

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1. Introduction

This chapter outlines the important aspects of the design and method of the study. The discussion begins with the implementation of research that is based on stages, followed by the proposed study framework as well as the proposed study model. The subsequent sections in the chapter focus on the research design, the study population as well as the study sample and the research instruments. This will be followed by discussions on the data collection and data analysis.

The study consists of five aims guided by five research questions as mention in Chapter 1, Section 1.3 and 1.4, respectively. Based on these aims, a case study following a quantitative technique was proposed. A case study is a type of study that uses as many data sources as possible to systematically investigate individuals, groups, organisations, or events (Wimmer and Dominick, 2001). Yin (1994) defined it in a more formal way where it is an empirical inquiry that uses multiple sources of evidence to investigate a contemporary phenomenon within a real-life context, in which the boundaries between the phenomenon's contexts are not clearly evident. In order to learn the phenomenon and relate to the actual setting of digital libraries' usage among students, academicians and researchers, the foci of this study is to the quantitative research using individual students, academicians and researchers as the units of analysis.

Furthermore, Merriam (1998) outlined four core characteristics of a case study research:

1. *Particularistic*: Case study focuses on a particular situation, event, program or phenomenon, making it a good method for studying practical and real-life problems.
2. *Descriptive*: Case study's final product is a detailed description of the topic under study.
3. *Heuristic*: Case study helps people to understand what is being studied where new interpretations, new perspectives, new meaning, and fresh insights are all goals of a case study.
4. *Inductive*: Case study is mostly dependent on inductive reasoning, i.e., principles and generalisations emerge from an examination of the data where many case studies attempt to discover new relationships rather than verify existing hypotheses.

In relation to the aforementioned aims of the study, particularistic characteristic best describes this research. The study scope is to study the phenomenon (use of academic digital libraries) under specific situation (users' perspectives), and the expected outcomes are the key indicators of digital library performance. The analysis of the digital library performance is based on real life settings where the environment under consideration is within institutions.

Several key elements were addressed in analysing the performance of the digital libraries. One of the preliminary expectations is that users' awareness, dimensions and measures for digital library usage for information provisioning and for digital libraries' success are all inter-connected factors affecting users' perceptions of the success of digital libraries. In addition, digital library usage is seen to be potential in influencing

how usable the system is to users for academic reasons. Burton-Jones and Straub (2006) in Sedera and Tan (2007) raised the central role of *usage* of a system which had been in place in the literature of information systems. Nevertheless, the conceptualisation of usage has varied across IS research resulting in variations of results in the dimensions and measures of IS successes. This study adopted the research design and methodology for meeting the targeted aims of the study, guided by these research questions formulated, as follows:

1. Is the usage for information provisioning model acceptable when applied in the context of digital libraries?
2. Do the relationships between Digital Library Usage for Information Provisioning (DLUIP) dimension and individual usage depend on the users' awareness factors?
3. What is the DLUIP dimension that has the largest influence on individual usage?
4. Is the DL Success model valid in measuring the success of academic digital libraries?
5. What is the degree of the impact of the four success dimensions on the DL Success?

Based on the research questions, the proposed research design adopted is discussed in the following section.

3.2. Stages of Research

This research process comprises stages as proposed, to be accomplished within a specified time frame. The stages are as illustrated in the following figure.

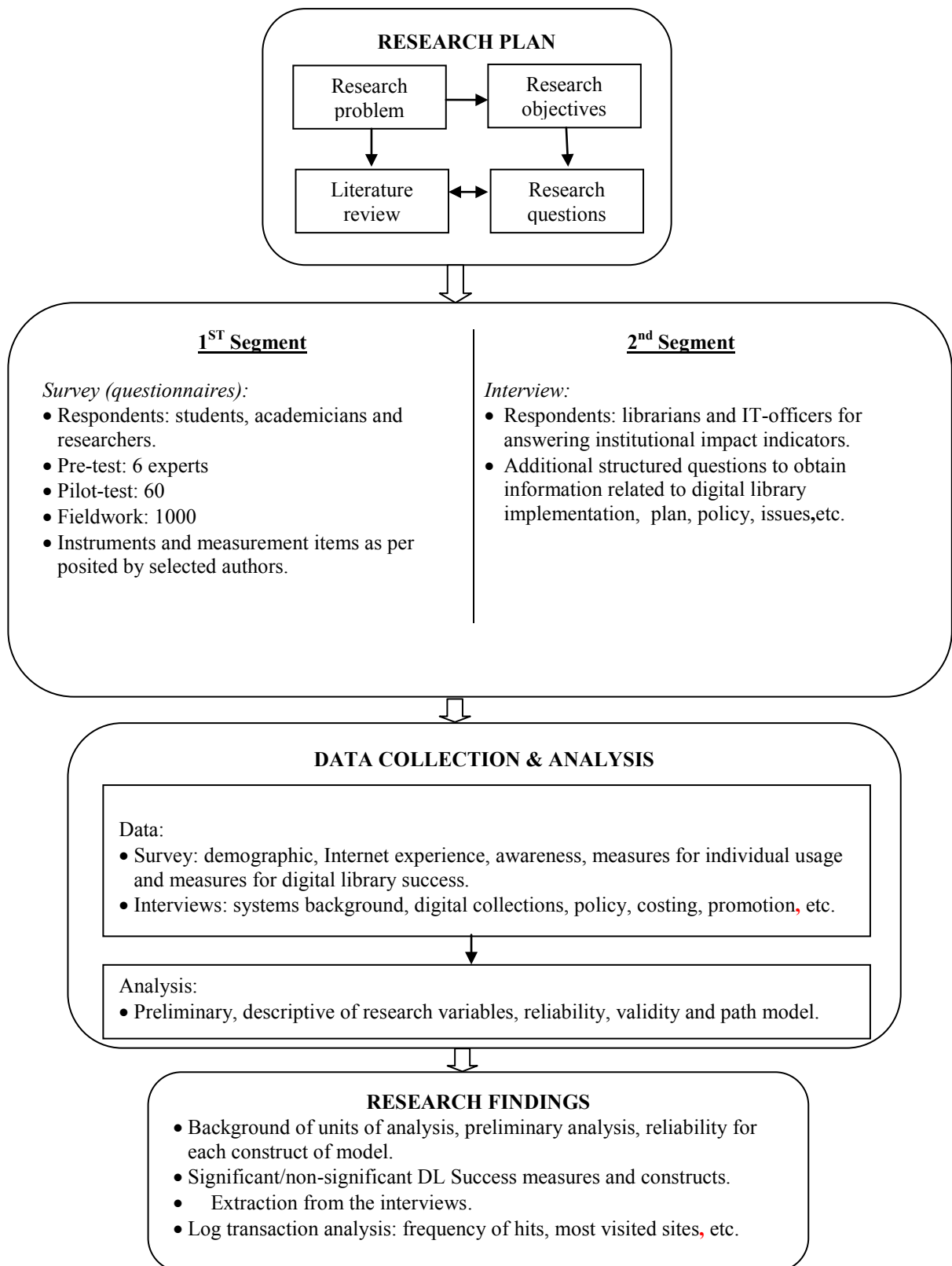


Figure 3.1: Stages of the research

Figure 3.1 displays the key stages and segments of the research activities. The descriptions for each stage are as follows:

3.2.1. Research Plan Stage

The initial phase of the research started with the research planning which consisted of definitions of the research problem, as well as formulation of research objectives and questions. This stage is largely supported by the review of literature on digital libraries.

3.2.2. Research Design Stage

This stage focuses on segments of survey implementation, interviews (to meet with librarians and IT personnel) and log analysis. The selection of research design was based on the research problem, objectives and research questions of the study, and divided further into two segments:

- *First segment: Survey*

Data collection from the survey began with the preparation of the instruments for the pilot test. The questionnaire was then refined based on the outcomes of the pilot test. The refined instruments were then used in the actual field work for collecting data from the survey. In ensuring the respondents understand the survey instrument, a pilot test was performed to pre-test the questionnaire. Pilot testing is intended to reveal errors in the design (Cooper and Schindler, 1998). The best way to discover whether a research instrument is adequately designed is to pre-test it, that is to conduct a mini study (Wimmer and Dominick, 2001). Wimmer and Dominick (2001) emphasised that the main aim of the pilot test is to determine whether the study approach is correct and to help refine the study questions. Cluster sampling design was selected to divide the target population into desired sub-groups of respondents. Communication with the correspondents from each university was established prior to the field work activities.

- *Second segment: Interviews*

Structured questions were designed only for librarians and information technology officers of the respective universities. The respondents selected for the data collection during the short interviews were Chief Librarians, Heads of ICT and ICT officers. The information gathered was mainly for the institutional impact indicators. Other information were regarded as additional matters in describing the current status of the academic libraries, such as the implementation of the universities' digital libraries, planning, issues, policy on institution's systems used, costing, resources, application, and vendors.

3.2.3. Data Collection and Analysis Stage

This was the main stage for the study where the data collected from the survey, interviews and log servers contributed to the research outcomes. Information and data collected from each segment are described below:

- *Survey*

The information and data from questionnaires distributed in the survey included respondents' demographic, internet usage experience, digital library usage, and other measurement items proposed to understand the users' behaviour, usage impact and perceptions of digital library using the IS Impact measures hypothesised in the literature.

- *Interview*

Data collected from the interview were mainly for the institutional impact measures, which included digital library planning, issues, policies, applications, vendors and resources of the digital library.

Data analysis was undertaken by using SPSS software for reliability analysis (for the pre-test and field work questionnaire), contingency analysis, t-test and χ^2 -test. For path

modelling of the DL Success model, the smartPLS (Ringle, Wende and Will, 2005) software was used.

3.2.4. Research Outcome Stage

This stage was the final stage of the research. All of the relevant findings were discussed in detail, with tabulated and graphical results included. The outcomes of the research were awareness of digital libraries, key determinants of digital libraries' usage and indicators for evaluating the performance of digital libraries (based on information system's perspectives). Further, suggestions and potential future works were highlighted based on the findings of the study.

3.3. Framework of Study

The framework of the analysis of the digital libraries' performance was developed by taking into consideration the interaction of the digital libraries' systems. This framework was intended for analysing all aspects covered in the study objectives, governing the aspects of information systems which were based on the users' perspectives. From the study objectives discussed in Chapter 1, the research framework proposed for this study was based on a reconciliation of the model grounded by the theory of Ambrose, Rai and Ramaprasad (2006) and Gable, Sedera and Chan (2008). The model was proposed as it is the most suitable framework for this study, due to the following reason. From the aspect of Human-Computer-Interaction (HCI), there exists an inter-connection (components and properties) between digital library systems and users, resulting in the need to place human participation in the analysis. The impact of digital libraries as successful systems that serve users to meet their information needs should be conceptualised as the impact of the usage of digital libraries on each individual. In meeting the users' information requirement needs, the usage construct has

to be a meaningful measure in evaluating IS success, such as the information needs of digital libraries.

Therefore, it is imperative to analyse the performance of digital libraries based on users' perspectives which requires investigation within the system's context →user, system→content, content→user (Information Systems Success). These three contexts were adopted by DARPA DLib Forum (DARPA, 1999) such that a quantitative performance measures and metrics (indicators) had been developed. They suggested that there are vast numbers of digital library indicators, and the three contexts were among the identified dimensions. In relation to this study, the evaluation indicators and dimensions were selected using Gable, Sedera and Chan's (2008) model. Furthermore, the dimension of the Individual Usage Impact was extended with the DLUIP developed from the work of Ambrose, Rai and Ramaprasad (2006). The proposed study framework is as illustrated in Figure 3.2.

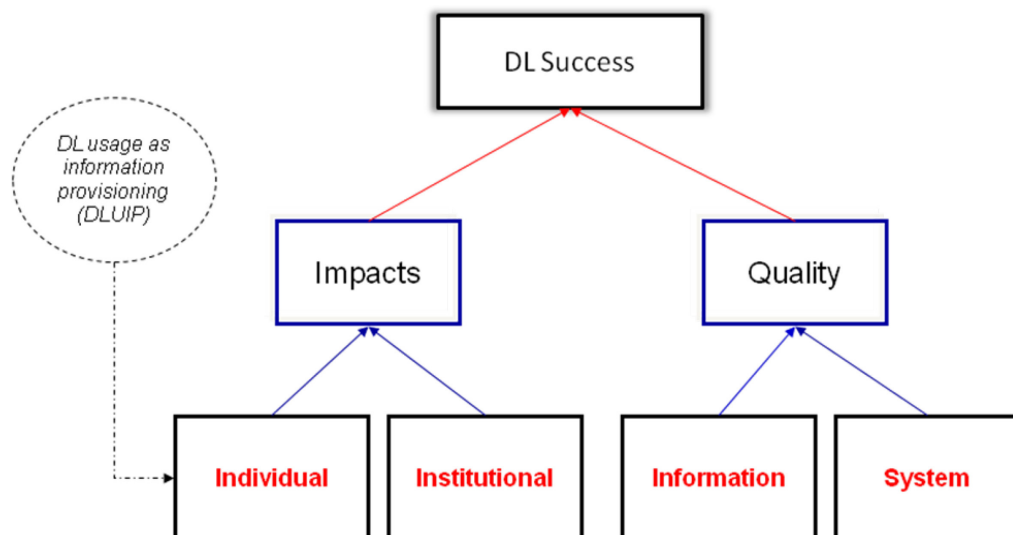


Figure 3.2: Proposed study framework for analysing digital libraries performance by extending Gable, Sedera and Chan's (2008) IS Impact model

The framework is based on the impacts from four dimensions that consist of individual impact and institutional impact (called *impacts*) and impacts anticipated - system quality and information quality (called *quality*). This model is grounded by the

theory discussed by Gable, Sedera and Chan (2008); however, the proposed framework reconciles the model by Ambrose, Rai and Ramaprasad (2006). The proposition of the model for this study was based on usage construct conceptualised as information provisioning that was incorporated as influencing individual impact. As judged by users, digital library systems' use, performance and usefulness were taken into account in analysing their performance, from the information system's perspective.

The framework explains that each component has its own properties, namely impacts to date (individual impact and institutional impact) and expected impacts (system quality and information quality). This framework was implemented so that an analysis of digital libraries' performance could be investigated by integrating the relationships between the impact of digital libraries by taking into consideration that digital libraries are used for information provisioning. In other words, digital libraries are used as a means to provide information that should meet users' information needs. This incorporates the usage construct that is conceptualised as the *use of a* digital library system. In addition, the reconciliation of DLUIP with the IS-Impact model fortified the study objectives by identifying the indicators for the performance of digital libraries as the proposed framework which considered the digital libraries as successful information systems. Razilan et al. (2009b) found that usability evaluation is potential on revealing two main contexts: the users' information needs and expectations towards the digital library, and how acceptable the system is supporting to, and fitting with the work practice / environments. Following this, digital library evaluation should take into consideration the institutional usability dimensions, as proposed in the study framework.

Specifically, based on the proposed study framework using the DL Success model (as in Figure 3.2), this study broadened the research perspective by analysing five main contexts, as follows:

- i). Use of digital libraries for information provisioning.
- ii). Users awareness' influence on the digital libraries' usage (refer to Figure 3.3).
- iii). The impact of digital libraries' usage on information provisioning.
- iv). Use of digital libraries for IS success.
- v). The performance indicators of digital library systems from Information Systems' impact measures.

3.4. Model of Study

The model of the study was developed to identify dimensions and measures that influence digital libraries' usage for information provisioning and for IS success. The proposition of the model was based on the conceptualisation of digital libraries' usage for information provisioning (for individual usage) and for IS impact (for the whole model). The proposed model is illustrated in the following figure.

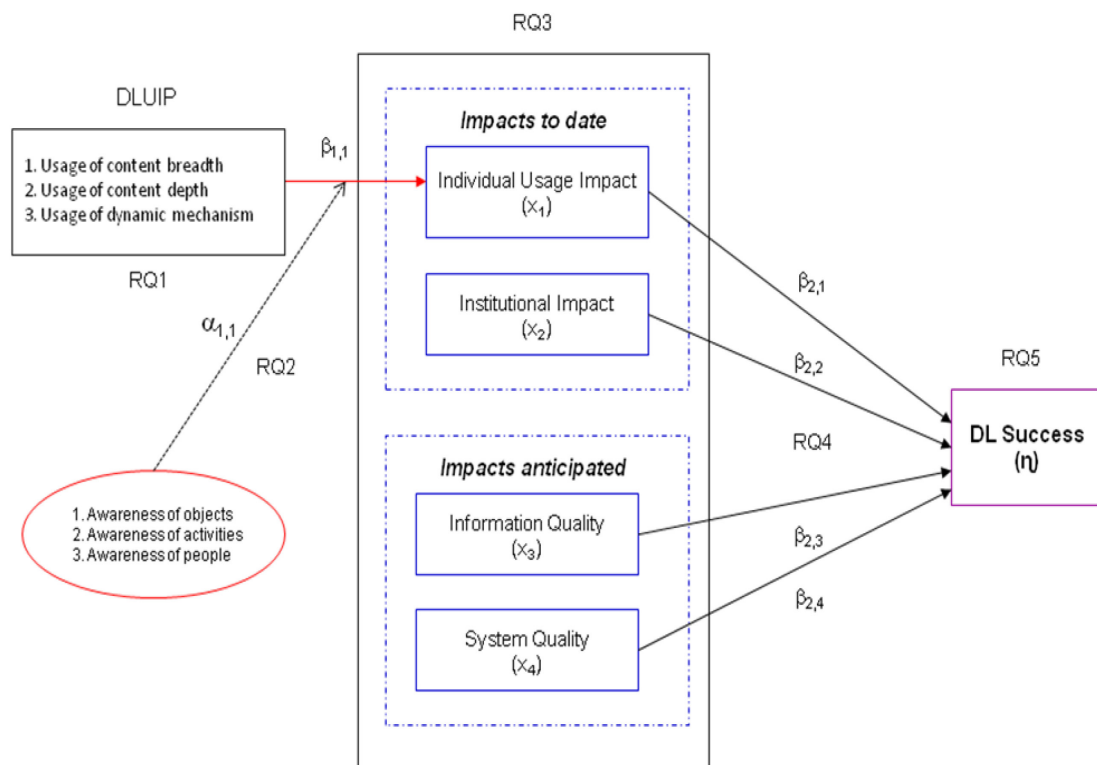


Figure 3.3: The proposed model of study for assessing academic digital libraries using IS Impact factors

In Figure 3.3, the DLUIP construct is the first level that relates to Individual Usage Impact (x_1) and the path coefficient is represented by $\beta_{1,1}$. Whereas the moderating variable of awareness factors' relationship is given by $\alpha_{1,1}$. The path coefficients of the independent variables for the second-level are depicted by $\beta_{2,1}$ to $\beta_{2,4}$, and the dependent variable (third level) is the DL Success (η). As illustrated by Figure 3.3, the list of research questions for the study is as follows:

Table 3.1: Research questions for the proposed model

RQ	Descriptions
1	Is the usage for information provisioning model acceptable when applied in the context of digital libraries?
2	Do the relationships between digital library usage for information provisioning (DLUIP) dimension and individual usage depend on the users' awareness factors?
3	What is the DLUIP dimension that has the largest influence on individual usage?
4	Is the DL Success model valid in measuring the success of academic digital libraries?
5	What is the degree of the impact of the four success dimensions on the DL success?

In Figure 3.3, RQ1 was to determine the properties of DLUIP, represented by the depth and the width of digital libraries' contents, as well as the interaction dynamic mechanism in modelling the Individual Usage Impact (IUI). The selected approach was using Partial Least Squares (PLS) path model where through the model, causal relationships between the two (DLUIP indicators and IUI) were examined. For RQ2, the properties of users' awareness factors for three categories: awareness of people, objects and activities by Hansen and Järvelin (2005), were identified in the mediating relationships between the DLUIP properties and individual usage. The first category signifies to such as knowing about one's colleagues needs or interest. The second category refers to sharing similar needs for information like for search strategies. While the last category designates for accessing different types of resources. In other words, RQ2 was formulated in examining the relationship between users' awareness and

individual usage of digital libraries, where awareness factors were treated as mediating effects. The reconciliation of *individual impact* (in the proposed DL-Success model) and *usage* construct (properties of DLUIP) was based on these motivations:

1. The IS-Impact model is developed for evaluating the enterprise system where the system is inclining towards company's benefits. In other words, users who are using such systems are subject to the requirement of the nature of the workplace and work environment. In contrast, users of academic digital library systems, such as online library resources, use it more for themselves and for their own benefits although the system is provided by the institution.
2. Individual impact measures in the IS-Impact model are designated on how the IS influenced individual capabilities and effectiveness on behalf of the organisation. Nonetheless, usage of academic digital library should emphasize the indicators that influence each individual, not on behalf of the organisation (in this case the university) but rather themselves.
3. The constructs and measures of individual capabilities and effectiveness have to be grounded by theory and should be used in different contexts with organisational impact. Ambrose, Rai and Ramaprasad (2006) developed the concept of IUIP as a concept of IS usage for individual information requirements which is more appropriate to conceptualise the context for individual usage of academic digital libraries as portrayed in the study.

In view of the above justifications, the proposed research model for evaluating digital library success was based on the theoretical model by Gable, Sedera and Chan

(2008) for the DL Success model and a new dimension, *individual usage impact* (as a result of reconciling individual impact with IUIP).

RQ3 was formulated to investigate the DLUIP properties' that had the highest influence on individual usage impact in determining the key indicators for each of the *impact* and *quality* dimensions. RQ4 was formulated to investigate the validity of the DL Success model using formative validation tests discussed in the literature. Lastly, the final research question, RQ5 was generated to identify the impact of the four success dimensions in measuring the digital library success by reconciling the key identified measures of DLUIP with individual impact, as well as three other dimensions, i.e. institutional impact, information quality and system quality. Each of the research question was developed based on the grounding theory, as exhibited in Table 3.2.

Table 3.2: The research questions formulated for the study

Research Questions (RQ)	Connection	Supporting theory/model
1	Individual usage measures to Individual Impacts (Success)	TPC & IUIP
2	Usage awareness	Hansen and Järvelin (2005)
3	Use to Individual Impacts	TPC & IUIP
4	Use to Success (current impacts and anticipated impacts)	D&M, IS-Impact
5	Use to 'total' or overall success	IUIP & IS-Impact

Note: TPC (Technology to Performance Chain), IUIP (Internet Usage for Information Provisioning), D&M (DeLone & McLean model) and IS-Impact (Information Systems Impact model)

The development of the five research questions (RQ) as in Chapter 1 described the construction of the study's model. The model was guided by the deployment of RQs where the relationships between variables are displayed in Figure 3.3 and Table 3.2. The following section discussed the selected design of the study.

3.5. Research Design

In general, different researchers defined research design differently. As pointed out by Kumar (1996), a research design is a plan, structure and strategy of investigation so

conceived as to obtain answers to research questions or problems. He referred to the definition of research design made by Kerlinger (1986) where the plan is the complete scheme or program of research. It includes an outline of what an investigator will do from writing the hypotheses and their operational implications to the final analysis of data. On the other hand, the definition of research design given by Selltitz, Wrightsman and Cook (1981) as quoted by Jankowicz (2000: 190) is one that is a deliberately planned “arrangement of conditions for analysis and collection of data in a manner that aims to combine relevance to the research purpose with economy of procedure”. Jankowicz (2000) further stated that the idea behind a design is that different kinds of issues logically demand different kinds of data-gathering arrangement so that the data will be relevant to research, unbiased and reliable, accurate in establishing causality, and capable of providing findings that can be generalised. Radford and Goldstein (2002) implied research methods as being like the contents of a tool box where they become relevant as tools to address the research problem. They stressed that the point of learning about research methods are:

- to understand the growing importance and value in using the methods.
- to know which methods to choose in order to carry out a particular task, to learn how to use those methods effectively and to know the limitations of each.

This study applied a mixed study design based on the survey and interview. Library user surveys have become widespread in academic libraries during the past twenty years and have often been used as a tool to assess service quality, library performance, and user satisfaction (Hiller and Self, 2001). With respect to this, the survey method is expected to offer a similar spectrum of advantage for academic digital libraries, based on the user-centred approach.

Based on a cross-sectional survey, the survey design encompassed data that were collected at one point in time from a sample (selected universities) to represent a

larger population (of universities in Malaysia). Surveys are a way of collecting information to describe, compare, or explain information, attitudes, and behaviours related to digital library use (Reeves et al., 2005). Surveys usually consist of two types: descriptive and analytic (Wimmer and Dominick, 2001). A descriptive survey attempts to picture or document current conditions or attitudes while an analytical survey attempts to describe and explain why certain situations exist. This survey applied the latter and consisted of these strategies:

1. Constructing questions and designing questionnaire.
2. Pretesting or pilot study.
3. Collecting survey data via questionnaire distribution and short interviews to get inputs from academic library authorities.

This study incorporated a quantitative research method through survey, which was selected because the focal point of this research was on academic digital libraries. The information needed to answer all research questions developed are not publicly available and cannot be gathered from other sources except from individuals who are using, experiencing and/or adopting such system for academic purposes. The study was based on the user-centred approach, therefore in achieving the objectives of the study, similar information was required from each of the respondent in order to extract knowledge of study interest and thus, the survey was the most appropriate design for this study. As claimed by Reeves et al. (2005), most often, within digital library evaluations, surveys were used to address issues that relate to user-centred concerns.

Cherry and Duff (2002) employed a web-based questionnaire where their survey confirmed the results of an earlier survey that found users highly valued Online/Notre Memoire En Ligne (ECO) digital library. Asemi and Riyahiniya (2007) conducted the survey to investigate the relationships between awareness and the use of digital

resources among students in Isfahan University of Medical Sciences. Fuhr et al. (2007) developed a digital library evaluation framework based on a large-scale survey of digital library evaluation activities. Xie (2008) performed a survey on two digital libraries namely American Memory and University of Wisconsin Digital Collections (UMDCs). It was a continuation of his previous survey on determining users' criteria in evaluating digital libraries. His recent study revealed an understanding towards the relationships between the users' use and evaluation of digital libraries, and the relationships between users' perceptions of digital libraries' evaluation criteria and their actual digital libraries' evaluation.

3.6. Population and Sample

The main focus of the study was on academic digital libraries where the main angle of research was on users' perspectives. Therefore, the population of this study was based on individuals who were using and/or had experiences in using digital libraries' of institutions they are attached to, for academic purposes. Based on the discussion in Chapter 1, the population of this case study was the academic institutions' individuals i.e. the students, academicians/researchers and librarians.

3.6.1. Theoretical and Study Population

The theoretical population of this study consisted of public universities in Malaysia, namely University of Malaya (UM), Universiti Kebangsaan Malaysia (UKM), Universiti Sains Malaysia (USM) and Universiti Putra Malaysia (UPM). The scope of this research is to focus on online library resources such as e-journals, e-books and e-thesis, as well as online past examination papers, which also included the institutional repositories. Even though it is argued that existing universities do not really provide proper digital libraries, these libraries have established hybrid libraries. The universities selected were Research Universities in line with Wan Ab. Kadir's (2008) study.

3.6.2. Sampling Procedure

The sampling procedure for this study is as follows:

1. Type of Sampling.

In order to generalise the study outcome from the sample to the population, probability sampling was chosen. The type of probability sampling selected was cluster sampling, as this research required different groups of respondents with some experience and knowledge in using academic digital library systems. It was expected that the usage, requirements, and so forth, may or may not be similar among these groups. In order to maintain the homogeneity of each group, cluster sampling was the most appropriate. In addition, using cluster sampling did not require a complete list of the population as compared to stratified sample. As indicated by Wimmer and Dominick (2001), estimates of cluster parameters which are made and compared to the population is among the advantages of this approach.

2. Sample size

It is a well-known matter that determining the sample size is one of the most controversial aspects of sampling. The sample size for each university is 255 (a total of 1020 respondents from four RUs). However, since achieving a high response rate was not wholly under the researcher's control, a contingency plan for total number of response was planned in advance, as a higher response rate could reduce response bias. When sample or survey response is large enough and deemed representative of the population being surveyed, data and results can be used to generalise to the whole population. Thus, the research provided statistically valid results from a smaller group, thus made the user survey a very powerful tool. The survey for this study was planned such that out of 1020 respondents, 70% would be students and 30% academicians/library personnel which were randomly selected from each university. The respondents were approached directly and being assisted by a research assistant

throughout responding to the whole questionnaire. For the study, the sampling procedure was also based on these concerns:

1. *Availability of respondents' information*

The respondents' academic digital library systems are exclusive because these systems are being used at academic institutions which are currently applying the technology. Therefore, the target respondents are specific users identified as students and academicians/researchers, as well as librarians. Furthermore, they can be approached, contacted and located from the selected universities at a convenient time. This study assumed that all respondents would cooperate without any problems in language and literacy (in terms of understanding the contents of the questionnaire).

2. *Sampling frame*

A sampling frame (i.e. list of population) is not applicable in this study because the sample is not drawn from any existing or up-to-date records/list of population. Hence, the cluster sampling for the survey is probability sampling.

3. *Response rate*

A well-designed survey may be affected if the response rate is poor. The response rate was unlikely a major concern for this study because the respondents were a specific community (i.e. from a university) and not a public community, and they were directly approached. Nevertheless, respondents were monitored closely (like collection of questionnaires, schedule of agreed date of appointments with contacted respondents (for interview sessions), and so forth).

4. *Quality of data*

Another main concern in a survey design is quality of data gathered. The respondents selected for this study were not from a complex mixture of respondent-types (i.e., differences in educational backgrounds/levels or from

numerous professional levels). Respondents chosen were among those who possessed experiences in using the universities' digital libraries for at least one semester.

5. *Administrative matters*

The administrative matters included correspondence (contacts at each university to assist with the administration of the distribution and collection of questionnaires, in addition to contacts with librarians involved in the study), locating the respondents, managing all the questionnaires and other data collection methods, as well as handling the cost of the survey.

3.7. Instruments

Instruments for gathering the survey data is explained in section 3.7.2 but it is worth to note that prior to finalising the survey instruments, pretesting and pilot study are the best way to discover whether the instruments are adequately designed and chosen.

3.7.1. Pretesting and Pilot Study

Pretesting of the study was done with experts in order to ensure respondents understood the questionnaires. Wimmer and Dominick (2001) stressed that pretesting the questionnaire is the best way to discover whether the research instrument is adequately designed. The pretest procedure can be accomplished by a run-through of questionnaire with friends and acquaintances (Baker, 2003). For this exercise, the questionnaire was pre-tested by two local experts and four international experts. The local experts were an associate professor from the College of Arts and Science, Universiti Utara Malaysia (UUM) and a senior lecturer (a Head of Department) from the Faculty of Education, Universiti Putra Malaysia (UPM). While the international experts were the Coordinator of Digital Repositories, RMIT University Library, Melbourne, two lecturers from the Business Information Technology, RMIT University, Melbourne and a lecturer from the

Library and Cultural Studies Unit, Victoria University, Melbourne. Based on the comments received from both local and international experts, the following two themes were identified:

- i. *Vague sentences*. Evaluators remarked that some of the questions needed to be reworded due to vagueness. In addition, some technical expressions were suggested to be replaced.
- ii. *Digital library term*: One of the evaluators commented on the term used for academic digital library where the person believed *online library resources* was the best term to use in the questionnaire to avoid confusion.

Based on the constructive comments and feedback received, sentences were reworded accordingly. Further, less technical words were used to replace those considered rather technical. In terms of the term “*digital library*” used in the questionnaire, the researcher maintained the term due to this reason: Each respondent was approached directly and prior to answering the questionnaire, each of them received an explanation regarding “*digital library*” as defined in the study. Thus, this explanation was reckoned to be sufficient to avoid the respondents from being confused with the term. All of the wordings and sentences were amended and subsequently, a pilot study was performed.

A pilot study was conducted by running a mini study with a small sample to determine whether the study approach was appropriate and to further refine the questions in the questionnaire. For the pilot study, this study used 15 respondents from each of the institutions selected. The total number of responded questionnaires received was 46. The results are provided in Table 3.3.

Table 3.3: Statistics of questionnaires distributed for the pilot test

Status of questionnaire	Count	%
Returned - Complete (43) - Incomplete (3)	46	76.7
Unreturned	14	23.3
Total	60	100.0

Table 3.3 shows that, of the 46 questionnaires distributed, 43 of the respondents returned the questionnaires and were valid for analysis. Three of them were incomplete, with some important sections left unanswered. The results of the reliability analysis of questionnaires for the study are discussed in Chapter 4.

3.7.2. Data Gathering

The survey was conducted in such a way to gather related information to answer the research questions developed. The instruments and rationale of using such instruments for this study are as follows:

1. Direct and/or online questionnaires. They included these main sections:
 - i. Demographics.
 - ii. Users' awareness of digital libraries.
 - iii. Digital library usage for information provisioning (Ambrose, Rai and Ramaprasad, 2006):
 - Usage for content breadth.
 - Usage for content depth.
 - Usage for dynamic mechanism.
 - iv. Digital library usage for IS Success (Gable, Sedera and Chan, 2008):
 - Individual impact.

- Organisational impact.
- System quality.
- Information quality.

Types of questions provided in the questionnaires were five-point Likert scales, closed-ended and as well as open-ended questions.

2. Interviews with library personnel.

- Personal interviews were carried out to interview the selected library authorities using structured questions. The structured questions were designed to elicit information related to academic digital library activities, promotions and issues from the library personnel's perspective. Apart from that, information related to digital library policies, applications and vendors were also gathered. The essence of conducting such interviews was to obtain feedback related to institutional impact (II) measures. It was considered as one of the important aspects in getting feedback from the library's perspective of the instrument items that measured the institutional impact indicators.

The survey and interviews were performed on the selected subjects mentioned in the framework selected for this study. In the following section, the data collection technique was presented. The stages of research planned in the beginning of the study, as shown in Figure 3.1 (pg. 88).

3.8. Data Collection

This study employed the quantitative method for collecting data, namely from the survey. The information collected from the survey's measurement items were based on a mixed type of measurement. Demographic and internet usage experience and usability

were designed as multiple choice items. While items for sections related to each dimension measures were measured using a five-point scale with intervals ranging from “strongly disagree” (or “strongly unaware/unfamiliar”) to “strongly agree” (“strongly aware/familiar”). The open-ended questions which formed the last item in the questionnaire was meant to obtain respondents’ personal opinions.

Getting information from the top management of an institution’s academic digital library was considered appropriate in a face-to-face session. Apart from getting additional facts and figures from the respective knowledgeable personnel, the suitability of getting the feedback for institutional impact indicators using this approach was apparent. Since it coincided with the tight schedule of the library personnel, the researcher approached them only when it was convenient. In addition, the measurement items for measuring the institutional impact dimension were defined according to a dichotomous scale.

In collecting the data for this study, contacts from each university were made prior to conducting the survey. All contacts and respondents involved (students/academicians/researchers) were briefed verbally prior to distributing the questionnaires. The correspondence process started at the end of semester period where the questionnaires were distributed personally to all respondents.

For the survey, humans are the main subject of the study, thus issues related to ethics and security were handled with care. Even though the information and records gathered from the subjects were not from the public domain, like most other surveys, this study also guaranteed confidentiality of data collected. Thus all subjects remained anonymous throughout the survey. Also, all subjects were invited to participate in the survey on a voluntary basis. Softcopy/hardcopy consents from subjects/contacts were one of the initial requirements of the survey.

3.8.1. Definition of Digital Library Usage for Information Provisioning (DLUIP) Indicators

The conceptualisation of IS Usage (with respect to *individuals* usage) for this study encompassed the usage of digital library for information provisioning. This usage metric was selected due to its relevance in knowledge-intensive context in terms of the variety of disciplines in academic studies or research topics (basic or applied). Usage as defined in the context of digital library use in this study refers to the *use of a system*. It focused on the extent to which the system (digital library) use satisfied the various information needs of academic individuals.

Rich measures should be provided by the IS Usage indicators. Ambrose, Rai and Ramaprasad (2006) claimed that previous IS-Impact studies exhibited ambiguous empirical support although the nomological network was included. They introduced Internet Usage for Information Provisioning (IUIP) as an evolution of the IS Usage concept where the conceptualisation is based on a formative construct.

In the following section, the items in the questionnaires, for each dimension postulated by Ambrose, Rai and Ramaprasad (2006), are defined and explained in detail, but in the context of academics users.

3.8.1.1 Content Breadth

IS Usage for breadth of content applied in the study was identified as usage that is relevant to academic contents and purposes. The requirements for content breadth may vary from faculty type and user type (students or academicians) but the breadth of information as a whole can be captured by the generic seven conceptually justified indicators in Table 3.4. All of the seven items were scaled with five Likert scales from 1= “strongly disagree” to 5= “strongly agree”.

Table 3.4: Indicators for content breadth construct used in the proposed DL Success model

	Items in the questionnaire	Definition for measures
1.	I obtain academic information on <i>my own</i> study background/research specialty on the digital library.	Information availability relating to his/her academic background.
2.	I obtain full-text of high-rank journal that <i>I request</i> from the digital library.	Information availability relating to what he/she has requested.
3.	I obtain full-text of <i>alternative</i> high-rank journal from the digital library.	Information availability relating to what has been suggested to him/her.
4.	I obtain academic information on my own study background/research specialty <i>as requested</i> from the digital library.	Information availability relating to his/her academic background, as per requested.
5.	I obtain academic information on my own study background/research specialty <i>as suggested</i> by the digital library.	Information availability relating to his/her academic background, as being suggested.
6.	I obtain the information I required for <i>internal</i> (university) resources from the digital library.	Information availability relating to his/her academic background from internal sources.
7.	I obtain the information I required from <i>worldwide</i> resources from the digital library.	Information availability relating to his/her academic background from global sources.

Source: Ambrose, Rai and Ramaprasad (2006).

3.8.1.2 Content Depth

The content depth construct which deals with the depth of related information required by users, obtained from online library resources and so forth, can be used to support their academic routines. Five-item scales were identified as indicators for this construct where each was scaled from 1= “strongly disagree” to 5= “strongly agree”. The list of items is as displayed in Table 3.5.

Table 3.5: Indicators for content depth construct used in the proposed DL Success model

	Items in the questionnaire	Definition for measures
1.	I obtain <i>detailed</i> academic information from the digital library.	The digital library provided him/her with detailed information (full-text articles).
2.	I obtain <i>abstracted</i> academic information from the digital library.	The digital library provided him/her with part of the information (abstract articles).
3.	I obtain <i>current</i> academic information from the digital library.	The digital library provided him/her with latest information.
4.	I obtain <i>archived</i> academic information from the digital library.	The digital library provided him/her with old information (full-text articles).
5.	I obtain <i>high quality</i> (high ranking journals) academic information from the digital library.	The digital library provided him/her with the best ranked information.

Source: Ambrose, Rai and Ramaprasad (2006).

3.8.1.3 Interaction Dynamism

In Table 3.6 four items with scales ranging from 1= “strongly disagree” to 5= “strongly agree” for the interaction dynamism construct are presented. The items are defined based on the ability of the digital library in supporting the tasks of searching and requesting for academic information and dynamics of the information obtained (to be reused or shared). Table 3.6 displays the four items as indicators for the interaction dynamism construct.

Table 3.6: Indicators for the interaction dynamism construct used in the proposed DL Success model

	Items in the questionnaire	Definition for measures
1.	I search for academic information from the digital library.	Passive interaction to the digital library.
2.	I request for academic information from the digital library.	Passive interaction to the digital library.
3.	I reuse academic information from the digital library (for other assignments/researches).	Dynamic interaction via using the information from the digital library for other use.
4.	I share academic information from the digital library with my colleagues.	Dynamic interaction via using the information from the digital library for sharing with others.

Source: Ambrose, Rai and Ramaprasad (2006).

Having discussed the items for measuring the properties in Individual Usage Impact (IUI) construct, the next discussion continues with an explanation on the measurement items for the digital library success model.

3.8.2. Definition of the Dimensions of the DL Success Model

Each measurement used in the survey instrument is based on four key dimensions of the IS-Impact model: individual impact, institutional impact, information quality and system quality. Gable, Sedera and Chan. (2008) introduced *a-priori* model consisting of 37 measures under the four dimensions.

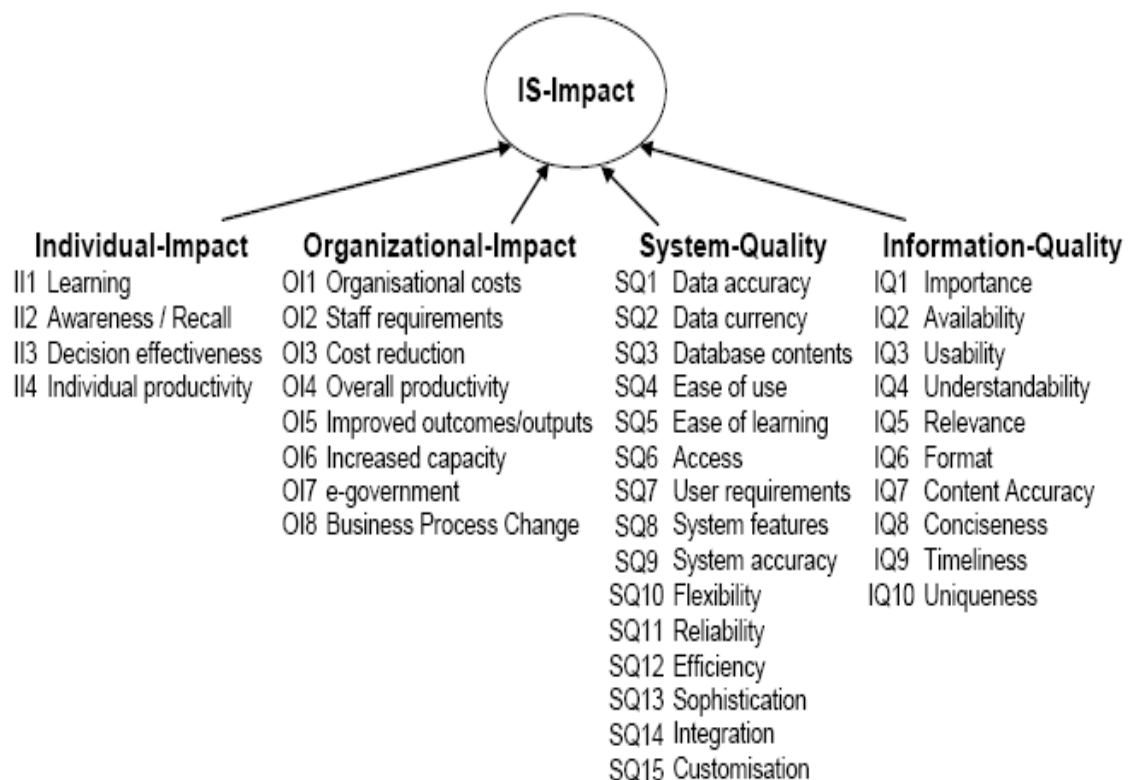


Figure 3.4: A-priori IS Impact model for the pool of 37 measures

Source: Gable, Sedera and Chan (2008: .402)

The 37 measures exhibited in Figure 3.4 were earlier defined and operationalised in the identification survey (first phase). Later, Gable, Sedera and Chan (2008) further tested

and operationalised them in the specification-survey (second phase). As a result, only 27 measures were validated (in the third phase) as the final measures for the IS-Impact model. However, for this study, the researcher identified only 25 measures as relevant to the success measures, for the context of academic digital libraries. The last two measures for organisational impact were dropped because they were considered irrelevant in the scope of information systems such as digital libraries that are used for non-profit making purposes. The list of each measure used in the questionnaire is as illustrated in the following sections.

3.8.2.1 Individual Usage Impact (IUI)

The Individual Usage Impact refers to the impact of the digital libraries on the users. It was represented by four measurement items namely learning, awareness, task's effectiveness and individual productivity. The dimension for Individual Usage Impact is a revised dimension based on the reconciliation with DLUIP. The indicators, however, are still fully conceptualised as formative measures as postulated by Gable, Sedera and Chan (2008). The main difference is that this study proposed the Gable, Sedera and Chan's (2008) four measures as exogenous variables of the IUI dimension in predicting the relationships between the indicators of the three dimensions in DLUIP. The indicators are as shown in Table 3.7.

Table 3.7: Indicators for the individual impact construct used in the proposed DL Success model

Items in the questionnaire	
1.	I have learnt much through the presence of the academic digital library.
2.	The academic digital library improves my work recall related to academic information.
3.	The academic digital library improves my study effectiveness.
4.	The academic digital library increases my academic knowledge.

Source: Gable, Sedera and Chan (2008).

All of these four indicators are measured via five scales ranging from 1= “strongly disagree” to 5= “strongly agree”.

3.8.2.2 Institutional Impact (II)

The measurement items collected for this dimension were based on the responses given by librarians and information technology officers, as well as those answered by academic staff (in a separate section of the questionnaire). The items were based on the binary variable (1= “Yes”, 0= “No”). The rationale of using binary variables for this dimension is based on Process Theories by Mohr (1982) who emphasized that the independent variable is assumed to be insufficient to “cause” the dependent variable (outcome), but it is held to be necessary for the outcome to occur. The organisational impact measures of the IS-Impact model (Gable, Sedera and Chan, 2008) primarily and adequately accounted for the organisational impacts of the enterprise system which may not portray the impact for academic institutions (through the use of academic digital libraries). Academic digital libraries are not meant to provide direct outcomes/outputs for business purposes, but indirectly they may assist the university in achieving the library’s (as well as academic) objectives. Moreover, there are no elements of business competition via the use of such systems, in view of the nature of the usage of academic digital libraries throughout the universities.

For this study, librarians, IT officers or academic staff members were not treated as key users of an academic digital library that could adequately experience and understand the whole impact on universities. But rather they were treated as representatives (for universities) in regards the aspects of Institutional Impact measures like digital library cost, staffing cost, benefits (of outputs) for academic staff, and so forth. Hence, the response expected is either *yes* or *no* for this level of users, in defining the impact on institutions.

The institutional impact dimension was hypothesised in defining the DL success model which was developed as a formative measurement model. The proposed research model was constructed using the Partial Least Squares (PLS) path model in defining the relationships between the constructs and indicators. Thus, the use of binary variable is acceptable in the PLS path modelling. As indicated by Temme, Kreis and Hildebrandt (2006), binary exogenous variables can be included in the analysis as it is one of the data scales available in the smartPLS software. Table 3.8 exhibits the indicators where the questions were meant for librarians and IT personnels.

Table 3.8: Indicators for institutional impact construct used in the proposed DL Success model

	Items in the questionnaire
1.	The academic digital library is cost effective.
2.	The academic digital library has resulted in reduced staff cost.
3.	The academic digital library has resulted in overall cost reductions (administration, hardware, software, etc.)
4.	The academic digital library has resulted in improved outcomes.
5.	The academic digital library has resulted in increase of capacity to manage growing volume of activity (e.g. transactions of searching, retrieving & etc.)
6.	The academic digital library has resulted in better positioning for research university.

Source: Gable, Sedera and Chan (2008).

3.8.2.3 Information Quality (IQ)

Another impact anticipated in the model is how well the information is produced by the digital libraries. Users perceive the information's goodness (the integrity of information) via measurement as demonstrated in the following table. All the ten items are represented on a 5-scale measurement, from 1= "strongly disagree" to 5= "strongly agree".

Table 3.9: Indicators for the information quality construct used in the proposed DL Success model

	Items in the questionnaire
1.	Information available from the academic digital library is important.
2.	The academic digital library provides output as what is exactly needed.
3.	The information needed is always available.
4.	Information from the academic digital library is readily usable.
5.	Information from the academic digital library is easy to understand.
6.	Information from the academic digital library is readable, clear and well-formatted.
7.	Though data from academic digital library is accurate, outputs sometimes are not.
8.	Information from the academic digital library is concise.
9.	Information from the academic digital library is always timely.
10.	Information from the academic digital library is unavailable elsewhere.

Source: Gable, Sedera and Chan (2008).

3.8.2.4 System Quality (SQ)

The system quality construct concerns the impact anticipated in the digital libraries' success model. It is based on users' perception of the capability of the system in serving its services to them, ranging from interface to technical aspects. Thus it is an impact that is gained from users who only actually use digital libraries in their study or research activities. Again, all of the 15 items under this construct were measured on a scale ranging from 1= "strongly disagree" to 5= "strongly agree".

Table 3.10: Indicators for the system quality construct used in the proposed DL Success model

	Items in the questionnaire
1.	Data from the academic digital library often need correction.
2.	Data from the academic digital library are current enough.
3.	The academic digital library is missing key information.
4.	The academic digital library is easy to use.
5.	The academic digital library is easy to learn.
6.	Often difficult to get access to information in the academic digital library.
7.	The academic digital library meets my (academic) requirement.
8.	The academic digital library includes necessary features and functions.
9.	The academic digital library always does what it should.
10.	The academic digital library user interface can be easily adapted to one's personal approach.

Table 3.10, continued

11.	The academic digital library is always up-and-running as necessary.
12.	The academic digital library system responds quickly enough.
13.	The academic digital library requires minimum number of fields and screens to achieve any task.
14.	All data within the academic digital library are fully integrated and consistent.
15.	The academic digital library can easily help me deal with errors.

Source: Gable, Sedera and Chan (2008).

3.9. Data Analysis

This study applied quantitative methods in analysing the data. The data analysis phase starts with data preparation. Data from questionnaires are raw data that need to be checked, keyed-in in statistical software, coded according to path analysis software, and so forth. The second phase deals with producing summaries of data, in tables or graphical forms. The final stage is to perform some related inferential statistics and modelling. The data collection and data analysis are as illustrated in Table 3.11, in accordance with the research questions of the study.

Table 3.11: Summary of data collection and data analysis according to research questions

Research Questions	Data Collection	Data Analysis
Is the usage for information provisioning model acceptable when applied in the context of digital libraries?	<i>Questionnaire</i>	Examining the validity of the use of digital libraries for provision information (DLUIP) properties in influencing the Individual Usage Impact (IUI), using the partial least squares (PLS) path model approach. The model was assessed using formative validation tests described by Urbach and Ahleman (2010), Henseler, Ringle and Sinkovics (2009) and Diamantopoulos, Riefler and Roth (2008).
Do the relationships between Digital Library Usage For Information Provisioning (DLUIP) dimension and individual usage depend on the users' awareness factors?	<i>Questionnaire</i>	Determining the level of awareness of digital libraries and investigating to what extent the awareness factors influence the individual usage of digital library via introducing awareness factors of the moderating effects in the relationships between the three dimensions of DLUIP and IUI construct.

Table 3.11, continued

What is the DLUIP dimension that has the largest influence on individual usage?	<i>Questionnaire</i>	Examining the highest influence of dimension in the relationships of digital library individual usage construct that was posited with the three DLUIP properties: content breadth, content depth and interaction dynamism.
Is the DL Success model valid in measuring the success of academic digital libraries?	<i>Questionnaire and input from interviews</i>	Examining the suitability of DL Success model that was validated using formative validation test; using all of the posited formative measures based on responses from students, academicians and librarian (with additional questionnaires from interviews)
What is the degree of the impact of the four success dimensions on the DL success?	<i>Questionnaire and input from interviews</i>	Investigating the degree of influence of the four dimensions (based on theoretical framework of IS-Impact and DLUIP properties) in measuring the overall success of digital library.

3.9.1. Preliminary Data Analysis

From the questionnaires, the data gathered were mixed, as responses were either of the nominal or ordinal type. Majority of the item measurements were the five-scale rating, ranging from 1 = “strongly disagree” to 5 = “strongly agree”. Questionnaires and rating scales are commonly used to measure qualitative variables in social science research. For the purpose of the questionnaires, the scales were recorded by numbers; however, in mathematical sense, they were only labels and possessed no numerical values. Thus, describing and analysing such data required careful attention because treating ordinal data is not the same as treating numerical data.

Summary statistics like means and standard deviations (sd) were also used together with graphical presentations such as bar charts and pie charts. In assessing the level of agreement in a survey instrument, reliability is the selected approach. The percentage of agreement in categories between two assessments on the same scale is a

basic measure (Svensson, 2001). The reliability and validity analysis of data are discussed in the following section.

3.9.2. Reliability and Validity

A reliable survey instrument is said to be relatively free of “measurement error,” which is important in ensuring that results represent the individuals’ “true” attitudes, opinions, etc. (Reeves et al., 2005). Reliability is the extent to which an experiment, test, or any measuring procedure yields the same results on repeated trials. As defined by Joppe (2000), reliability is the extent to which results are consistent over time and an accurate representation of the total population under study is referred to as reliability. If the results of a study can be reproduced under a similar methodology, then the research instrument is considered to be reliable. Without the agreement of independent observers able to replicate research procedures, or the ability to use research tools and procedures that yield consistent measurements, researchers would be unable to satisfactorily draw conclusions, formulate theories, or make claims about the generalisability of their research (Colorado State University, 2009).

The use of reliability analysis is common in quantitative studies. Kirk and Miller (1986) identified three types of reliability for quantitative research, (1) the degree to which a measurement (given repeatedly) remains the same, (2) the stability of a measurement over time, and (3) the similarity of measurements within a given time period. Based on the instruments used in collecting the data for this study, the reliability for this study depended on internal consistency. Internal consistency is one of the types of reliability which refers to the extent to which tests or procedures assess the same characteristic, skill or quality. It is a measure of the precision between the observers or of the measuring instruments used in a study (Colorado State University, 2009).

Validity of survey instruments depends on what they measure and what they ought to measure. Moreover, the instrument must at first be reliable. This study considers content validity in validating the instruments used for the survey. Content validity is a method for estimating validity. It depends on expert opinions, compared to face validity which depends on test-takers. Opinions of experts will decide whether the test adequately represents the construct of interest. The strategy in content validity is to assure that the test will have a high validity by controlling the content of the test (Hunter, 1982).

The validity analysis of the pilot study was done such that experts from local and international universities were invited to review the questionnaire. The expert reviews were done by academicians and a coordinator of repositories, experts in library science; two of them local and four international (refer to section 3.7.1). As noted by Popham (2000), content validity is the attempt to judge the degree to which a test is consistent with the content, skills or objectives it is supposed to measure. The constructive comments given by them for each related question were then scrutinised, and actions were taken accordingly, like rewording the questions and deleting repeated or redundant questions.

3.9.3. Descriptive Analysis

In elucidating the survey data used in the study, a descriptive analysis was performed, focussing on the basic statistical measures in describing the behaviour of the surveyed data. The analysis included the demographic profiles of respondents, rate of return as well as summarising the pattern of internet usage and literacy which were then further associated with the use and awareness of academic digital libraries. As indicated by Wildemuth (2009), the role of descriptive statistics in data analysis is to summarise the results of a study.

3.9.4. Measures of Association between Indicators

This study also proposed to observe the association and strength of relationships between indicators, such as to measure association between contexts of internet usage and digital libraries' awareness. Some inferential statistics based on non-parametric methods were proposed in this study to observe the different outcomes between the samples in the cluster. Non-parametric statistics deal with problems where hardly anything is known about the underlying distribution of the data. Statistical tests such as the chi-square (χ^2) test via contingency analysis (for categorical data such as nominal and ordinal values) were also performed. The chi-square test is an independency test for null hypothesis with no dependency between two variables (indicators). The rejection of a null hypothesis indicates that there is no relationship between the two selected variables, at the selected significant level. Additional non-parametric methods used were Kendall tau_b and Gamma (for ordinal data) and phi, Cramer's V (for nominal data) in order to find out the strength of the relationships, if any. This is in line with Tukey (1986) who outlined four purposes of statistical analysis; they are to aid in summarisation of data, obtaining what is going on, extracting information from the data and communication.

Further, based on Tukey's (1986) guidelines, this study also proposed the use of basic correlational statistics in observing certain associations/relationships between variables, for example, the correlation between the criteria and their impacts on different contexts of usage or between usage measures (as indicators for digital libraries' performance) and individual impact, and so forth.

In the next section, a brief discussion on the Structural Equation Model (SEM) namely the Partial Least Squares (PLS) path modelling is presented. Apart from that, an introduction to formative as well as reflective models are also included.

3.9.5. Partial Least Squares Path Model

Relationships between indicators and latent constructs, and relationships between different constructs have long been discussed in many areas in social sciences including IS and marketing. Relationships between the six main constructs of DeLone and McLean's IS Success model (1992) have been tested by many researchers (Gable, Sedera and Chan, 2008; Petter, DeLone and McLean, 2008; Seddon, 1997; Hunton and Flower, 1997; Boner, 1995). As a result, the studies yielded mixed results that indicated the evidence of causal paths. As criticised by Ballantine et al. (1996) and Myers, Kappelman and Prybutok (1998), DeLone and McLean's model raised some questions toward the causal nature in which Seddon (1997) believed was needed to be supported by some model paths. Long before that, Bollen (1989: 65) once reminded that *"...researchers in the social sciences assume that indicators are effect indicators. Cause indicators are neglected despite their appropriateness in many instances"*. His statement implies the nature of model paths that exist in relationship between constructs and indicators, and between constructs that have been overlooked by many.

This study proposed the PLS path modelling for measuring the DL success. According to Chin, Marcolin and Newstead (1996), the Structural Equation Modelling (SEM), i.e., causal modelling is rapidly becoming a dominant technique for analysing data among IS researchers. PLS was said to be a more appropriate statistical approach especially it precludes conditions as required by LISREL (covariance-based technique), i.e., non-normality and small sample size. This means PLS is capable of modelling the latent constructs under the conditions of non-normality and small sample size. Furthermore, this study opted for using f-dimensional formative measurement of DL Success model, as it is based from the theoretical foundation of IS-Impact and IUIP theories (formative measurement models). PLS model can be used to estimate parameters of multi-dimensional constructs model (Wetzels, Odekerken-Schröder and

Oppen, 2009). In addition, the PLS algorithm has become increasingly popular in IS research, as well as in other disciplines like marketing (Albers, 2010).

3.9.5.1 Formative and Reflective Measurement Models

Interdependencies between indicators and constructs portrayed in a path model can be defined and assessed via two measurement models: formative and reflective. The former model assumes the direction of relationships is from the indicators to the latent constructs. On the other hand, the latter is formed with the assumption of having relationships from the latent construct to the indicators. Chin (1998b) reminded that failure of paying attention to the direction of relationship between measures (indicators) and construct will result in a misspecification of the measurement model.

In the following discussion, a brief explanation on both measurement models is presented.

1. Formative measurement model

According to Diamantopoulos, Riefler and Roth (2008), the model was first proposed by Curtis and Jackson (1962) where they disputed that measures with positive correlation were regarded as a necessary condition. For $i = 1, \dots, n$ of indicators, the model specification is as follows:

$$\eta = \sum_{i=1}^n \beta_i x_i + \delta \tag{1}$$

where,

η is the latent construct,

β_i is the regression coefficient,

x_i is the i -th indicator and

δ is the error term associated with the construct.

Equation (1) describes the linear relationships of the dependent variable (the latent construct, η) with indicators (x_i) as explanatory variables, as in the multiple regression model. In diagram form, Equation (1) is as depicted in the next figure, which exhibits the specification of dependency relationship in a first-order formative model.

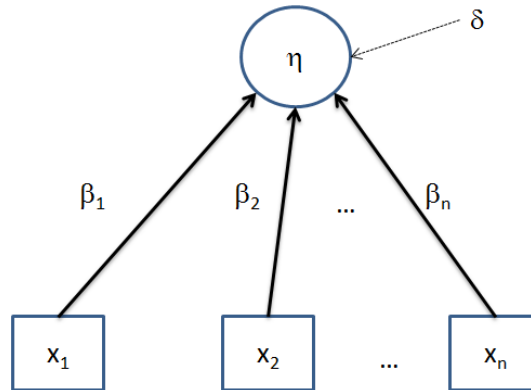


Figure 3.5: First-order formative measurement model

The direction of relationship in Figure 3.5 shows that it is from the indicators to the underlying latent construct and each indicator is error-free in the conventional sense (refer to Edwards and Bagozzi, 2000 for details).

2. Reflective measurement model

This model is based on the classic theory (Lord and Novick, 1968) where the measures are the manifestation (effects) of an underlying latent construct. In other words, the manifest variables are effect variables (and not caused variables as in the formative model). The formal specification of the reflective model with $i = 1, \dots, n$ of indicators is,

$$x_i = \sum_{i=1}^n \beta_i \eta + \delta_i \quad (2)$$

where,

η is the latent construct,

β_i is the regression coefficient,

x_i is i -th the indicator and

δ_i is the error term associated with each of the indicators.

The linear relationships of multiple regression for reflective model in Equation (2) specifies that in contrast to Equation 1, the indicator (x_i) is regressed to latent construct plus the error term, δ_i .

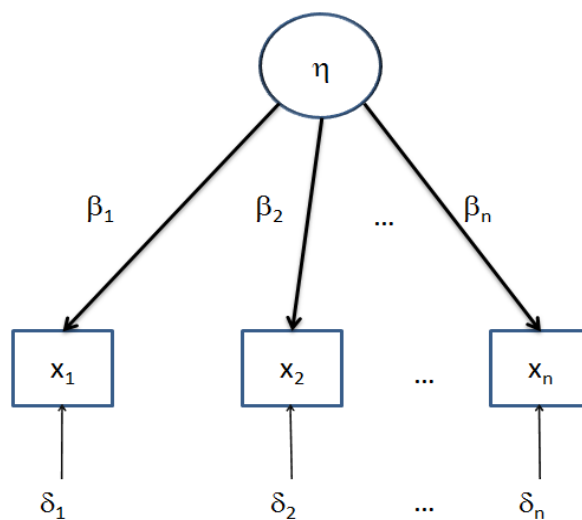


Figure 3.6: First-order reflective measurement model

Based on previous type of model (Figure 3.5), comparatively, it indicates the measurement error δ_i of formative model is associated at the latent construct level, and not the individual indicator level. However, the error term (δ_i) for the reflective model (Figure 3.6) is associated with each individual indicator and is assumed to be independent ($\text{cov}(\delta_i, \delta_j) = 0$ for $i \neq j$) and unrelated to the underlying latent construct ($\text{cov}(\eta, \delta_i) = 0$).

Latent constructs (or latent variables) cannot be observed directly and must be assessed by their manifest variables (Diamantopoulos, Riefler and Roth, 2008). In addition, latent constructs can be measured using reflective or formative indicators

(Ambrose, Rai and Ramaprasad, 2006). Given the two types of measurement models, reflective and formative, issues related to validating the model and the structural aspect may not gain much debate for the former, but more for the latter model. Nevertheless, due to more extensive works that have been published in the social science literature like Diamantopolous, Riefler and Roth (2008), Henseler, Ringle and Sinkovics (2009), Ringle (2006), Ringle et al. (2009) and Hulland (1999); guidelines in validating both types of model is by far accepted by many IS researchers. Table 3.12 provides a summary of the differences between the formative and reflective measurement models.

Table 3.12: Comparison between formative and reflective measurement models

	Characteristic	Formative measurement model	Reflective measurement model
1.	Nature of relationships (theoretically)	<ul style="list-style-type: none"> • From indicators to construct • Indicators <i>define</i> the construct 	<ul style="list-style-type: none"> • From construct to indicators • Indicators <i>manifest</i> the construct
2.	Impact of changes	<ul style="list-style-type: none"> • Indicators cause the construct thus changes in the indicators should change the construct • On the other hand, changes in the construct do not necessarily change the indicators 	<ul style="list-style-type: none"> • Indicators are reflections of the construct thus changes in the indicators should not cause changes in the construct • However, changes in the construct should change the indicators
3.	Indicators interchangeability	<ul style="list-style-type: none"> • No because indicators are in different themes 	<ul style="list-style-type: none"> • Yes because indicators may share a common theme
4.	Indicators' covariation	<ul style="list-style-type: none"> • Indicators do not necessarily covary • Low correlations are expected (to avoid multicollinearity) 	<ul style="list-style-type: none"> • Indicators are expected to covary • Should be highly correlated with each other
5.	Nomological net of the construct indicators	<ul style="list-style-type: none"> • Should differ • Same antecedents and consequence are not required 	<ul style="list-style-type: none"> • Should be similar • Indicators are required to have the same antecedents and consequence

Source: Jarvis, MacKenzie and Podsakoff (2003), Petter, Straub and Rai (2007)

Since this study did not aim at presenting methodological works of PLS estimation procedures, the author suggests the reader to refer to Wold (1982) for a detailed

description. Also, the author focused on the formative measurement model and therefore, the following sections are meant to discuss the PLS assessment of pure formative measures and constructs where it comprises of assessing the measurement model (outer) and structural model (inner).

3.9.5.2 The Measurement Model (Outer Model)

According to Bagozzi (2000), cited in Diamantopoulos, Riefler and Roth (2008), the measurement model describes relationships between a construct and its indicators. It is also known as outer model. The procedure is meant to determine the responses (based on indicators) given by subjects in the survey where it is actually measuring the corresponding latent constructs.

The correlations between formative indicators may be positive, negative or zero (Diamantopoulos and Winklhofer, 2001; Diamantopoulos, Riefler and Roth, 2008). Thus it leads to the alertness of reliability (in the sense of internal consistency) for formative indicators are **not** meaningful (Hulland, 1999). In other words, both factor analysis and Cronbach Alpha (validity assessment for reflective model) are **inappropriate** in the context of formative model (Gable and Sedera, 2009; Christophersen and Konradt, 2008). On the other hand, assessment of formative measures (indicators) is based on the multicollinearity and significance impact on the dependent variables. In smartPLS, a multicollinearity test is not provided; however, based on the scores given in the output, it can be transferred to SPSS for checking such problems. The significance relationship of each indicator is determined by running the bootstrapping method in smartPLS. The following Table 3.13 summarizes the assessment criteria for the outer model which are used as a basis in validating the PLS formative measurement model for the DL Success.

Table 3.13: Validation criteria for the formative measurement model (outer model)

Assessment	Criteria	Fit indices
Indicator validity	Indicator weights	Indicator should be significant at least at 5% level. Preferable coefficients of weights of 0.100 and greater (Lohmöeller, 1989; Wold, 1982) but cut-off lower limit was set as 0.05 (Pedhazur, 1997).
	Variance inflation factor (VIF)	Acceptable values for VIF of indicators of the construct should be less than 10 (Cohen, 1988; Gefen, Straub and Boudreau, 2000) and a more rigid one, $VIF < 3.3 - 4.0$ (Diamantopoulos, Riefler and Roth, 2008; Petter, Straub and Rai, 2007; Diamantopoulos and Siguaw, 2006).
Construct validity	Nomological validity	The construct behaves as expected and as sufficiently referred to in prior literature (Straub, Boudreau and Gefen, 2004; Henseler, Ringle and Sinkovics, 2009)
	Interconstruct correlations	Correlations between the formative and all other constructs in the model should be less than 0.71 (Mackenzie, Podsakoff and Jarvis, 2005)

3.9.5.3 The Structural Model (Inner Model)

The subsequent step for validating the measurement model is to assess the structural model or also known as the inner model. As noted by Diamantopoulos, Riefler and Roth (2008), the formative model's structural assessment procedure is considered the most debated one in the literature so far. Assessing the structural model is to assess the relationships between different constructs. Assessing the structural portion of a formative model requires the check on several criteria including each of the latent variables' coefficients of determination, R^2 , and path coefficients (sign, magnitude and significance of relationships between the constructs). In smartPLS, path coefficient analysis is done through a re-sampling method, i.e., bootstrapping (Efron, 1979; Efron and Tibshirani, 1993). While how good the model fits the data could be checked via the R^2 values. The values of R^2 can be in between 0 and 1. Since the value can be between these two extremes, R^2 can be defined as a proportion of the total variation of

one measure that can be determined by the other measure(s) where 1 (or 100%) shows a perfect predictability.

The Model validity process also includes assessing the effect size, f^2 . The smartPLS software used in the study however did not provide the f^2 value, however, it can be calculated based on the SEM approach using Cohen's f^2 (Cohen, 1988) formula. The f^2 value indicates the effect size of the impact of an independent latent variable on a dependent latent variable. The effect of size $f^2 = 0.02$ is considered small, $f^2 = 0.15$ (medium) and, large if $f^2 = 0.35$ and above (Cohen, 1988; Chin, 1998b). The last criterion is based on the predictive relevance measured using Q^2 statistic. In smartPLS, the predictive relevance is calculated using Stone-Geisser's nonparametric test (Geisser, 1975; Stone, 1974) employed using a blindfolding approach (Chin, 1998b). The Q^2 value, as indicated by Chin (1998b) suggests an index of goodness of reconstruction by model and parameter estimations (Andreev et al., 2009) which measures the extent the model's prediction is successful (Urbach and Ahlemann, 2010). The $Q^2 > 0$ confirms the presence of predictive relevance; on the other hand, $Q^2 \leq 0$ indicates the absence of predictive relevance. The following Table 3.14 provides a summary of the assessment of the structural or inner model.

Table 3.14 Validation criteria for formative structural model (outer model)

Criteria	Fit indices
R^2	Approximation values of $R^2 = 0.670$ are considered substantial, 0.333 (moderate) and weak with 0.190 (Chin, 1998b).
Path coefficients	Analyses include the algebraic sign, magnitude and significance of the path coefficients (Albers, 2010).
f^2	Value of $f^2 = 0.350$ and above indicates large effect, 0.150 (medium) and low with 0.020 and below (Cohen, 1988; Chin, 1998b).
Q^2	Threshold value of $Q^2 > 0$ (Geisser, 1975; Stone, 1974; Chin, 1998b)

The aim of developing the DL Success model is to investigate the performance of the academic digital library using all of the postulated measures and constructs adopted

from previously validated study. Thus, in terms of the effect size (f^2) of the success model, it may not be applicable for this study. It is mainly because the main objective of this study concerns only the total effect; i.e. overall total effect size of the PLS model when all of the indicators (or variables) are used. With respect to this concern, only Q^2 statistics were used in calculating the total effects. The value of Q^2 is a way to measure the impact of the whole model as compared to f^2 , measuring by means of including and excluding certain indicators. Apart from using Q^2 , the validation of the study model applies R^2 and the path coefficient analysis. All of the constructs and scale items used in the research were adopted from previously validated sources, from the IS-Impact and IUIP models.

3.9.5.4 SmartPLS Software

The proposed research model is analyzed with the smartPLS version 2.0 M3 (Ringle, Wende and Will, 2005). It is meant for performing PLS path modeling (Wold, 1985; Chin, 1998b; Chin, Marcolin and Newstead, 2003) as well as producing comprehensive statistical tests. It includes assessing the indicators' validity, checking for collinearity problems and estimating the path modeling relationships.

SmartPLS is Java-based, an independent-platform and a free software that is capable of graphically analysing the PLS model by performing its related statistical analysis including bootstrapping (resampling method) method to handle missing values and choice of analysing reflective and formative indicators. The software was selected based on a review by Temme, Kreis and Hildebrandt (2006). In addition, this study incorporated a mixed type of item measurements, rating scales (with five categories) and binary variables (1 - "Yes", 0 - "No"). SmartPLS is capable of analysing the indicators of the latent constructs with a continuous, rating scale (5 or more categories) or binary exogenous variables (Temme, Kreis and Hildebrandt, 2006).

The PLS path model estimation is constructed via estimating the measurement model as well as the structural model. The study opted the formative measurement model based on the formative indicators justified conceptually as a formative that had been established theoretically.

3.10. Summary

This chapter presented in detail the research design, proposed study framework and model, the population, instruments, data collection and analysis. Since this study was a quantitative study with user-centered approach, a survey method was chosen. In addition, as part of the digital libraries' success analysis, data collection was done via interviews to each of the university libraries' authorities. The main aim was to get input for Institutional Impact measures that can be given only by the library authorities. It was actually a part that fulfilled the need to measure the indicators for the said dimension as proposed in the DL Success model.

The survey is an effective way to gather information about respondents' previous or current behaviours, attitudes, beliefs, and feelings (Covey, 2002). Thus this study attempted to investigate users' usage behaviours related to digital libraries that were collected as metrics or indicators towards evaluating the performance of the digital libraries, based on the IS success measures and dimensions, as developed by Gable, Sedera and Chan (2008). Specifically, the data collection method was based on the quantitative data gathered from the questionnaire; for dimensions in the proposed model which included measurement items in a 5-point scale, and binary (only for exogenous variables for the institutional impact dimension collected from library personnel's perspectives). The survivability of digital libraries actually depends on humans – either developer, designer, librarian or user. From time to time, digital library services and content providers should continuously incorporate such information systems with

current information and technology to comply with diverse and changing users' needs, expectation and preferences in their context of usage.

Based on the framework and model proposed and discussed in this chapter, this study would serve as a sound basis for measuring the success of academic digital libraries using the IS success model, namely the IS-Impact model (Gable, Sedera and Chan, 2008), via a user-centred approach. The IS-Impact model was developed with a strong analytic theory and was considered as the most comprehensive model in IS evaluation (Rabaa'i, 2010; Elias and Cao, 2009; Ifinedo, 2006).

From the methods and data analysis discussed in this chapter, the following chapter presents the results of the analyses, as well as discussions of the findings. The results are accompanied with detailed explanations especially in the outcomes of the partial least squares path model. Such undertakings include the procedures for validating the formative measurement model as postulated in the study model. In addition, all of the statistical models and analyses applied in the study were performed using smartPLS 2.0 and SPSS version 16.