DETERMINATION OF QUANTITY ACCURACY USING BULK CHECK

SIA PEI ER

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Name of Second Reader	:	**DR. NAFISAH ABDUL RAHIMAN**
Date	:	**10 JUNE 2018**

DETERMINATION OF QUANTITY ACCURACY USING BULK CHECK

SIA PEI ER

A dissertation submitted in partial fulfilment of the
requirements for the awards of the degree of
Bachelor of Quantity Surveying

Faculty of Built Environment
Universiti Teknologi Malaysia

JUNE 2018

DECLARATION

I declare that this thesis entitled "**Determination of Quantity Accuracy using Bulk Check**" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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DEDICATION

To my beloved father, mother and siblings,

Thanks for understanding and all the financial and moral supports.

To my respected supervisor,

Assoc. Prof. Sr. Dr. Kherun Nita

Thanks for your guidance and knowledge throughout the research.

And to friends who encourage me to move forward.

Thanks for the support and encouragement all the way

Thanks for Everything

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Besides that, sincere appreciation goes to all the respondents who provide all the useful sources for this research. Thank you for providing the information required for document analysis purposes and involved in the interview that provides me the advantage of their knowledge, views and also even sharing some experience. I am also thankful to all my friends for their moral support and encouragement throughout this research.

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Thank you.

ABSTRACT

Quantity surveyors demand for high accuracy in the preparation of Bill of Quantities (BQ). Basically, quantity take-off applied to the buildings must accurate and consistent either it is conduct manually or using specialised software. Adoption of specialised software contributes greater accuracy and yet tedious and error-prone of manual quantities take-off currently practiced in consultant firms. Thus, the research aim is to determine the range of quantity accuracy using bulk checking and encourage the profession in utilizing the software application during taking-off. The research objectives are to compare the range of quantity accuracy between the BQ that produced using specialised software and by manual; and to identify the accuracy of quantity in the BQ. Total nine double-storey terrace houses projects' BQ were obtained and analysed using descriptive analysis where bulk check list acts as an instrument for determining the range of quantity accuracy. Besides, semi-structured interviews were conducted with consultant quantity surveyors in Johor Bahru to identify the factors affecting the quantity accuracy in the BQ and the interview data were analysed using thematic analysis. Based on the finding, the range of percentage difference on bulk check quantity for manual measurement is between 2% to 33% meanwhile for the specialised software measurement, the range of percentage difference on bulk check quantity is between 1% to 12%. Hence, it shows that the quantity produced by the specialised software had greater accuracy as compared to manual measurement with a lower range of percentage difference on bulk check quantity. Human errors are the most significant factors affecting the quantity accuracy in the BQ. This research emphasized that software adoption provides greater accuracy and improve the satisfaction and confidence in BQ preparation.

ABSTRAK

Juruukur bahan memerlukan ketepatan yang tinggi dalam penyediaan senarai kuantiti (BQ). Asasnya, pengukuran kuantiti untuk bangunan mestilah tepat dan konsisten sama ada ia dijalankan secara manual atau menggunakan perisian khusus. Penggunaan perisian khusus menyumbang ketepatan yang lebih tinggi namun kaedah manual masih dilaksanakan dalam perunding. Oleh itu, matlamat penyelidikan adalah untuk menentukan julat ketepatan kuantiti menggunakan *'bulk check'* dan menggalakkan profesion dalam aplikasi perisian semasa pengukuran. Objektif penyelidikan adalah untuk membandingkan julat ketepatan kuantiti antara BQ yang dihasilkan melalui perisian khusus dan secara manual; dan untuk mengenalpasti ketepatan kuantiti dalam BQ. Sejumlah sembilan buah BQ bagi rumah teres dua tingkat telah diperoleh dan dianalisis dengan menggunakan analisis deskriptif di mana senarai *'bulk check'* digunakan sebagai instrumen untuk menentukan julat kuantiti ketepatan. Selain itu, temubual semi-struktur telah dijalankan bersama juruukur bahan perunding di Johor Bahru untuk mengenalpasti faktor-faktor yang mempengaruhi ketepatan kuantiti di BQ dan data temubual dianalisis menggunakan analisis tematik. Berdasarkan dapatan, julat perbezaan peratusan pada kuantiti *'bulk check'* bagi pengukuran manual adalah antara 2% hingga 33% sementara bagi pengukuran melalui perisian khusus, julat perbezaan peratusan pada kuantiti *'bulk check'* adalah antara 1% hingga 12%. Dengan itu, ia menunjukkan bahawa kuantiti yang dihasilkan melalui perisian khusus mempunyai ketepatan yang lebih tinggi dibandingkan dengan pengukuran manual dengan perbezaan peratusan yang lebih rendah pada kuantiti *'bulk check'*. Faktor utama yang mempengaruhi ketepatan kuantiti dalam BQ adalah faktor kesilapan manusia. Kajian ini menegaskan bahawa penggunaan perisian memberi tahap ketepatan yang lebih baik serta meningkatkan kepuasan dan keyakinan dalam penyediaan BQ.

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LIST OF ABBREVIATIONS

SMM	-	Standard Method of Measurement
BQ	-	Bill of Quantities
m	-	metre
no	-	number

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CHAPTER 1

INTRODUCTION

CHAPTER 1

INTRODUCTION

1.1 Introduction

Basically, quantity take-off in the measurement practice applied to buildings has to be accurate and consistent. There are different taking off method adopted in preparing the quantities in the bill of quantities which may be performed through manually or using software application. The accuracy level of the quantities, descriptions and rates determine the quality of bill of quantities (BQ).

1.2 Research Background

A quantity surveyor portrays important disciplines in the construction industry, which involved building measurement and preparation of bill of quantities (BQ) (Olatunji et al., 2010). A quantity surveyor prepares BQ during the pretender stages by taking measurements (Seeley, 1997).

In the construction industry, BQ acts as a tender document which provides a valuable aid to variation works pricing and computation of valuation of interim certificates (Keng & Ching, 2012; Seeley, 1997). Moreover, the BQ is a document which sets out the quantities and quality of all items required for the construction work which complying to Standard Method of Measurement (SMM) (Wheeler & Clark, 1992).

Currently, the consulting firms in Malaysia are practising on the Malaysian Standard Method Measurement of Building Works, Second Edition (SMM2) for private and government project. Nevertheless, there are also some mega projects or overseas projects carried out according to the Standard Method of Measurement of Building Works (SMM7) (Akbar et al., 2014).

In the BQ, quantity is regarded as an important element as the accurateness of the quantity may result in under or over measurement of cost items (Adnan et al., 2011). There are different techniques of measurement used by the quantity surveyor. The usage of the measurement technique is dependent on the preference of quantity surveyor either by manual or by using the software. A different method of measurement provides different accuracy of quantities when preparing the BQ.

Razali and Keng (2012) highlighted on the definition on the ‘accuracy’ in the BQ. They summarized it as free-error information, exact and correct without mistakes. Mistakes or error in the bill of quantities influences the level of accurateness of the documents. Low accuracy of quantities may due to the exposure of errors on the misinterpretation of drawings, communicating with clients and designers.

Therefore, the bulk check is a procedure practised by the quantity surveyors during the preparation of BQ. It provides the accuracy of the measurement quantities and avoids any major mistakes (Marsden, 1999). In the earlier research, Arif (2007) highlighted the bulk check list that prepared by the quantity surveyor is according to the drawings and specifications provided by the engineers and architects.

1.3 Problem Statement

Basically, quantity surveying job required high accuracy. The higher the complexity of the project, the greater accuracy required in the quantity surveying profession (Agyekum et al., 2015). The mistakes occurring during the preparation of bill of quantities (BQ) affect the accuracy of BQ in writing the descriptions, measuring the quantities and estimating the unit rates. As a result, the accurateness of the BQ had been criticised most of the time (Razali & Keng, 2012). For instance, the quantity had been an important element in BQ. Inaccurate in quantity may result from under or over measurement.

Moreover, there is often deficiency on the quantities in BQ and rises in dissatisfaction of parties especially for the successful tenderer. Adnan et al. (2011) had highlighted the dissatisfaction of the contractor towards the nett quantities in the BQ. Time constraint of the tendering process hinders them from comparing the quantities with the consultant before tender submission. Hence, the quantity obtained more than the actual quantity will provide gains to the successful tenderer whereas the quantity less than the actual contribute loss to the successful tenderer.

Apart from that, the measurement method in producing the quantity in BQ contributes to the level of quantity accuracy. In this technological era, there are kinds of software available in the construction market. The availability of the software in the market allows the quantity surveyors, to measure using the software. By adopting the software, the quantity surveyors can produce an accurate and high quality of BQ. The specialised software allows the data extraction done automatically. Common measurement software that available in the market are BuildSoft, Binalink, Masterbill, CatoPro, Cost X and Glodon. Nevertheless, manual method of measurement currently still practised in quantity surveying consultant firms in Malaysia (Keng & Ching, 2012).

During the preparation of BQ, there is a compulsory procedure that shall be conducted in ensuring the accuracy of the quantity, namely bulk checking practice. The purpose of bulk checking is to avoid major mistakes in achieving an accuracy of the quantity in BQ. Nevertheless, in nowadays, there is still lack of the bulk check practice using a bulk check list. The quantity surveyors are neither preferred doing the quantity check neither based on their working experiences nor referring to concrete to reinforcement ratio. In the findings of research done by Arif (2007), among 37 consultant firms, only 26 consultant firms prepared bulk check list whereas 11 consultant firms did not prepare bulk check list. For the consultant firms that did not prepare bulk check list, the quantity is checked using their own preferences. Improper bulk check practice also affected the accuracy of the quantities.

Overall, the quantity surveyors shall ensure the quantities produced are accurate and within an acceptable range so that it brings fair in between the parties; client and contractor. Adoption of the software is encouraged for accuracy purposes. Precautions such as bulk checking carried out during the preparation of BQ to reduce the mistakes and allow an earlier amendment on the mistakes subsequently increasing the accuracy of quantity.

1.4 Research Questions

From the issues arising from the accuracy of the quantity during the preparation of bill of quantities, the research questions are:

a. How different is the range of the quantity accuracy of the bill of quantities that produced using specialised software and by manual?

b. What are the factors affecting the accuracy of the quantity in the bill of quantities?

1.5 Research Objectives

The aim of this research is to determine the range of quantity accuracy using the bulk checking and encourage the profession in utilizing the software application during taking-off. Thus, the objectives of this research are:

a. To compare the range of quantity accuracy between the bill of quantities (BQ) that produced using specialised software and by manual.

b. To identify the factors affecting the accuracy of quantity in the bill of quantities.

1.6 Significant of Research

This research emphasized the method of quantity take-off affect its accuracy. This was because the precision of each method was different between quantification using specialised software and manual taking-off. There was more automation when specialised software was used as compared to manual taking-off (Wijayakumar & Jayasena, 2013).

From the findings of the research, it had shown that the range of quantity accuracy for the measurement method used in quantity preparation. Thus, it provided encouragement to the quantity surveyors in using software application in doing taking off. This is due to the demand for accuracy in quantity surveyor profession is high (Agyekum et al., 2015).

Apart from that, this research helps to improve parties' satisfaction and confidence in bill of quantities (BQ) preparation (Razali & Keng, 2012). Bulk checking towards the accuracy during the preparation of the BQ was enhanced in quantity surveying profession in delivering better and accurate documentation. This research also helps to identify the factors affecting quantity accuracy in the BQ.

1.7 Scope of Research

For this research, the first objective is to compare the range of quantity accuracy between the bill of quantities (BQ) that produced using specialised software and by manual. This objective is mainly focused on the bill of quantities for double-storey terrace houses that produced using specialised software and by manual. The reason for selecting double-storey terrace house was because it comprised of all elements that bulk check covered and the projects were commonly found in the construction industry. In addition, due to the time constraint in this research, it also restricted in selecting complex projects BQ.

Besides, the second objective of this research is to identify the factors affecting the accuracy of quantity in the BQ. The target respondents are the quantity surveyors who prepared the BQ and works in quantity surveying firms in Johor Bahru.

1.8 Research Methodology

This research employs both quantitative and qualitative approach. Document analysis and semi-structured interview were conducted in this research.

Document analysis is a systematic process of reviewing and evaluating either printed or digital material (Bowen, 2009; Corbin & Strauss, 2008). Bill of quantities (BQ) produced by quantity surveyors on the double-storey terrace houses were collected from the quantity surveying consultant firms in Johor Bahru. Checklist was prepared for document analysis purpose. For this research, the bulk check list of building elements obtained from the previous research by Arif (2007) had been utilised. Drawings and information related to preparation of the BQ are obtained during the collection of the BQ. This document analysis aimed to achieve the first objective of research which is to compare the range of quantity accuracy between the BQ that produced using specialised software and by manual.

On the other hand, the quantity surveyors from the quantity surveying consultant firms in Johor Bahru were selected for an interview session. A semi-structured interview was conducted for this research and the questions were designed before the interview session. The interview session intended to find out the factors affecting the accuracy of quantity in the BQ. All the interview sessions were recorded with the recorder and transcribed and generated into useful information. The details of research methodology used will be further discussed in Chapter 3 later.

1.9 Chapter Organisation

In this research, there were five chapters.

1.9.1 Chapter 1

This chapter discussed in the introduction to this research. It provided the reader with the general ideas and background related to the accuracy. Besides, this chapter also provides general knowledge about BQ and accuracy of quantity during the preparation of BQ. Moreover, issues that related to the quantity accuracy, research questions and research objectives, significance of study and scope of work were determined in this chapter.

1.9.2 Chapter 2

This chapter consists of the literature review. All the theories related to BQ, roles of quantity surveyor, preparation of BQ, accuracy of BQ, bulk check practice, importance of bulk check, type of bulk check, elements in bulk check list with its accuracy justification, manual measurement, specialised measurement software used for BQ preparation, common errors in the BQ are discussed in this chapter. The theories and information all obtained from the journal articles, conference papers, thesis, books and the like.

1.9.3 Chapter 3

This chapter discussed the research methodology. The techniques of instruments used in this research are document analysis and semi-structured interviews.

In fulfilling the first research objective, the document analysis was used to compare the range of quantity accuracy between the BQ that produced using specialised software and by manual. Thus, projects' BQ for double-storey terrace houses were obtained and collected from the quantity surveying firms in Johor Bahru. Other than that, the drawings, method of measurement and information related to design gross floor area (GFA) were requested for the purpose of bulk checking during the data analysis chapter. Before that, the bulk check list also was prepared.

Besides, semi-structured interview session was conducted with the quantity surveyors from the quantity surveying consultant firm in Johor Bahru in order to achieve the second research objective. The purpose of the interview was to discover the factors affecting the accuracy of quantity in the BQ. As a research instrument, the list of questions for semi-structured was developed before the interviews conducted.

1.9.4 Chapter 4

The data collected from the previous chapter were analysed and converted into usable information to achieve the objectives of this research. The relationship between the techniques production of the quantity in the BQ and range of percentage difference on bulk check quantity were analysed through the bulk checking.

For second research objective, the interview data recorded using the recorder had been transcribed into Microsoft Word. The data were coded and categorised into different suitable themes.

1.9.5 Chapter 5

This chapter discussed in the conclusion and recommendations. All the chapters were summarised in this chapter accordance with the objectives. The recommendations of this research provide ideas for the future research.

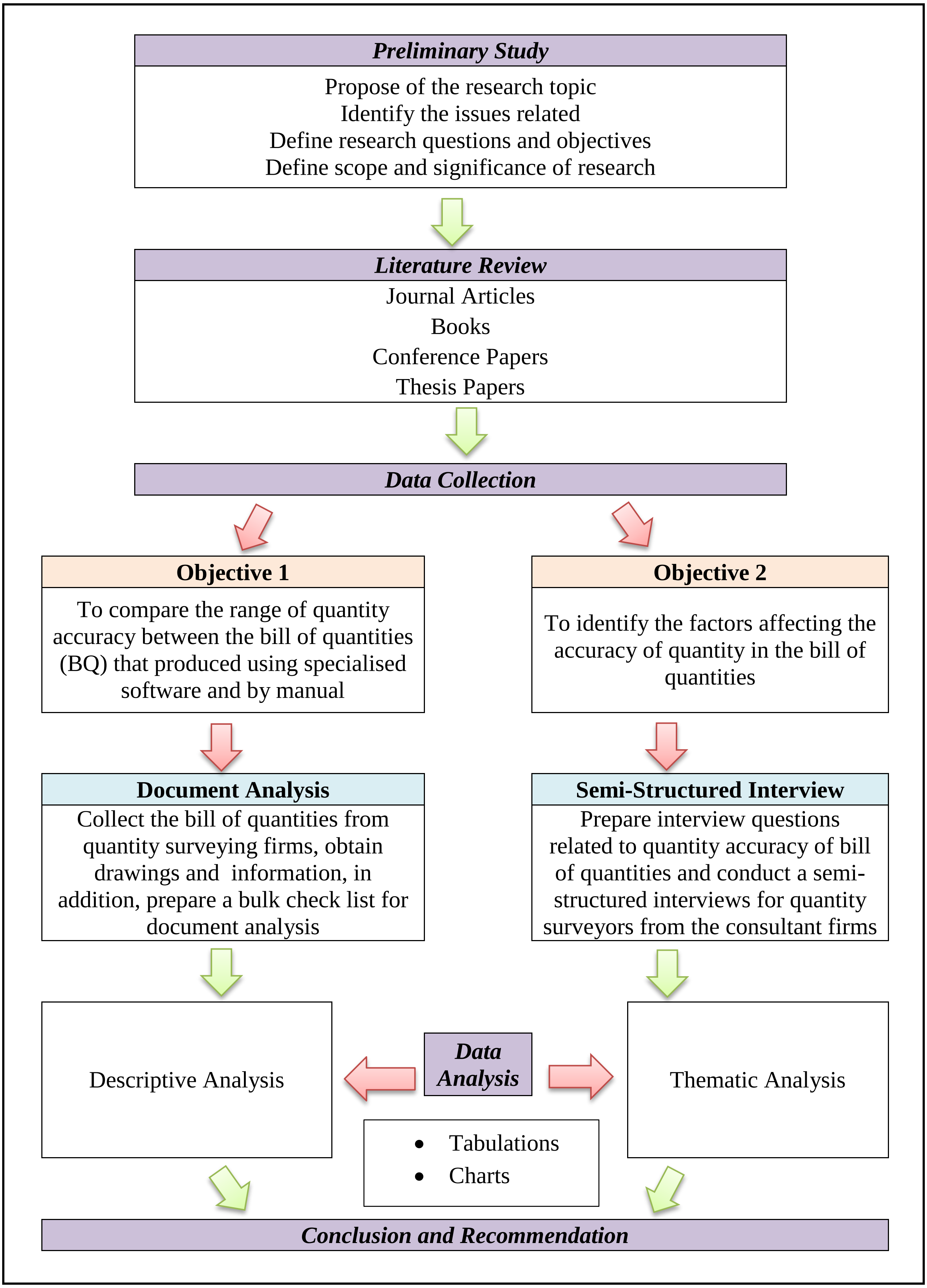

Figure 1.1 Research methodology flow chart

CHAPTER 2

LITERATURE REVIEW

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discussed the bill of quantities (BQ), the roles of the quantity surveyor, preparation of BQ, accuracy, bulk check practice, including its importance and types of the bulk check, bulk check elements and its accuracy justification, measurement method either manually or by specialised measurement software. Common errors in the BQ also been discussed in this chapter in order to aware the quantity surveyors from those mistakes and produce high quality of BQ.

2.2 Bill of Quantities (BQ)

Rashid et al. (2006) highlighted that the BQ consisted of qualitative and quantitative aspects of every constituent part of a proposed construction project. It is a book that consisting list of all the items of works for construction. The items are completed with its description of works and labour needed for construction works quantity and unit price. Besides, BQ is an important output for the quantity surveyors during the design phase of the project. It acts as a medium of communication between the contractor and client (Bandi & Abdullah, 2012).

The purpose of the BQ preparation is to assist the contractor and provide the contractor with a basis for estimating the prices for the building works during the tendering process (Davis et al., 2009). Preparation of the bills can avoid duplication of works on measurement, which is a wasteful duplication of effort and increase in contractor's overhead (Seeley, 1997).

Moreover, the Standard Method of Measurement of Building Works will be the guidelines for BQ preparation. By doing so, it provides an adequate description of work and creates the same basis of tendering (Abdullah & Rashid, 2003).

The priced BQ will become a contract document that provides a basis for valuation of work for the interim payment (Davis et al., 2009). BQ utilised by the contractor and the quantity surveyor to provide historical information. It provides them with time-saving and greater accuracy (Abdullah & Rashid, 2003; Lee et al., 2011). It is also prepared for the settlement of final account (Maclean & Scott, 2000).

Other than the measured work section, the contents of the BQ also include the preliminary items, preamble items, prime cost and provisional sum, and day work. Inside the preliminaries, it sets out all the circumstances that may affect the tenderer. The items are not necessarily related to the permanent work quantities, but the items are provided for the pricing purposes by the estimator as method-related charges, divided into time-related and fixed charges. A time-related charge is considered to be proportional to the period of work executed rather than to the quantity of the items. Meanwhile, a fixed charge is considered to be neither proportional to the quantity of work nor to the time taken (Lee et al., 2011).

The preambles in the BQ specify on the quality and description of materials, standards of workmanship and other relevant information, such as testing and measurement notes. Preambles items are commonly a separate section of the bill. By doing so, the bill descriptions can be shortened and repetition of information can be avoided (Lee et al., 2011; Wheeler & Clark, 1992).

Apart from that, prime cost (PC) sum is an amount of money allocated by the tenderer for the work and services carried out by the nominated sub-contractor. Nowadays, the PC sum is in a separate section of the bill, which provides advantages in facilitating adjustment in the final account and provides ease in the identification of various items. However, the cost of each work section is required appropriate prime cost sum to be added and not obtained simply by taking the section from the priced bill (Lee et al., 2011; Wheeler & Clark, 1992).

A provisional sum is the amount of money allocated when there is insufficient information available for proper description of work. It is used to cover the expenses of the work in which the nature of work has not known during the tendering period (Wheeler & Clark, 1992). The works paid to the contractor is based on the basis of labour cost, materials and plant and added with the agreed percentage for overheads and profit. Day work payment is usually applied to the work that cannot be quantified and priced in normal ways, such as variation works which occur unexpectedly (Lee et al., 2011).

2.3 Roles of a Quantity Surveyor

The term ‘quantity surveyor’ highlighted by Maclean and Scott (2000) is defined as a person who trained in accounting for building materials, construction costs, and construction procedures who costs feasibility studies, advising the client on contractor selection, prepared the bill of quantities (BQ) and financially control during pre and post contract.

According to Seeley (1997), he described that; a quantity surveyor who is professionally trained, qualified and experienced in handling with the construction cost and management as well as enhancing construction communication for the client. He helps the client to make sure the project is often at intervals of the agreed budget and deriving the employer with value for money.

Traditionally, quantity surveyor is responsible for preparing cost estimates during the initial stages of the construction procurement process for the client. A quantity surveyor also plans for the overall cost control of the project, prepares the BQ by abstracting information from the drawings. Later, he described and prepared the materials schedule, workmanship and quantities used in the project. He has to make sure that he produces an accurate BQ which will be priced by the tenderers during the tendering process as well as for who measured for the variation of works during the progress work (Maidin & Sulaiman, 2011; Seeley, 1997).

Other than that, a quantity surveyor is in-charged for the preparation of cash flow of the project. The job scope of a quantity surveyor also comprising of tender analysis, preparation and analysis cost data as well as performing contract administration, such as interim payment evaluation, variation assessment and settlement of claims and contract account (Maidin & Sulaiman, 2011; Zakaria et al., 2006).

2.4 Preparation of Bill of Quantities (BQ)

Based on the above discussion, we knew that quantity surveying playing a role in the preparation of BQ. There are several ways of preparing the BQ which can be a traditional method, billing direct, cut and shuffle method, as well as a computerised method (Wheeler & Clark, 1992).

2.4.1 Traditional Method

Traditionally, the preparation of bills is categorised into two stages which are taking-off and preparation of bills. The preparation of BQ started with taking-off, which involves measurement of the dimensions and compilation of compact and precise of descriptions to ensure the accuracy of pricing works. The descriptions can obtain from drawings and specifications provided by the engineers and architects (Lee et al., 2011).

Next, once the taking off completed, squaring is carried out. Squaring refers to the calculation of the numbers, lengths, areas or volumes and their entry to the third column of dimension paper. It shall be independently checked to avoid mistakes. When there are errors found, the incorrect figures are crossed neatly using red ink and the correct figures are written above it. The usage of correction liquid shall be avoided (Civil Engineering and Development Department, 2016).

After that, the descriptions and the squared dimensions are entered on the abstract to gather similar items and are arranged in accordance with the items order in the bill. The general order of the items follows the Standard Method of Measurement (SMM). From the abstract, working-up of the draft bill is produced (Lee et al., 2011).

2.4.2 Direct Billing

After years, the very first method introduced to improve speed in the preparation of BQ was direct billing. Through direct billing, it skipped the abstracting stages. The items can be directly transferred from the dimension paper into the bill. The items must transfer systematically to ensure the listed items in the correct sequence in the bill. By doing so, it can save both time and cost (Seeley & Winfield, 1999; Wheeler & Clark, 1992).

Nevertheless, direct billing is applicable to simple project when the number of the items is limited. Quantity surveyor can produce a draft bill with a single trade as the items are completed with its descriptions and headings as well as the quantities. Later, the bill can be produced once the calculation check is done. Although this direct billing provides speedy work, it is also exposing to risk of redundancy or deficiency, especially when a quantity surveyor carried out several works (Seeley & Winfield, 1999).

2.4.3 Cut and Shuffle Method

According to Wheeler and Clark (1992), cut and shuffle method is another method to improve the speed of work after direct billing method. It is a slip system that sorts the dimensions, descriptions into the bill to reduce the time during the preparation of BQ and rationalised the traditional method (Wheeler & Clark, 1992). Application of cut and shuffle method eliminates the preparation and checking of the abstract and draft bills. This method is different from the abstracting and billing which did not have a universally accepted format. Difference techniques or approaches used by the different offices. Some offices might utilise more than one technique to suit different types of work (Seeley & Winfield, 1999).

During the application of the cut and shuffle method, the taking off the paper is divided into four or five sections which later is cut into individual slips. The taking off is done with single description and dimension on each section and for reference purpose, the taking off papers are numbered (Wheeler & Clark, 1992). After that, the taking off papers will be split into separate slips and sorting according to the billing order. The procedure is followed by calculating and editing. The slips become the draft for typing the final BQ (Seeley & Winfield, 1999).

2.4.4 Computerised Method

Preparation of BQ becomes easier when computer usage increases as well as the development of cost equipment and software programs. The production of the BQ using a computerised method also able eliminates the process of reducing, abstracting and billing. By using the computerised method, the level accuracy of output will be determined through the input data (Wheeler & Clark, 1992).

In this globalization, the advancement of computer technology and software application has become less expensive as most of the firms adopted computer system which available in the market. The availability of the computerised software assists quantity surveyors, to carry out the quantity surveying function (Lee et al., 2011).

Traditionally, the quantity surveyor prepared the BQ using written dimension paper. Through a computerised method, the paper-based taking off can be entered into the system manually. However, the availability of the facilities creates better input dimension directly using the keyboard or a digitiser. According to Lee et al. (2011), the digitiser is an electronically sensitive drawing board from which the dimension may electronically be scaled from the drawings into the system. An automation of calculation for simple and complex shapes on lengths, perimeters and areas can be carried out (Lee et al., 2011).

Furthermore, the systems run using a standard library which comprises of descriptions that is easy to use, flexible and easily updated. The BQ can be produced in a short period, takes few hours rather than days (Willis & Newman, 1988). Despite the fact that, the computerised method having a problem when there are numbers of different standard libraries used by each supplier of bill production software. They often use software to develop their own standard library, whereas some modified the standard library provided by adding items that are frequently used (Lee et al., 2011).

2.5 Accuracy of Bill of Quantities (BQ)

Given that the definition in Oxford Dictionary of English, the term 'accuracy' is a noun, defined as the quality or state of being precise. Additionally, accuracy is the level of correctness in measurement, calculation, or specification (Stevenson, 2010). A problem that often debated nowadays is that of the accuracy of the BQ. The quality justification of a BQ takes the descriptions, quantity and unit rates into account. The accuracy of the descriptions, quantity and unit rates leads to a successful project.

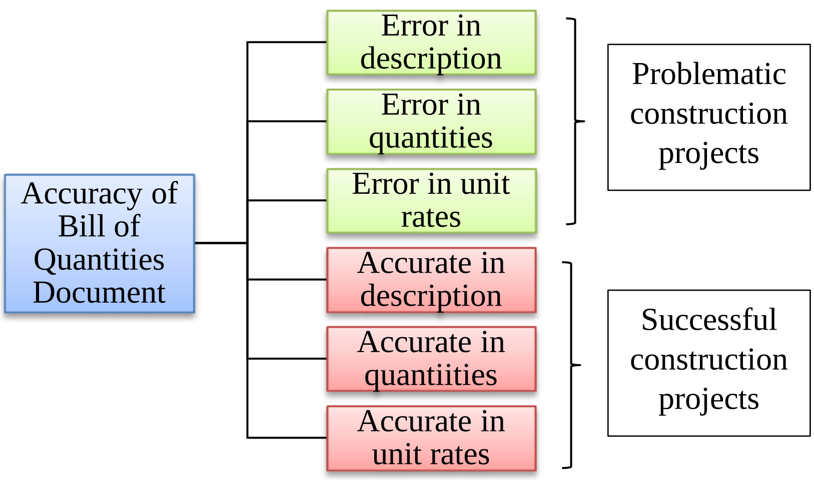

Figure 2.1 Factor affecting the accuracy of bill of quantities
Source: (Razali & Keng, 2012)

2.5.1 Description

The definition of the description is highlighted by Maclean and Scott (2000) that it is part of the BQ that illustrates the materials, form and location of a job of work which in understandable form by the estimator. The descriptions developed should be accordance with the standard method of measurement.

Accordance to Bandi (2011), the description comprised of the name of the item being measured and described, the size of the item, type, quality and the size of an item if applicable, any worked imposed to the item concerned as well as the method of installation of fixing position. The descriptions framed along the applicable section in the Standard Method of Measurement of Building Works (SMM2) (Bandi, 2011).

Additionally, the description must be clear and concise so that the contractor can price the items easily. Framing a clear and concise description might not easy, but the descriptions must at utmost value. The description must be well draft, and care must be taken to leave no doubt as to their meaning (Lee et al., 2011).

The deficiency information in the description causes arising issue where the contractor making their assumption for pricing purposes. For instance, the technique of excavation work for the pad footing could be manual or by machine. Due to the limitation of the information of the work, the contractor made his own decision to do pricing (Adnan et al., 2011). Hence, compact and understandable description of work influenced the accuracy of BQ.

2.5.2 Quantity

Generally, quantity surveyor carried out the measurement to produce the quantity in BQ. Different techniques can be applied to the work measurement, which can be by manual or by specialised software. The selection of techniques used depends on individual preferences.

The quantity is used as a basis for estimating to indicate the probable cost of project work. It is used for the purpose of comparison between submitted bids. Monthly basis payment is dependent on the actual work progress on site. During the preparation of BQ, quantity surveyor required to ensure the quantities are accurate to avoid future arguments or dissatisfaction of the contractor. Bulk check practice shall be undertaken as it had been part of compulsory procedure during the preparation of BQ. The accuracy of the quantities can be achieved when the quantities obtained is not exceeded the amount that supposedly gives and not lesser than the actual quantities.

Yet, there is issue arises resulted from the deficiency of the quantities. The contractors are unsatisfied with quantities in the BQ during the tendering process. There is uncertainty in the quantities whereby the contractor will gain from the extra quantities, will lose when the quantities are less than the actual in addition the quantities in the BQ are nett quantities (Adnan et al., 2011). Consequences, the contractor will price high on the items of work to cover his losses.

2.5.3 Unit Rates

Maclean and Scott (2000) highlighted that unit rate is the price per metres, square metres, cubic metres, kilogram for building works such as excavation work, concrete work, brickwork, plastering, painting and other related works in construction. Unit rate comprised of three components which are labour cost, material cost and plant and machinery cost.

Labour cost in the construction work is dependent on the labour productivity constants in each work and the cost of various labour types per hour. Different kind of work has different labour productivity constant. Material cost is relatively based on material units which include the delivery cost, unloading and storage on site. Additionally, the wastage shall be considered before includes the unit rate and an adequate allowance shall be made for sundries. For the plant and machinery, during Contractor can choose to purchase or rent the plant and machinery. Considerations on the purchase price, expected lifespan, assessment of finance cost, return on capital invested and other (Higham et al., 2016).

On top of that, the calculation of the unit rate considers on the output and usage rate. The output rate referred to the work quantity per hour, and the usage rate referred to duration required for a fixed quantity of work (Jha, 2011). The formula used in calculating the unit rates is as follows:

Unit rate *= the output of usage rate x the unit cost of the resources*

During the design stage, the unit rate can obtain from previous projects. The unit rate also can be obtained from cost data, publications such as Jabatan Kerja Raya (JKR) or National Construction Cost Centre (myN3C) or Arcadis Construction Cost Handbook Malaysia. Adjustment of the cost is required to overcome the design changes, construction method, and economic climate during estimating. Incorrect of unit rate resulted in overestimation or underestimation (Ogunlana, 1989).

2.6 Bulk Check

2.6.1 What is 'Bulk Check'?

According to Oxford English Dictionary by Stevenson (2010), the term 'bulk' defined as the mass or something that is large in size. Meanwhile, the term 'check' is referred as examine something to determine its accuracy, quality, or condition or to detect the presence of something. Combination of two terms resulted in the meaning of checking large numbers of items to determine its accuracy and quality.

2.6.2 Bulk Check Practice

During the preparation of the bill of quantities (BQ), a bulk checking process must carry out before the BQ distributed and issued to the tenderers. It is a compulsory practice to quantity surveyors during the preparation of the BQ. By doing so, it provides the quantity surveyors with a high quality of work in preparing the BQ. The practice usually conducted by the quantity surveyor who is expert with the standard method of measurement (Civil Engineering and Development Department, 2016).

The bulk checking is conducted through a simple form. The items checked consists of the items which involved large quantities or of major cost, the item coverage of the most significant items should be checked consistency against the design requirements and those shown in the drawings, and ensuring that the squaring, abstracting and billing of all items have been independently checked (Civil Engineering and Development Department, 2016).

2.6.3 Importance of Bulk Check Practice

Bulk checking ought to carry out to confirm the quality of the BQ. The bulk check practice during the preparation of BQ provides the quantity surveyor with a greater confidence with the quantities they obtained from the measurement. It is often we heard the issues related deficiency of quantities. The deficiency of quantities increased the numbers of variation work on site. Consequences, the cost increased and the period of construction process extended. For the public project, the approval of the variation orders involved a complicated procedure that resulted in extra time is required. In addition, the deficiency of quantities also cause the dissatisfaction of the client and at the same time affect the professionalism of the quantity surveyors (Ali, 1997; Arif, 2007).

Apart from that, the amendments of the quantities can be carried out when the mistakes are discovered when the bulk check is practised. The common errors that the quantity surveyors made are during squaring, sum up total besides missed up the measurement items (Ali, 1997; Arif, 2007). Early amendment of quantity before distributing to the tenderers reduces the future consequences and arguments by the contractor when there are found mistakes or errors in the BQ.

Hereby, the bulk check procedure must practice during the preparation of the BQ to enhance the production of the high-quality document.

2.6.4 Type of Bulk Check

There are few methods of practising bulk check. The method use is dependent on individual preferences. According to Ali (1997), she mentioned that bulk check is a process of checking the entire quantities obtained and compared with the other quantities. Nevertheless, the bulk check practice is not only applicable to the quantity; the bulk check can apply on the overall BQ including the unit of measurement. The unit of the measurement ought to be accordance with the standard method of measurement. There are three types of bulk check that include the comparison method, ratio method and through the bulk check list.

2.6.4.1 Comparison Method

Through the comparison method, the quantities obtained are compared with either the quantities of other items or quantities obtained resulted from an approximate check from the drawings. Most of the items checked through this method.

a. <u>Comparison between the quantities of related items</u>

Based on the bulk check list summarised by Arif (2007), the quantities of certain items are same with the quantities of other items. For instance, the quantities of pile point cutting are equivalent to quantities of the initial pile.

Number of pile point cutting (No) = Number of the initial pile (No)

Besides, the quantities of some elements can be compared by a combination of quantities. From this, an example of the items that can be compared through a combination of quantities is the excavation work. For work below level floor finish, the volume of excavation can be obtained by combining the total quantities of soil filling and disposal soil on site.

$$Volume\ of\ excavation\ (m^3) = Backfilling\ (m^3) + Disposal\ of\ soil\ (m^3)$$

b. Comparison of quantities with the drawings

This comparison method usually applies for items which are measured by enumerated. For examples are the doors, windows and sanitary fittings. The quantities will be remeasured using the drawings. In addition, the comparison also can be done using the schedule of items (Arif, 2007).

2.6.4.2 Ratio Method

According to Arif (2007), she also highlighted the bulk check practice using ratio method. This method carried out on the items that had been analysed and recorded. It is a common practice of bulk check on the reinforcement bar. This ratio method of bulk check usually accompanied with the schedule of steel to the concrete ratio by elements. Through the ratio method, the quantity of the reinforcement weight in concrete building element can be determined. Besides, the schedule for steel to concrete ratio is different from one firm to another and it depends on the previous quantities of analysed project.

During the bulk check using ratio method, the quantity surveyors ought to ensure the steel to concrete ratio is within the range of the standard ratio from the previous project. For instance, the steel and concrete ratio of the reinforced wall is between 80 kg/m^3 to 149 kg/m^3(Ali, 1997). The steel and concrete ratio must be within the allowance ranges of ratio. When the ratio that obtained is not within the range; either too big or too small, the quantity of concrete and rebar shall be checked.

Additionally, there might have the probability of the quantities of concrete is high. This may due to the characteristics of the wall itself as a non-bearing wall. The usage of ratio method in bulk check process provides the guidelines for the quantity surveyors in preparation of quantities.

2.6.4.3 Bulk Check List

The bulk check list can be defined as an outline of measured items for a construction work which prepared by the quantity surveyors. By doing so, all the items are measured especially small items such as architrave, skirting and stop ends for roof gutters. There are times when quantity surveyors missed up the items while doing the measurement (Arif, 2007). Thus, the bulk check practice using check list can be carried out to ensure greater accuracy of quantity.

2.6.5 Bulk Check List

The bulk check list is a list of items that needed during the bulk check. The list is prepared in accordance with the standard method of measurement. Normally, each firm had a different bulk check list. Arif (2007) had analysed and compiled the items for bulk check list from different firm bulk check sample in accordance with Standard Method of Measurement of Building Works (SMM2). The items consisted in the bulk check list are as follows:

a. Piling Works
b. Work Below Level Floor Finishes
c. Frame
d. Upper Floor
e. Roof
f. Staircase
g. External Wall
h. Internal Wall
i. Door
j. Window
k. Internal Wall Finishes
l. Internal Floor Finishes
m. Internal Ceiling Finishes
n. External Finishes
o. Fittings and Furnishing
p. Sanitary Fittings
q. Pipe Work
r. External Work
s. Prime Cost and Provisional Cost

Source: (Arif, 2007)

Other than the list of items, the bulk check list also shows the percentage of minimum difference of quantities between quantities in the BQ and bulk check quantities. Each item had a different percentage of accuracy. Furthermore, the comments or action to be taken will be written based on the evaluation of percentage differences on bulk check quantity.

2.6.6 Bulk Check Elements

2.6.6.1 Piling Works

According to Abdullah and Rashid (2003), piling works are piles that installed as part of foundation work. Piling is very important because it provides the support with a load of buildings and distributes uniformly to soil strata which is harder so that the buildings are located on the strong foundation.

During the measurement of piling, it ought to be referred to Section E in Standard Method of Measurement of Building Works (SMM2), piling and diaphragm wall. The piling works involved the measurement of initial piles, extension piles, driving piles, and cutting of piles head.

Based on the SMM2 by ISM (2000), Clause E.5.3a stated that the piles are measured enumerated and accompanied with a description of specified the length of piles. The size and weight of heads and shoes also deemed to be included in the description. The length of piles had varied length; usually comes in 3 metres, 6 metres and 12 metres. The driven depth is measured in metres as stated in Clause E.5.3.b.

The driven depth quantities can be obtained by sum up the total length of initial piles and extension piles. Based on the bulk check list analysed by previous research, the minimum difference percentage of quantities is 5%.

Driven depth (m)
= *Total length of pile provided (m)*
= *[No. of initial pile (No) x Length of initial pile (m)] + Total extension pile length (m)*

Additionally, the number of cutting heads of the pile can be directly compared to the number of initial piles. Thus, the percentage of difference must be zero.

Cutting of pile head (No) *= Number of initial piles (No)*

2.6.6.2 Excavation Works

Generally, the works related to excavation can be found in Section D: Excavation and Earthwork in SMM2. Excavation of topsoil is measured in square metres and described completely with its average depth (Clause D.7). The percentage difference for excavation of topsoil must be zero when the quantities are compared with the combination of two elements; area of ground floor slab and area of the apron. Besides, the topsoil also can be checked with a combination of quantities between the total area of hardcore and area of lean concrete below the concrete bed.

Excavation of topsoil (m^2)
= *Area of ground floor slab (m^2) + Area of apron (m^2)*
= *Total area of hardcore (m^2) + Lean concrete below the concrete bed (m^2)*

On the other hand, excavation work that been listed in the bulk check list also included the excavation of pipe. The excavation of pipe is measured linearly as mentioned in Clause V.2.1. According to Clause V.5.1, it stated that the length of pipe also measured in metres. The percentage of difference allocated for pipe excavation is 3% because the pipes might lay to the slope.

Length of pipe (m) *= Excavation of trenches for pipe (m)*

2.6.6.3 Concrete Work

According to Clause F.3.1, the concrete is measured in cubic metres. There shall no deduction to the void not exceeding $0.05m^3$ (Clause F.1.8).

For the building frame, the bulk check of column concrete carried out by multiplication of the area of cross-section, the average height and the number of column of the project. The previous research allocated the percentage difference of quantities at 5%. Meanwhile, quantities of the beam concrete can be checked by multiplying the area of beam section with the length of the beam in addition the percentage difference allocated is 3% by the previous research.

Volume column concrete (m^3)
= *Area of column section (m^2) x Average height (m) x Number of column (No)*

Volume of beam concrete (m^3)
= *Area of beam section (m^2) x Length of beam (m)*

Nevertheless, Arif (2007) also highlighted in her research that it is hard to compare quantities using cubic metres for slab checking purposes and it is more logical of using unit square metres in doing a comparison with the gross floor area. The concrete work for ground floor and upper floor must measure separately. The minimum percentage of differences in quantities is 5% and 3% respectively.

Area of concrete ground slab (m^2)
= *Gross area of ground floor slab (m^2) - Area of lift core (m^2) - Area of openings (m^2)*

Area of concrete upper floor slab (m^2)
= *Gross area of upper floor slab (m^2) - Area of lift core (m^2) - Area of staircase (m^2) - Area of openings (m^2)*

Apart from that, the fabric reinforcement is measured in square metres and no deductions to the voids that are not exceeding 1.00m^2 (Clause F.9.2 and Clause F.9.3). The reinforcement also required to be classified according to Clause F.8.4. Therefore, the fabric reinforcement of ground floor and upper floor must be separated.

Area of fabric reinforcement for ground floor slab (m^2)
= *Area of ground floor slab (m^2)*

Area of fabric reinforcement for upper floor slab (m^2)
= *Total area of upper floor slab (m^2)*

As for the allowance of the difference in quantities, the previous research had allocated it as 3%. There had little difference in the area covered by the fabric reinforcement and area of the slab due to the presence of concrete cover at the end point of fabric reinforcement. The bulk check also can be carried out based on the poundage of steel to concrete ratio. Each element had its own standard poundage that been analysed previously.

Moreover, soffit formwork of upper floor slab can be compared with the quantities produced from the deduction of the area of lift core wall and area of openings from the gross area of the upper floor slab. The quantities will be almost similar to each other, thus 3% of the difference in percentage is allocated.

Area of soffit formwork for upper floor slab (m^2)
= *Gross area of upper floor slab (m^2) - Area of lift core (m^2) - Area of openings (m^2)*

On the other hand, the formwork for the column can be checked with the multiplication of the average height of the column, a number of columns and the total length of side column. Similar to the quantity checked for the column, quantities of beam formwork can be obtained when the total length of the beam is multiplied with the total length of sides and soffit of the beam. Previous research allocated both column and beam formworks 5% as a minimum percentage of quantities difference.

Area of column formwork (m^2)
= *Average height (m) x Number of column (No) x [Length of side column (m) x 4]*

Area of beam formwork (m^2)
= *Total length of beam (m) x [Height of side beam (m) x 3]*

Damp proof membrane generally located on the floor slab. The quantities can be directly compared to the area of the concrete slab. For the concrete flat roof, the area of the damp proof membrane can be determined by addition of an area of roof slab formwork and area of soffit of room beam formwork.

Area of damp proof membrane (m^2) = *Area of ground floor slab (m^2)*

Area of damp proof membrane (m^2) (Concrete Flat Roof)
= *Area of roof slab formwork (m^2) + Area of soffit of roof beam formwork (m^2)*

2.6.6.4 Roof

Based on SMM2, the roof covering is measured as square metres and the slope more than 50 degrees shall be included (Clause L.4). The batten also ought to be included in the description (Clause L.14.1). Besides, the roof insulation as described in Clause L.15 in SMM2 measured in square metres and the type, lapping and method of fixing are stated.

Hence, it is logical to compare the quantity of roof covering the area of the roof from the plan and multiplying to angle slope. The quantities can be directly compared to the area of roof insulation, sisalation and roof batten areas. There must no percentage difference of quantity between the bulk check quantity and the quantity in the BQ.

Area of sloping roof covering (m^2)
= *Area of roof from plan (m^2) x $(\cos \theta)^{-1}$*
= *Area of roof insulation (m^2)*
= *Area of sisalation (m^2)*
= *Area of roof battens (m^2)*

According to Clause L.35, the gutter is measured in metres. Due to the location of the gutter usually placed at the perimeter of the roof or aligned with the fascia board, thus the length of the gutter can be directly compared to the length of fascia board and the perimeter of the roof. Nonetheless, the percentage of differences in quantities allocated for 5%.

Length of gutter (m) *= Length of fascia board (m) = Perimeter of roof (m)*

Arif (2007) also claimed that SMM2 did not a specific method of measurement on the rainwater outlet. However, rainwater outlet shall be measured in order to measure the extra over for pipe fittings. There must no difference in the quantity when compared with the drawings.

Total rainwater outlet (No)
= *Total rainwater outlet in drawings (No)*
= *Extra over for damp proof membrane for rainwater outlet (No)*

2.6.6.5 Staircase

During the bulk check, the height of the staircase is checked to ensure the dimension in the drawing is correct (Arif, 2007). The height of the riser is multiplied by the total number of the riser to obtain the overall height of the staircase. The allowance for minimum difference in quantities is 3%.

Height of the overall staircase (m) *= Height of riser (m) x Number of risers (No)*

Other than that, Clause F.12.5 stated that the formwork for the riser is measured in metres and the height of the riser ought to be included following the categories. The finishes for the nosing tiles and riser also measured in metres as stated in Clause S.5.3. Therefore, the length of the riser formwork can be directly compared to the length of the nosing tiles as well as the length of the steps.

Length of formwork for the riser (m)
= *Length of nosing tile (m)*
= *Length of riser finishes (m)*
= *Length of steps (m)*

For the string of the staircase, the formwork is measured in metres as stated in Clause S.5.5 in SMM2. The formwork of the string can be directly compared with the string finishes.

Length of formwork for string (m) = *Length of string finishes (m)*

According to SMM2, it stated that the formwork staircase is measured in square metres. The formwork is classified into three categories which are horizontal, sloping not exceeding 15 degrees from horizontal and sloping more than 15 degrees from horizontal. Hence, the horizontal and sloping formwork required to measure separately. The bulk check can be carried out by comparing the formwork and the finishes of staircase and quantity surveyor shall bear in mind no difference in quantity percentage.

Area of soffit formwork to staircase (m^2) = *Area of soffit finishes to staircase (m^2)*

Area of formwork for sloping slab (m^2) = *Area of finishes for sloping slab (m^2)*

Poundage for the reinforced concrete staircase can be conducted by referring to analysed data on concrete reinforcement ratio.

2.6.6.6 Wall and Finishes

Abdullah and Rashid (2003) highlighted that the quantity of each work ought to be separate for the ease BQ preparation as it will prepare by following the format. The wall shall be measured separately for the internal and external wall. The wall constructed can be reinforced concrete wall or brick wall.

According to Clause F.3.15 in SMM2, the reinforced concrete wall is measured in cubic metres. The height of the reinforced concrete wall is taken from the upper surface of beam up to the bottom surface of the upper floor. Later, the height will be multiplied by the cross-section area of the wall.

Meanwhile, for the brick wall, it is measured in square metres and the thickness of the brick required to be stated (Clause G.3.3a). The brick wall is measured by taking the girth multiplied by the height of the wall. In addition, the deduction for the openings such as doors and windows required during bulk checking. From that, the allowance for the minimum percentage of difference in quantities is 5%.

Area of brick @ concrete wall (m^2)
= *[Perimeter of wall by floor level (m) x Height of floor level (m)] - Area of openings on wall (Door & windows) (m^2)*

Area of formwork for the external wall can be checked by multiplying the area of the external wall with 2 sides. For this, the percentage of quantities different limited to 3%.

Area of formwork for external concrete wall (m^2)
= 2 x Area of external concrete wall (m^2)

Apart from that, for the wall finishes, it is measured in square metres and no deduction with the void less than $0.50m^2$ (Clause S.2.2, Clause S.11.3, S.18.2 and S.24.3). The height of the wall is taken from the floor level to ceiling (Abdullah & Rashid, 2003). From the both checked for internal wall finishes, 3% is allocated for the difference of quantities.

Total area of internal wall finishes (m^2)
= Area of external wall (m^2) + [2 x Area of internal wall] (m^2)

Area of screeding (m^2) *= Area of wall tiles (m2)*

The area of the external painting can be directly compared with the external wall plastering with the painting because usually painting is applied on the plastering surface in addition both are measured in square metres. Therefore, the quantity obtained from the external wall painting must be equivalent to the external wall painting.

Area of external wall painting (m^2) *= Area of external wall plastering (m^2)*

2.6.6.7 Floor and Finishes

ISM (2000) stated in Clause S.2.2 that all floor finishes measured in square metres. The finishes are laid to the top of the slab. Hence, it is rational to compare the quantity of finishes directly to the floor area. The gross floor area has to deduct with the area of lift core and area of the staircase because the floor is not finished. The percentage of quantities difference allocated by previous research is 3% because the total area of floor finishes taken included with the area of below the door leaf whereas the gross floor area taken from the perimeter of the room.

Total area of floor finishes (m^2)
= *Gross floor area (m^2) - Area of lift core (m^2) - Area of staircase (m^2)*

Besides, the area of floor screeding can be compared to the area of finishes above the screeding. For instance, the finishes of the floor are floor tiles. Before the floor tiles are laid on the floor, screeding is applied on the floor. Then, the floor tiles placed on the screeding surface. Therefore, it is relevant in comparing the area of screeding with the area of top surface finishes. There is also 3% of percentage difference allocated when doing quantity check.

Area of screeding (m^2) *= Area of finishes above screeding (m^2)*

2.6.6.8 Ceiling Finishes

According to Clause S.2.2, the ceiling finishes is measured in square metres, area measured is in contact with the base. There is also no deduction made for voids that not exceeding $0.50m^2$. The ceiling finishes work also consider for the sides and soffits of the attached beam, openings, sides of attached columns (Clause S.2.3). Thus, the area of ceiling plastering is compared with the total area of the soffit to upper floor slab and area of soffit and sides to upper floor beam and there must no percentage of difference as both covering the same area.

Area of ceiling plastering (m^2)
= *Area of soffit to upper floor slab (m^2) + Area of soffit and sides to upper floor beam (m^2)*

Furthermore, there is also no allocation for the quantity of area of ceiling plastering when it is compared with the addition of both plaster ceiling and suspended ceiling in square metres.

Area of ceiling painting (m^2)
= Area of plaster ceiling (m^2) + Area of suspended ceiling (m^2)

In SMM2, Clause S.1.1a mentioned that the finishes work shall be classified into internal and external. So, the external ceiling work finishes shall measure separately. There is an allocation of 5% difference in quantity during the bulk check. The area of external ceiling finishes is compared with the external floor finishes and area of the apron.

Area of external ceiling finishes (m^2)
= *Area of external floor finishes (m^2)*
= *Area of apron (m^2)*

2.6.6.9 Doors and Windows

According to Clause M.19, the doors are measured in number. When doing the bulk check, the number of the measured doors can be compared with the number of doors in the drawings or schedule. Bulk check also applied to the windows where the number of windows measured also compared to the number of windows in the drawings or schedule. Hence, the quantities must have equivalent to each other.

Number of measured doors (No)
= *Number of doors in drawings or schedule (No)*

Number of measured window (No)
= *Number of window in drawings or schedule (No)*

Clause M.20.1 stated that the door frame can be measured in metres by stating the size of the frame. The length can be measured from the bottom of the jamb to corner head and followed by corner head to the end of the head and lastly from the end head till the bottom of the jamb. Packing piece measurement same as the measurement of the door frame. Therefore, both items can be directly compared and there must have no difference in quantities. Additionally, the architrave of the door also can be checked by comparing the length of the door frame that multiply by 2 sided because the architrave is located on both sides of the door frame. As a result, both quantities must be to each other.

Length of door frame (m) *= Length of packing piece (m)*

Total length of architrave (m) *= 2 x Length of door frame (m)*

Moreover, the threshold of the door is measured in metres as stated in Clause F.18.1. The precast units are measured in number (Clause F.17.1). Then, the threshold can be either measured in metres or number. It is rational in comparing the total number of doors with the deduction number of doors without threshold. Similarly, for the number of window threshold, it compared with the deduction number of windows without threshold. There must have no difference of quantities.

Number of door threshold (No)
= *Number of door (No) - Number of door without threshold (No)*

Number of window threshold (No)
= *Number of window (No) - Number of window without threshold (No)*

Painting of door can be directly compared with the area of the door surface. However, 3% of percentage different on quantities is allocated because not all the surface of the door is painting.

Area of painting (m^2) *= Area of door surface (m^2)*

As referred to Clause M.31.1, the ironmongery has to measure in numbers. The method of fixing ought to be included with the items. The number of hinges and set of the key is required to check to ensure that there is no wastage. The set of the key must be equal to the number of doors. Thus, there must have no percentage difference in quantities for ironmongery.

Number of hinges (Pair)
= [Number of single leaf door x 1.5 pair] +
[Number of double leaf door x 3 pairs]

Number set of key (No) *= Number of door (No)*

2.6.6.10 Fitting and furnishings

According to ISM (2000), the fittings and furnishings had to measure in number. When doing bulk check on the fitting and furnishings, the drawings or schedules are used. There is also no percentage different in quantities allocated for fittings and furnishings.

Number of fittings and furnishing (No)
= Number of fittings and furnishing in drawings or schedule (No)

2.6.6.11 Sanitary fittings

The quantity checked of the sanitary fittings also carried out by referring to the drawings or schedule. In addition, there must have no difference in the percentage of quantities.

Number of sanitary fittings (No)
= *Number of sanitary fittings in drawings or schedule (No)*

2.6.6.12 External Works

According to Clause D.26, the filling is measured in cubic metres when the thickness more than 250mm meanwhile, filling less than 250mm thickness, it is measured in square metres. For the bulk checking, it is hard to compare the quantities using cubic metres. The area of the bitumen layer can directly compare to the area of trimming and compacting, the area of base layer and area of wearing course. No percentage of quantities difference is allocated.

Area of bitumen layer (m^2)
= *Area of trimming and compacting (m^2)*
= *Area of base layer (m^2)*
= *Area of wearing course (m^2)*

For the walkway, the area of finishes can be directly compared to concrete slab and area of hardcore.

Area of finishes (m^2) = *Area of concrete slab (m^2) = Area of hardcore (m^2)*

2.7 Manual Measurement

Stevenson (2010) defined the word 'manual' as something operated or controlled by hand. In other words, it is lack of automation. Manual measurement can briefly means the action of taking a measurement without automation and using manual labourer.

2.7.1 Microsoft Excel Spreadsheet

Microsoft Excel spreadsheet is commonly used in the construction industry in performing the tasks. The Microsoft Excel plays important roles in calculating, scheduling, charting, tabulation, as well as the production of the bill of quantities (BQ) (Hamid & Siang, 2004).

Additionally, Microsoft Excel is a powerful and flexible tool for quantity surveyors either for financial or accounting purposes with simple calculation, tabulation and charts preparation. It caters all kind of functions. The usage of Microsoft Excel helps the quantity surveyors to create the taking-off templates, besides preparation of cost planning and BQ.

According to Hamid and Siang (2004), they also mentioned that the spreadsheet can produce a good application in inexpensive ways. They also can function as other specialised software available in the market. Nevertheless, Microsoft Excel is still unable to show fully automation in work because manual customisation is still required. During taking off, the taker-off still required to extract the data manually. Hence, Microsoft Excel is considered as a manual method of measurement.

2.8 Specialised Measurement Softwares

There is various specialised software for quantities surveyors to perform their daily task. With the presence of that specialised software, it produces automaton in taking of the quantities and reduce the time consuming for preparation of bill of quantities (BQ).

2.8.1 BuildSoft

BuildSoft is a leading software application as it provides ease and increases the efficiency of works. Besides, BuildSoft provides combo packages which can perform different functions in a single package which includes accounting, costing and estimating as well as project management. Integration of functions contributes to the effectiveness and efficiency of work in a project. The part of BuildSoft packages comprised of BuildSoft Global Estimating and BuildSoft Take-Off System (BTOS).

BuildSoft Global Estimating is a software program that used for commercial purposes in the building and construction industry. By application of BuildSoft Global Estimating, it able to produce BQ or detail estimate and cost plans. This program allows the sorting and analysis of the data by using powerful grouping columns. Later, the estimate can be summarised to produce totals by area, block, stage, cost centre, accounting group, or any user-defined a set of codes (BuildSoft, n.d.). The key features of BuildSoft Global Estimating System are as follows;

- 4 Level Estimating system
- Unlimited Number of Jobs
- Progress claims / Valuations
- Bills of Quantities calculation and reporting.
- Price Lists
- Variations Management

- Job Analysis/Grouping
- Quick analysis grouping
- Organise Jobs into Projects
- Job comparison
- Item notes
- Apply bulk quantity factors
- Weight conversion tables
- Expand composite rates
- Integration with Cubit

(BuildSoft, 2016)

Besides, BuildSoft Take-Off system (BTOS) is an ‘add-on’ module for the Global Estimating and Offsider Estimating. It is the latest advancement of on-screen take-off system and features enhanced 3D viewing. It provides the estimators more time to focus on using their skills rather than performing the laborious measuring task. The taking off can be carried by importing the digital drawings likely in PDF, DXF and DWG into the program. Then, simply trace the drawings with the mouse, the lengths, areas, volumes can be measured. Deductions are entered so that the program itself can automatically calculate the quantities and transfer the information into the estimating program (BuildSoft, n.d.).

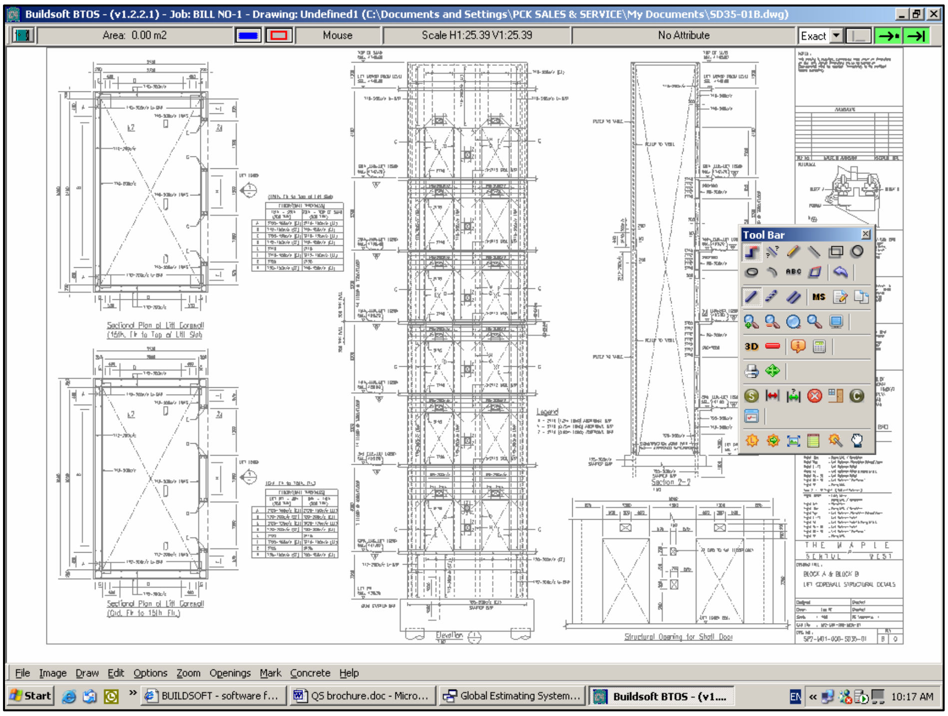

Figure 2.2 BuildSoft Take-Off System (BTOS) – CAD measurement module
Source: (BuildSoft, n.d.)

The benefits of this software to quantity surveying consultant firms are it speeds up the production of BQ process, estimating, measurement, job analysis and tender evaluation period. It is also beneficial as it provides a proper record of standard description and cost data. It is easy to trace back the measurement as well as easy to learn and use (BuildSoft, n.d.).

2.8.2 CATO CADMeasure

CATO CADMeasure is a tool that allows doing measurement with high accuracy from a computer-aided design (CAD) drawing. It can build on Autodesk technology which provides a future-proof platform for all future measurement functions. By using CATO CADMeasure, it also provides convenience where it enables the measurement from the paper copy integrated with digitising tablet, or from photo digital images captured from the digital camera. Besides, the measurement also can be carried out from fax copies when it is saved into digital format. CATO CADMeasure also can range from on-screen point and click measurement to fully automated script measurement allowing the whole drawings measured with a single command (Causeway, 2017).

CADMeasure can cater all the measurement needs in a comprehensive system. It can measure directly from the CAD files in addition receiving drawing in the form of PDF and DWF formats. Although the current practice encumbered with paper drawings, CADMeasure can extract relevant details required for accurate measurement. The time taken in measurement can be reduced. By application of CADMeasure, it can carry out a comprehensive range of measurement which includes lengths, perimeters, area and volumes as well as enables the 3D measurement from 2D drawings (Causeway, n.d.).

2.8.3 Autodesk

Autodesk is known as a leader in 3D design, engineering and entertainment software. Autodesk Quantity Take-Off (QTO) is one of the software under Autodesk and currently, known as Autodesk Navisworks. It is a combination two-dimensional and three-dimensional design to perform quantity take-off, which later used for cost estimation. There are various types of file can be used in the QTO are Design Web Format ™ (DWF) or non DWF such as PDF files, DWG files, JPG or TIF image files. The DWF is created by Autodesk itself which had the capabilities in combining two dimensional and three-dimensional designs created from Revit into a single file. Nevertheless, taker-off required carried out taking off manually when importing non DWF flies (Hsu, 2012).

Apart from that, there are several functions of Autodesk Quantity Take-Off software. It provides automation in quantity take-off that reduces the time to perform quantity take-off by integration of 2D and 3D design data. It has a greater flexibility than typical database or spreadsheet because it can perform an interactive examination of 3D models for material cost estimating purposes. Other than that, it can count and quantify design data quickly and easily. Summary and detailed quantity surveying report can be created quickly and easily (Yong, 2016)

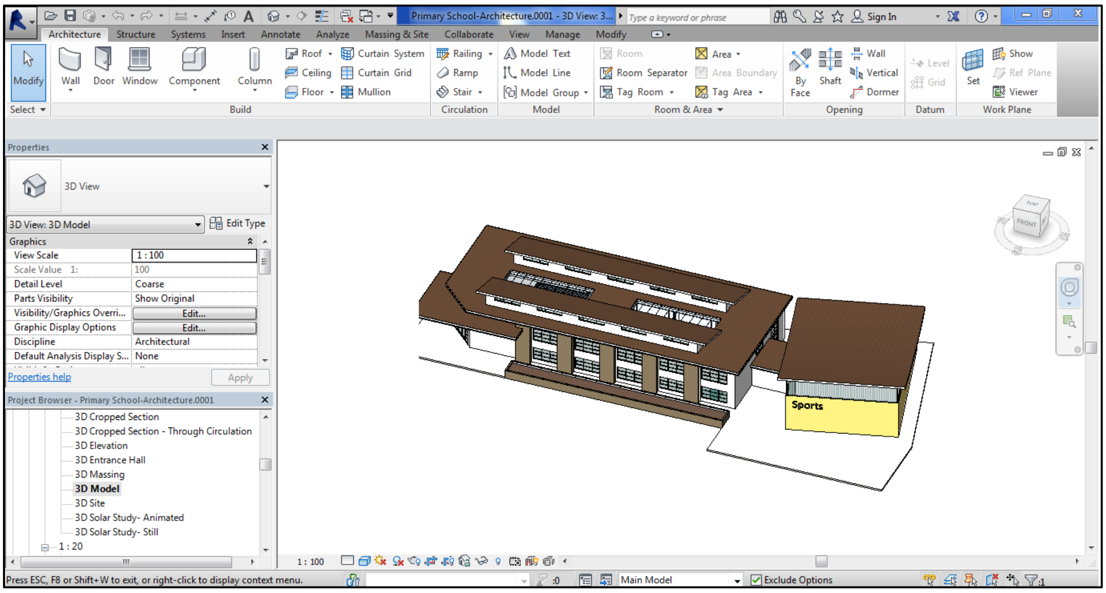

Figure 2.3 Autodesk QTO
Source: (Wu et al., 2014)

2.8.4 Cost X

Cost X is a top product of Exactal which usually use by the quantity surveyors, builders, subcontractors and estimator, from both large and small company. By using Cost X, it enables the quantity take-off carried out faster and produces accurate quantities from 2D drawings. It also generates automatic quantities from 3D models using the most advanced electronic take-off system available. It functions to prepare estimates, BQ and tenders in short time (Exactal, 2017).

There are also advantages of Cost X to the quantity surveyors profession. It is generally easy to use as it provides a user-friendly interface which guides the users to navigate their way easily. The most important advantages of Cost X are cost savings and time savings. The integration system reduces the cost overruns by ensuring a greater certainty of outcome, as well as automation in take-off and live-linked workbook, reduces the time from the manual job. Application of Cost X also provides a greater accuracy in estimates. This is because Cost X uses drawing file intelligence to speed up measurement and make sure the quantities are free from mistakes and accurate (Exactal, n.d.).

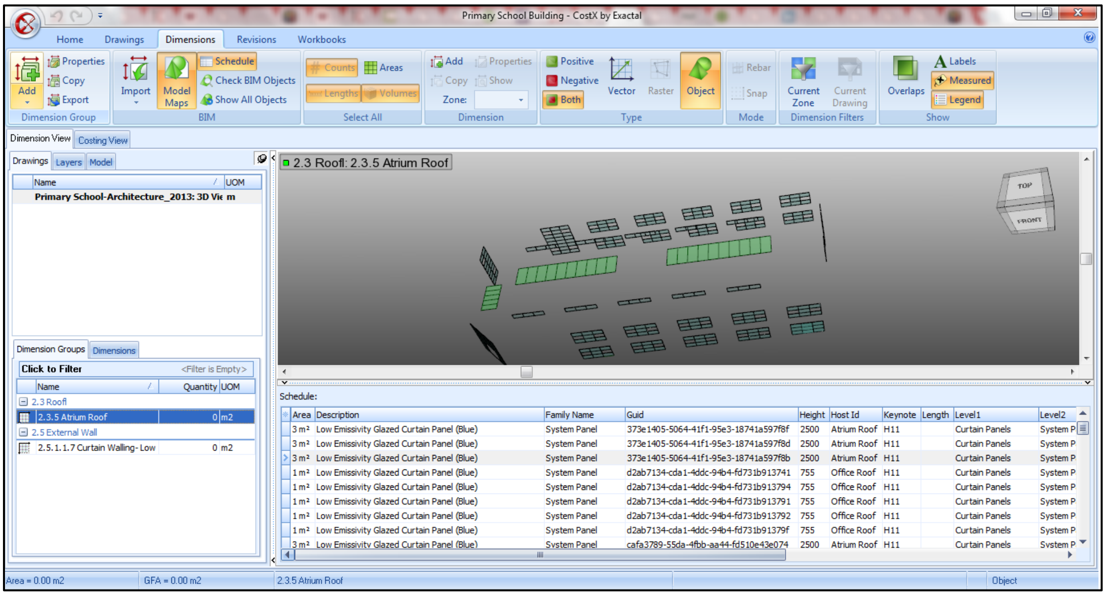

Figure2.4 Cost X measurement schedule
Source: (Wu et al., 2014)

2.8.5 Glodon

In the market, there are many types of Glodon software which includes Glodon Take-off for Rebar (TRB), Glodon Take-off for Architecture and Structure (TAS), Glodon Tender Series for Bill of Quantities (TBQ) and Glodon Take-off for mechanical and Electrical (TME). Different types used to quantify different elements (Glodon, 2015). Basically, Glodon also provides automation in quantification and generation of BQ. Besides, it also provides visualisation for a better understanding of design. In other words, Glodon has a 3D visualisation that provides benefit when doing bulk check (Muhammad, 2015).

Other than that, Glodon provides ease in editing the measurement. During the pre-tender stage, the design might have changed. Thus, application of Glodon can amend the measurement with ease, just a few clicks of button. By application of Glodon, the productivity of work can be increased. The measurement work can be done on time with little effort (Lead, 2017).

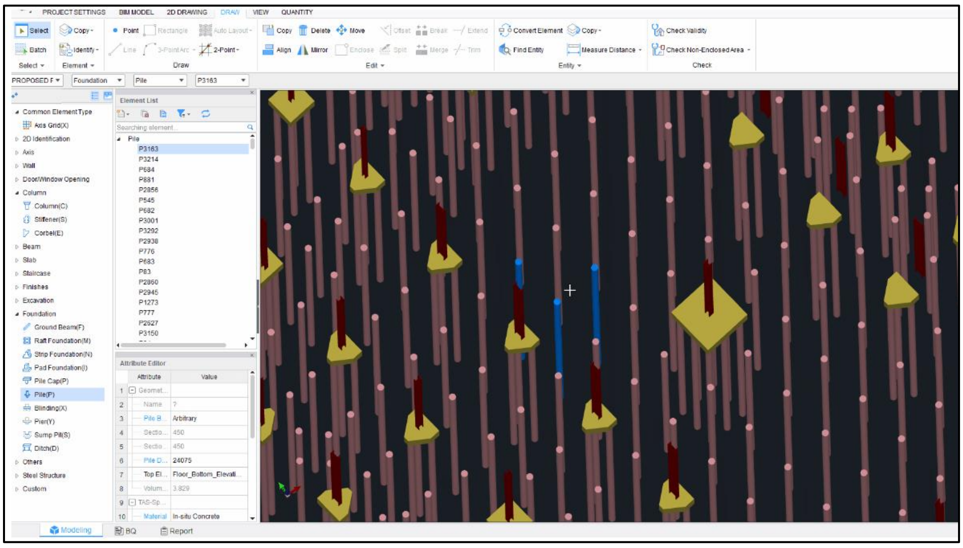

Figure 2.5 Glodon Take-off for Architecture and Structure (TAS)
Source: (Glodon UK Software Limited, 2017)

2.9 Common Errors in Bill of Quantities

Agyekum et al. (2015) had claimed that quantity surveyors required a high level of accuracy especially preparation of documentation such as a bill of quantities (BQ). It must free from errors in description, quantities or rate which will result in disputes in time, cost or quality (Gunathilaka & Senevirathne, 2013).

Incorrect quantities had become one of the common errors during the preparation of BQ. Adnan et al. (2011) had highlighted that quantity is the most important element in BQ. However, BQ always lack of the accuracy on the quantities. This might result from under or over measurement of cost items. The inaccuracy of the quantities also causes the dissatisfaction of the successful tenderer with the fact that quantities in the BQ is a nett quantities. As a resulted of nett quantities, the tenderers are required to price at the average price for the upper floor. Basically, upper floor cost is higher than the lower floor due to hoisting cost. In addition, during the bidding, the tenderers also priced the preliminary items with a high rate to reduce their uncertainty in quantities.

Besides, there is also irrelevant of the preliminary items under the preliminary bill. The deficiency of the preliminary items occurs when the preliminary items of other different project scope and name are used without any adjustments (Gunathilaka & Senevirathne, 2013). Moreover, there is often containing many irrelevant and unnecessary items in the bill. Irrelevant of preliminary items causes the amount of the tender price high. The tenderers may price themselves out against their competitors (Adnan et al., 2011).

According to Adnan et al. (2011), common errors in the BQ also resulted from insufficient information in description especially the location of work. The cost will be various as upper floor cost higher compared to ground floor due to additional of hoisting cost. Incomplete or insufficient description of works may result in the contractors to make assumptions and make their own decision for them to price the work.

Furthermore, omissions and discrepancies between drawings and BQ is also an error during preparation of BQ. This may result in out-dated drawings used in doing the measurement. It is also may result from the carelessness in taking off as they might miss up the taking off items (Gunathilaka & Senevirathne, 2013).

Lastly, those above are common errors in BQ. The taker-off must always aware of the common errors and reduce the frequency of making errors.

2.10 Summary of Chapter

As a conclusion, the bulk check practice must carry out by the quantity surveyors during the preparation of the bill of quantities (BQ). They must always bear in mind of their responsibility in the production of high-quality documentation such as BQ. Production of high accuracy BQ can prevent the disputes. Besides, the application of specialised software is important as it contributes to the effectiveness and efficiency of work carried out by the quantity surveyors. Since the profession of quantity surveyors required a high level of accuracy, it is important for them to practice bulk check during the preparation of BQ to reduce the major errors such as deficiency of quantities, descriptions, irrelevant of preliminary items and the omissions and discrepancies between drawings and BQ.

CHAPTER 3

RESEARCH METHODOLOGY

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discussed about the methodology of the research. The techniques or approaches used during data collection are for the further data analysis in chapter 4. Data collection aims at achieving the purpose of the research. Last but not least, this chapter also discussed on appropriate research methodology procedure to conduct the research.

3.2 Research Design

The research design is an action that carried out in order to achieve research objective (Naoum, 2012). It shows what kind of data required, what method used to collect data, analyse data and how to achieve the research objectives. According to Rajasekar et al. (2013), the basic and applied research applied are qualitative approach and quantitative approach. In this research, both approaches are used to achieve the research objectives.

Blaxter et al. (2006) also stated that a quantitative approach is an empirical approach where the numerical data is gathered. Naoum (2012) described the quantitative approach as 'objective' in nature. A quantitative approach can use to describe, test and examine the relationship that related to the number. In contrast, qualitative research is 'subjective' in nature. It is mainly highlighted in the definition, experience, description and the like. According to Hennink et al. (2010), qualitative research is a technique to examine of individual experience in detail through in-depth interview, group discussion, observation, content analysis, visual techniques, and life histories and biographies.

Table 3.1 Research design

Research Objectives	Research Approach	Data Gathered	Document/ Respondents
To compare the range of quantity accuracy between the bill of quantities (BQ) that produced using specialised software and by manual	Quantitative Approach	Bill of Quantities	▪ Manual production of the bill of quantities ▪ Specialised software production of the bill of quantities
To identify the factors affecting the accuracy of the quantity in the bill of quantities	Qualitative Approach	Factors affecting the accuracy of the quantity in the bill of quantities	Quantity surveyors

3.3 Stages of Research Methodology

According to Rajasekar et al. (2013), research methodology is a systematic process to solve problems. It provides the flow how the research is carried out to obtain the knowledge or result. There are five stages of research methodology which comprises of preliminary study, literature review, data collection, data analysis and conclusion and recommendation.

3.3.1 First Stage - Preliminary Research

During the preliminary research, personal interest subject had identified before the research title was initiated. When developing the research titles, different kind of consultation carried out such as previous theses, journals, or even seeking advice, comments and suggestions from a supervisor. Through the preliminary study, problem statement and the research title was identified. Additionally, background study, objectives of research, the scope of research and significance of research were generated.

3.3.2 Second Stage - Literature Review

A literature review is an important stage which is related to the research. During this stage, there are five activities carried out that includes identifying of appropriate information sources, understanding on how the library works, obtaining knowledge related, doing reading and note taking, organising the literature orderly as well as appraising and writing up the literature review (Naoum, 2012).

In this research, all the theories and information were obtained from the journal articles, books, conference papers, theses paper and the like. The information obtained was for the achievement of the research objectives. Theories that discussed in this stage related to the bill of quantities, roles of quantity surveyors in preparation of bill of quantities, preparation of bill of quantities, the accuracy of bill of quantities, bulk check, measurement method as well as common errors that may occur in the preparation of bill of quantities.

3.3.3 Third Stage – Data Collection

Every research carried out data collection. Data collection aims to achieve the research objectives and the quality of the data is highly dependent on the adequacy and appropriateness of the data. According to Blaxter et al. (2006), they stated that data can be a numerical, consists of works, or even a combination of two. The data collected or the raw materials can be a primary data or secondary data. Primary data is normally the data which is collected and had not been explored by someone else.

There are several methods can be undertaken to collect the data (Pawar, 2004). For instance, the data can be collected from the documents analysis, interviews, questionnaires, observation and experiments. Before that, the research instruments, research sampling and techniques in data collection are identified and determined.

3.3.3.1 Techniques of Data Collection

A. Document Analysis

In this research, document analysis was used to achieve first research objective. The bills of quantities for double-storey terrace houses were obtained through random sampling from the quantity surveying firms in Johor Bahru. Information about the measurement method on quantity produced during the preparation of bill of quantities obtained during the collection of the bill of quantities from the firms. Additionally, the project's drawings of the bill of quantities also had been requested for bulk checking purposes. For the bulk checking purpose, the bulk check list was obtained from the previous research in Arif (2007) thesis paper.

The total sample of this research objective was nine (9) sets of the bill of quantities that comprised of four (4) sets of the bill of quantities produced by manual measurement and five (5) sets of the bill of quantities produced by specialised software measurement. Among the projects' BQs, some projects comprised of corner, intermediate and end units; some comprised of corner and intermediate units; some comprised of intermediate units only. For the purpose of comparison, this research classified into corner and intermediate units for respective measurement method; namely manual measurement and specialised software measurement. There was no comparison for the end unit because the collected BQs set that comprised end units only for manual measurement.

In order to conduct an ideal comparison, for corner units, the comparison was conducted between four (4) projects that manual quantity take-off projects and four (4) projects that produced through specialised software measurement. Meanwhile, for the intermediate units, the comparison was between five (5) projects that produced manually and five (5) projects that produced via specialised software measurement.

B. Semi-structured Interview

Data collection of the second objective was carried out through the interview. Basically, interview session allows in exploring the opinion, view, perspective or attitude towards one topic and usually conducted face-by-face. Interview consisted of three types which are structured interview, semi-structured interview and unstructured interview. Nevertheless, the semi-structured interview was selected to achieve second research objectives.

According to Naoum (2012), a semi-structured interview is more formal compared to unstructured interview. This is because semi-structured comprised of specific topics that build the interview. The questions form can be ‘open’ or ‘closed-ended’ questioning, in addition, the questions are not asked orderly. The purpose of the semi-structured interview is to obtain the information as much as possible on the research topic. By conducting a semi-structured interview, it provides the freedom for the interviewer to ask queries during the interview session.

The second research objective of this research mainly focuses on the quantity surveyors who prepare the bill of quantities. Through the semi-structured interview, the information on the factors affecting the accuracy of quantity in the bill of quantities was obtained. Due to the limitation of time, seven (7) samples were collected for this research objective.

3.3.3.2 Research Instruments

Research instrument is a device used to gather and record information for assessment, decision making and ultimately understanding (Colton & Covert, 2015).

A. Bulk Check List

The bulk check list was the main tool used to achieve the first research objective. In the construction industry, there were many version of bulk check list. There were no standard of format and also bulk check items required during the practice. The bulk check list of each company might different in term of their arrangement order of items, bulk check items, detail of bulk check list, the minimum percentage difference of quantity, method of the bulk checking, bulk check instructions as well as use of the comment and analysis column.

A decade ago, Arif (2007) had analysed the three samples of bulk check list from different firms and managed to proposed bulk check list that accordance with Standard Method of Measurement of Building Works Second Edition (SMM2). In addition, the bulk check list she proposed still compatible with the current practice of measurement. Thus, the proposed bulk check list by Arif (2007) was used as an instrument used for data analysis in achieving first research objective. The rubric of the bulk check list is shown below.

Table 3.2 Rubric of bulk check list

Bulk Check Items	**BQ Quantity**	**Bulk Check Quantity**	**Percentage Difference on Bulk Check Quantity (%)**	**Minimum Percentage Difference (%)**	**Comment and Analysis**

Furthermore, interview form was used as an instrument for the second research objectives. The semi-structured interview questions were separated into different sections.

a) Interviewee Profile

The interviewee profile was included as part of semi-structured interview question. By doing so, the background of the interviewee in terms of their name, position and his working experience were identified.

b) Method of Measurement in Bill of Quantities Preparation

It was important to determine the type of measurement method the interviewee used during the preparation of bill of quantities. This was much related to the accuracy of the quantity in the bill of quantities especially when the specialised software was utilised. Their opinions were important as on the type of method as it may become part of factors affecting the quantity accuracy in the bill of quantities.

c) Bulk Check Practice

In this section, the questions were all about the practice of bulk check during the preparation of bill of quantities. The information related to the practice of bulk check in the project, type of bulk check method commonly applied, elements that covered under the bulk check list as well as the best timing of doing bulk check. The impact of bulk checking towards the quantity accuracy was identified in this section.

d) Factor Affecting the Accuracy of Quantities

Section D of the interview questions designed to meet the second research objective. Through this section, the common errors in the bill of quantity had been identified as well as the factors affecting the accuracy of quantity in the bill of quantities were determined.

Table 3.3 Research instrument

Research Objectives	Research Approach	Research Instrument	Research Outcomes
To compare the range of quantity accuracy between the bill of quantities (BQ) that produced using specialised software and by manual	Document Analysis	Bulk Check List	To determine the range of quantity accuracy and compare the bill of quantities produced by manual and specialised software through bulk check
To identify the factors affecting the accuracy of the quantity in the bill of quantities	Semi-structured interview	Interview Form	To gather the information on the factors affecting the accuracy of quantity in the bill of quantities

3.3.4 Fourth Stage – Data Analysis

After the data was done collected, the data was analysed, interpreted and organised into useful, structured and reliable information using the Microsoft Excel and Microsoft Word. The information that analysed can be used as a guideline future related research and provide information for the people who require the information for other purposes.

3.3.4.1 Descriptive Analysis

Basically, descriptive analysis is used to describe the world or phenomenon in answering the questions on who, what, where, when and to what extent. The description can use for identifying and describing the pattern and variation of a large group, creating a new measure of key phenomena as well as describing the causal-effects event (Loeb et al., 2017). In this research, descriptive analysis was carried out to compare the range of quantity accuracy between the bill of quantities (BQ) that produced using specialised software and by manual.

Firstly, the bulk check on quantity was carried out on the projects' bill of quantities collected from the quantity surveying firms by using the bulk check list proposed by Arif (2007) in her previous research. After completed bulk checking for all the projects obtained, the bills of quantities that produced using the same method were sorted together. Since the projects obtained were double-storey terrace houses, thus the sorting was conducted onto the type of measurement method of the bill of quantities production and type of units of houses.

The process of analysis was followed by the calculation of range or percentage difference between the projects' bill of quantities. Ranges of percentage difference were calculated based on the percentage difference on bulk check quantity obtained via the bulk checking using interquartile range. According to Social Studies 201 (1989) publication, interquartile range is known as range of the variable values over central distribution that ranges from first quartile (25%) to third quartile (75%) variable. It is commonly used in determining the variability of the dataset by arranging the data in ascending order. Then, divided the percentage into the median, first quartile and third quartile. The interquartile range obtained by deduction between the third quartile with the first quartile.

$$\textbf{\textit{Interquartile Range (IQR)}} = Q_3 - Q_1$$

The percentage that obtained from the calculation was compared with the fixed variable of minimum percentage difference on bulk check quantity allocated for each item to determine the accuracy of the quantity take-off according to measurement method. Next, the comparison between the range between manual and specialised software production quantities was carried out. The lower the percentage difference range, the greater the accuracy of quantity.

Tabulation was used for comparison purposes and became part of the analysis instrument. This was because tabulation was the simplest technique in presenting the data in a systematic way. It was easier to be understood. Therefore, the tabulation was developed to achieve the first research objective.

Table 3. 4 Range of percentage difference

Bulk Check Items	Minimum Percentage Difference	Range of Percentage Difference	Percentage Difference on Bulk Check Quantity				
			A	**B**	**C**	**D**	**E**
WORK BELOW LEVEL FLOOR FINISH							
Area of concrete ground slab (m^2) = Area of damp proof membrane (m^2) = Gross area of ground floor slab (m^2) - Area of lift core (m^2) - Area of openings (m^2) = Area of ground floor slab (m^2)	**5%**	**5%**	1%	2%	0%	4%	7%

Calculation of range of percentage difference;

Step 1: Arrange the percentage in an ascending order.
Step 2: Find the median, first quartile (Q_1) and third quartile (Q_3).
Step 3: Calculate the interquartile range by deduction of $Q_3 - Q_1$.

Example:
1%, 2%, 0%, 4%, 7%

Step 1:

0%, 1%, 2%, 4%, 7%

Step 2:

Median = 2%

Q_1 = (0 + 1) / 2

= 0.5%

Q_3 = (4 + 7) / 2

= 5.5 %

Step 3:

Interquartile range (IQR) **= $Q_3 – Q_1$**

= 5.5% - 0.5%

= 5%

Table 3. 5 Comparison of percentage difference range

Bulk Check Items	Minimum Percentage Difference	Specialised Software Range of Percentage Difference	Manual Range of Percentage Difference
WORK BELOW LEVEL FLOOR FINISH			
Area of concrete ground slab (m^2) = Area of damp proof membrane (m^2) = Gross area of ground floor slab (m^2) - Area of lift core (m^2) - Area of openings (m^2)	**5%**	**0%**	**5%**

3.3.4.2 Thematic Analysis

For the second research objective, thematic analysis was used to analyse the data. In qualitative research, thematic analysis is mostly selected by the researcher to analyse the interview raw data. According to Braun and Clarke (2006), thematic analysis is a technique used for identifying, analysing and theme categorisation of report pattern within the data. Through thematic analysis, it provides the insightful analysis that answers specific research inquiries.

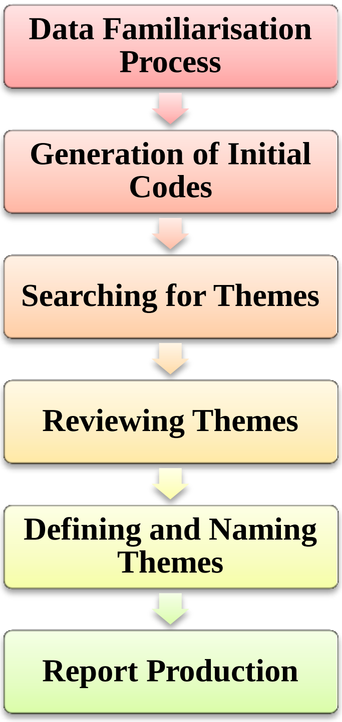

Figure 3.1 Thematic analysis phases
Source: (Braun & Clarke, 2006)

According to Braun and Clarke (2006), there are six phases of thematic analysis. The thematic analysis phases can be classified into data familiarisation process, data coding and theme development and revision.

During the familiarisation of data, it required of in-depth study with the raw data. In this research, the data on the factors affecting the quantity accuracy in the bill of quantities are collected and recorded using a recorder. The recordings are played repeatedly so that an accurate translation and transcription can be generated. Translation and transcription of data are carried out using Microsoft Word.

Next, the initial codes are applied to textual data. Coding aims for arranging, the data collected into meaningful categories in order to achieve the research objective (Braun & Clarke, 2006). Besides, it can be carried out either manually or through software programme. Nevertheless, the coding tool for this research is Microsoft Word.

Table 3. 6 Example of coding

Respondent	Answer	Code
R1	The accuracy of the quantity is dependent on logical quantity.	**F2**
	Sometimes, the drawings received from the consultant are not to scale.	**F4**
	Duration in preparation of tender documentation is very rush.	**F5**
R2	By using the specialised software in measuring the earthwork is considered more accurate than using manual.	**F1**
	Basically, a bulk check is roughly checked for a large amount. Nevertheless, small items might not include in it. Thus, it causes the missing items.	**F6**
R3	Preventing overlook items through bulk check that listed the common items that might miss up by the taker off.	**F7**
R4	Sometimes, the line drawn in the Glodon cannot be detected. So, it still needs to checked manually either if the items been covered or not.	**F3**
R5	Denying of work scope by the QS during the taking-off. For example, sometimes, the soffit of the beam is measured under the slab. Thus, the beam taker off said it must be measured by the slab taker off and vice-versa.	**F9**
R6	Insufficient information such as incomplete drawing affect the accuracy of quantity	**F8**
R7	Overlooked the missing items	**F3**

During the third phase, the coded data are re-focused for the sorting potential theme and collating all the relevant coded data extracts within the identified themes. Additionally, the relationship between the codes and the level of theme are determined. Some of the coded data will be categories into main theme and sub theme. For the theme that might not belong to any group, the additional theme can be formed to fit it (Braun & Clarke, 2006).

Furthermore, the themes are reviewed to reduce the data into a more manageable set of significant themes during the fourth phase (Stirling, 2001). It is conducted on two levels. According to Braun and Clarke (2006), the themes review is started on the coded data extracts. From the coded data extract, integration of theme will be conducted if the themes are coherent to each other. Meanwhile, for the problematic themes, researchers can either rework the theme or create a new theme for them. The process of level one is same but it involves the relation of the overall data set. Through this level, the validity of individual themes is discovered. Researchers are required to re-check the entire data to ensure the theme work in relation to the data set. The data of within theme that missed up at the initial coding stage will be coded. Once the thematic map works, then it proceeds to next phase.

During the defining and naming phase, the researchers shall identify the entity of the theme and also figure out the information aspect of each theme. When doing detailed analysis, it is vital to ensure the matching of the theme on the data with the research questions. This is to ensure little or no overlapping between themes. During the refinement, it is important to identify the sub-theme within a theme. Basically, the sub-theme can be helpful for giving the structure a very massive and sophisticated theme, and also for demonstrating the hierarchy to the data. The name of the theme must be clear, forceful and provide s the reader a sense of what the theme is about (Braun & Clarke, 2006).

Table 3.7 Examples of themed coded data

Theme	Answer	Code	Number of Respondents
Type of measurement method used in producing the quantities in the bill of quantities (BQ)	By using the specialised software in measuring the earthwork is considered more accurate than the using manual.	**F1**	**1**
Experience and knowledge of QS	The accuracy of the quantity is dependent on logical quantity.	**F2**	**1**
Human Errors	Sometimes, the line drawn in the Glodon cannot be detected. So, it still needs to checked manually either if the items been covered or not.	**F3**	**2**
	Overlooked the missing items		
Discrepancies of drawings	Sometimes, the drawings received from the consultant are not to scale.	**F4**	**1**
Time constraint in preparing the tender documents	Duration in preparation of tender documentation is very rush.	**F5**	**1**
Insufficient items in bulk check list	Basically, a bulk check is roughly checked for a large amount. Nevertheless, small items might not include in it. Thus, it causes the missing items.	**F6**	**1**
Bulk checking practice	Preventing overlook items through bulk check that listed the common items that might miss up by the taker off.	**F7**	**1**
Lack of information	Insufficient of information such as incomplete drawing affect the accuracy of quantity	**F8**	**1**
Miscommunication among the taker off	Denying of work scope by the QS during the taking-off. For example, sometimes, the soffit of the beam is measured under the slab. Thus, the beam taker off said it must be measured by the slab taker off and vice-versa.	**F9**	**1**

Last but not least, thematic analysis process ended with the final report production. For this research, transcript interview data must be compelling with the second research objective. The data was analysed by theme. Besides, when writing the report, the analysis of overall theme was well explained, clear, logic and non-repetitive.

3.3.5 Fifth Stage – Conclusion and Recommendations

During this stage, the results from the collected data are drawn into the conclusion and all the research objectives were achieved. The conclusion was made based on the findings of the research and recommendation for future research was made.

3.4 Research Flow

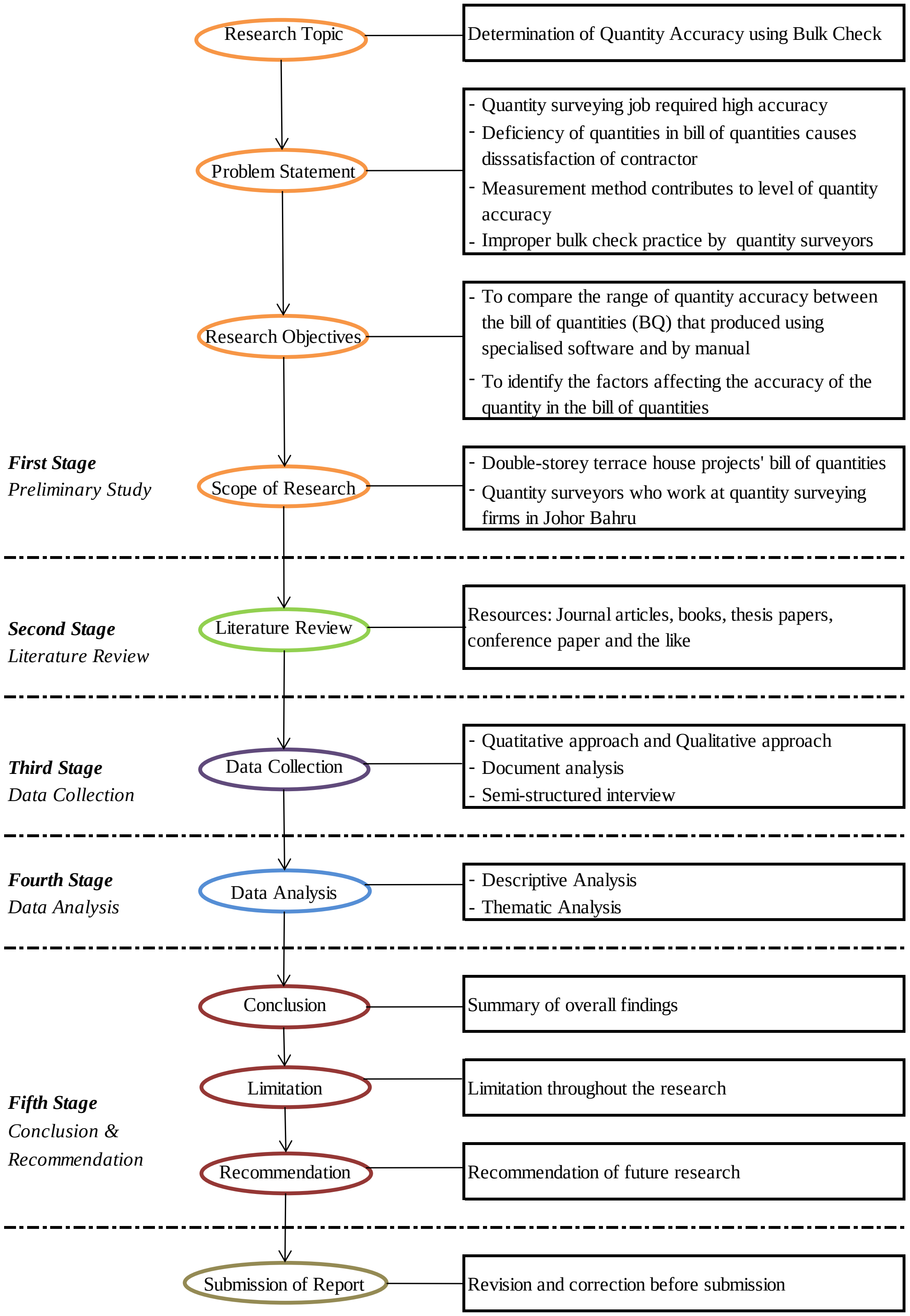

Figure 3.2 Research flow chart

3.5 Summary of Chapter

The research methodology was discussed in this chapter. The flow of research discussed to ensure the research objectives were achieved. Both qualitative and quantitative approaches were applied in this research. The data collected through the document analysis and semi-structured interview. Moreover, the data were analysed using descriptive analysis and thematic analysis.

CHAPTER 4

DATA ANALYSIS

CHAPTER 4

DATA ANALYSIS

4.1 Introduction

In this chapter, it discussed on the findings and analysis for this research. Basically, the data obtained through semi-structured interview as well as through the document analysis. Therefore, the data analysis carried out to achieve the research objectives. My first research objective is to compare the range of the quantity accuracy between the bill of quantities (BQ) that produced using specialised software and by manual. Meanwhile, my second objective is to identify the factor affecting the accuracy of quantity in the bill of quantities.

As mentioned in Chapter 3, the document analysis through bulk checking used to achieve the first objective. The thematic analysis method is used to analyse semi-structured interview data. All the interview data coded and categorised into themes which means that data that having similar meaning fall under same category.

4.2 Document Analysis

4.2.1 Collected Projects' Bill of Quantities (BQ)

The first research objective is to compare the range of quantity accuracy between the bill of quantities (BQ) that produced using specialised software and by manual. Therefore, to achieve the objective, the bill of quantities those produced by specialised software and by manual were collected from the quantity surveying firms in Johor Bahru. Hereby, Table 4.1 displayed on the bill of quantities obtained from the quantity surveying firms with its method of preparation.

Table 4. 1 Collected bill of quantities (BQ)

Quantity Surveying Firms	Project Title	Method of Measurement
A	114 Units Double Storey Terrace Houses (22' x 75')	Manual Measurement
B	147 Units Double Storey Terrace House (22' x 75')	Manual Measurement
C	78 Units Double Storey Terrace House (20' x 60')	Manual Measurement
D	215 Units Double Storey Terrace House (20' x 70')	Specialised Software Measurement
E	53 Units Double Storey Terrace House (22' x 70')	Manual Measurement
F	143 Units Double Storey Terrace House (22' x 70')	Specialised Software Measurement
G	Double Storey Terrace House (20' x 72')	Specialised Software Measurement
H	Double Storey Terrace House (22' x 72')	Specialised Software Measurement
I	Double Storey Terrace House (24' x 72') and (25' x 72')	Specialised Software Measurement

Among all BQ collected, there are four sets of BQ quantities produced using manual method of measurement which involved traditional method and through spreadsheet Microsoft Excel. Meanwhile, there are five sets of BQ that prepared using specialised software such as Binalink and Glodon.

4.3 Range of Quantity Accuracy

Different method of measurement used, produced different quantities accuracy. Therefore, the bulk checking was conducted to determine the range of quantities accuracy in each BQ through the percentage difference on bulk check quantity.

Generally, the percentage difference on bulk check quantities is as stated in the bulk check list by Arif (2007). As highlighted by Arif (2007), the minimum percentage difference allocated for bulk checking are 0%, 3% and 5%. The minimum percentage of 0% is allocated for the items which can be directly extracted from the quantity of other items or quantity from the drawings and schedule. 3% is allocated for the items that are high cost and bulk in quantity. For instance, the items are concrete work, formwork, finishes and reinforcement. In addition, the items whichever given a lower cost are allocated with 5% minimum percentage difference in bulk check list.

In this analysis, the range of quantity accuracy is analysed for intermediate units and corner units with respective method of measurements which are manual measurement and specialised software measurement. The range is obtained using interquartile range to measure the variability of minimum percentage difference between the items in the bill of quantities by dividing the data set into quartile.

Basically, it also showed on the central tendency of the percentage difference by deduction of third quartile and first quartile.

$$\textit{Interquartile Range (IQR)} = Q_3 - Q_1$$

4.3.1 Manual Measurement

4.3.1.1 Corner Unit

Table 4. 2 Tabulation for manual measurement range of percentage difference - Corner unit

Bulk Check Items	Minimum Percentage Difference	Manual Measurement Range of Percentage Difference
WORK BELOW LEVEL FLOOR FINISH		
Area of concrete ground slab (m^2) = Area of damp proof membrane (m^2) = Gross area of ground floor slab (m^2) - Area of lift core (m^2) - Area of openings (m^2)	**5%**	5%
Area of fabric reinforcement (m^2) = Area of ground floor slab (m^2)	**3%**	12%
UPPER FLOOR		
Area of concrete upper floor slab (m^2) = Gross area of upper floor slab (m^2) - Area of lift core (m^2) - Area of staircase (m^2) - Area of openings (m^2)	**3%**	18%
Area of fabric reinforcement (m^2) = Total area of upper floor slab (m^2)	**3%**	9%
Area of soffit formwork for upper floor slab (m^2) = Gross area of upper floor slab (m^2) - Area of lift core (m^2) - Area of openings (m^2)	**3%**	8%

Bulk Check Items	Minimum Percentage Difference	Manual Measurement Range of Percentage Difference
ROOF		
Area of damp proof membrane (m^2) ***(Concrete Flat Roof)*** = Area of concrete screeding (m^2) = Area of roof slab formwork (m^2) + Area of soffit of roof beam formwork (m^2)	**5%**	9%
STAIRCASE		
Length of formwork for the riser (m) = Length of nosing tile (m) = Length of riser finishes (m) = Length of steps (m)	**0%**	3%
Length of formwork for string (m) = Length of string finishes (m)	**0%**	9%
Area of soffit formwork to staircase (m^2) = Area of soffit finishes to staircase (m^2)	**0%**	33%
STAIRCASE		
Area of formwork for sloping slab (m^2) = Area of finishes for sloping slab (m^2)	**0%**	8%
DOOR		
Number of measured doors (No) = Number of doors in drawing or schedule (No)	**0%**	0%
WINDOW		
Number of measured window (No) = Number of window in drawings / schedule (No)	**0%**	7%
INTERNAL WALL FINISHES		
Total area of internal wall finishes (m^2) = Area of external wall (m^2) + [2 x Area of internal wall] (m^2)	**3%**	27%
Area of screeding (m^2) = Area of wall tiles (m^2)	**3%**	0%
INTERNAL FLOOR FINISHES		
Total area of floor finishes (m^2) = Gross floor area (m^2) - Area of lift core (m^2) - Area of staircase (m^2)	**3%**	9%
Area of screeding (m^2) = Area of finishes above screeding (m^2)	**3%**	0%

Bulk Check Items	Minimum Percentage Difference	Manual Measurement Range of Percentage Difference
INTERNAL CEILING FINISHES		
Area of ceiling plastering (m^2) = Area of soffit upper floor slab (m^2) + Area of soffit and sides of upper floor beam (m^2)	**0%**	19%
Area of ceiling painting (m^2) = Area of plaster ceiling (m^2) + Area of suspended ceiling (m^2)	**0%**	0%
EXTERNAL FINISHES		
Area of external wall painting (m^2) = Area of external wall plastering (m^2)	**0%**	3%
Area of external ceiling finishes (m^2) = Area of external floor finishes (m^2) = Area of apron (m^2)	**5%**	12%

Table 4.2 depicted the result of bulk checking with its range of the percentage difference on bulk check quantities. Nevertheless, the results displayed from the bulk checking on the projects' bill of quantities that produced manually mostly varies from the allocated minimum percentage difference.

The greatest range of difference from the minimum percentage difference among the items is staircase element; the area of staircase soffit formwork with 33%. Basically, there shall no difference in percentage as the surface of staircase soffit is equivalent to the finished surfaces. Besides, the second highest percentage difference from its allocated minimum percentage (3%) is total area of internal wall finishes at 24%. Meanwhile, the third highest range of difference from its minimum percentage difference of 0% is area of ceiling plastering at the range of 19%.

Other than that, the range obtained from analysis of manual production of bill of quantities for corner unit lowest range of difference from the minimum percentage difference is 3% for staircase element; length of riser formwork and area of external wall painting. For the items which met or within the minimum percentage differences are the area of concrete ground slab; number of measured door; area of screeding for internal wall and internal floor finishes; and area of internal ceiling painting.

4.3.1.2 Intermediate Unit

Table 4. 3 Tabulation for manual measurement range of percentage difference - Intermediate unit

Bulk Check Items	Minimum Percentage Difference	Manual Measurement Range of Percentage Difference
WORK BELOW LEVEL FLOOR FINISH		
Area of concrete ground slab (m^2) = Area of damp proof membrane (m^2) = Gross area of ground floor slab (m^2) - Area of lift core (m^2) - Area of openings (m^2)	**5%**	2%
Area of fabric reinforcement (m^2) = Area of ground floor slab (m^2)	**3%**	9%
UPPER FLOOR		
Area of concrete upper floor slab (m^2) = Gross area of upper floor slab (m^2) - Area of lift core (m^2) - Area of staircase (m^2) - Area of openings (m^2)	**3%**	12%
Area of fabric reinforcement (m^2) = Total area of upper floor slab (m^2)	**3%**	7%
Area of soffit formwork for upper floor slab (m^2) = Gross area of upper floor slab (m^2) - Area of lift core (m^2) - Area of openings (m^2)	**3%**	8%

Bulk Check Items	Minimum Percentage Difference	Manual Measurement Range of Percentage Difference
ROOF		
Area of damp proof membrane (m^2) ***(Concrete Flat Roof)*** = Area of concrete screeding (m^2) = Area of roof slab formwork (m^2) + Area of soffit of roof beam formwork (m^2)	**5%**	14%
STAIRCASE		
Length of formwork for the riser (m) = Length of nosing tile (m) = Length of riser finishes (m) = Length of steps (m)	**0%**	2%
Length of formwork for string (m) = Length of string finishes (m)	**0%**	7%
STAIRCASE		
Area of soffit formwork to staircase (m^2) = Area of soffit finishes to staircase (m^2)	**0%**	33%
Area of formwork for sloping slab (m^2) = Area of finishes for sloping slab (m^2)	**0%**	4%
DOOR		
Number of measured doors (No) = Number of doors in drawing or schedule (No)	**0%**	0%
WINDOW		
Number of measured window (No) = Number of window in drawings / schedule (No)	**0%**	12%
INTERNAL WALL FINISHES		
Total area of internal wall finishes (m^2) = Area of external wall (m^2) + [2 x Area of internal wall] (m^2)	**3%**	11%
Area of screeding (m^2) = Area of wall tiles (m^2)	**3%**	0%
INTERNAL FLOOR FINISHES		
Total area of floor finishes (m^2) = Gross floor area (m^2) - Area of lift core (m^2) - Area of staircase (m^2)	**3%**	20%
Area of screeding (m^2) = Area of finishes above screeding (m^2)	**3%**	0%

Bulk Check Items	Minimum Percentage Difference	Manual Measurement Range of Percentage Difference
INTERNAL CEILING FINISHES		
Area of ceiling plastering (m^2) = Area of soffit upper floor slab (m^2) + Area of soffit and sides of upper floor beam (m^2)	**0%**	3%
Area of ceiling painting (m^2) = Area of plaster ceiling (m^2) + Area of suspended ceiling (m^2)	**0%**	0%
EXTERNAL FINISHES		
Area of external wall painting (m^2) = Area of external wall plastering (m^2)	**0%**	7%
Area of external ceiling finishes (m^2) = Area of external floor finishes (m^2) = Area of apron (m^2)	**5%**	22%

Based on Table 4.3, the finding shows the range of manual measurement percentage differences for intermediate units. There are total 15 items varies in range of percentage difference from their minimum percentage allocated.

The item which having the greatest difference from its minimum percentage allocated is area of staircase soffit formwork. The percentage range obtained is 33%. Furthermore, item total area of internal floor finishes and item area of external ceiling finishes have 17% difference of percentage between the minimum percentage of 3% and 5% respectively and range obtained from the project bill of quantities. Apart from that, the lowest range of percentage difference on bulk check quantity for intermediate unit bill of quantities that manually produced is length of riser formwork; staircase elements with 2%.

Even though the number of items varies from minimum percentage allocated, there are number of items that achieved the minimum percentage difference allocated. There are area of concrete ground slab; number of measured doors; area of screeding for internal wall finishes and floor finishes; and internal area of ceiling painting.

4.3.2 Specialised Software Measurement

4.3.2.1 Corner Unit

Table 4. 4 Tabulation for specialised software range of percentage difference - Corner unit

Bulk Check Items	Minimum Percentage Difference	Specialised Software Range of Percentage Difference
WORK BELOW LEVEL FLOOR FINISH		
Area of concrete ground slab (m^2) = Area of damp proof membrane (m^2) = Gross area of ground floor slab (m^2) - Area of lift core (m^2) - Area of openings (m^2)	**5%**	0%
Area of fabric reinforcement (m^2) = Area of ground floor slab (m^2)	**3%**	8%
UPPER FLOOR		
Area of concrete upper floor slab (m^2) = Gross area of upper floor slab (m^2) - Area of lift core (m^2) - Area of staircase (m^2) - Area of openings (m^2)	**3%**	0%
Area of fabric reinforcement (m^2) = Total area of upper floor slab (m^2)	**3%**	4%
Area of soffit formwork for upper floor slab (m^2) = Gross area of upper floor slab (m^2) - Area of lift core (m^2) - Area of openings (m^2)	**3%**	3%

Bulk Check Items	Minimum Percentage Difference	Specialised Software Range of Percentage Difference
ROOF		
Area of damp proof membrane (m^2) ***(Concrete Flat Roof)*** = Area of concrete screeding (m^2) = Area of roof slab formwork (m^2) + Area of soffit of roof beam formwork (m^2)	**5%**	0%
STAIRCASE		
Length of formwork for the riser (m) = Length of nosing tile (m) = Length of riser finishes (m) = Length of steps (m)	**0%**	11%
Length of formwork for string (m) = Length of string finishes (m)	**0%**	0%
Area of soffit formwork to staircase (m^2) = Area of soffit finishes to staircase (m^2)	**0%**	0%
Area of formwork for sloping slab (m^2) = Area of finishes for sloping slab (m^2)	**0%**	0%
DOOR		
Number of measured doors (No) = Number of doors in drawing or schedule (No)	**0%**	0%
WINDOW		
Number of measured window (No) = Number of window in drawings / schedule (No)	**0%**	0%
INTERNAL WALL FINISHES		
Total area of internal wall finishes (m^2) = Area of external wall (m^2) + [2 x Area of internal wall] (m^2)	**3%**	5%
Area of screeding (m^2) = Area of wall tiles (m^2)	**3%**	0%
INTERNAL FLOOR FINISHES		
Total area of floor finishes (m^2) = Gross floor area (m^2) - Area of lift core (m^2) - Area of staircase (m^2)	**3%**	1%
Area of screeding (m^2) = Area of finishes above screeding (m^2)	**3%**	0%

Bulk Check Items	Minimum Percentage Difference	Specialised Software Range of Percentage Difference
INTERNAL CEILING FINISHES		
Area of ceiling plastering (m^2) = Area of soffit upper floor slab (m^2) + Area of soffit and sides of upper floor beam (m^2)	**0%**	12%
Area of ceiling painting (m^2) = Area of plaster ceiling (m^2) + Area of suspended ceiling (m^2)	**0%**	1%
EXTERNAL FINISHES		
Area of external wall painting (m^2) = Area of external wall plastering (m^2)	**0%**	4%
Area of external ceiling finishes (m^2) = Area of external floor finishes (m^2) = Area of apron (m^2)	**5%**	6%

According to depicted Table 4.4 on the specialised software range of percentage difference on bulk check quantity, it is obviously shown that the number of items that varies in percentage less than the manual production of bill of quantities. The highest percentage difference range from the minimum percentage allocated is item on area of ceiling plastering that achieved 12%. The lowest range of difference was 1% for items upper floor area of fabric reinforcement, area of internal ceiling painting and area of external ceiling finishes with minimum percentage difference of 3%, 0% and 5% respectively.

There are more than half of the items achieved or within the minimum percentage difference allocated in the bulk check list; 0%, 3% and 5%. Hence, the list of the bulk check items achieved or within the minimum percentage difference as allocated was shown Table 4.5.

Table 4. 5 List of items that met or within the allocated percentage difference for specialised software – Corner unit

Elements	Bulk check items
Work Below Level Floor Finish	Area of concrete ground slab (5%)
Upper Floor	Area of concrete upper floor slab (3%)
	Area of soffit formwork for upper floor slab (3%)
Roof	Area of damp proof membrane (5%)
Staircase	Length of formwork for string (0%)
	Area of soffit formwork to staircase (0%)
	Area of formwork for sloping slab (0%)
Door	Number of measured doors (0%)
Window	Number of measured windows (0%)
Internal Wall Finishes	Area of screeding (3%)
Internal Floor Finishes	Total area of floor finishes (3%)
	Area of screeding (3%)

4.3.2.2 Intermediate Unit

Table 4. 6 Tabulation for specialised software range of percentage difference - Intermediate unit

Bulk Check Items	Minimum Percentage Difference	Specialised Software Range of Percentage Difference
WORK BELOW LEVEL FLOOR FINISH		
Area of concrete ground slab (m^2) = Area of damp proof membrane (m^2) = Gross area of ground floor slab (m^2) - Area of lift core (m^2) - Area of openings (m^2)	**5%**	1%
Area of fabric reinforcement (m^2) = Area of ground floor slab (m^2)	**3%**	4%

Bulk Check Items	Minimum Percentage Difference	Specialised Software Range of Percentage Difference
UPPER FLOOR		
Area of concrete upper floor slab (m^2) = Gross area of upper floor slab (m^2) - Area of lift core (m^2) - Area of staircase (m^2) - Area of openings (m^2)	**3%**	0%
Area of fabric reinforcement (m^2) = Total area of upper floor slab (m^2)	**3%**	3%
Area of soffit formwork for upper floor slab (m^2) = Gross area of upper floor slab (m^2) - Area of lift core (m^2) - Area of openings (m^2)	**3%**	4%
ROOF		
Area of damp proof membrane (m^2) ***(Concrete Flat Roof)*** = Area of concrete screeding (m^2) = Area of roof slab formwork (m^2) + Area of soffit of roof beam formwork (m^2)	**5%**	0%
STAIRCASE		
Length of formwork for the riser (m) = Length of nosing tile (m) = Length of riser finishes (m) = Length of steps (m)	**0%**	8%
STAIRCASE		
Length of formwork for string (m) = Length of string finishes (m)	**0%**	0%
Area of soffit formwork to staircase (m^2) = Area of soffit finishes to staircase (m^2)	**0%**	0%
Area of formwork for sloping slab (m^2) = Area of finishes for sloping slab (m^2)	**0%**	0%
DOOR		
Number of measured doors (No) = Number of doors in drawing or schedule (No)	**0%**	0%
WINDOW		
Number of measured window (No) = Number of window in drawings / schedule (No)	**0%**	0%

Bulk Check Items	Minimum Percentage Difference	Specialised Software Range of Percentage Difference
INTERNAL WALL FINISHES		
Total area of internal wall finishes (m^2) = Area of external wall (m^2) + [2 x Area of internal wall] (m^2)	**3%**	4%
Area of screeding (m^2) = Area of wall tiles (m^2)	**3%**	0%
INTERNAL FLOOR FINISHES		
Total area of floor finishes (m^2) = Gross floor area (m^2) - Area of lift core (m^2) - Area of staircase (m^2)	**3%**	3%
Area of screeding (m^2) = Area of finishes above screeding (m^2)	**3%**	0%
INTERNAL CEILING FINISHES		
Area of ceiling plastering (m^2) = Area of soffit upper floor slab (m^2) + Area of soffit and sides of upper floor beam (m^2)	**0%**	4%
Area of ceiling painting (m^2) = Area of plaster ceiling (m^2) + Area of suspended ceiling (m^2)	**0%**	1%
EXTERNAL FINISHES		
Area of external wall painting (m^2) = Area of external wall plastering (m^2)	**0%**	1%
Area of external ceiling finishes (m^2) = Area of external floor finishes (m^2) = Area of apron (m^2)	**5%**	8%

According to the Table 4.6, most of the items have a slightly difference of 1% percentage range from the allocated minimum percentage difference. There are items on area of ground floor fabric reinforcement, area of soffit formwork for upper floor, total area of internal wall finishes, area of internal ceiling painting and area of external wall painting. Moreover, the greatest difference in percentage range item was staircase element on length of formwork for the riser with 8%. The items that within the minimum percentage difference area as follows;

Table 4. 7 List of items that met or within the allocated percentage difference for specialised software – Intermediate unit

Elements	Bulk check items
Work Below Level Floor Finish	Area of concrete ground slab (5%)
Upper Floor	Area of concrete upper floor slab (3%)
	Area of fabric reinforcement (3%)
Roof	Area of damp proof membrane (5%)
Staircase	Length of formwork for string (0%)
	Area of soffit formwork to staircase (0%)
	Area of formwork for sloping slab (0%)
Door	Number of measured doors (0%)
Window	Number of measured windows (0%)
Internal Wall Finishes	Area of screeding (3%)
Internal Floor Finishes	Total area of floor finishes (3%)
	Area of screeding (3%)

4.3.3 Comparison of Accuracy Range

4.3.3.1 Corner Unit

Table 4. 8 Tabulation for comparison of percentage difference range - Corner unit

Bulk Check Items	Minimum Percentage Difference	Specialised Software Range of Percentage Difference	Manual Measurement Range of Percentage Difference
WORK BELOW LEVEL FLOOR FINISH			
Area of concrete ground slab (m^2) = Area of damp proof membrane (m^2) = Gross area of ground floor slab (m^2) - Area of lift core (m^2) - Area of openings (m^2)	**5%**	0%	5%
Area of fabric reinforcement (m^2) = Area of ground floor slab (m^2)	**3%**	8%	12%
UPPER FLOOR			
Area of concrete upper floor slab (m^2) = Gross area of upper floor slab (m^2) - Area of lift core (m^2) - Area of staircase (m^2) - Area of openings (m^2)	**3%**	0%	18%
Area of fabric reinforcement (m^2) = Total area of upper floor slab (m^2)	**3%**	4%	9%
Area of soffit formwork for upper floor slab (m^2) = Gross area of upper floor slab (m^2) - Area of lift core (m^2) - Area of openings (m^2)	**3%**	3%	8%

Bulk Check Items	Minimum Percentage Difference	Specialised Software Range of Percentage Difference	Manual Measurement Range of Percentage Difference
ROOF			
Area of damp proof membrane (m^2) *(Concrete Flat Roof)* = Area of concrete screeding (m^2) = Area of roof slab formwork (m^2) + Area of soffit of roof beam formwork (m^2)	**5%**	0%	9%
STAIRCASE			
Length of formwork for the riser (m) = Length of nosing tile (m) = Length of riser finishes (m) = Length of steps (m)	**0%**	11%	3%
Length of formwork for string (m) = Length of string finishes (m)	**0%**	0%	9%
Area of soffit formwork to staircase (m^2) = Area of soffit finishes to staircase (m^2)	**0%**	0%	33%
Area of formwork for sloping slab (m^2) = Area of finishes for sloping slab (m^2)	**0%**	0%	8%
DOOR			
Number of measured doors (No) = Number of doors in drawing or schedule (No)	**0%**	0%	0%
WINDOW			
Number of measured window (No) = Number of window in drawings / schedule (No)	**0%**	0%	7%
INTERNAL WALL FINISHES			
Total area of internal wall finishes (m^2) = Area of external wall (m^2) + [2 x Area of internal wall] (m^2)	**3%**	5%	27%
Area of screeding (m^2) = Area of wall tiles (m2)	**3%**	0%	0%

Bulk Check Items	Minimum Percentage Difference	Specialised Software Range of Percentage Difference	Manual Measurement Range of Percentage Difference
INTERNAL FLOOR FINISHES			
Total area of floor finishes (m^2) = Gross floor area (m^2) - Area of lift core (m^2) - Area of staircase (m^2)	**3%**	1%	9%
Area of screeding (m^2) = Area of finishes above screeding (m^2)	**3%**	0%	0%
INTERNAL CEILING FINISHES			
Area of ceiling plastering (m^2) = Area of soffit upper floor slab (m^2) + Area of soffit and sides of upper floor beam (m^2)	**0%**	12%	19%
Area of ceiling painting (m^2) = Area of plaster ceiling (m^2) + Area of suspended ceiling (m^2)	**0%**	1%	0%
EXTERNAL FINISHES			
Area of external wall painting (m^2) = Area of external wall plastering (m^2)	**0%**	4%	3%
Area of external ceiling finishes (m^2) = Area of external floor finishes (m^2) = Area of apron (m^2)	**5%**	6%	12%

Based on the Table 4.8, it shows the percentage difference range obtained from the bulk checking. By comparing both manual and specialised software production of bill of quantities for corner unit, it is vividly shown that majority of specialised software production bill of quantities items having lower range of percentage difference compared to manual production bill of quantities.

In addition, there is only little percentage difference range if compared to the minimum difference in percentage allocated. The highest percentage difference for the specialised software is 12% for the internal ceiling plastering. The quantity of the internal ceiling plastering that produced through specialised software has lower percentage difference compared to manual measurement (19%). In contrast, the highest percentage of the manual measurement is 33% for the area of soffit formwork to staircase by which it shall has no difference on bulk check quantity. However, although specialised software showing greater accuracy as compared to manual measurement through the range of percentage difference on bulk check quantity, there are also an occurrence where the quantity obtained through the specialised software has slightly higher than the quantity produced through specialised software such as length for formwork riser and area of external wall painting.

Furthermore, through the specialised software measurement, it able to produce greater number of items that within the minimum percentage allocated. Thus, it showing that the production of bill of quantities using specialised software basically better method as it portrayed a greater accuracy compared to manual production of bill of quantities.

4.3.3.2 Intermediate Unit

Table 4. 9 Tabulation for comparison percentage difference range - Intermediate unit

Bulk Check Items	Minimum Percentage Difference	Specialised Software Range of Percentage Difference	Manual Measurement Range of Percentage Difference
WORK BELOW LEVEL FLOOR FINISH			
Area of concrete ground slab (m^2) = Area of damp proof membrane (m^2) = Gross area of ground floor slab (m^2) - Area of lift core (m^2) - Area of openings (m^2)	**5%**	1%	2%
Area of fabric reinforcement (m^2) = Area of ground floor slab (m^2)	**3%**	4%	9%
UPPER FLOOR			
Area of concrete upper floor slab (m^2) = Gross area of upper floor slab (m^2) - Area of lift core (m^2) - Area of staircase (m^2) - Area of openings (m^2)	**3%**	0%	12%
Area of fabric reinforcement (m^2) = Total area of upper floor slab (m^2)	**3%**	3%	7%
Area of soffit formwork for upper floor slab (m^2) = Gross area of upper floor slab (m^2) - Area of lift core (m^2) - Area of openings (m^2)	**3%**	4%	8%
ROOF			
Area of damp proof membrane (m^2) ***(Concrete Flat Roof)*** = Area of concrete screeding (m^2) Area of roof slab formwork (m^2) = + Area of soffit of roof beam formwork (m^2)	**5%**	0%	14%

Bulk Check Items	Minimum Percentage Difference	Specialised Software Range of Percentage Difference	Manual Measurement Range of Percentage Difference
STAIRCASE			
Length of formwork for the riser (m) = Length of nosing tile (m) = Length of riser finishes (m) = Length of steps (m)	**0%**	8%	2%
Length of formwork for string (m) = Length of string finishes (m)	**0%**	0%	7%
Area of soffit formwork to staircase (m^2) = Area of soffit finishes to staircase (m^2)	**0%**	0%	33%
Area of formwork for sloping slab (m^2) = Area of finishes for sloping slab (m^2)	**0%**	0%	4%
DOOR			
Number of measured doors (No) = Number of doors in drawing or schedule (No)	**0%**	0%	0%
WINDOW			
Number of measured window (No) = Number of window in drawings / schedule (No)	**0%**	0%	12%
INTERNAL WALL FINISHES			
Total area of internal wall finishes (m^2) = Area of external wall (m^2) + [2 x Area of internal wall] (m^2)	**3%**	4%	11%
Area of screeding (m^2) = Area of wall tiles (m^2)	**3%**	0%	0%
INTERNAL FLOOR FINISHES			
Total area of floor finishes (m^2) = Gross floor area (m^2) - Area of lift core (m^2) - Area of staircase (m^2)	**3%**	3%	20%
Area of screeding (m^2) = Area of finishes above screeding (m^2)	**3%**	0%	0%

Bulk Check Items	Minimum Percentage Difference	Specialised Software Range of Percentage Difference	Manual Measurement Range of Percentage Difference
INTERNAL CEILING FINISHES			
Area of ceiling plastering (m^2) = Area of soffit upper floor slab (m^2) + Area of soffit and sides of upper floor beam (m^2)	**0%**	4%	3%
Area of ceiling painting (m^2) = Area of plaster ceiling (m^2) + Area of suspended ceiling (m^2)	**0%**	1%	0%
EXTERNAL FINISHES			
Area of external wall painting (m^2) = Area of external wall plastering (m^2)	**0%**	1%	7%
Area of external ceiling finishes (m^2) = Area of external floor finishes (m^2) = Area of apron (m^2)	**5%**	8%	22%

Based on the Table 4.9, it illustrated the comparison between the percentage ranges of specialised software and manual production for bill of quantities for intermediate unit. From the findings using interquartile range, manual production of bill of quantities has higher percentage of difference as compared to specialised software production. Even some of the percentage range obtained twice or trebled or even more that the allocated minimum percentage difference.

Similarly to the comparison for corner unit, quantity produced manually for intermediate unit also achieved highest percentage difference of 33% for the area of soffit formwork to staircase. As compared to the quantity that produced through specialised software, it has no percentage difference on bulk check quantity. The highest percentage difference on bulk check quantity is 8% for the length of formwork to the riser. However, the quantity for the length of formwork to the riser that produced through the manual measurement has lower percentage difference at 2%. This may resulted to human factor in quantity take-off. For the specialised software, the lowest percentage difference from its allocated minimum percentage difference on bulk check quantity is 1% for ground floor fabric reinforcement; area of soffit formwork for upper floor slab; total area of internal wall finishes; and area of internal ceiling painting.

In addition, most of the items' quantity that produced by specialised software has achieved the allowance percentage range of difference. Hence, it shows that quantity produced through the specialised software has higher range of quantity accuracy compared to manual quantity production as it has lower percentage difference on bulk check quantity.

4.3.4 Summary for the Range of Quantity Accuracy between the Bill of Quantities (BQ) that produced using Specialised Software and by manual

Table 4. 10 Summary on the range of quantity accuracy

Specialised Software Measurement	Type of Measurement Method	Manual Measurement
Lower	**Range of Percentage Difference on Bulk Check Quantity**	Higher
More	**Number of items that achieved or within the allocated minimum percentage difference**	Less
Higher	**Range of Quantity Accuracy**	Lower

Based on Table 4.10, it summarized on the range of quantity accuracy resulted from the bulk checking on the bill of quantities (BQ) collected from the quantity surveying firms. From the findings, the range of the percentage difference on bulk quantity is lower for the specialised software meanwhile higher for the manual measurement. There are more number of items that achieved or fall within the allocated minimum percentage of difference as 0%, 3% and 5% for the specialised software measurement. In contrast, there is less number of items for the manual measurement. Thus, it can be concluded that the quantity that produced using specialised software having a greater accuracy as compared to the manual measurement.

4.4 Interview with Selected Respondents

Seven (7) respondents were interviewed during the data collection period. The respondents are from the quantity surveying firms who having experience and knowledge in preparation of quantities for projects bill of quantities. The interview form comprised of four sections. Section A was for the general information of the interviewee. The rest of the section comprised of open-ended questions that imposed in the interview to achieve the second research objectives which was to identify the factors affecting the accuracy of quantity in the bill of quantities.

During the data collection, the confirmation of the interview session with the interviewee was done through the phone call to ensure their willingness in acceptance of the interview. The interview session was mainly conducted in their respective offices. The list of interviewee was displayed in the Appendix D. The interview sessions were recorded using recorder and transcribed using Microsoft Word.

4.5 Respondents' Information

The design of the question in Section A was to identify the background information of the interviewees. The raw data was transcribed into table and useful information provided by the interviewees was highlighted in the following sub-topic.

4.5.1 Position of Work

The interviewees of this research objective were all working in the quantity surveying firms. Nevertheless, they worked as different work position in their firms. The Figure 4.1 and Table 4.11 show on the working position of the interviewees who involved in interview sessions.

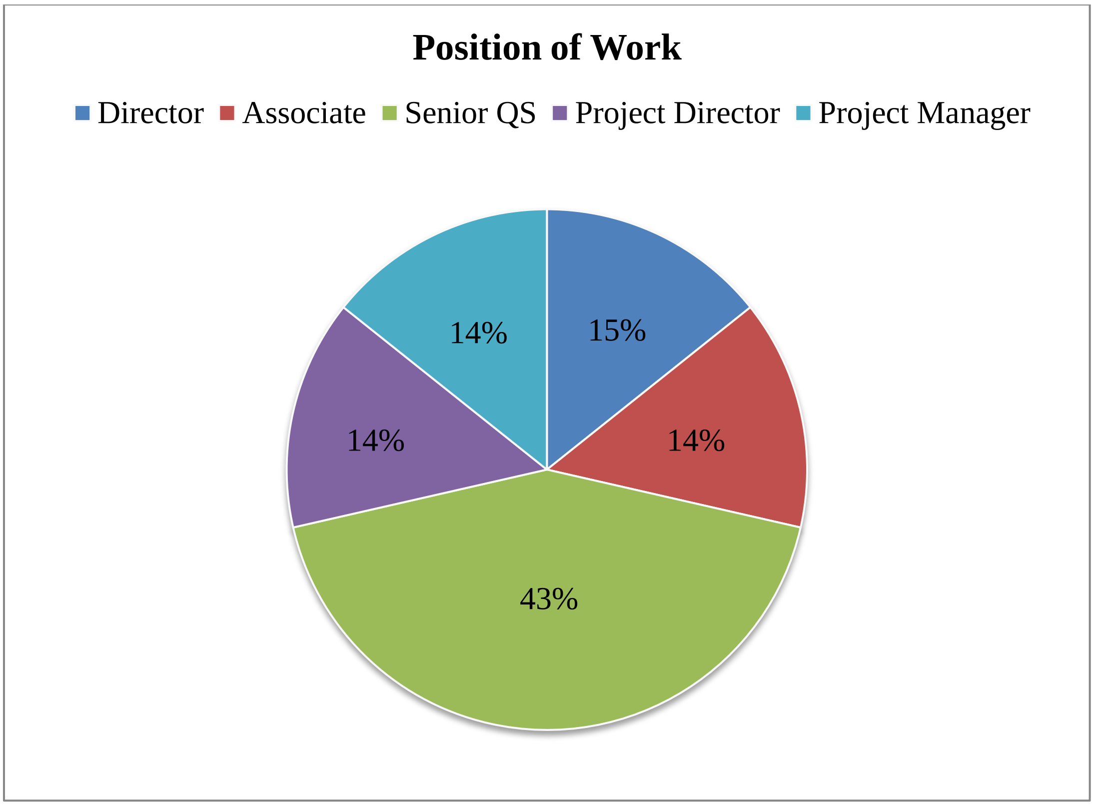

Figure 4. 1 Respondents' position of work

Table 4. 11 Respondents' position of work

Position of Work	Number of Respondents
Director	1
Associate	1
Senior Quantity Surveyor	3
Project Director	1
Project Manager	1

Basically, the work position of interviewees was important as it might affect the reliability of the data collected. In this data collection, there was one (1) director, one (1) associate who worked as top management in the quantity surveying firms. Other than that, the most of interviews were conducted with senior quantity surveyor which with a total of three (3). The interview session also conducted with one (1) project director and one (1) project manager.

The purpose of the interview session was to identify the factors affecting the accuracy of quantity in the bill of quantities. Therefore, as mentioned above the work position of respondent was correlated with the preparation of bill of quantities.

4.5.2 Working Experience

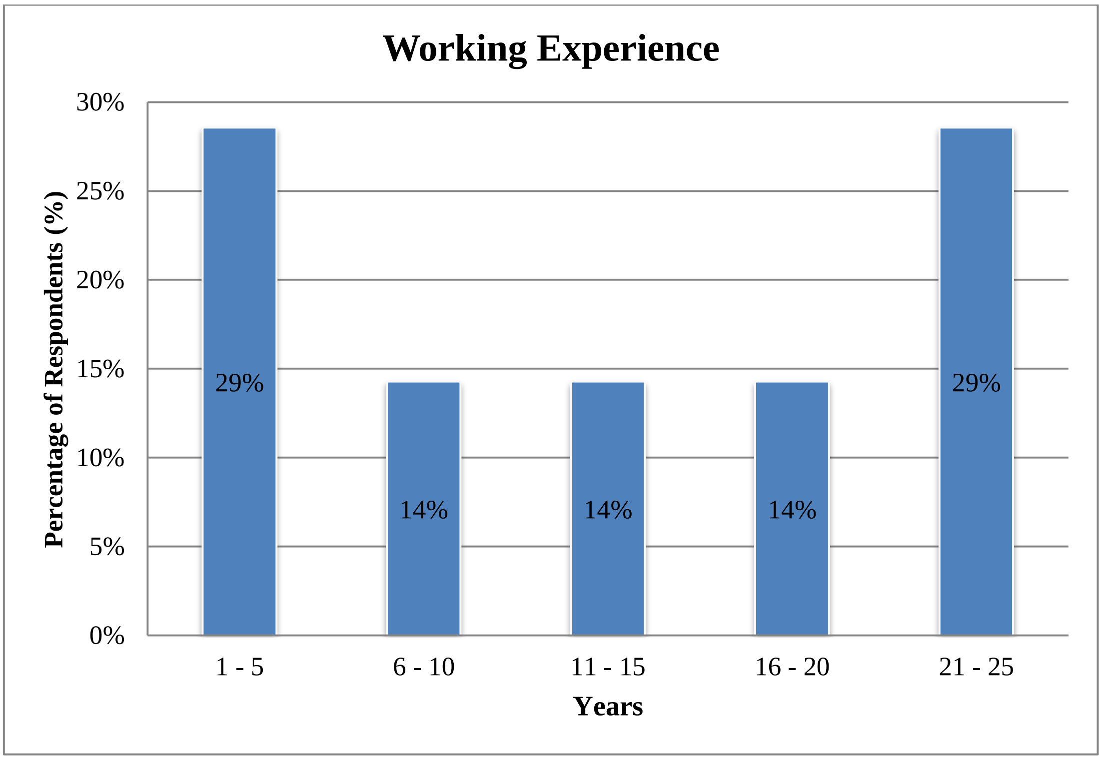

Figure 4. 2 Working Experiences of Respondents

According to the Figure 4.2, it shows that the working experience of the interviewees corresponded with the percentage number of interviewee. Based on the Figure 4.2, most of the interviewee's working experience was within one (1) to five (5) years and twenty-one (21) to twenty-five (25) years with 29% each. Meanwhile, there was 14% of the overall number of interviewees who had experience of six (6) to ten (10) years, eleven (11) to fifteen (15) years and sixteen (16) to twenty (20) years. Overall, the interviewees were experience person and eligible for the answering the question during the interview session as well as the data collected will be reliable that brought to achieve the success of research objective.

4.6 Thematic Analysis

Thematic analysis is a method that used to analyse the raw data from the interview sessions. The raw data that had been recorded during the interview had been transcribed into wording or table and useful information. Later, the raw data were given codes for the ease of theme categorisation.

In this research, the thematic analysis was used to identify the factors affecting the accuracy of quantity in the bill of quantities.

4.7 Factors Affecting the Accuracy of Quantity in the Bill of Quantities

This section discussed on the finding and analysis the factors affecting the accuracy of quantity in the bill of quantities in order to achieve my second objective.

Table 4. 12 Theme Categorisations

Code	Theme	Respondents
F1	Type of measurement method used in producing the quantities in the bill of quantities (BQ)	R1, R2, R5, R7
F2	Experience and knowledge of quantity surveyor (QS)	R1, R5, R6, R7
F3	Human errors	R1, R2, R3, R4, R5, R6, R7
F4	Discrepancies of drawings	R1, R7
F5	Time constraint in preparing the tender documents	R1, R7
F6	Insufficient items in bulk check list	R2
F7	Bulk checking practice	R3, R5, R7
F8	Lack of information	R5, R6
F9	Miscommunication among the taker-off	R5

Based on Table 4.12, it shows on the list of the factors affecting the quantity accuracy in the bill of quantities. The most significant factor on quantity accuracy is human errors.

4.7.1 Type of measurement method used in producing quantities in the Bill of Quantities (BQ) [F1]

Table 4. 13 Statements on type of measurement method

Statements	Respondents
"...using Cost X more accurate as it depends on what we click on. But when you are using scale rule and with your eyes, tendency to make mistakes."	R1
"...for earthworks used specialised software and calculation method is considered as better accuracy compare to use manual."	R2
"...the software cut short your process. More productivity. Avoiding silly mistakes. If you are doing manually, 2 times 6 maybe written as 5. For the software, it is already calculated for you. That one is the good thing. So it is more efficient. Reduce human mistakes method."	R5
"...I think if you are using the Excel definitely the accuracy less than using the Glodon..."	R7
"...specialised software doing more detail work as compared to manual measurement. It's like more automation. Easily to visualize. So, it can reduce the mistakes. When it comes to accuracy, the mistakes are very hard to justify..."	R7
"...Sometime the top bar, there will many lapping means at the cross beam there are many overlapping. If we measure without overlapping, in the Glodon we can set the rule, it will auto deduct. That's why I say the method of measurement actually affecting the accuracy."	R7

Table 4.13 shows the statements related to the type of measurement for quantity production in BQ. Generally, the type of measurement method was meant

by the method used in producing the quantities in the bill of quantities. There are different kinds of measurement method use by quantity surveyor in preparing the quantities in the bill of quantities in the quantity surveying firms. Basically, it is depends on the availability of software application in the firms. The measurement method choose may comprised of manual method of measurement which involved traditional taking off and spread sheet in addition measurement using specialised software such as Cost X, Glodon and Binalink.

According to the respondents, more than half of them agreed that the type of measurement method used in producing quantities in the bill of quantities. R1 mentioned that the measurement using Cost X was more accurate as compared to paper-based taking off using scale rule. This is because by using the specialised software it was generally dependant on the point clicked whilst there was a tendency in making mistakes when using the scale rule. For instance, the taker off might had wrongly read the scale on the ruler.

Other than that, R2 also highlighted that the measurement of earthwork using the specialised software such as Infravera was more accurate compared to method of using manually. Add on to this point, R5 said that the usage of the specialised software also managed to prevent silly mistakes and human mistakes especially in doing multiplication. For instance, two multiply six written as five and the multiplication supposedly is twelve. By using specialised software is said to have greater automation as compared to manual taking off which involved intensive labour input which is error-prone.

Apart from that, Glodon software was emphasized of having a greater accuracy compared to spread sheet such as Microsoft Excel by R7. According to R7, Glodon had its precept rules that able to minimize mistakes. It was easier to visualize can make auto deduction whenever it came with interception points. Specialised software can carry out the measurement in detailed as it was more automated. Thus, the mistakes were hard to justify. For example, when measuring for the fabric reinforcement, Glodon able to set rule prevent the overlapping of reinforcement meanwhile it was difficult in making the deduction for overlapping if using the Microsoft Excel. Hence, the measurement method affected the quantity accuracy in the bill of quantities.

4.7.2 Experience and knowledge of Quantity Surveyor [F2]

Table 4. 14 Statements on experience and knowledge of quantity surveyor

Statements	Respondents
"… for infrastructure we did not perform bulk checking. It is based on logical."	R1
"The experience of the staff, when they do the measurement, they already know the poundage… For the new fresh graduate, they don't know whether their quantity is not logic."	R1
"When you need the bill, you know when doing concrete work; there must be concrete, reinforcement, and formwork. Maybe if you talk about ground slab, damp proof membrane then anti-termite. Such knowledge. If you are junior, what's next supposing? For the experience staff, they can know the missing that anti-termite forgot to measure. Things like that. That's why the senior QS need to check all these things."	R5
"Do not know how to read the drawings, interprets the drawings wrongly. That's` why you do not obtain the correct quantity."	R6
"Sometime is the knowledge on the drawings. Because some of the junior are not really familiar with the project and they don't study the drawings…"	R7
"…Once they familiar with the drawing, they are more familiar with what kind of details to look for then they also familiar with company BQ."	R7
"…As we a using the Glodon, they use a 2D layout for doing the model. So, sometimes they don't refer to the details. Structural engineer and architect will give many details, sometimes is the typical details, sometimes in another drawings…"	R7

As a quantity surveyor, he or she required to equip with the knowledge especially in measurement knowledge and experience in projects estimation. The measurement must be accordance to the Standard Method of Measurement used, namely SMM2. Correct measurement way was very vital in order in achieving a greater accurate of quantities. Experience in projects estimation of quantity surveyor helped in determining the logical amount of quantities for a specified project. Table 4.14 depicted the statements by the respondents that related to the experience and knowledge of quantity surveyor.

Based on the statements in Table 4.14, four (4) of respondents agreed that experience and knowledge of quantity surveyor affected the quantity accuracy in the bill of quantities who are R1, R5, R6 and R7. In term of experience, R1 emphasized that the accuracy of quantity was dependent on logical quantity. Experience senior quantity surveyor normally will check on the quantity to ensure the quantity was logical, within the range and produced in a correct way before they transferred to the bill of quantities. If there was found illogical value, therefore, he had to counter-check the quantity obtained. For example, when measuring the concrete work, the senior quantity surveyor will check on the poundage. They will refer to previous similar project analysed or even they had already familiar with the standard quantity of poundage. If they found weird on the quantity, then for sure there will be something wrong. Then, he will check back the rebar and also for the concrete.

Knowledge on measurement items or known as taking off list is required as a quantity surveyor. This is because to ensure all the items are measured. R5 and R7 both said about related to knowledge as quantity surveyor with measurement knowledge, he would definitely know what kind of items to be taking off and what details to look for when doing the measurement as well as familiar with the standard of the bill of quantities; for instance concrete work comprised of concrete, rebar and formwork. Therefore, they can easily track the missing items.

In contrast, R1 highlighted that for the new fresh graduate quantity surveyor, it was hard for them in determining the logical value of an item due to lack of experience. Moreover, R6 stated quantity surveyor that had lack of knowledge on drawings in reading the drawings, consequences he interprets the drawings wrongly and obtained the quantity wrong. Furthermore, R7 also stated accuracy affected especially when some of junior who was unfamiliar with the drawings, did not study and understand the drawings. For example, when doing the measurement using Glodon, some of the details were located at different drawings but the junior having no knowledge on it. Thus, they definitely making mistakes resulted in irrelevant quantities. Same goes to the quantity surveyor who had lack of knowledge in measurement would result in incorrect way of measurement. Hence, the experience and knowledge in a quantity surveyor was very important in order to achieve quantity accuracy in the bill of quantities.

4.7.3 Human errors [F3]

Table 4. 15 Statements on human errors

Statements	Respondents
"Overlook. When you do the measurement, I can say that we always doing the same mistakes, over and over again even you are using the specialised software."	R1
"Quantity sometime not measured incorrectly. But then transferred incorrectly"	R2
"...measured in metre cubic but then in the BQ you measured in metre square. Cost different. Then the quantity becomes metre square."	R2
"...measure all the correct but you sum up wrongly."	R2
"Sometimes using Excel, if don't pull all the formula in"	R3
"...Sometimes the measurement is correct, but is the billing entered or not."	R3
"...Sometimes, the quantity is correct but when we go to the bill it is wrong. Sometime it is really a mistake, then we need to find out before we issue to the tenderers."	R3
"...Sometime, let 'say 100, maybe we will put down 1000 or 10. Or sometime unit rate wrong; metre square to metre cube. 10m2 and 10m3 a lot of difference."	R3
"...The computer is perfect. You give whatever data, it will give whatever data. It is perfect. Sometime is human, you miss out this one. You didn't see this is a wall, you didn't measure this wall. Same thing the drawings are perfect. You don't measure it, colour it, 'pangkah' it, then no measurement..."	R3
"...sometimes they didn't multiply it, then it becomes a	R3

mistake. Or they didn't do certain setting of computer software, then maybe they come out with different result…"	
"…Sometime measurement is correct, but when transferring is wrong…"	R3
"…it is depend how perfect the drawings are. Sometime, lines drawn for wall cannot be detected by the Glodon… You still need to go manually to see whether this is covered or not."	R4
"When you are rushing the works, will it affect the accuracy…is human because when you start rushing, when you start working until late night, the performances is slowing down… When the time is rushing, it forces you to make a lot of mistakes."	R5
"…During the measurement. Simple things like formwork for the beam. Side times two plus soffit. Sometime they forgot to times two. Sometimes they forgot to add the soffit."	R5
"…Since the specialised software already generated with formula, still got errors? Yes. Because it comes from the input from the human. Errors is not comes from the machine"	R5
"Is period for tender document preparation. That will affect. Let say the time constraint, you only have two weeks to prepare a very complicated building because you are rushing then mistakes tend to happen."	R6
"…overlooked the missing items…"	R7

Human errors basically occur due to the human nature himself. No one in this world is perfect. People tend to do mistake. We always do the same mistakes repeatedly even though the measurement was aided with specialised software. Hence, one of the factors affecting the quantity accuracy in the bill of quantities was human error. In this research finding, all the respondents claimed that human error was the major factor toward the quantity accuracy.

According to R1 and R7 statements in Table 4.15, missing items in the bill of quantities claimed as a result of human mistakes and R1 emphasized that it was due to human careless in overlooking the items during the measurement despite fact using of specialised software. R2 and R3 emphasized that the careless of quantity surveyor also occurs when transferring the quantities from the measurement into bill of quantities. Sometimes, the quantity of the measurement was correct but the quantity was keyed in wrongly by the quantity surveyor. Furthermore, measurement using specialised software also imposed with the human mistakes. R3 and R5 both emphasized that the input was inserted by human and tends to make mistakes. There also can make mistakes when the item supposedly tiles but the quantity surveyor measured it as carpet.

In addition, the accuracy of quantity also affected when different measurement units from the stated units in the bill of quantities as highlighted by R2 and R3. It was taker-off careless in doing measurement. Besides, they also mentioned that there were also formula errors occurs where the formula was wrongly set and having wrong sum up. For instance, when the quantity surveyor using software; Binalink, it was equipped with the formula. The quantity surveyor just keyed in the data and it generated the result based on the input inserted, thus it had no problems with the formula setting. In opposite, when using Microsoft Excel, it might have possibility of doing mistakes of not pulling all the formula in. It might cause the missing quantity.

Other than that, R3 and R5 also had highlighted that the accuracy also affected when the multiplication was conducted wrongly or did not do any setting for computer software. For example, the taker-off forgot to multiply two when measuring the sides of the beam formwork.

According to R5, human careless also happened whenever they rushed the work until late night because their working performances were gradually decreased with the increase of working hours. Thus, they tend to make mistakes. R4 also stated before doing the measurement, the taker-off was required to check manually if all the line detected when using Glodon, this was because sometimes the lines in Glodon failed to be detected. The checking shall be conducted to ensure all the items were covered in measurement. If they failed to do checking, thus it can cause lower quantity accuracy. As summary, human errors affects the quantity accuracy in the bill of quantities.

4.7.4 Discrepancies of drawings [F4]

Table 4. 16 Statements on discrepancies of drawings

Statements	Respondents
"... sometime the drawings we received, the scale from the architect or engineer is not to scale."	R1
"...Then, of course the detail for the drawings, sometimes there are many discrepancies between the architectural and structural drawings. We need to issue the queries. You know sometimes they also didn't return back."	R7
"Actually, the anchorage should be provided by engineer...Normally they will give 40d or 52d...using CAD drawings to measure the line that engineer draw. But actually the engineer draws line maybe not correct. Because sometimes they will just simple draw length there to show there is a bend and anchorage. The anchorage should follow the general notes by the engineer..."	R7

Discrepancies of the drawings meant by the drawings provided by the architects and engineers were incomplete or sometimes incorrect. Basically, the discrepancies of drawings might influence the quantity take-off. This was because if the drawings were not adequate therefore, and the taker off using the drawings for take- off. It resulted in the lack of quantities due to discrepancies of the drawings informations.

In general, the drawings normally were given to the quantity surveyor for the purpose of estimation. Based on the statement given by R1, sometimes the drawings received from the architects and engineers were not to scale. If the quantity surveyor failed to check the scale, perhaps, the tendency of inaccurate quantity will obtained.

Besides, there were also discrepancies between architectural and structural drawings as highlighted by R7. Therefore, quantity surveyor will send the queries to them but unfortunately sometimes when the queries issued were not replied by the architects or the engineers. Moreover, there were also times when the Computer Aided Drawing (CAD) file received had different from what the general notes. For instance, the line drawn by the engineer might not equal to what written in the general notes.

4.7.5 Time constraint in preparing the tender documents [F5]

Table 4. 17 Statements on time constraint in preparing the tender documents

Statements	Respondents
"…period of preparing the tender is too short affect the accuracy and very rush"	R1
"…we will assume. We will call up the architect and engineer and asked your drawings didn't come. So, how can assume; let say example one of my project, one of the layout which is the basement layout haven't done by the engineer… But certainly that one is not so accurate."	R7

Time management was very important in tender preparation. Failure to manage the time resulted in the inadequacy of the documents as well as might affect the quantity in the bill of quantities. The production of the bill of quantities was fully dependent on the drawings produced by the designers who were architects and engineers.

According to R1's statement as depicted in Table 4.17, period of preparing the tender document was short and causes the work carried out very rush. This might due to the late drawings received. R7 stated that in order to produce complete tender documents before the calling of tender, the quantity surveyor required in doing assumption based on the brief design from the engineers or the architects. However, the assumption might not so accurate. Thus, it affected the quantity accuracy in the bill of quantities.

4.7.6 Insufficient items in bulk check list [F6]

Table 4. 18 Statements on insufficient in bulk check list

Statements	Respondents
"…bulk means large amount. So like small items like sundries items, sometimes didn't put inside."	R2
"… Bulk check is a huge, can be considered as major amount in your contract to be checked. But then sure 70 or 80% will been checked. But then 20 or 30% will not been checked…."	R2

Fundamentally, bulk check list comprised of the major items that use when doing the quantity checking before finalising the quantity in the bill of quantity. Nevertheless, small items might not include in the checklist. Therefore, there might have the probability of missing items.

According to Table 4.18, R2 stated that bulk checking usually carried out on the major items which considered as major amount of contract up to 70% or 80% items. That means still got 20% or 30% items not being checked. Sometimes, the small items can be considered as big amount. So, if the items were missed up perhaps it required to pay for the loss. Comprehensiveness of the bulk checklist items affected the quantity accuracy.

4.7.7 Bulk checking practice [F7]

Table 4. 19 Statements on bulk checking practice

Statements	Respondents
"Bulk check is part of preventive action… Because of done so many wrong, also to know the potential items maybe the taker off overlook or oversight…"	R3
"We have the system of checking from the taker off. Actually we had not doing so much checking because we used to wait for final product. Like bulk checking is helping us. When the time is rushing, it forces you to make a lot of mistakes."	R5
"…at least we can check some mishap."	R5
"Sure, the bulk check practice will affect the accuracy. Some there is major mistake like you saw the poundage very high so means have certain problem in our quantity or engineer design."	R7

Bulk checking was an important and compulsory procedure that shall be undertaken when preparation of bill of quantities. It involved in the checking the major items in the project.

Among the respondents, there are only three respondents mentioning that bulk checking affect the accuracy as depicted in the Table 4.19. R3 emphasized that bulk checking should be practice as it helped in preventing overlook items which commonly might miss up by the taker-off. Besides, R5 emphasized that bulk checking practiced at the end of the product and was very beneficial especially during the time constraint. This was because, when rushing in completing work, it had the tendency exposed to the mistakes. By practicing the bulk checking, it helped in checking on some mishaps. R7 also stated when doing the bulk check on structural members, if the poundage was too high from the standard poundage therefore it must have certain problems on the quantity or engineer design.

Hereby, the bulk checking practice influenced the quantity accuracy as it helped in reducing the mistakes in the quantity.

4.7.8 Lack of Information [F8]

Table 4. 20 Statements on lack of information

Statements	Respondents
"…If there is an odd building like office building, shopping complex which is only single building, which is complicated, and the detail is also not so detail, then I will affect the accuracy of the quantity…"	R5
"…If the drawing is incomplete then it will indirectly affect the accuracy of quantity."	R6

Lack of information received for the preparation of the quantity in the bill of quantities affect its accuracy. Information also referred to the previous similar project. This was because the previous similar project can act as the reference for the quantity preparation.

Based on the statements in Table 4.20, R5 and R6 both mentioned that lack of information affect the quantity accuracy. R5 highlighted insufficient information especially for the complex project that had odd building like office tower and shopping complex affected the quantity accuracy in the bill of quantities. Moreover, sometimes the drawings were incomplete as there were only about 30% or 40% drawings available when the date of the bill of quantities preparation started. The available drawings were only major drawings that comprised of floor plans, sections and elevations. The details of drawings still not yet received. Thus, detailed information available might affect the quantity accuracy in the bill of quantities. In other words, quantity accuracy affected due to incomplete drawings.

4.7.9 Miscommunication among the taker-off [F9]

Table 4. 21 Statements on miscommunication among the taker-off

Statements	Respondents
"…Sometimes the soffit is measured under the slab. So many matters. The quantity is missing. You say the soffit must be measured by the slab taker -off, slab taker off say this one is under beam. So at the end of the day, both not measuring the soffit of beam…"	R5

Communication was an important in conveying the correct information. Miscommunication between the taker-off of the measurement work scope definitely affected the quantity accuracy. This was because it might result in the missing quantity.

According to statement of R5, miscommunication occurred when doing the measurement for beam formwork. Sometimes, the beam soffit was measured under slab soffit. Therefore, there happened where the slab taker-off said the quantity shall be measure by the beam taker-off and vice-versa. Consequences, the quantity might be missed up. Hence, miscommunication between the taker-off was one of the factors affecting the quantity accuracy in the bill of quantities.

4.7.10 Summary of Factors Affecting the Accuracy of Quantity in the Bill of Quantities (BQ)

Table 4. 22 Summary of Factors Affecting the Quantity Accuracy in Bill of Quantities

Themes \ Respondents	R1	R2	R3	R4	R5	R6	R7
Type of measurement method used in producing the quantities in the bill of quantities (BQ)	√	√			√		√
Experience and knowledge of quantity surveyor (QS)	√				√	√	√
Human errors	√	√	√	√	√	√	√
Discrepancies of drawings	√						√
Time constraint in preparing the tender documents	√						√
Insufficient items in bulk check list		√					
Bulk checking practice			√		√		√
Lack of information					√	√	
Miscommunication among the taker-off					√		

Overall, among the nine (9) factors affecting the accuracy of quantity, human errors was rated the highest among the respondents. Experience and knowledge of quantity surveyor and the type of measurement method used in producing the quantities in the bill of quantities (BQ) which rated second highest. Bulk checking practice ranked the third among the nine factors.

Discrepancies of drawings, time constraint in preparing the tender documents and lack of information were rated the second lowest among the respondents. Lastly, insufficient items in the bulk check list and miscommunication among the taker-off were rated the lowest among the respondents. As a conclusion, the human errors was the major factor that affected the quantity accuracy in the bill of quantities.

4.8 Summary of Chapter

As a conclusion, this chapter had discussed and analysed all the raw data obtained through the interview session and also documentary analysis. From the finding, basically the bill of quantities that produced through the specialised software having lower range of percentage difference as compared to the manual bill of quantities production. In contrast, the bill of quantities that produced through manual method of measurement was found of greater variability.

Apart from that, the most significant of factors that affects the quantity accuracy was human errors. Human errors might involve one’s carelessness either in doing transferring or keying the data into the bill of quantities. Besides, having person that careless also might overlooking items during measurement.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter summarized the findings and analyses for this research. The conclusion discussed based on the research objectives and related to the findings obtained. Other than that, this chapter also provided some recommendations for future potential research and limitation in this study.

5.2 Research Outcomes

The research objectives are to compare the range of quantity accuracy between the bill of quantities that produced using specialised software and by manual and follow by to identify the factors affecting the accuracy of quantity in the bill of quantities. However, this research concluded through two sections which accordance to highlighted objectives.

5.2.1 Comparison of quantity accuracy range between the Bill of Quantities (BQ) that produced using specialised software and by manual

In the first research objective, it is to compare the range of quantity accuracy between the bill of quantities produced by specialised software and by manual. Document analysis is conducted to achieve the first objective. The bills of quantities (BQ) of double storey terrace houses are collected from the quantity surveying firms in Johor Bahru. In addition, information related to quantity production and gross floor areas as well as drawings are obtained for the purpose of bulk checking.

For the corner unit, the quantity that produced through the manual measurement has the highest percentage difference on 33% whereas the lowest percentage difference of 3%. On the other hand, the highest percentage difference on the bulk check quantity using the specialised software is 12% and the lowest percentage difference is 1%.

Moreover, the quantity that produced through the manual measurement for intermediate unit has similar highest percentage difference on bulk check as corner unit at 33%. For the manual quantity production, it achieved lowest percentage difference of 2%. Adoption of the specialised software in quantity take- off for the intermediate unit has the highest percentage difference of 8% and the lowest percentage difference at 1%.

Based on the findings, the percentage difference for the manual measurement can be in the range percentage difference on bulk check quantity between 2% to 33%. As for the specialised software measurement, the range of percentage difference on bulk check quantity is between 1% to 12%. From the finding, it is clearly shown that the range of percentage difference on bulk check quantity for the manual measurement generally higher as compared to the specialised software measurement. The lower the range of percentage difference on the bulk check quantity, the greater the accuracy of quantity. The range of the quantity accuracy is highly dependent to the human nature in doing the quantity take-off for the projects.

5.2.2 Factors affecting the accuracy of quantity in the Bill of Quantities (BQ)

The second research objective is to identify the factors affecting the accuracy of quantity in the bill of quantities. Semi-structured interview has been conducted with the quantity surveyors from the quantity surveying firms in Johor Bahru. Thus, the most significant factors affecting the accuracy of quantity in the bill of quantities (BQ) are human errors, experience and knowledge of quantity surveyor, type of measurement method used in producing the quantities and followed by the bulk checking practice.

Human errors are one of the major factors affecting the quantity accuracy in the BQ. Generally, human is not perfect and is an error-prone. During the taking off, quantity surveyors are imposed with his carelessness such as overlooking the items, failed to transfer the quantity from the measurement sheet onto the bill of quantities, formula related error and multiplication error. Besides, quantity surveyors also tend in making mistakes when rushing the preparation of tenders. The human errors definitely affect the quantity accuracy in the BQ.

Quantity surveyor shall furnish themselves well with the measurement knowledge such as Standard Method of Measurement which provides them idea of the taking off items for each element to prevent any missing items as well as to ensure correct way of measurement. Knowledge on drawings is also important as to prevent misinterpretation that result in irrelevant quantities. For experience, quantity surveyor who has experience in project estimation could help him in determined the logical quantity take-off. For instance, they will always check back to the measurement whenever they found the quantity is illogical. Henceforth, the experience and knowledge in a quantity surveyor is important to ensure the quantity accuracy in the bill of quantities.

Other than that, the finding shows that the type of measurement method used in producing the quantities affect the quantity accuracy. Basically, the measurement methods available are specialised software measurement and manual measurement. Manual take-off had greater tendency in making mistakes as compared to the software application. Nevertheless, taking off using specialised software can prevent silly mistakes as it has a greater automation and having precept rules such as Glodon especially in measuring the steel reinforcement whereby the overlapping can be eliminate. Hence, the type of measurement method affects the quantity accuracy.

Bulk checking is said to be a preventive measures towards the accuracy of quantity in the BQ. The practice involved in checking the major items of projects. The comprehensiveness of the bulk check items are encouraged in order to prevent any other items miss up during the measurement. It can contribute towards better accuracy especially when the quantities are produced within the time constraint. Therefore, by practicing bulk check, the quantity surveyors can know if their quantity is within the acceptable range and also prevent any illogical value that arise the disputes.

5.3 Limitation of the Research

Through this research, there are numbers of limitations. The research encountered the following limitations;

a) Findings from this research can only applicable to the double-storey houses but not applicable to other types of the residential buildings such as bungalow, semi-detached and apartments.

b) Other than that, this research only provides an overview on the range of quantity accuracy between both manual and specialised software measurement but not specifically on method. For instances, range of quantity accuracy for paper based quantity take-off or spreadsheet measurement and the type of software adoption such as Glodon, Binalink, Cost X and others.

5.4 Recommendation for Future Research

Based on the findings and conclusion of this research, the followings are recommendations for future study;

a) Identify the limitations of quantity take-off features of specialised software.

b) Develop new comprehensive bulk check list accordance to Standard Method of Measurement II (SMM2).

c) For further research, conduct survey through the questionnaire for the firms who used both measurement method in quantity take-off to what extend the accuracy of quantity when utilized specialised software and manual quantity take-off.

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APPENDICES

APPENDIX A – BULK CHECK LIST

'BULK CHECK' LIST

Project Name :	**Project Code** :
	Block :
Person in-charge :	

FLOOR AREA

Floor Level	Height of floor level (Floor to Floor) (m2)	Gross Floor Area (m2)	Apron (m2)	Roof Area from plan (m2)
a.				
b.				
c.				
d.				
e.				
f.				
g.				
h.				
i.				
j.				
Total				

Checked by :
Date :
Notes :

A: PILING WORKS

Type of piling :
Size of piling :

Bulk Check' Items	BQ Quantity	'Bulk Check' Quantity	Percentage Difference on 'Bulk Check' Quantity	Minimum Percentage Difference	Comment and Analysis
Cutting of pile head (No) = Number of initial pile (No)				0%	
Driven depth (m) = Total length of pile provided (m) = [No. of initial pile(No) x Length of initial pile (m)] + Total extension pile length (m)				5%	
Other Items					

B: WORK BELOW LEVEL FLOOR FINISH

'Bulk Check' Items	BQ Quantity	'Bulk Check' Quantity	Percentage Difference on 'Bulk Check' Quantity	Minimum Percentage Difference	Comment and Analysis
Excavation of topsoil (m2) = Area of ground floor slab (m2) + Area of apron (m2) = Total area of hardcore (m2) + Lean concrete below the concrete bed (m2)				0%	
Total excavation (m3) = Total of back filling (m3) + Total disposal of soil (m3)				0%	
Area of concrete ground slab (m2) = Area of damp proof membrane (m2) = Gross area of ground floor slab (m2) - Area of lift core (m2) - Area of openings (m2)				5%	
Area of fabric reinforcement (m2) = Area of ground floor slab (m2)				3%	
Check poundage					
Other Items					

C: FRAME

'Bulk Check' Items	BQ Quantity	'Bulk Check' Quantity	Percentage Difference on 'Bulk Check' Quantity	Minimum Percentage Difference	Comment and Analysis
Volume column concrete (m3) = Area of column section (m2) x Average height (m) x Number of column (No)				5%	
Volume of beam concrete (m3) = Area of beam section (m2) x Length of beam (m)				3%	
Check poundage					
Area of column formwork (m2) = Average height (m) x Number of column (No) x [Length of side column (m) x 4]				5%	
Area of beam formwork (m2) = Total length of beam (m) x [Height of side beam (m) x 3]				5%	

D: UPPER FLOOR					
'Bulk Check' Items	**BQ Quantity**	**'Bulk Check' Quantity**	**Percentage Difference on 'Bulk Check' Quantity**	**Minimum Percentage Difference**	**Comment and Analysis**
Area of concrete upper floor slab (m2) = Gross area of upper floor slab (m2) - Area of lift core (m2) - Area of staircase (m2) - Area of openings (m2)				3%	
Area of fabric reinforcement (m2) = Total area of upper floor slab (m2)				3%	
Check poundage					
Area of soffit formwork for upper floor slab (m2) = Gross area of upper floor slab (m2) - Area of lift core (m2) - Area of openings (m2)				3%	
Other Items					

E: ROOF					
'Bulk Check' Items	**BQ Quantity**	**'Bulk Check' Quantity**	**Percentage Difference on 'Bulk Check' Quantity**	**Minimum Percentage Difference**	**Comment and Analysis**
Area of sloping roof covering (m2) = Area of roof from plan (m2) x (cos ɵ)-1 = Area of roof insulation (m2) = Area of sisalation (m2) = Area of roof battens (m2)				0%	
Area of damp proof membrane (m2) ***(Concrete Flat Roof)*** = Area of concrete screeding (m2) = Area of roof slab formwork (m2) + Area of soffit of roof beam formwork (m2)				5%	
Length of gutter (m) = Length of fascia board (m) = Perimeter of roof (m)				5%	
Total rainwater outlet (No) = Total rainwater outlet in drawings (No) = Extraover for damp proof membrane for rainwater outlet (No)				0%	
Other Items					

F: STAIRCASE					
'Bulk Check' Items	**BQ Quantity**	**'Bulk Check' Quantity**	**Percentage Difference on 'Bulk Check' Quantity**	**Minimum Percentage Difference**	**Comment and Analysis**
Height of the overall staircase (m) = Height of riser (m) x Number of risers (No)				3%	
Length of formwork for the riser (m) = Length of nosing tile (m) = Length of riser finishes (m) = Length of steps (m)				0%	
Length of formwork for string (m) = Length of string finishes (m)				0%	
Area of soffit formwork to staircase (m2) = Area of soffit finishes to staircase (m2)				0%	
Area of formwork for sloping slab (m2) = Area of finishes for sloping slab (m2)				0%	
Check poundage					
Other Items					

G: EXTERNAL WALL

'Bulk Check' Items	BQ Quantity	'Bulk Check' Quantity	Percentage Difference on 'Bulk Check' Quantity	Minimum Percentage Difference	Comment and Analysis
Perimeter for external wall (measured separately by floor level) (m) = Gross floor area for floor level measured (m2) x 4				1%	
Area of external brick @ concrete wall (m2) = [Perimeter of external wall by floor level (m) x Height of floor level (m)] - Area of openings on wall (Door & windows) (m2)				5%	
Area of formwork for external concrete wall (m2) = 2 x Area of external concrete wall (m2)				3%	
Check whether if the exmet and bonding ties are measured					
Other Items					

H: INTERNAL WALL

'Bulk Check' Items	BQ Quantity	'Bulk Check' Quantity	Percentage Difference on 'Bulk Check' Quantity	Minimum Percentage Difference	Comment and Analysis
Area of internal brick @ concrete wall (m2) = [Perimeter internal wall by floor level (m) x Height of floor level (m)] - Area of openings on wall (Door & windows) (m2)				5%	
Check whether if the exmet and bonding ties are measured					
Other Items					

I: DOOR

'Bulk Check' Items	BQ Quantity	'Bulk Check' Quantity	Percentage Difference on 'Bulk Check' Quantity	Minimum Percentage Difference	Comment and Analysis
Number of measured doors (No) = Number of doors in drawing or schedule (No)				0%	
Length of door frame (m) = Length of packing piece (m)				0%	
Length of door frame (m) / Number of doors (No) = ±5500mm				5%	
Number of door threshold (No) = Number of door (No) - Number of door without threshold (No)				0%	
Total length of architrave (m) = 2 x Length of door frame (m)				0%	
Area of painting (m2) = Area of door surface (m2)				3%	
Number of hinges (Pair) = [Number of single leaf door x 1.5 pair] + [Number of double leaf door x 3 pairs]				0%	
Number set of key (No) = Number of door (No)				0%	
Check whether steel frame, hinges, opening and painting are measured					
Other Items					

J: WINDOW

'Bulk Check' Items	BQ Quantity	'Bulk Check' Quantity	Percentage Difference on 'Bulk Check' Quantity	Minimum Percentage Difference	Comment and Analysis
Number of measured window (No) = Number of window in drawings / schedule (No)				0%	
Number of window threshold (No) = Number of window (No) - Number of window without threshold (No)				0%	
Check whether steel frame, hinges, opening and painting are measured					
Other Items					

K: INTERNAL WALL FINISHES

'Bulk Check' Items	BQ Quantity	'Bulk Check' Quantity	Percentage Difference on 'Bulk Check' Quantity	Minimum Percentage Difference	Comment and Analysis
Total area of internal wall finishes (m2) = Area of external wall (m2) + [2 x Area of internal wall] (m2)				3%	
Area of screeding (m2) = Area of wall tiles (m2)				3%	
Other Items					

L: INTERNAL FLOOR FINISHES

'Bulk Check' Items	BQ Quantity	'Bulk Check' Quantity	Percentage Difference on 'Bulk Check' Quantity	Minimum Percentage Difference	Comment and Analysis
Total area of floor finishes (m2) = Gross floor area (m2) - Area of lift core (m2) - Area of staircase (m2)				3%	
Area of screeding (m2) = Area of finishes above scrreding (m2)				3%	
Check whether screeding is measured when the floor tiles are used					
Check on the damp proof membrane for wet area					
Check whether the drop is measured					
Check whether skirting is measured					
Other Items					

M: INTERNAL CEILING FINISHES

'Bulk Check' Items	BQ Quantity	'Bulk Check' Quantity	Percentage Difference on 'Bulk Check' Quantity	Minimum Percentage Difference	Comment and Analysis
Area of ceiling plastering (m2) = Area of soffit upper floor slab (m2) + Area of soffit and sides of upper floor beam (m2)				0%	
Area of ceiling painting (m2) = Area of plaster ceiling (m2) + Area of suspended ceiling (m2)				0%	
Check whether the cornice and mouldings are measured					
Check whether the access panel is measured					
Other Items					

N: EXTERNAL FINISHES

'Bulk Check' Items	BQ Quantity	'Bulk Check' Quantity	Percentage Difference on 'Bulk Check' Quantity	Minimum Percentage Difference	Comment and Analysis
Area of external wall painting (m2) = Area of external wall plastering (m2)				0%	
Area of external ceiling finishes (m2) = Area of external floor finishes (m2) = Area of apron (m2)				5%	
Check whether drop is measured					
Other Items					

O: FITTINGS AND FURNISHINGS

'Bulk Check' Items	BQ Quantity	'Bulk Check' Quantity	Percentage Difference on 'Bulk Check' Quantity	Minimum Percentage Difference	Comment and Analysis
Number of fittings and furnishing (No) = Number of fittings and furnishing in drawings or schedule (No)				0%	
Other Items					

P: SANITARY FITTINGS

'Bulk Check' Items	BQ Quantity	'Bulk Check' Quantity	Percentage Difference on 'Bulk Check' Quantity	Minimum Percentage Difference	Comment and Analysis
Number of sanitary fittings (No) = Number of sanitary fittings in drawings or schedule (No)				0%	
Other Items					

P: PLUMBING WORKS

'Bulk Check' Items	BQ Quantity	'Bulk Check' Quantity	Percentage Difference on 'Bulk Check' Quantity	Minimum Percentage Difference	Comment and Analysis
Check the length of the supply pipe					
Check the connection to main items					
Other Items					

R: EXTERNAL WORKS

'Bulk Check' Items	BQ Quantity	'Bulk Check' Quantity	Percentage Difference on 'Bulk Check' Quantity	Minimum Percentage Difference	Comment and Analysis
Sewerage Piping					
Length of pipe (m) = Excavation of trenches for pipe (m)				3%	
Number of manhole (No) = Number of manhole cover (No)				0%	
Check the connection to main sewerage items					
Roadwork					
Area of bitumen layer (m2) = Area of trimming and compacting (m2) = Area of base layer (m2) = Area of wearing course (m2)				0%	
Check whether road marking, parking lots and kerb are measured					
Walkway					
Area of finishes (m2) = Area of concrete slab (m2) = Area of hardcore (m2)				0%	
Check total length of fencing measured					

S: PRIME SUM AND PROVISIONAL COST

'Bulk Check' Items	BQ Quantity	'Bulk Check' Quantity	Percentage Difference on 'Bulk Check' Quantity	Minimum Percentage Difference	Comment and Analysis
Check the prime sum and provisional cost requested by the client					
Other Items					

APPENDIX B – LIST OF BILL OF QUANTITIES OBTAINED

No.	Project Name	Consultant Firms
1	114 Units Double Storey Terrace Houses (22' x 75')	KAS Juruukur Bahan Sdn Bhd
2	147 Units Double Storey Terrace House (22' x 75')	KAS Juruukur Bahan Sdn Bhd
3	78 Units Double Storey Terrace House (20' x 60')	KAS Juruukur Bahan Sdn Bhd
4	215 Units Double Storey Terrace House (20' x 70')	AQS Services Sdn Bhd
5	53 Units Double Storey Terrace House (22' x 70')	ARH Juruukur Bahan Sdn Bhd
6	143 Units Double Storey Terrace House (22' x 70')	ARH Juruukur Bahan Sdn Bhd
7	Double Storey Terrace House (20' x 72')	Total QS Services
8	Double Storey Terrace House (22' x 72')	Total QS Services
9	Double Storey Terrace House (24' x 72') and (25' x 72')	Total QS Services

APPENDIX C – INTERVIEW FORM

Reference No:

FACULTY OF BUILT ENVIRONMENT
DEPARTMENT OF QUANTITY SURVEYING

RESEARCH TITLE:
DETERMINATION OF QUANTITY ACCURACY USING 'BULK CHECK'

RESEARCH OBJECTIVE:

To identify the factors affecting the accuracy of quantity in Bill of Quantities

==

SUPERVISOR	**:**	**ASSOC. PROF SR. DR. KHERUN NITA**
NAME	**:**	**SIA PEI ER**
IC. NO. & MATRIC NO.	**:**	**950310-13-6114 & A14BE0141**
COURSE	**:**	**BACHELOR OF QUANTITY SURVEYING**
H/P. NO & E-MAIL	**:**	**014-3986785 & faith100395@gmail.com**

NOTES: All the information provided will be kept **CONFIDENTIAL** and **ONLY** used for academic purpose.

Your cooperation is highly appreciated. Thank you.

SECTION A INTERVIEWEE PROFILE

Company Name : ______________________________

Company Address : ______________________________

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Name of Respondent : ______________________________

Position : ______________________________

Working Experience : ______________________________

Telephone Number : ______________________________

Email Address : ______________________________

Company stamp :

Signature :

SECTION B METHOD OF MEASUREMENT

Currently, construction industry had developed different kinds of specialised software that aided in quantity surveyors work. However, some of the firms still practice traditional method which involved taking off, abstracting and billing stages.

1. May I know what types of measurement method currently used in your company during preparation of bill of quantities (BQ)?
2. If specialised software is applied during preparation of bill of quantities (BQ), what kind of specialised software is used?
3. In your opinion, what is relationship between the measurement methods with the accuracy of the bill of quantities especially in terms of quantity?

SECTION C 'BULK CHECK' PRACTICE

'Bulk check' is an important procedure during preparation of bill of quantities. It prevents quantity surveyors from making major errors during preparation of bill of quantities.

1. During preparation of bill of quantities, do you practice 'bulk check'?
2. If 'bulk check' is not practiced, how you determined the accuracy of quantity in the bill of quantities (BQ)?
3. What types of 'bulk check' method you used?
4. What elements usually you choose to do 'bulk check'?
5. When is the best timing in doing the 'bulk check'?
6. Does your company own 'bulk check' list?

SECTION D FACTOR AFFECTING THE ACCURACY OF QUANTITY

Accuracy of the bill of quantities is important to prevent any disputes to time, cost and quality. Most of the time, deficiency of quantity had been debated because contractors had to bear the loss whenever the nett quantity in the bill of quantities is less than the actual quantity required.

1. What are the common errors that occur during the preparation of bill of quantities?
2. What are the factors affecting the accuracy of quantity in the bill of quantities?

~END OF QUESTIONS~

APPENDIX D – INTERVIEWEES' LIST

No.	Respondent's Name	Consultant Firms
1	Mr Afif Bin Shapiai	KAS Juruukur Bahan
2	Mr Sie Leeh Chyuan	JQS International Sdn Bhd
3	Sr Peter Kong	AQS Services Sdn Bhd
4	Miss Rafidah Binti Ismail	AQS Services Sdn Bhd
5	Mr Mairul Mahmud	ARH Juruukur Bahan Sdn Bhd
6	Miss Yee Han June	Baharuddin Ali & Low Sdn Bhd
7	Mr Ten Yuen Her	Total QS Services