Quality	SF	1.504	0.334	[0.180,0.486]	<0.001
	UO	1.540	0.473	[0.263,0.638]	<0.001
	AD	1.224	0.457	[0.336,0.592]	<0.001

Table 9
Assessment of structural model.

VIF						R^2	Q^2
	eWOM	LOY	PBI	PSQ	SAT		
eWOM		1.22				0.180	0.155
LOY						0.588	0.459
PBI	2.338	2.501			1.566	0.361	0.265
PSQ	1.838	1.838	1		1.566		
SAT	2.594	2.605				0.615	0.509

displayed on app store platforms instead of inside the app. Yet, as suggested by Nielsen's detailed usability heuristics (Abulfaraj and Steele, 2020), any changes in the system, especially if they have enormous consequences, should be notified to users. Hence, taking serious to the users' security issue, push notifications should be established to ensure users understand errors and amendments of the app.

In addition, a recent study has promoted the use of blockchain technology in public sector applications (Warkentin and Orgeron, 2020). By adopting a decentralized network, all information-intensive activities between government agencies, citizens, and other organizations can be recorded and protected in a secure and transparent system. Unquestionably, much research is required to conduct in the future to evaluate the potential benefits and challenges of blockchain technology to the existing government information services.

4.3.3. Suggestions for "appearance and design"

Our findings indicated that users generally gave a negative rating on the enjoyment. In light of this, "My Library" can take the mobile app developed by Biblioteche di Roma Public Libraries as a reference to adopting gamification to increase users' engagement (Colasanti et al.,

Table 10
Results.

Direct/Indirect effect	β	CI_BC0.95	*t*-value	Supported?
Direct effects				
Loyalty (LOY) (R² = 0.588)				
H1: PSQ → LOY	0.100	[−0.008, 0.198]	1.591	No
H3: SAT → LOY	0.484	[0.367, 0.610]	6.512 ***	Yes
H6: PBI → LOY	0.230	[0.118, 0.339]	3.413 ***	Yes
H10: eWOM → LOY	0.054	[−0.019, 0.127]	1.220	No
Satisfaction (SAT) (R² = 0.615)				
H2: PSQ → SAT	0.324	[0.226, 0.414]	5.662 ***	Yes
H5: PBI → SAT	0.546	[0.453, 0.635]	9.829 ***	Yes
Perceived brand image (PBI) (R² = 0.361)				
H4: PSQ → PBI	0.601	[0.521, 0.660]	14.43 ***	Yes
Electronic Word-of-Mouth (eWOM) (R² = 0.180)				
H7: PSQ → eWOM	−0.021	[−0.143, 0.106]	0.277	No
H8: PBI → eWOM	0.365	[0.216, 0.502]	4.202 ***	Yes
H9: SAT → eWOM	0.092	[−0.066, 0.238]	0.992	No
Indirect effects				
H11a: PSQ → PBI → LOY	0.139	[0.071, 0.206]	3.329 ***	Yes
H11b: PSQ → SAT → LOY	0.157	[0.108, 0.215]	4.822 ***	Yes
H11c: PSQ → eWOM → LOY	−0.001	[−0.013, 0.004]	0.217	No
H11d: PSQ → PBI → SAT → LOY	0.159	[0.110, 0.226]	4.609 ***	Yes
H11e: PSQ → PBI → eWOM → LOY	0.012	[−0.003, 0.033]	1.094	No
H11f: PSQ → SAT → eWOM → LOY	0.002	[0.000, 0.008]	0.704	No
H11g: PSQ → PBI → SAT → eWOM → LOY	0.002	[0.000, 0.008]	0.718	No

Note: ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

2020). The strategy is to develop a points system to encourage users to behave positively and actively participate in the app and other outreach activities. For instance, points will be added when users post a review, use a service, or subscribe to relevant social media or information sources via the app. Rewards can be given after obtaining certain points. In this way, the points system can successfully connect online and offline activities, enhance knowledge circulation, and thus attract customers to continue and even expand using such services.

Meanwhile, more improvement should be made regarding the appearance of "My Library," as users were generally not attracted to the screen layouts and the graphic interfaces. Participants left negative comments to the app such as:

"Design is poor."

"The app is old fashion."

Although the term attractiveness is subjective, Yang et al. (2018) emphasized that an app's interface design should primarily be based on user needs instead of system functions or administrators' preferences. As a public information provider, the library should align with users' operating habits to develop a more suitable interface. Take iLib Guider, an app launched by the National Public Library in Taiwan, as an example. It provides a kid version mobile app to evoke children's curiosity. The developers also create several monster icons representing different subject categories to arouse children's interest in exploring the app services (Wu et al., 2019). Though the present findings discovered

that local users care about the "My Library" appearance, HKPL should not ignore the app design and consider users' preferences to build the next-generation app.

5. Discussions

5.1. Development of the third-order service quality model

Synthesizing the findings from prior research, the attributes of service quality (i) vary by industries (Ladhari, 2010), (ii) change over time (White, 2010), and (iii) should be present in a hierarchical manner to highlight their uniqueness (Blut, 2016). Therefore, this study developed a novel third-order service quality instrument with three primary dimensions, eight sub-dimensions, and thirty-seven observed variables to capture all possible attributes related to m-library and m-government to constitute constructs.

5.1.1. Establishing and modifying the higher-order constructs

Regarding the observed variables of the first-order constructs, six items (IN1, IN2, IN3, AU4, AU5, & AT5) were eliminated in the instrument because their outer loadings were low. Also, in line with Jansen and Ølnes (2016), we argue that the observed items in the service quality instrument should show a certain degree of flexibility, which can be adjusted according to the features provided by the library app.

The creation of the latent variables of the second-order constructs was inspired by Tsui's (2015) instrument "e-sq of MLS." It gave an organized framework to divide the sub-constructs into different constructs. Furthermore, we tested the conceptualization suggested by Shareef et al. (2014), which they advocated using five constructs (i.e., understandability, interactivity, authenticity, connectivity, and security) to measure m-government service quality. Because these factors were relevant to the characteristics of a public library app, they were combined with Tsui's attributes to represent the first-order constructs. Unlike the results of Shareef et al. (2014), we found that security, together with the other four constructs, had significant impacts on PSQ. Eventually, after refining the measuring items with existing attributes, our data supported the argument that security is a valuable sub-dimension of m-government service.

Furthermore, we advocated PSQ is a comprehensive concept that should be measured from multiple perspectives, including service contents, technical operation, and aesthetic issues. Hence, similar to the "e-sq of MLS," three third-order latent constructs (i.e., service and function, usage and operation, and appearance and design) were formed.

5.1.2. Relationships among the higher-order constructs

We also attempted to develop a third-order service quality model which includes attributes not covered by the existing scales. While Blut (2016) proposed a reflective-formative-formative approach, we employed a reflective-reflective-formative approach to demonstrate the relationships among constructs. The first- and second-order indicators were conceptualized as reflective because their latent constructs caused them to be highly correlated, sharing a common theme. More importantly, given the exploratory nature of our study, eliminating the indicators were not expected to change the conceptual domain of their assigned latent construct. Meanwhile, we shared a similar view with Blut (2016) to treat the third-order construct as formative because the primary dimensions (second-order indicators) were perceived to be a general concept that wholly mediates the impact on the subsequent construct (Crocetta et al., 2021).

Apart from theoretical contributions, this study provided empirical supports for the relationships among the higher-order service quality constructs. In particular, *authenticity* emerged as the most vital component of service and function, followed by *interactivity* and *understandability*. Similar to Shareef et al. (2014), our findings showed that the reliability of the public services is always a serious concern for citizens. In addition, *effectiveness* was found to have a greater reflection of usage

and operation than *security* and *connectivity*. In addition, our results showed that the local users seek *effectiveness* as a major component of the technical aspects of "My Library." A reasonable explanation is that with the development of today's technology, users have a much higher standard for the response time of mobile apps. Surprisingly, both the variables *enjoyment* and *attractiveness* were discovered to have a powerful reflection of appearance and design, implying that the library users were sensitive to the visual appeal and entertainment issues even using a government app.

While Tsui (2015) investigated users' service quality gap in terms of service and function, usage and operation, and appearance and design, we investigated the relative contribution of these three dimensions to the overall perceived service quality and verified their statistical influence further. Among these dimensions, usage and operation inhibited slightly higher importance to forming the overall service quality than appearance and design, followed by service and function. Indeed, we argued that the impact of each component was fairly equal, indicating that all-around improvements should be made to maintain the overall service quality of a library app.

5.2. Explanation on service quality and its nomological network

This research echoed extant knowledge to evaluate how service quality influences user satisfaction and loyalty in the digital libraries and e-government. Prior studies usually adopted information technology theories such as IS success theory (Alruwaie et al., 2020), Technology Acceptance Model (Xu and Du, 2018; Kallweit et al., 2014)., or quality management theory such as Kano Model (Shokouhyar et al., 2020; Chen et al., 2020) as their foundations. Unlike prior research, we attempted to combine the updated IS success theory (DeLone and McLean, 2016) and the S–O–R model (Mehrabian and Russell, 1974) to better understand the evaluation process from service quality to user loyalty. Further, we responded to the calls to reinforce the components of service quality (Jansen and Ølnes, 2016; Tan et al., 2017) and explore possible factors that may affect user loyalty in library service settings (Bakti and Sumaedi, 2013).

Through extensive literature review, we discovered that apart from fundamental elements like service quality and user satisfaction, perceived brand image (Alam and Noor, 2020) affects user loyalty across different contexts and places. Besides, e-word-of-mouth is a novel element that may influence user experience, corporate image, and user satisfaction (Khoo, In Press). While prior studies usually investigated these factors in isolation, we integrated these constructs in a single nomological network based on the S–O–R model: perceived service quality as Stimulus (S), perceived brand image and user satisfaction as Organism (O), and e-word-of-mouth and user loyalty as Responses (R).

Consistent with Alam and Noor (2020), our findings acknowledged a positive and significant effect of PSQ on PBI. Then, results showed that PBI had a more significant standardized path coefficient on SAT than PSQ, indicating that the PBI had a more substantial influence on SAT. Moreover, our findings only confirmed that PBI had a positive and significant effect on eWOM, whereas the PSQ and SAT showed no statistical impact on eWOM. This suggested that users are more willing to express positive opinions online when they think an app deserves a good public reputation. Besides, the analysis also corresponded with results from prior studies, attesting to the positive direct effect of PBI (Alam and Noor, 2020) and SAT (Tan et al., 2017) on LOY. In addition, no effect was found on PSQ and eWOM to user LOY. Notably, there is no need to inhibit a direct impact from establishing mediation (Zhao et al., 2010; Hair et al., 2021).

While the proposed full path model was rejected, the results suggested the final S–O–R model, in which S represented PSQ, O signified PBI and SAT, and R as LOY. This result has several implications. First, as mentioned earlier in the findings, full mediation was found in the model because PSQ had no direct effect on LOY in the public library app service. The results corroborate those of Kiran and Diljit (2011) and Bakti

and Sumaedi (2013), indicating that library users who have a high PSQ are not necessarily using the library services again. The public library is no longer the only way to search for information in recent decades. Numerous information sources on the Internet by diversified parties enable users to use their preferred apps to seek information. Also, driven by the pandemic, citizens may spend more time at home to explore diversified information channels. Again, our results reinforced Bakti and Sumaedi's (2013) claim that it is an essential requirement for a public library to ensure high service quality of its services. Most importantly, our findings are consistent with research conducted during COVID-19 (Demir et al., 2021), pointing out that users would build loyalty only when they feel impressed with the service provider and satisfied with the services.

Second, H11a and H11b, which only included one mediator (i.e., PBI or SAT) in the path model, H11d consisted of two mediators and showed the highest path coefficient value. We concluded that aside from the traditional triangular relationship (service quality-satisfaction-loyalty), PBI is also a key attribute in the service quality conceptual network and should be considered in further service quality studies.

5.3. Exploration of behavioral and attitudinal loyalty

Prior research (Dick and Basu, 1994) also proposes that loyalty can be considered a combination of behavioral and attitudinal loyalty. Other researchers, such as Mols (1998) and Yang and Peterson (2004), have measured loyalty as a combined construct encompassing behavioral and attitudinal loyalty. In our study, the loyalty we measured is behavioral loyalty. Plus, eWOM is recommendatory and could be considered a proxy for attitudinal loyalty. Therefore, we also explored the possibility of loyalty as a higher-order construct comprising (behavioral) loyalty and eWOM. We hoped that the result could bring more insights into the members' behavior and attitude. Our findings are presented in Appendix A. As shown, "overall loyalty" (i.e., the secondary-order construct of "loyalty") has a lower Cronbach's α value. Therefore, we show that eWOM, at least for this study, is not a good candidate to act as a proxy for attitudinal loyalty.

6. Implications

6.1. Theoretical implication

This research has the following theoretical implications and contributions. First, we extended Tsui's (2015) theory from the academic library context to the public library context. We further reiterated the importance of usability concepts when discussing PSQ. Through systematic classification, the ideas of the detailed Nielsen's usability heuristics (Abulfaraj and Steele, 2020) can be effectively combined with other service quality attributes. In addition, the study contributed to explaining the relationships between eWOM and the other constructs. Initially, it was foreseen that people nowadays, especially during COVID-19, are keen to share opinions through electronic devices. Hence, mediation relationships might be found from eWOM. However, our findings rejected these hypotheses. One possible explanation is that Hongkongers are not used to discussing public library services online, even when they spent more time with online communication during the lockdown. In addition, due to Hong Kong's "complaint culture," local citizens may tend to criticize rather than post positive comments online. In sum, concerning the cultural issue, more studies are suggested to examine the associations among all five constructs in the future.

6.2. Practical implications

For practical implications, we opined that the arrival of the pandemic is expected to accelerate the development of Web 4.0 and

Library 4.0, stimulating library intellectualization and thereby changing library users' preferences and perceptions in the long run. Our finding proposes the evaluation criteria of service quality and its consequences should be updated continuously according to different circumstances. In addition, we hope that the findings and suggestions can inspire researchers and practitioners to improve the features of public library apps and contribute to the development of the service quality framework in the library and other public information service fields.

7. Limitations and future research directions

Similar to other research, this study also has some limitations. First, the results from this study refer to a specific case study focusing on the local library users in Hong Kong, which derives cultural differences. Also, regarding the differences in app development and users' habits of using library services worldwide, the outcome of the service quality and its nomological network can differ in other cultures. In brief, considering the unique settings (a study conducted during the COVID-19 pandemic) and background of the study, the findings are inadequate to draw absolute causal conclusions. Therefore, the proposed approach should be applied to other library settings or even other service fields across different cultures to explore its stability and applicability. Given the individual features of each service provider, it is reminded that minor adjustments are needed when conducting the replication in the future.

Second, as the higher-order library service design is still in an early stage, further empirical studies should be conducted to explore other potential factors and consequences. The current holistic instrument was designed from the comprehensive view of multidiscipline (i.e., m-library and m-government) and served as a starting point for future research. The assessment conducted in this study may not be sufficient because only a few preceding studies have examined the current topic. Future research should develop new items according to the development of m-library services and the integration of service quality and usability concepts into the model. Regarding the nomological network of service quality, other possible constructs can be found in existing theories (e.g., TAM and UTAUT) and literature. For instance, it would be possible to integrate the dimensions of IS success model (e.g., information quality and system quality) (DeLone and McLean, 2016) with the dimensions of m-government service quality (e.g., environment quality and network quality) (Al-Hubaishi et al., 2017) as the lower-order constructs of the overall service quality. Also, apart from investigating the mediating effect of e-WOM further, several government-related attributes such as trust (Santa et al., 2019; Uzir et al., 2021), service fairness (Alam and Noor, 2020), self-efficacy (Alruwaie et al., 2020) and attitudinal loyalty and behavioral loyalty (Kim et al., 2021) are suggested to examine in later public library app's studies. Besides, in addition to hypothesizing the direct and indirect relationships, some demographic factors, social norms, and situational influences could be perceived as a moderator between service quality and user loyalty in future research.

Finally, although this study offered a coherent procedure for researchers and practitioners to evaluate a library app, a qualitative approach is suggested for in-depth analysis or follow-up. For instance, researchers can interview the public and library professionals to understand what items should be added to the higher-order assessment, what dimensions should be most concerned when evaluating the service quality of a library app, and why some of the hypothesized relationships were rejected in the current study. For example, research can be developed using the framework of Fung et al. (2016), in which a comprehensive heuristics evaluation can be carried out by comparing the usability of several similar libraries. The qualitative study may help better demonstrate the library app's strengths and weaknesses and discuss the changes and impact of new technologies on public libraries. It is believed that the above arrangements can triangulate the findings of this research and improve the credibility of the proposed framework.

Appendix A. Alternative Model

Prior research (Dick and Basu, 1994) also proposes that loyalty can be considered a combination of behavioral and attitudinal loyalty. Other researchers, such as Mols (1998) and Yang and Peterson (2004), have measured loyalty as a combined construct encompassing behavioral and attitudinal loyalty. In our study, the loyalty we measured is behavioral loyalty. Plus, eWOM is recommendatory and could be considered a proxy for attitudinal loyalty. Therefore, we also explored the possibility of loyalty as a higher-order construct comprising (behavioral) loyalty and eWOM. We hoped that the result could bring more insights into the members' behavior and attitude. The alternative model is presented in Figure A1 below.
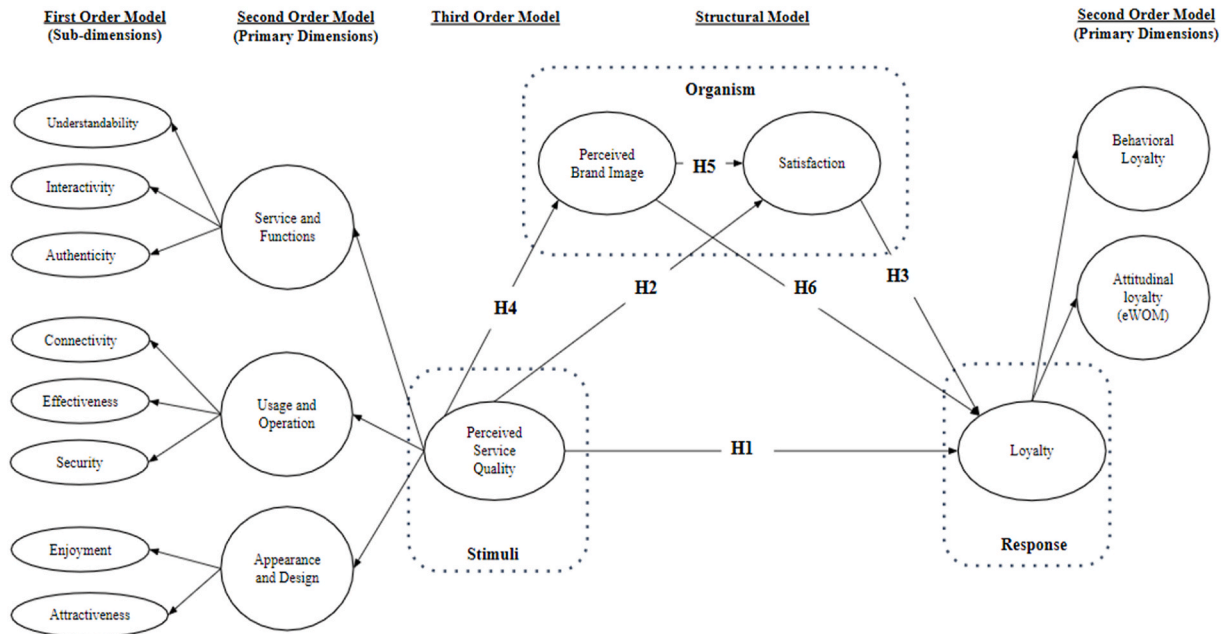

Fig. A1. Alternative research model.

Table A1 presents the reflective measurement model of the first-order constructs. To reach good item reliability, the outer loadings of items should score 0.708 or above. Hence, six items (IN1, IN2, IN3, AU4, AU5, & AT5) were removed because of the low factor loadings (<0.660). Then, Cronbach's α and the Composite reliability (CR) values were adopted to assess the lower and upper bound of internal consistency reliability. All scores from both tests are exceeded 0.7, indicating acceptable reliability. Also, the average variance extracted (AVE) of all items surpass 0.5, revealing a good convergent validity.

Table A1

Assessment of reflective measurement model of the first-order constructs of the alternative model.

First-order construct	Item	Outer Loading	α	CR	AVE
Understandability (UN)			0.796	0.865	0.616
	UN1	0.809			
	UN2	0.784			
	UN3	0.710			
	UN4	0.832			
Interactivity (IN)			0.717	0.876	0.779
	IN4	0.895			
	IN5	0.870			
Authenticity (AU)	AU1	0.877	0.795	0.879	0.707
	AU2	0.860			
	AU3	0.784			
Connectivity (CO)			0.870	0.908	0.711
	CO1	0.882			
	CO2	0.838			
	CO3	0.783			
	CO4	0.868			
Effectiveness (EF)			0.851	0.892	0.623
	EF1	0.809			
	EF2	0.769			
	EF3	0.830			
	EF4	0.757			
	EF5	0.778			
Security			0.877	0.910	0.669
	SE1	0.846			
	SE2	0.803			
	SE3	0.833			
	SE4	0.830			

(continued on next page)

Table A1 (*continued*)

First-order construct	Item	Outer Loading	α	CR	AVE
	SE5	0.775			
Enjoyment (EN)			0.879	0.917	0.735
	EN1	0.808			
	EN2	0.896			
	EN3	0.853			
	EN4	0.869			
Attractiveness (AT)			0.847	0.896	0.685
	AT1	0.905			
	AT2	0.891			
	AT3	0.786			
	AT4	0.712			
Perceived Brand Image (PBI)			0.894	0.927	0.759
	PBI1	0.834			
	PBI2	0.886			
	PBI3	0.877			
	PBI4	0.887			
Satisfaction			0.936	0.954	0.840
	SAT1	0.900			
	SAT2	0.923			
	SAT3	0.929			
	SAT4	0.913			
Attitudinal Loyalty (EWM)			0.958	0.970	0.889
	EWM1	0.955			
	EWM2	0.950			
	EWM3	0.958			
	EWM4	0.908			
Behavioral Loyalty (BEL_LOY)			0.916	0.941	0.799
	LOY1	0.891			
	LOY2	0.870			
	LOY3	0.903			
	LOY4	0.911			

Discriminant validity was investigated by using the Fornell-Larcker criterion. The square root of the AVE for each construct was greater than its correlation with all other constructs. This result demonstrated a reasonable discriminant validity.

Table A2
Correlation matrix of the first-order constructs of the alternative model.

	AT	EWM	AU	BE_LOY	CO	EF	EN	IN	PBI	SAT	SE	UN
AT	**0.827**											
EWM	0.161	**0.943**										
AU	0.381	0.175	**0.841**									
BE_LOY	0.434	0.344	0.442	**0.894**								
CO	0.267	0.011	0.436	0.281	**0.843**							
EF	0.349	0.068	0.516	0.399	0.671	**0.789**						
EN	0.717	0.226	0.284	0.340	0.144	0.257	**0.857**					
IN	0.225	0.295	0.546	0.284	0.159	0.262	0.228	**0.883**				
PBI	0.464	0.420	0.433	0.671	0.169	0.389	0.423	0.377	**0.871**			
SAT	0.481	0.347	0.537	0.739	0.345	0.468	0.405	0.369	0.739	**0.916**		
SE	0.355	0.268	0.486	0.473	0.327	0.524	0.315	0.363	0.548	0.500	**0.818**	
UN	0.264	0.130	0.605	0.288	0.389	0.392	0.253	0.415	0.227	0.313	0.271	**0.785**

Note. The bold numbers are the square roots of the AVE of each construct, and other numbers are correlations between constructs.

Similar evaluation steps were performed for the reflective measurement model of the second-order constructs. However, as shown in Table A3, the outer loading of EWM is lower than 0.7, and the Cronbach's α is only 0.512. These results indicate the poor reliability of combining these two first-order constructs, i.e., attitudinal loyalty (electron word-of-mouth) and behavioral loyalty. We also presented the corresponding correlation matrix in Table A4 for reference.

Table A3
Assessment of reflective measurement model of the second-order constructs for the alternative model.

Second-order construct	Item	Outer Loading	α	CR	AVE
Service and Functions (SF)	UN	0.769	0.766	0.863	0.679
	IN	0.795			
	AU	0.902			
Usage and Operation (UO)	CO	0.717	0.755	0.853	0.660
	EF	0.874			
	SE	0.837			
Appearance and Design (AD)	EN	0.917	0.835	0.923	0.858
	AT	0.936			
Loyalty (LOY)	EWM	0.684	0.512	0.790	0.657
	BE_LOY	0.921			

Table A4

Correlation matrix of the second-order constructs and the first-order endogenous constructs for the alternative model.

	AD	LOY	PBI	SAT	SF	UO
AD	**0.926**					
LOY	0.416	**0.811**				
PBI	0.481	0.697	**0.871**			
SAT	0.480	0.719	0.740	**0.916**		
SF	0.363	0.429	0.437	0.511	**0.824**	
UO	0.390	0.456	0.500	0.553	0.557	**0.812**

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