CHAPTER III

RESEARCH METHODOLOGY

3.1 Introduction

There are two approaches in research methods which are quantitative and qualitative method. A quantitative approach is 'explaining phenomena by collecting numerical data that are analyzed using mathematically based methods (in particular statistics)'. In quantitative approach, the numerical data are collected and analyzed using mathematically based method (Balnaves & Caputi, 2001). On the other hand, qualitative methods are often used to answer the how and whys of human behavior, opinion, as well as experience information which is difficult to address by quantitative methods of data collection.

Qualitative data is generally difficult to measure and quantify; it can yet reveal valuable attitudes and perspectives that can hardly be accessed through a traditional quantitative approach. The exploratory character of qualitative research permits the gathering of new information on specific areas of research, very often through an intensive dialogue between the interviewer and the respondent (Broda, 2006; Naderer & Balzer, 2007).

Since fieldwork is done without predetermined categories of analysis, qualitative studies provide depth and detail. In contrast to quantitative methods, which can statistically measure and evaluate the reactions of a great

number of people thanks to a limited set of questions and standardized answer categories, a qualitative study can yet never reach the same breadth due to the reduced number of cases (Patton, 2002).

In contrast to quantitative research, where hypotheses are formed and are then applied to various specific cases (deduction), qualitative research uses inductive reasoning, proceeding from particular to more general statements.

This chapter explains the methodology stages that have been followed in this research to achieve the main objective of this research. This research used a systematic literature review methods and qualitative methods to achieve the main objective of this research. Systematic literature review has been undertaken based on kitchenham guidelines. The purpose of the systematic literature review is to summarize and assess the existing studies related to topic area by answering the review questions formulated in advance. Systematic literature review method was chosen to address the current state of security policies for BYOD solution by answering the review questions for this research to come out of proposed framework. The qualitative method used to evaluate this framework. To achieve this goal must follow the methodology stages as shown in Figure 4.

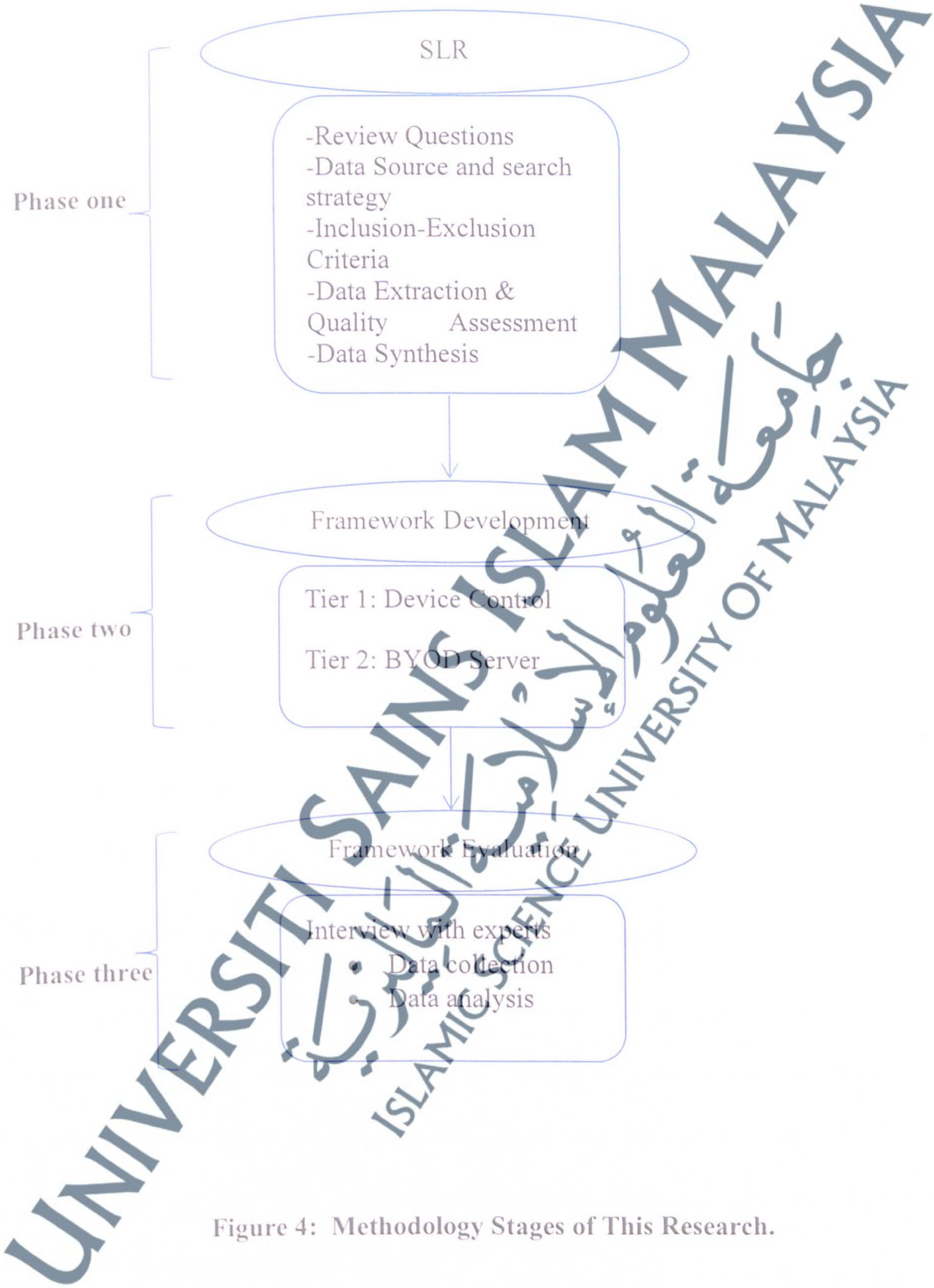

Figure 4: Methodology Stages of This Research.

3.2 Systematic Literature Review (SLR)

This section to give an overview about systematic literature review (SLR) process.

3.2.1 Definition

Since the 1990s the systematic literature review became very common research methodology. It was vastly used in medical research in the 1990s. There are many well documented standards to support its use. In software engineering there are number of researches performed as systematic literature review since 2004 (Kitchenham et al., 2009). In addition, many major journals and magazines have published papers on systematic literature review.

According to Kitchenham (2004), "a systematic literature review can be defined as means of identifying, evaluating and interpreting all available research relevant to a particular research question, or topic area, or phenomenon of interest".

3.2.2 Reasons for Adopting Systematic Literature Review

Systematic Literature Review (SLR) must be undertaken according to a pre-defined search strategy. To assess the search, the search strategy should allow the completion of the research. According to Kitchenham (2004), there are many reasons for adopting systematic literature review. The most common reasons are as following:

1-To review the existing evidence concerning a certain phenomena.

2-To identify any gaps in current research for proposing areas for the further investigation.

3-To provide a background and framework to organize new research activities on the topic area.

3.2.3 Important Features of Systematic Literature Review (SLR)

There are some features contributed in creating the difference between systematic literature review and a conventional expert literature review as following (Keele, 2007; Kitchenham, 2004):

1- Development the review protocol is one of the most important features of the systematic literature review. This protocol defines the research questions begin specifies and the methods have be used for undertaking a special review.

2- A special search strategy used to carry out the review. The objective of the search strategy is to determine the maximum possible number of literatures reviews related.

3- Document the search strategy and results to be used as a reference for future researchers.

4- SLR requires the specification of inclusion and exclusion criteria for study selections, to evaluate the potential primary study.

5- SRL identifies that the data and information needed to be extracted from primary studies and assesses them during quality criteria. Extracted information documented using data extraction forms or other reviewing.

6- SRL is deemed as prerequisite for the quantitative meta-analysis which presents integrated research studies from different sources around the same topic.

3.3 Planning the Review

The starting point of the review starts in planning phase. In this phase the developing of the review protocol including all the steps, research question, inclusion and exclusion criteria, and analysis procedures identified.

3.3.1 Development of a Review Protocol

Review protocol is a detailed plan in order preforming a systematic literature review and provides a method for selecting primary studies (Keele, 2007). This section describes a review protocol which will be used to carry out the actual study. The review protocol is identified based on the review process has been described in the guidelines for performing the systematic literature review.

3.3.1.1 Formulating Review Questions

Formulating review questions is a very important part to conduct a systematic literature review. It helps the researcher to look at research trends related to research topic. In this review the review questions discusses an overview about previous studies already done on security policies for BYOD trend, the methods and the mechanisms that have been applied for BYOD security as well as the limitations for these studies.

RQ#	Question	
RQ1	What is the current state of security policies in BYOD environment?	
RQ2	How BYOD security policies are implemented in previous studies?	
	RQ2.1	What are the mechanisms/applications used to approaching security policies for BYOD?
	RQ2.2	What are the limitations of the current security policies models for BYOD?

Table 8: The Review Questions

3.3.1.3 Data Sources and Search Strategy

The main objective of systematic review is to collect as many primary studies related to research area and answer review questions as possible. To this end, Figure 5 showing the search strategy applied to various databases. Searching for the literature is conducted through using different sources of available electronic databases. An extensive search was implemented on the several electronic databases, and the keyword used to find articles, conference, journals or academic papers regarding to BYOD security policies.

The search results are dramatically influenced depending on the type of database and keyword used in the search process. To know the quantity of the articles related to this topic, we can do a quick search on the Google Scholar using *bring your own device security policies* keyword this process defined as

a trial search. The research can be modifying by using quotes around the keyword and running the search again.

This review was done from different digital databases using keyword "bring your own device" AND "security policies" in the article title and abstract. The search process conducted on published journals and conferences dated since 2011 until 2015 within English language only. The articles that have been gathered in this review are found in the IEEE and ScienceDirect as the most useful ones in computer science. On the other hand, IEEE is considered as a large innovative association for excellence in the field of technology. Springerlink was chosen because it coordinates with the academicians and authors in the scientific community, Scopus is the largest abstract and citation database of peer-reviewed literature: scientific journals, books and conference proceeding (Sheuly, 2013). There are the following digital databases used to carry out the review on BYOD security policies:

- IEEE Xplore Digital Library
- Science Direct
- SpringerLink
- Scopus

There are three Boolean operators allow to researcher to combine terms to narrow or broaden the search process such as AND, OR, NOT. In this search we used AND Boolean operator to combine between "Bring Your Own Device" AND "security policies" through searching process in databases mentioned above since 2011 until 2015 using English language only and the results was as following:

Database Name	Number of articles (2011-2015)
IEEE Xplore	3
ScienceDirect	83
SpringerLink	71
Scopus	15
Total	172

Table 9: Search Result

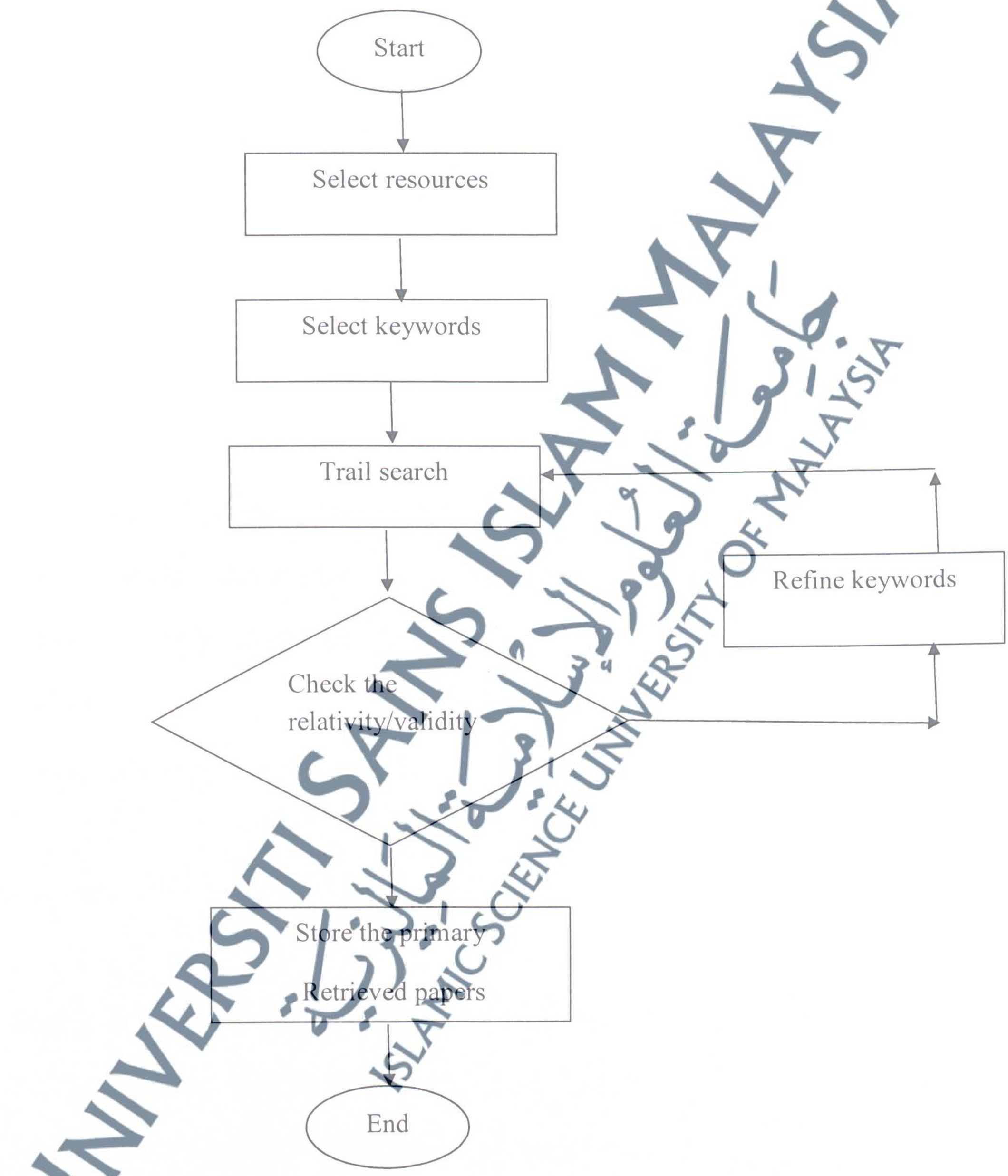

Figure 5: Search Strategy (Sheuly, 2013)

3.3.1.4 Inclusion-Exclusion Criteria

Screening process is a very important stage to carry out the SLR. The articles collected during search process must send forward to screening process. In this stage the researcher is explicit about which studies are for review and which studies should be discarded (Okoli & Schabram, 2010). The research study selections are based on the inclusion and exclusion criteria as following:

Inclusion Criteria:

- Articles where the BYOD security policies as the major topic.
- Research article should be closely or related to review questions.
- Articles should be related to the implementation of BYOD security in general.
- Articles in full text should be available.

Exclusion Criteria:

- Duplicate copy of the same research study is excluded.
- Articles that do not focus on BYOD security policies.
- Articles did not regard to review questions or search area.
- Short articles, summary of articles, proposals, Doctoral workshop and tutorial that were not peer reviewed.
- Articles which were written in language other than English.

The study selection process carried out through studying the title and abstract of the article. If the title and abstract of the paper very close to main topic mentioned inclusion criteria and thorough and full reading.

3.3.1.5 Quality Assessment

The assessment of the quality conducted in order to evaluate the papers and articles which have been sent forward to quality assessment stage after screening stage to find the ones which will be used in final literature review report (Okoli & Schabram, 2010). Study quality assessment conducted based on the paper structure criteria. Therefore, the papers and articles which have been selected after screening process will be evaluated on following structure: Introduction, Research Method, Results, and Conclusion. The assessment process preformed based on the answer to the following questions in each paper:

Introduction: Does the introduction section in the research paper provide an overview of BYOD?

Research Methodology: Does the research methodology clearly explained in the research paper?

Results: Does the results section in the research paper defined? Are the results clearly and answered the research questions?

Conclusion: Does the conclusion section clearly describe the positive and negative findings? Does the limitations of the study described?

3.3.1.6 Data Extraction

After identified and selected the articles and papers to be in the final review, the next step is to record the information from primary studies. Data is extracted from each research paper using a pre-defined data extraction form. This form involves some general information and some specific information which shown in Appendix A.

3.3.1.7 Data Synthesis

This phase includes collecting and summarizing the findings of the selected primary studies (Keele, 2007). In this research, the data synthesis is produced by using descriptive analysis; this is because of heterogeneous nature of the data of primary study. The results from primary studies are presented according to review questions early mentioned in review process.

3.4. Developing BYOD security framework

Through the analyzing of the systematic literature review the BYOD security framework was created. Then after analyzing the results of the systematic literature reviews that depends on the evaluation of previous studies. The proposed framework was presented.

3.4.1 The Proposed Framework

The proposed framework in this research targets to mitigate the emerging attacks of using the employees their own devices in workplace as well as to address the limitations of device resources. The framework created based on systematic literature review related to BYOD security policies. The elements

used in this framework which is created to solve the problem of BYOD security through control the user access are device profiles, anti-malware scanner, user role, user profiles, internal apps and external apps. These elements are derived from the review analysis results.

The proposed framework consists of two layers of Security Control. Layer one for Device Control Tier and the second tier is BYOD Server Tier. Figure 6: shows the proposed framework includes two tiers. First tier or Device Control is located on the physical device itself. Within the Device control are Device Profiles and a Light Anti-Malware scanner. The second tier is BYOD Server Tier; this tier consists of Applications Control which is Internal Applications and External Applications, User Control which are User Profiles and User Role. By separating the system into these two tiers, the system can be easier and more flexible to manage.

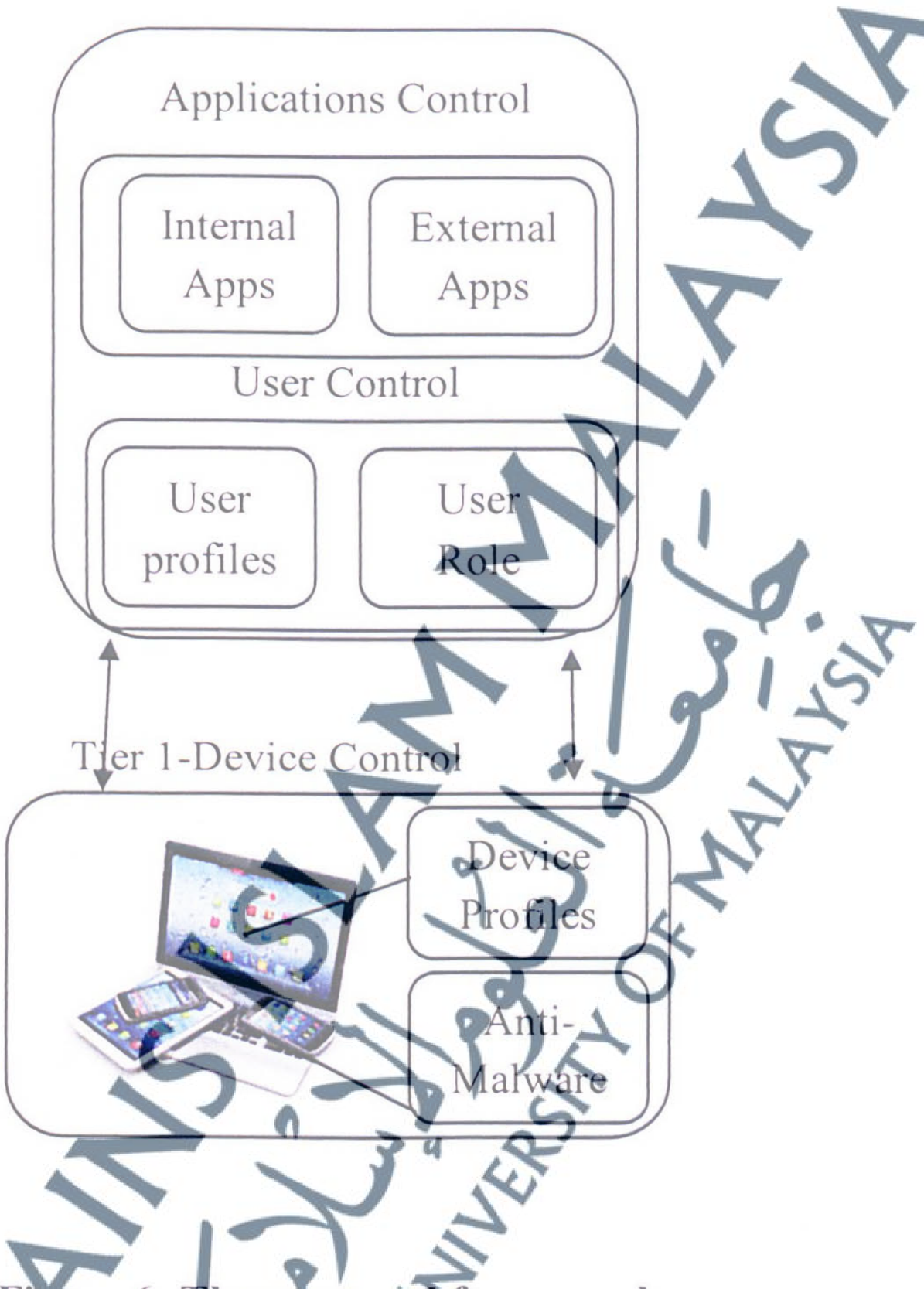

Figure 6: The proposed framework

3.5 BYOD Security Framework Evaluation

The evaluation of the proposed framework is considered an important stage of this research. The proposed framework is evaluated for its flexibility and possibility to adopt BYOD security framework in organizations. The processing steps of the evaluation of the proposed framework are as follow. Firstly, the researcher had made the proposed framework based on SLR. Secondly, the researcher used an interview as evaluation descriptive tools to

evaluate the framework by doing interviews with a number of experts from IT department.

3.5.1 An Interview Method

An interview is considered the main instrument data collection procedure closely associated with qualitative approach (Kvale & Brinkmann, 2009). An interview technique was used in the evaluation stage of this research. Cohen et al., (2011) defined the interview as "a two-person conversation initiated by the interviewer for the specific purpose of obtaining research-relevant information, and focused by him on content specified by research objectives of systematic description, prediction, or explanation".

The interview is an important tool used to depict the story behind the interviewees' experiences. The interview type was face-to-face with 2 experts from IT department in USIM and three lecturers who interested in the mobile security research. The interview questions type were open-ended questions as shown in Appendix B. According to (Kvale & Brinkmann, 2009) an interview is an appropriate method to collect data from number of experts and could contribute to enhance confidence for generalizing of the results. The open-ended type of questions is useful in answering the interview was developed based on previously studies. This type of questions aims to understand the thoughts, perceptions and experience of individuals. The collected data by the interview are analyzed qualitatively.

3.5.2 Using Qualitative Analysis for This Particular Study

The researcher decided to use qualitative analysis for this research because the research questions of this study could not be answered using quantitative methods. This is due to two reasons:

1 -The research questions are largely exploratory in nature.

2-Their purpose is to gain general insight into a topic on which little literature exists. In fact, the character of the study required access to profound expert information on the topic of event management which could not be acquired through a standardized questionnaire with predetermined answer categories as used in quantitative research. The aim was not to measure or quantify something, but to improve understanding of the phenomenon by obtaining information from experts on personal experiences.

3.5.3 Data Collection

3.5.3.1 Sampling in Qualitative Research

There are no specific rules for the determination of sample sizes in qualitative research. Sample size rather depends on considerations of the researcher related to the purpose of the study, the usefulness and the credibility of the selected cases and, last but not least, on the available time and resources (Sayre, 2001; Patton, 1990).

The selected cases will be judged according to the purpose of the research and to their relevance in answering the research questions on the phenomenon

under investigation (Patton, 1990). In the following, the sampling procedure as applied in this particular study will be explained in detail.

According the proposed framework, there are six variables could be identified as the most important restrictions in sampling that perform two tiers as following:

1- Tier 1: Device Control

Device control is consists of two main variables (device profiles and light anti-malware scanner).

2- Tier 2: BYOD Server

BYOD server is about the security management system and is containing of four variables, two are perform the user control which are user profiles and user role and the other two are perform the application control which are internal apps and external apps.

3.5.3.2 Data Collection Method

The basic idea for collecting data is to conduct interviews on the proposed framework with a number of information security experts in USIM. In-depth interviews with such experts are likely to reveal valuable information to evaluate the proposed BOYD framework.

The interview can be described as a communicative process through which the investigator extracts information from a person or informant. The extracted information will be strongly influenced by the respondent, who

acts and interprets his/her environment on the basis of his previous experiences. So every interview generates a subjective informative product shaped by the interviewees' experiences (Delgado & Gutierrez, 2007).

Based on these considerations, it becomes clear that the goal of qualitative interviewing is to provide understanding of things that cannot directly be observed, such as feelings, thoughts, opinions, attitudes or behaviors of interviewees. Since qualitative interviewing is based on the assumption that the perspective of others is meaningful and knowable, entering into their perspective becomes a major objective for the qualitative researcher. The tools of observation and interviewing are often used in a complementary way (Sayre, 2001; Patton, 1990).

The interview format that was applied in this research is the *interview guide approach*, where the questions predetermined, but the sequence determined during the conversational flow. The advantage of this approach is that it makes data collection more systematic and ensures that certain topics and issues of interest will be covered. The major goal is to obtain relevant information and opinions on evaluating the proposed framework.

An interview guide specifies important issues and topics related to the formulated research questions that will have to be covered during the interview. In qualitative research, questions need to be open-ended, neutral, singular and clear. The interview guide developed for this research mainly consists of experience and behavior questions as well as opinion questions. The interview guide can be found in Appendix B.

In total, five qualitative interviews were conducted and interview transcripts can be found in Appendix C.

The answers from different respondents were grouped by topics from the guide; the relevant data was dispersed throughout the respective interviews. After conducting the interviews they were transcribed in order to process them for the subsequent analysis.

A suitable method for this analysis seems to be the qualitative content analysis by Mayring. This method and how it was applied will be described in the following:

3.5.4 Qualitative Content Analysis

Qualitative content analysis by Mayring is an approach aiming at analyzing communication material in a systematic way (Mayring, 2007).

According to Mayring (2007) there exist three basic forms of interpretation in qualitative content analysis, namely *'summary'*, meaning the reduction of the data *'explication'*, by finding further material and *'structuring'*, meaning filtering important aspects from the data. For the present qualitative content analysis, 'structuring', and filtering the relevant content out of the material as a whole and analyze them regarding in advance specified categories (thematic blocs) seemed to be the most appropriate way. Defining the categories serves as a means to filter the interviews for statements fitting into the categories.

The categories were developed in an inductive way, guided through the conducted data. However, some categories were found in a deductive way

reconsidering the defined categories, the content of the transcript was structured using a color scheme. Statements, opinions and quotes were taken out by order of their color; summarizing them into the category system. In case the contents did not fit in existing categories, new ones were developed. Some statements were quoted directly, but most were summarized and paraphrased in the researchers own words.

After coding all interviews, the collected statements were analyzed and interpreted. It seems important to mention that in order to do the data analysis some of the categories needed to be changed, merged or switched around. This was for example due to their interrelation. Moreover, the findings shifted the focus of the study.

Qualitative content analysis seems to be a valuable method for this thesis because it permits taking into account the context in which the material was generated and at the same time it considers the theoretical background of the research (Mayring, 2007). Coding the material by using a structured category system makes it possible to reconstruct the steps of analysis. This strengthens the reliability of the analysis and the comparability of the results. The category system, furthermore, could be revised during the process in a flexible way according to the material (Mayring, 2007).

3.6 Summary

This chapter focused on the methodology which is needed to achieve the aims of this research. The illustration is given regarding the methods which were used in this study work is discussed and elaborated. Systematic literature review method undertaken in this research to come out of main aim of this research which is BYOD security framework. The review processes which are followed in this review are formulating review questions, search process which includes source of selection and search keywords, inclusion-exclusion criteria, and quality assessment criteria in primary articles and data extraction as well as data synthesis. Existing developed framework is proposed and evaluation process is described so the framework will be present in the next chapter of this research.