Computer Aided Design (CAD) System for Quantity Surveyors in Malaysia

Final Report

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1.1 Background

Since the 1980s, there exist many speculations on the effect of computer aided design (CAD) software towards the quantity surveying profession. Many have mentioned the use of CAD software that can automatically generate bills of quantities would replace the quantity surveyor (Rycroft 1980, Campion 1980, Cox 1983, Brandon 1983 and Wexler 1986). This issue has received a lot of attention from the quantity surveying profession because CAD is now seen as being a threat to the "bread and butter" service of the profession, which is the production of bills of quantities. In as early as 1986, Royal Institution of Chartered Surveyors has commissioned a study into CAD opportunities for quantity surveying (McGeorge 1989). Since then there has been tremendous improvement in CAD technology that has not only spawn much improved draughting software but also improved measurement software that could extract quantities directly from CAD drawings thus further strengthened the possibility of computerized quantity measurements based on CAD drawings (Tse and Wong, 2004).

1.2 Definition of measurement

Measurement can be defined as a process to acquire quantities of items in a building based on drawings. It is done based on regulations that have been set in The Standard Method of Measurement of Building Works (SMM2). Besides that, measurement also involves the process of acquiring description for items based on drawings and specifications as stated in SMM2. Measurement is as part of the process of preparing a complete bill of quantities (Ong, 2004)

Quantities measurement is performed by using a scaled rule to measure the dimension from drawings and enter the dimension in a special ruled paper. The dimensions are then calculated according to the unit of measurement. The resultant lengths, areas and volume are transferred to the abstract, where they are arranged in a convenient order for billing and reduced to the recognised units of measurement; and finally the billing

operation, where the quantities involved are transferred in a suitable order under trade or elemental headings to the bills of quantities. (Seeley, 1999)

1.3 CAD Software

Construction industry first encounter with computer-aided draughting (CAD)software was in the 1970s. Such software replaced the manual drawing board and drawings can be produced in the digital format. As technology progresses, object-oriented CAD software was developed which also included functions relevant to the different participants of the design team. With such tools, making changes to the design will automatically update the changes in all documents, views, sections, elevations, schedules, layouts leading to tremendous saving in time and risk of errors (Wong, 1995).

Currently many architectural and engineering firms are utilizing 2D CAD software in the preparation of drawings, be it for design, tender or construction purposes (Wong, 1995). Realizing the possibility of acquiring quantities directly from the CAD drawings, software providers has managed to produce CAD based measurement software (CBMS). CBMS has added function of allowing the user to extract quantities. Some of the CBMS that is available in the market is CADlink, ArchidCAD, CADMeasure, Revit, Triforma and Autodesk.

1.4 Research Question

In line with our country policy to embrace technology and information technology in all areas, it is expected that the professional quantity surveyors should also follow suit. Nevertheless, after close to 30 years since the prediction of Brandon and a decade of investing in information technology, Jaffri (1994) and Ong (2004) has found that contrary to the architectural practices, usage of computerized measurement of quantities based on CAD drawings is still in its infancy stage in Malaysia. The low level of computerized quantities measurement by quantity surveyors does not augurs well for the profession in terms of technology advancement. With the promise of automated measurement by using CAD software, does this mean that measurement work, which is sole responsibility of quantity surveyor, can be taken over by other profession. As such, what is the actual impact of CAD software to the quantity surveying profession?

1.5 Research Aim and Objectives

The aim of this research is to investigate the benefit and threat of CAD software to the quantity surveying profession in Malaysia. In order to achieve this aim, the objectives are outlined as follows.

1. Identify the strength and weakness of CAD software for use by quantity surveyors.
2. Identify the usage of CAD software measurement function by architects.

1.6 Methodology

This study utilizes postal questionnaires survey as the main method of data collection. The postal questionnaire survey method was employed due to the population size of the respondents and also the need to survey two different groups of respondents. There was a need to allow the respondents to reflect on their experience in the use of CAD software and/or CBMS in answering the questions, thus questionnaire survey could allow the respondent to think about the questions before answering (Cooper and Schindler, 2003).

To achieve the first objective, data was collected from postal questionnaire survey to quantity surveying firms. Using judgmental sampling, opinions were sought from quantity surveying firms that have used CAD based measurement software in their work. Questionnaires were posted to 10 quantity surveying firms identified to have utilized CBMS in their office. Completed questionnaire was collected by hand from firms that did not return it by mail. Out of the 10 questionnaires sent out to the firms, 9 were returned. This provides a good response rate of 90%. In addition, two interviews were conducted with two experts in the study area.

For the achievement of the second objective, this research utilised postal questionnaire method to gather primary data from architects. Structural and civil engineers were not surveyed because a pilot survey confirmed that engineers do not use CAD software for their daily work but bespoke software that caters to their specific need, i.e. structural design. The full list of registered architectural firms in Malaysia for 2004 was obtained from Lembaga Akitek Malaysia (LAM). In all, 1,269 questionnaires were sent out to all the firms registered with LAM. A census was used to capture the richness of diversity of

the architectural firms in Malaysia, from the sole proprietor to the corporate categories. Ahmad (2003) discovered that even though postal questionnaire survey is a common method used in Malaysia, the percentage of obtaining good response rate is very slim. Still this research managed to achieve a reasonable response rate of 11%.

Statistical Package for Social Sciences was used for data transformation and analysis for this study. Descriptive statistics was applied in the analysis of data.

1.7 Scope of Research

Questions included in this research will cover both CAD software and CAD based measurement software. For the specific use of quantities measurement from CAD drawings, CBMS is preferred over conventional draughting software such as AutoCAD. Therefore, questions to the quantity surveying firms will only explore on the usage of CBMS. The reason being CBMS is specially programme for quantities measurement from CAD drawings and is relevant to quantity surveying firms while CAD software is written mainly for producing drawings.

The other professional in the industry that uses CAD drawings is the Architect and questions to architectural firms will explore on the use of CAD software and CBMS for measurement purpose. Engineering firms will not be surveyed as they do not utilized CAD software in the preparation of drawings.

1.8 Significance of Research Findings

The findings of this research provide a snapshot of the current usage level of computerized quantities measurement from CAD drawings by quantity surveyors. This will provide a point of reference for the profession to deliberate on the need for the profession to move forward in this area. The insights derive from the architects will allow the quantity surveyors to have knowledge of the technological advancement of their counterpart in the industry. This will help the profession in the strategic planning for the future. Thus, it is anticipated that the findings of this research will provide the impetus for the quantity surveying profession to chart the best course forward in technological advances for the betterment of the profession.

1.9 Outline of Report

This chapter introduces the study that will be undertaken. Chapter 2 will reviews the measurement process and the use of CAD software as a measurement tool. Chapter 3 reports the findings from the survey of quantity surveyors while Chapter 4 reports the findings from the survey of architects. Chapter 5 closes the report with highlights of the findings and suggestions for further research.

CHAPTER 2

MEASUREMENT AND COMPUTER

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2.1 Measurement

Measurement here is defined as the process to obtain quantities of each element and sub-element of a building from drawings by way of measuring the dimension using the scale rule. Taking-off is the usual term use for measurement. Element and sub-element pertains to the different part of a building that is commonly categorised as below in Table 2.1.

Table 2.1 : Breakdown of building elements

No.	Element and sub-element
1	Piling
2	Work below lowest floor finish
3	Frame
4	Upper Floors
5	Roof
6	Stairs
7	External Walls
8	Windows & External Doors
9	Internal Walls & Partitions
10	Internal Doors
11	Internal Wall Finishes
12	Internal Floor Finishes
13	Internal Ceiling Finishes
14	External Finishes
15	Sanitary Appliances
16	Plumbing Installation
17	Refuse Disposal
18	Air-conditioning & Ventilation System
19	Electrical Installation
20	Fire Protection Installation

21	Lift & Conveyor Installation
22	Communication Installation
23	Special Installation
24	External Work
	a) Site Work
	b) Drainage
	c) External Services
	d) Ancillary Buildings
25	Recreational Facilities

Note: adapted from ISM Guide to Elemental Cost Analysis

The purpose for doing this is to enable the calculation of the cost of constructing the building. The quantum of cost is determined by pricing the quantities of materials, with the current market rate that includes cost for materials labours, wastage and also overhead expenditure, to obtain the elemental cost. The total of each elemental cost will provide the total cost of constructing the building.

The Standard Method of Measurement of Building Works Second Edition (SMM2) sets out rules for the measurement and description of building works (Willis and Newman,1989). This is important so that both the producer and user of the bills of quantities know what is included and what is to be assumed.

The quantities obtained from the drawings will be formatted into a document named as bill of quantities. In addition to the quantities, the bill of quantities also contained information such as the description of each of the measured item. The guidelines on what should be included in the description are also contained in the SMM2. As such, it can be said that the preparation of bill of quantities is well regulated and has a standard format to be followed by industry players. The main item in a bill of quantities consists of the quantities and also the description of the work for the quantities.

2.2 Traditional Measurement Method

According to Wainwright and Whitrod (1981), there are two methods of measurement in building construction works namely, trade method and group method.

2.2.1 Trade Method

In this method, the quantity surveyor will measure the quantity according to the work description based on the equivalent standard measurements. For example, all brickwork measurements should be done before the rest of the building. Work description as stated in the bill of quantities should be obtained without doing abstract work. The weakness of this method is that the item to be measured may be inadvertently left out. This is because the quantity surveyor has to measure the entire building to obtain only one work description. Therefore, this method is now rarely practice by the quantity surveyor.

2.2.2 Group Method

Measurement done by this method follows according to the elements of the building in terms of substructure, superstructure, external wall and others whereby one element will be thoroughly measured covering all the work specifications before measuring other elements. In this way, measurement is done in a logical system and accuracy is assured as no items are omitted from the measurement. However, an abstract is needed before the bill of quantities is drawn up. An abstract is the collection of all quantities of the same items. In addition, description will also be written on to the abstract that corresponds with the quantities. Once the compilation is completed for all elements, it will be typed into a bill of quantities format.

2.2.3 Preparation of Bill of Quantities

The preparation of bill of quantities is usually done in one of the three methods, the traditional method, the cut and shuffle method or the direct billing method. Any of this method can be used to produce bill of quantities from measurement done either using the trade or group method.

The traditional method is the most basic and earliest method used in the preparation of bill of quantities. Measurement is done on traditional taking-off paper. Taking-off paper are special pre-printed paper used specifically for measurement. The quantities are then

abstracted into an abstract paper and finally into the bill of quantities. The cut and shuffle method is done on cut and shuffle paper. This is a special pre-printed paper that is sub-divided into four or five separate sections, which can subsequently be split into individual slips. This system is designed to eliminate the preparation and checking of abstract and draft bill process (Seeley, 1999). Due to the lengthy and tedious process in preparation of bills of quantities using the traditional method, direct billing method was introduced to shorten the process. This method transfers the items directly from the dimension sheet to the bill thus eliminating the need for an abstract. However, this method is suitable only for work that is not too complex (Seeley, 1999).

2.2.4 Measurement Process

Regardless of which measurement method is used the process of quantities measurement remains the same. The quantity surveyor first must know the unit of measurement for the building element that he is measuring. The unit of measurement for different building element and item is guided by the SMM2. Having that information, the next step is to extract the dimension from the drawing, which will then be recorded in the taking-off paper. The dimension written could either be the length, width or depth of an element or a combination of two or three dimensions, depending on the unit of measurement. If the unit of measurement required is volume, then all three dimensions will be written down. The extraction of dimension from the drawing is done using a scale rule and measuring the dimension directly from the drawings. If the unit of measurement required were number of items, the quantity surveyor would just need to count the quantity of items shown in the drawings. As the quantity surveyor need to measure each and every element and item in a building to extract the quantities for preparation of bill of quantities, this causes the measurement process to be a tedious and time consuming activity.

2.3 Computers for Quantity Surveying in Malaysia

According to Zainuddin (1986), the use of computers in the quantity surveying profession started in 1962 when the Royal Institution of Chartered Surveyors (RICS) set up a team of people to study the probability of computers being used in taking-off. In the mid 60s, they succeeded in producing bills of quantities using computers. Since then, quantity surveying firms started to use computers in producing bills of quantities. During the late

70s, a few firms started using micro-computers to produce bills of quantities and interim payments.

The use of computers in the quantity surveying profession in Malaysia began in 1977 in the Public Work Department (PWD) quantity surveying unit. The first computer, NOVA 840 along with the computer unit was created to prepare a program for bills of quantities. However, due to hardware problems, the attempt had to be stopped. In August 1983, PWD once again attempted to move forward by using the mini computer, Prime 750 to produce bills of quantities for school projects. Terminals and printers were distributed to branches.

In 1985, quantity surveying branches were equiped with APPLE MACINTOSH and IBM computers. Later, software called Quantity Surveying System (QSS) was used to perform functions such as taking-off, cost planning, tender management, progress payments, variation order, tender report, specifications, initial work list and contractor work list. Using computers during the 1980s were costly and required a certain level of skill, thus the development of computer usage in the quantity surveying field was slow and limited to documentation work such as the preparation of bills of quantities and interim payments.

In the 1990s, computer technology grew rapidly. With the advancement of computer gadgets and software, computer usage became more effective and user friendly. This indirectly contributed to the increase of computer usage in quantity surveying firms. Various softwares were developed to aid quantity surveyors in performing tasks like taking-off, bills of quantities, documentation, etc.

2.4 Use Of Computers In Measurement

In the 1980s, computers started making their way into the building industry. In the 1990s, technology advanced into exchange of data integration. In the 21st century, contractors will be able to receive project data and be able to tender via compact discs (CD) and the internet (Jarrett, 1991).

According to Lim (2001), information technology refers to all things related to computers and telecommunication systems used to record, store, process, present and receive

information. The information mentioned is in the form of numeric, graphics, documents, images and sounds. Telecommunication system enables information to be transferred from one place to another through the internet. Information technology has advanced substantially especially after 1998.

With the emergence of software such as Microsoft Windows, the usage of computers increased dramatically worldwide. The rapid development of technology resulted in the production of all kinds of new and advanced computer technology and this played a role in the lowering of computer prices. Incentives were also offered by the government to promote the usage of computers. The rapid growth of internet usage enables information to be transferred faster. As such, more and more quantity surveying firms use the internet to send and receive emails and drawings, as this is cheaper and faster compared to ordinary post or courier service.

As a result of this rapid growth in technology, the future of a quantity surveyor will be focused on the role as an information manager with the aid of electronic mails and business via the internet. Therefore, quantity surveying firms are encouraged to practice using the computer to perform traditional tasks that requires intensive involvement of workers such as producing bills of quantities, documentation etc (Donohoe & Symonds, 1999). A study done by Kirby (1991) also shows that technology enables a quantity surveyor to provide faster and more efficient service. Therefore, quantity surveyors are able to compete with other professions through information technology. Information technology enables decisions to be made based on more valid and reliable research and information. This has indirectly improved the value of service offered by quantity surveyors.

Approximately 75% of the workload of a quantity surveyor comes from preparing tender documents, post contract services, etc. (Wheeler, 1994). All these workload will diminish with the adoption of new technology and a change in contract handling. According to Smitch (1999), taking-off using the computer will be able to lessen the time spent to prepare budget and tender by 10%. Operation that normally takes a very long time will then be abandoned and replaced by quantifying items directly from the computer using available sophisticated software (Mokhtar, 1997). The most important issue for a

quantity surveyor is to be able to quickly produce quantities from measurements. This is to enable a more accurate construction cost management.

According to a study conducted by Smitch (1999) on his own workers, he found that 80% of their time was spent doing measurement of quantities while the balance 20% was spent on preparing the tender document and pricing. This is the core activity that any quantity surveying engages in during the stage of tender preparation.

In addition to being time consuming, Wheeler (1992) also raises the problem that measurements of quantities obtained manually from drawings are not accurate. This is due to various factors such as error in reading the proper scale and the scale of drawings may be inaccurate in reproduced drawings. Curran (1987) advocates that computer can measure quantities automatically and is more accurate compared to measurement done manually.

This goes to show that the usage of computers is vital to the quantity surveyor as it helps in reducing the time needed to prepare taking-off. Besides that, the accuracy level will be increased as the scale in CAD system is able to reach up to 1:1 but the scale in a printed drawing is only up to 1:100 or 1:50 (Ashley, 1997).

In addition to that, the usage of computers may help decrease the operation costs of a firm. According to Tan (2002), in Singapore, one of the government departments produced bills of quantities in a CD for their tendering exercise. A CD is able to store up to 250,000 pages. This way, expenditure for printing, time and electricity can be saved. This also gives the option of printing only the required parts needed by the contractor.

2.5 Use of Computer Aided Design/Drafting (CAD) software

According to Brandon (1992), there are three main tasks that involves the usage of CAD to produce more accurate and quality work:

1. Cost modelling
2. Bills of quantities production
3. Data management

2.5.1 Cost Modelling

The preparation of cost modelling in the initial stages of the design process is important as the cutting down of cost can be done at this stage. The quantity surveyor has to have a good rapport with the client and should be able to communicate effectively about the needs and implications of the costs upon the designs that are desired. Before the emergence of CAD software, the quantity surveyor had difficulties in identifying the effect of design and cost because the production of rough plans took a longer time and delayed the cost estimate. This caused many ideas to diminish before they can even be brought to the client. CAD has helped in improving communication ties between the quantity surveyor and the client as clients now are given the liberty of studying and visualizing the types of design produced by the architect. The quantity surveyor will then be able to take necessary actions immediately to show the implications of the cost involved. It would be redundant if the architect were able to produce various designs using CAD according to the clients' requirements in such a short period of time, yet the quantity surveyor is not able to quickly estimate the cost of the designs due to the time consuming tasks of measuring quantities.

2.5.2 Bills of quantities production

Currently the use of computers for production of bills of quantities mimicked the normal taking off process. Measurement was carried out with items selected from the computer's library of standard phraseology and directly keyed-in by the quantity surveyors (Curran,1987).

In contrast with conventional measurement software, CAD software can be used to measure quantities directly from CAD drawings. However, obtaining quantities do not automatically produced a bill of quantities. As mentioned earlier, there exists the process of abstracting and transferring of the quantities into the bill of quantities format. Currently, the production of bills of quantities directly from CAD based software (CBS) has yet to be developed. As such CBS is only able to help quantity surveyors to quickly generate quantities from drawings. For example, components such as windows, doors and sanitary fittings can be counted easily using scheduling. CAD measurement also includes the length and area of an object. Quantity surveyors are able to obtain these measurements accurately and with ease using CAD drawings by clicking the object and the software will compute the quantity needed. However, the proper instruction must be

given to the software in advance to ensure that the correct quantity is being computed. Nevertheless, in comparison with the manual method of measurement, using CAD software reduces the need to measure the different dimension, recording it in the taking-off paper and squaring the dimension to obtain the quantity. In brief, CAD software can provide the quantity in one step compared to three steps needed for manual measurement.

There are many CAD software that are being developed and available in the worldwide market namely Autocad, Microstation, ArchidCAD, InteliCAD, Architectural Desktop or Fast CAD software. Consequently, these software producers have also developed CAD based software for measurement.

CAD based software has been developed to directly measure quantities off 2D and 3D drawings. Some examples of CAD based software that could be used for measurement are as follows.

1. CADlink
2. ArchidCAd
3. CADMeasure
4. Revit
5. Triforma
6. Architectural Desktop

However, CAD software can only provide the quantities required but it does not have the ability to transform the quantities into the required bill of quantities format. The quantities obtained would have to be exported to another customised software for the preparation of bill of quantities.

2.5.3 Data Management

CAD-basd software is also used to manage data of a certain project more effectively. Data can be classified as graphic data and non-graphic data. Graphic data refers to drawings of a project. Meanwhile, non-graphic data are data such as specifications, quantities, costs etc. These data are grouped and arranged systematically. This enables the quantity surveyor to refer to the data with more ease. For example, a quantity surveyor is able to locate a certain drawing in the storage system of a computer

without much hassle. After a project has been completed, cost analysis can be done using the data stored. These data can also be used as a reference guide for future projects. CAD drawings can also be sent to the quantity surveyor in a matter or minutes through e-mails. This enables the quantity surveyor to receive drawings from the architect in a very short period of time after the design is completed. Any changes in design can be related to the quantity surveyor immediately and necessary changes in cost estimate can be done as soon as possible.

With the advancement of CAD system, quantity surveyors will benefit more compared to traditional method. Therefore, quantity surveyors should utilise CAD software to improve and upgrade their services and provide value for money for their clients.

However, the function that interests the quantity surveyor the most is the CAD software ability to measure quantities directly from the digital drawings. Extracting quantities from drawings have always been a slow and tedious process, requiring high manpower and are a process that cannot be rush. However, CAD software seems to promise that quantities can now be extracted quickly and accurately.

This research will only focus on the part of preparation of bill of quantities and not the cost modelling nor the data management function of CAD software.

2.6 Measurement Process using CAD software

According to a study conducted by Ong, et.al (2005), there are benefits and also problems related to quantities measurement using CAD software. To enable the measurement process to be performed in an efficient manner, the draughting method must be consistent and follow certain rules. Highlighted below are the benefits and barriers found in the study by Ong, et.al (2005).

2.6.1 Benefits of CAD software in measurement

1. The measurement process for irregular shape is faster and easier. If the irregular area measurement is measured manually, the irregular shape will need to be divided into a few regular shapes and the areas of each shape is calculated and totalled to get the area of the whole irregular shape. By using

CAD software, the area of irregular shape of a building can easily be measured by just clicking the boundary of the shape.

2. The layering concept in CAD software will assist the taker off in the ease of viewing and identifying the different type of floor finishes. Different floor finishes can be separated using various colours or hatch patterns and the exact area of the different type of floor finishes is then calculated by clicking on the objects. Area of floor finishes in separate location but is of the same type can be easily obtained by commanding the software to calculate area for all objects that contains the same code of the selected hatch pattern.

3. Measurement is more accurate as CAD drawings are produced in actual size and thus error in quantities due to usage of wrong scale is eliminated.

2.6.2 Barriers of CAD software in measurement

1. Objects must be drawn using "polyline" in CAD drawings to facilitate ease of measurement. If the object is not drawn using "polyline", CAD software can only measure the length of the line but not the area of the object. This will then defeat the purpose of using CAD software to measure as the quantity surveyor would have to revert back to the manual method of obtaining length and width to calculate area of an element.

2. Same object repeated in CAD drawings must be produced using the "cut and paste" function to enable the software to automatically measurement the numbers of such object, e.g. doors. This is so that the code of the object is the same, which will then enable the software to identify it during the measurement process. If this rule is not adhered to, the software will not be able to identify and capture the actual number of the same object.

3. The use of CAD software is limited to measuring quantities only. To generate Bills of Quantities, the quantities obtained has to be transferred manually or exported to another software that can generate quantities in a bills of quantities format. The requirement for the two-step method is cumbersome and mistakes may occur during transfer of data.

4. As the drawings are two-dimensional, measurement is also limited to unit of measure that required two dimensions only. As such CAD software would not be able to measure quantities that are require three dimensions such as the measure of volume.

5. CAD drawings should also be produced using a standard method of layering and naming the layers. For example, all doors must be produced in the same layers to enable the quantity surveyor to easily locate and measure.

6. Sketch drawings could not be measured using CAD software.

2.7 Threat from Computer Aided Design/Drafting (CAD) software

Before the emergence of computers, papers were the main means of communication between negotiators in the design process. These may come in all kind of forms such as drawings, cost planning, bills of quantities, specifications etc. The architect or quantity surveyor will handle details of a project. Now, the emergence of computers has altered the communication pattern in the design process. The use of computer aided design (CAD) software has become a norm among designers and many data is stored in the computer. Thus, in a way, CAD software has become an important means of communication between the designer and the people (Brandon, 1992).

CAD, which is an abbreviation for Computer Aided Design or Computer Aided Drafting, is a computer system that enables a computer to produce working drawings by designers. Currently, the most popular CAD software is AUTOCAD. CAD system can be found in two forms; 2D draughting system and 3D draughting system. 2D draughting system produces two dimensional drawings such as plans, shapes and symbols in drawings, and enables shapes to be scaled and rotated. 3D draughting system involves a three dimensional computer system that stores and presents objects in real life, other than curves and various geometrical shapes. Each object does not only store data that contains specific details but also from the aspect of the building that is related to the object (Smitch, 1999).

CAD software has been used in aiding the design process of the aeronautical and automotive engineering industry since the 1960s. Use of CAD software in the building industry started in the 1970s and it has proven to be economical.. In the present day, almost all designers use CAD software in the design process. From a study conducted by Edgil and Atkin (1987) on the usage of CAD system by quantity surveyors, the results showed that quantity surveyors have yet to fully understand the usage of CAD software. In actual fact, CAD software is a very useful tool for all professionals in the building industry, including quantity surveyors.

The advancement of CAD software usage is a challenge to QS. The pressure to become a cost consultant specialist in construction industry is increasing, since the scope of CAD software has expanded and is now able to generate quantities directly from CAD drawings. For example, quantity of items in units such as windows, doors and sanitary fittings can be produced together with the specifications for those items. Architects use CAD software to produce various designs in a shorter time and estimates by quantity surveyors are required in the same time frame. If quantity surveyors do not take the initiative to advance themselves by learning and adopting CAD software in their profession, their services may be affected. Smith (2004) found that in Australia, the usage of CAD software by quantity surveyors is still at a low level.

One of the fears that emanated from CAD technology is the automated quantities measurement would now allow profession such as Architect to produce bill of quantities instead of quantity surveyors (Rycroft 1980, Campion 1980, Cox 1983, Brandon 1983 and Wexler 1986). In other words, if the work of a quantity surveyor can be easily performed by the computer, anyone that knows how to use the software would be able to do the job. The most relevant profession that would pose a threat would be the architect due to reason that they are most well versed with CAD software. In addition, they are also part of the team that is involved in the preparation of bill of quantities. Therefore, if CAD software could automatically generate quantities, it would be easy for the Architects to use CAD software to produce drawings and bill of quantities. The service of the quantity surveyor would no longer be needed.

2.8 Layering

Layering is a technique used in CAD software to systematically store different information in different location for ease of reference and viewing. Layers containing information that is not currently required can be switched off. This facility enables the user to choose only the required information to be shown on screen at any one time.

In the construction industry, different consultant firms use CAD layer mechanism to structure their drawings differently (Bjork, 1997). Without standardization, drawings from different consultant has different configuration and the user of these drawings will have to spend time studying and understanding the different style.

Currently, there is no standardization in the division and naming of layers in CAD software but in countries such as Britain, USA and Canada there exists some standards some 30 years ago while Sweden established the SfB system 50 years ago (Goh & Chu, 2002).

Commonly, there are two main systems that is the AIA Layer Standard and the CSI standard. The AIA Layer Standard is a word-based system from the American Institute of Architects. This system categorizes the different layers according to the different professions that are involved in the construction industry, e.g. Architect. The CSI standard is from the Construction Specifications Institute. This system divides the layers according to different elements in a building.

In addition to the systems described above, the committee TC10/SC8 of the International Organization for Standardization have appointed a new working group ISO TC10/SC8/WG13 with the scope of defining an international standard for the use of layering in construction. The committee had its first meeting in Stockholm in October 1993 and a Draft International Standard was approved in September 1996 (Bjork, 1997). This system uses mixed letter number system to identify the party that is responsible for information stored in a CAD file.

2.9 Benefits and Barriers of Layering

Despite the fact that computer-aided design (CAD) systems are extremely powerful, they are not being utilized thoroughly in the industry (Marir, 1998). As more and more drawings are being produced using CAD software, the influence of CAD software has also expanded to non-designers in the construction team. Non-designers are frequently receiving digital copies of drawings for reference. However, in this country, as there is no standard system for layering, each designer layers his drawings according to his own reference system. Therefore, different designer will use different line styles, layer naming conventions, etc.

Lack of standardization will cost losses in terms of time, cost due to extra effort in interpreting the drawings and also quality problems (Marir, 1998, Tse and Wong, 2004). These problems constantly plague users of digital drawings and causes difficulty for

quantity surveyors to use the digital drawings to measure efficiently. Standardized layers and consistent appearance will allow the user to immediately measure without having to spend much time in interpreting the drawings. This translates into time and cost savings.

2.10 Summary

The measurement process is the core activity for quantity surveyors and at the same time is the most time consuming activity in any quantity surveying office. As measurement forms 80% of a quantity surveyors workload, it is only logical to look for a solution to improve the productivity in this phase of work. The evolution of computer in the field of quantity surveying is not new. It has begun as early as the 1960s (Zainudin, 1986) in the UK. The early experiences with computers are mainly concerned with using the computers to input quantities obtained from manual measurement with the added ability to perform faster calculation and to print quantities in the format of a bill of quantity.

However, due to technological advances, development of software for quantity surveying is now focusing on computerised quantities measurement directly from CAD drawings. Benefits of CAD software includes increase in the speed of measurement, ease of locating element by using the layers in the file and increase accuracy. The time saving benefit will lead to cost saving. Nevertheless, there are also limitation in the use of CAD drawings. In order for the file to be usable for measurement, the drawings must be produced using "polyline" and the function of "cut and paste" for repetitive items. In addition, it is possible only to extract quantities that are calculated using two dimensions because the drawings are drawn in 2-D. 3-D drawings are not common in the industry as yet.

CHAPTER 3

RESULTS AND DISCUSSIONS: SURVEY OF QUANTITY SURVEYORS

CHAPTER 3

RESULTS AND DISCUSSIONS : SURVEY OF QUANTITY SURVEYORS

To fulfil the first objective of the research, a survey was conducted to obtain the opinions from quantity surveyors on the strength and weaknesses of CAD software in measuring quantities for the preparation of bills of quantities. As the scope and questions will be narrowly focused on the use of CAD software to measure quantities, it is only relevant that the sampling frame should consist only of firms that have such software in their office. To identify the firms that have such software, a list of quantity surveying firms that bought the currently available software was obtained from the vendor. The type of CAD software that quantity surveyors purchase is CAD based measurement software (CBMS). The complete list of registered quantity surveying firms was obtained from the Board of Quantity Surveyors and to identify the sampling frame, this population list of registered quantity surveying firms were counter-check against the list of firms that have CBMS. It was found that currently only 10 quantity surveying firms have bought and utilises CBMS in the office.

Questionnaires were posted to all the quantity surveying firms identified due to the small number of respondents. Most of the questionnaires were returned by post. Those that did not return by post were collected by hand. In spite of that, out of 10 questionnaires sent out to the firms, only 9 were returned. Nevertheless, this provides a good response rate of 90%. However, due to the low number of data, advance statistical analysis is not suitable, thus data collected will be analysed and interpreted using descriptive statistics. In addition, two interviews were conducted with two experts in the study area to capture further clarification on the responses in the questionnaires. One expert is a director of an international quantity surveying firm in charge of IT and the other expert is the director of a CBMS provider. The names of the interviewees are not disclosed to uphold confidentiality.

3.1 Profile of Respondents

Respondent profile in terms of size of firms is quite balance as shown in Table 4.1. The measure of size in this survey is based on the number of staff employed. It can be seen that the usage of CBMS is not influence by the size of firms. This finding is confirmed by one of the interviewee as smaller firms have also purchased CBMS. The need of this tool would depend on the volume of work, specifically the preparation of bills of quantities that the firms have on hand.

Table 3.1 : Profile of Respondent by Size of Firms

No. of Staff Employed	Percentage of Respondent (%)
1 – 10	22
11 – 20	22
21 – 50	34
More than 50	22
Total	100

The survey indicated that CBMS is mainly used by firms that have been established 6 years or more as shown in Table 3.2. It is found that 67% of those using CBMS are established more than 20 years ago. This shows that while size of firm does not determine the use of CBMS, age of the firm has some influence. This could be due to the high capital cost needed for the purchase of software that deters the young firms from using CBMS. It is understandable that new firms are apprehensive about adopting new technology, as new software requires new hardware, support systems and also communication systems. Established firms would have the financial capability and confidence to invest in newer technology. The first interviewee opined that only large and financially sound would be able to purchase CBMS. In addition, the newer firms may not have the high volume of project as the more established firms and the current manual method is sufficient to handle to workload.

Table 3.2 : Years of Establishment

No. of Years	Percentage of Respondent (%)
1 – 5	0
6 – 10	33
11 – 20	0
More than 20	67
Total	100

3.2 Type of CAD Based Measurement Software

The survey found that the most commonly used software in the industry is CADMeasure (67%) followed by CATOPRO (22%) and PDS (11%). Respondents that are using CATOPRO and PDS have started since 3-5 years ago while those that are using CADMeasure only started about 2 years ago. Although this technology has been available in other countries in the past 10 years but it has only reach our shore in recent years. This concurs with a similar study conducted in Australia where the results indicate that quantity surveying profession is more conservative than most in terms of IT utilization (Smith, 2004).

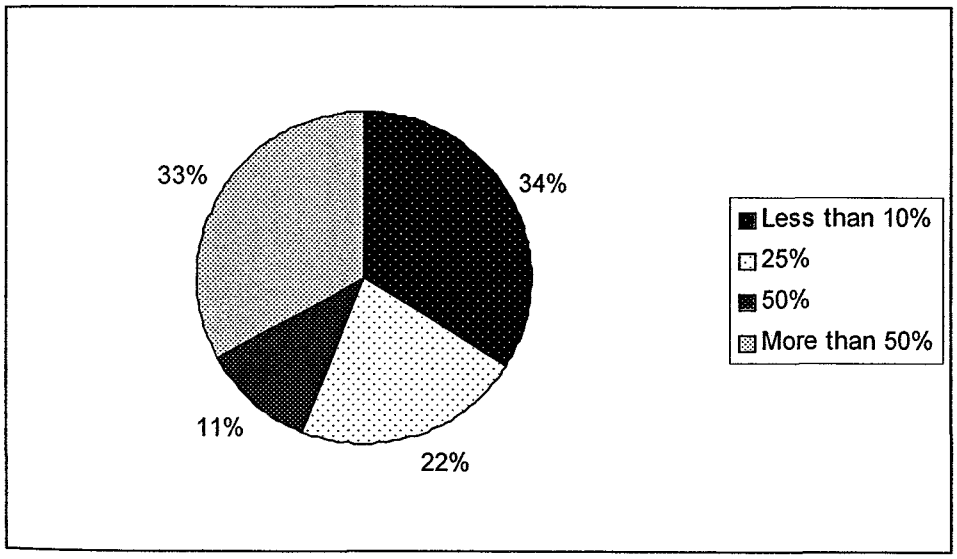
3.3 Transmission of CAD drawings

When employing new technology in measurement of quantities, there is also a need to integrate information technology so that the flow of data is not broken. To this end, the survey found that 8 out of the total 9 respondents utilized e-mails to transfer and receive CAD drawings for measurement. One of the interviewees mentioned that this method of communication cuts cost and delivery time. This finding concurs with the study conducted by Lim, (2002) where it shows that construction industry in this country has one of the highest accessibility to the Internet.

3.4 Use of CBMS

Although all of the respondents have CBMS but the usage of the software in measuring quantities for preparation of bills of quantities is still not widely use. The survey shows that 1/3 of the respondents uses the CBMS to produce more than 50% of their bills of quantities while another 1/3 uses it to produce between 25-50% of their bills of quantities. The last 1/3 uses it to produce less than 10% of the bills of quantities as shown in Figure 3.1. Taking into consideration that only small number of quantity surveying firms uses CBMS and within these firms, bills of quantities is still not fully prepared using CBMS. As such, we construe that the usage of CBMS in measuring quantity for preparation of bills of quantities in the industry is still very limited.

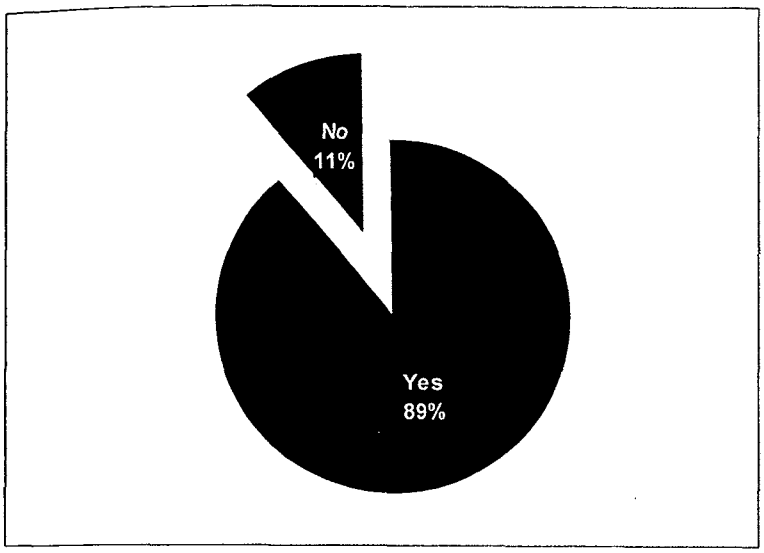
Figure 3.1 : Percentage of Bills of Quantities prepared using CBMS



3.5 CBMS able to measure quantities according to SMM2

In order to produce bills of quantities, it is crucial for the quantities to be extracted from the drawings according the rules in SMM2. As such any technology that assists in measurement must have the ability to enable quantity surveyors to configure the measurement accordingly. Majority of the respondents (89%) agreed that CBMS could be configured to allow the quantity surveyors to measure quantities in accordance to SMM2 (Figure 3.2). The interviewees further clarified that relevant instructions must be given to CBMS before measurement can be carried out to ensure compliance with SMM2.

Figure 3.2 : Ability to measure quantities according to SMM2



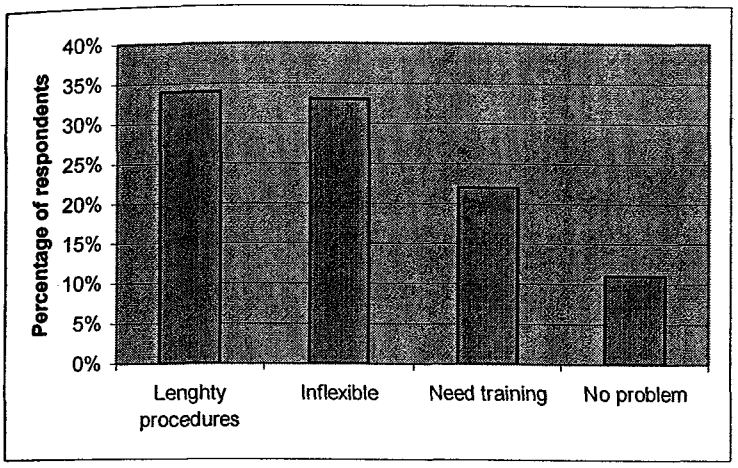
3.6 Disadvantages of CBMS

Based on the above findings, we would first focus on the disadvantages in using CBMS to understand why it is difficult for quantity surveying firms to fully adopt this technology.

The respondents indicated the following as common problems associated with CBMS (Figure 3.3).

a) The use of such software requires learning and remembering many procedures (33%)
b) Lack of flexibility (33%)
c) Need to train new staff to use the software (22%)

Figure 3.3 : Problems associated with CBMS



Using CBMS to take-off quantity requires the taker-off to perform a higher number of steps to produce the quantities in the bills of quantities format as compared to the manual method. However, as we say this, newer technology is being developed that allows seamless transfer of quantities from CBMS to the customized software for the preparation of bills of quantities. Nevertheless, this problem has not been fully solved and users of CBMS are still faced with the cumbersome method of manually abstracting and typing the quantities into the required format.

Firms that use CBMS would need to spend money and time to train existing and new staff to use the software before the CBMS can be utilized efficiently. This is due to the reason that quantity surveyors are not involved in the production of drawings and thus do not possess the skill in using CBMS. This could explain why the percentage of bills of quantities prepared by CBMS is still low. The survey further shows that 67% of the respondents conducted their training on their own (in-house) while 23% sourced for external training. This shows that although there is a need for training but time and cost could be reduced by organizing in-house training for their staff. This is one method that could be duplicated by other firms intending to use CBMS.

The education of quantity surveyors also does not focus on this skill, as it has never been required. However, change to education curriculum is necessary to produce quantity surveying graduates that are skilled in using CBMS to reduce the need for the employer to retrain the staff in this new skill.

The survey also probe for further problems and found that 78% of the respondents indicated that it is difficult to check the accuracy of the quantities if the measurement is done using CBMS as compared with the manual method. Only staff that is skilled in using the CBMS would be able to check the quantities easily. As such, if the senior staff were not skilled in using CBMS, they would face difficulty in checking the quantities measured by the junior staff.

89% of the respondents also agreed that CBMS is not user friendly. The reasons given are the icons and menus are different and need training to familiarize and understand the functions of each icon. In addition, the need to transfer the quantities from the CBMS to another software creates additional work and problems.

3.7 Layering

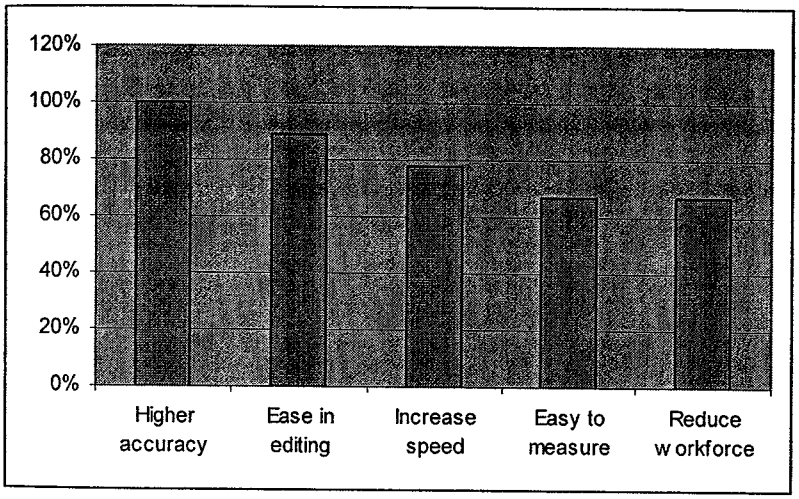
As discussed in Chapter 2, one of the problems that the quantity surveyor may faced is the due to the different conventions employed by different architect in naming the layers in a CAD drawing file. The survey attempted to elicit from the quantity surveyors problems pertaining to layering and found that no standardization in naming and no segregation of elements in different layers causes problems to quantity surveyors. Having a standard layer naming convention will enable the users of the CAD drawings to quickly understand the information contained in each layer which will further increase the speed in measurement. Segregation of different elements will then follow the convention in the naming of layers and thus reduced the difficulty of quantity surveyors in locating the required information. However, opinion differs between the interviewees. One opined that many might not follow the established standards even though there is one while another advocates for an industry standard for better co-ordination of drawings between consultants.

3.8 Advantages of CBMS

Following are the advantages as indicated by the respondents (Figure 3.4).

a) Higher accuracy (100%)
b) Ease in editing the measurement (89%)
c) Increase speed of measurement (78%)
d) Easy to measure (67%)
e) Reduction of workforce (67%)

Figure 3.4 : Advantages of CBMS



All of the respondents agreed that utilizing CBMS in measurement of quantities produces high accuracy. Measurement of quantities directly from CAD drawings removes the need to reproduce drawings on paper. Reproduction of drawing on paper will reduce the accuracy of the drawings and measurement scaled from paper will further erode the accuracy (Wheeler, 1992). Mistakes due to human error in reading the dimension off scale rule and recording the dimension on paper or spreadsheet file is also eliminated. As such, using CBMS in measurement of quantities can enhance the accuracy of quantity surveyors work.

89% of the respondents agreed that as compared to the manual method, CBMS allows for easy editing of quantities measured. This is due to reason that similar with any other software, CBMS also contained function such as block, entity area, copy, paste, delete, undo that facilitate the editing process. Most of the respondents (78%) also agreed that using CBMS increases the speed in measuring quantities as compared to manual

method. This is due to the semi-automatic ability of the software to generate quantities. For example, just by giving a command to the software to calculate the number of Type A door in the drawing, it can generate the total number of Type A doors. Compared to the manual method, the taker-off would have to physically count the door one by one which would take a longer time.

Although CBMS reduces the time needed for measuring quantities but one-third of the respondents still think that using CBMS does not mean it is easier to measure quantities. However, 67% of the respondents indicated that CBMS do make it easier to measure quantities as compared to the manual method. This could be due to the reason that the ability to generate quantities is not applicable to all type of building elements. Only elements that are measured in number and area are able to utilize the ability of the software to auto-generate quantities. For quantities that are required in volume, the measurement process would be more difficult if compared to the manual method.

67% of the respondents agreed that workforce required to measure quantities could be reduced with the use of CBMS. Only 33% maintained that the number of staff could not be reduced. However, the common practice in the industry is that most quantity surveying firms have reduced the number of technical assistants specializing only in measurement of quantities. Instead there are more assistant quantity surveyors that have a wider scope of work, which includes both measurement of quantities and project administrative work as explained by one of the interviewees. Quantity surveyors now are required to be able to multi-task instead of specializing. This shows a shift in the type of worker needed by the quantity surveying firms due to utilization of technology. With the use of technology, the measurement work is now easier and faster but the skill needed has also evolved to a higher level.

3.9 Cost of Software

Surprisingly, 67% of the respondent indicated that they do not find the cost of CBMS high while only 33% indicated otherwise. As such, it would seem that cost might not be a barrier in using CBMS for quantity surveying firm. Although this seems to be the case, the use of CBMS is still low in this country. To identify the reason for this is would require further study, which is beyond the scope of this current research.

3.10 Conclusion

The survey yielded several insights into the use of CBMS by quantity surveyors as follows.

1. Years of establishment rather than size of firm is the determinant on whether a particular firm might use CBMS.
2. Although the respondents have purchased the CBMS for measurement purposes and the main objective is to help in the preparation of bills of quantities, the survey found that none of the respondents use the CBMS in all of their bills of quantities work. At most only 1/3 uses it to prepare more than 50% of their bills of quantities. As such, the usage level is considered to be low even for firms that have the software.
3. CBMS can be configured to measure quantities in accordance to SMM2. The study also found that such compliance is dependent on the ability of the quantity surveyor rather than the software.
4. The survey also shows that the barriers faced by quantity surveyors in using CBMS centre on the need for learning of a new skill. Training will need cost and time and this is off-putting to both employer and employee. If the quantity surveying graduates are already equipped with the skill in using CBMS, logically, it would be easier for employer to convert to digital measurement from CAD drawings.
5. The respondents agreed that using CBMS create benefits in terms of the increase in accuracy, increase in speed of obtaining quantities, ease of editing, the measurement process is easier and also reduce the need for manpower which is one of the universal benefit of automation using technology.
6. Although it is the initial thinking that cost will be the biggest barrier in purchasing CBMS, surprisingly the survey shows that more than half of the respondents do not find that cost is a deterrent. It would be to the benefit of the profession to further explore what is the biggest barrier and to find a solution to remove the barrier.

CHAPTER 4

RESULTS AND DISCUSSIONS: SURVEY OF ARCHITECTS

CHAPTER 4

RESULTS AND DISCUSSIONS: SURVEY OF ARCHITECTS

Opinions were sought from architectural firms that have used CAD software in their work. Postal questionnaire survey was used, as the population number is big and also widely dispersed geographically. Questionnaires were posted to all architectural firms registered the Board of Architect, amounting to 1,269. Ahmad (2003) discovered that even though postal questionnaire survey is a common method used in Malaysia, the percentage of obtaining good response rate is very slim. Nevertheless a response rate of 11% was achieved which is satisfactory for survey using the postal questionnaire method.

4.1 Profile of Respondents

Respondent profile is shown in Table 4.1. Majority of the respondents are of small to medium size. The measure of size in this research is based on the number of staff employed.

Table 4.1 : Profile of Respondent by Size of Firms

No. of Staff Employed	Percentage of Respondent (%)
1 – 5	52
6 -10	27
11 – 15	16
16 - 20	3
21 and above	2
Total	100

4.2 Application of CAD software in architectural firms

Almost all respondents (97%) agreed that CAD software should be used in the daily practice of an architecture firm (Table 4.2). This shows that unlike quantity surveyors as shown in Chapter 4, most architectural firms use CAD software in their daily work.

The reasons cited being:

(a) Time saving in editing drawings (72%)

(b) Time saving in preparing drawings (61%)

(c) Better productivity (32%)

(d) Cost saving in preparing drawings (25%)

(e) Better appearance in drawings (16 %)

Table 4.2: Response to the question whether CAD software should be used in the architecture daily practice.

No:	Response	Percentage (%)
1.	Agree with application of CAD software in architecture daily practice.	97%
2.	Disagree with application of CAD software in architecture daily practice.	0%
3.	No idea	3%

For those that did not support the application of CAD software in daily practice, the main reason are as follows:

(a) Lacking of IT exposure (78%)

(b) Not involved in design stage (12%)

4.3 Quantities measurement package incorporated in CAD software

Majority (67%) of the respondent firm's CAD software did not incorporate quantities measurement package (Table 4.3). When probed further, the reason given was high cost and risks involve in ICT investments. Architecture firms, like any other businesses, have to ensure that the software package would give them the best return on investment. Furthermore, quantity surveyor will be appointed who will be responsible for measuring quantities.

Table 4.3 : Measurement package in CAD software

Response	Percentage (%)
Yes	28%
No	67%
No Idea	5%

The survey also shows that 82% of the respondents use AutoCAD and none uses CAD based measurement software. Although AutoCAD have measurement function but it is limited as compared to CAD based measurement software such as CADMeasure. Thus it can be construed that architectural firms utilises CAD software more for production of drawings rather than production of quantities.

4.4 Use of CAD software as measurement tool and familiarity with SMM2

Only 23% of the respondents use quantities measurement package in their CAD software while 77% did not use CAD software as measurement tool. Of the firms that use CAD software to measure, it was primarily utilised for basic area measurement and enumerating sanitary wares and fittings. None of the responding firms prepared bill of quantities using the software.

The survey shows that 80% of the respondents indicated that their staff is not familiar with SMM2 while 12% answered positively. The balance 7% does not know if the staff has such knowledge. The standard method of measurement is crucial in measurement and as such could be used as an indicator to determine whether the firm engages in measurement actively or not. A cross-tabulation of the data showed that 41% of those

that use quantities measurement package are not familiar with SMM2 (Table 4.4). Eliminating the above 41% and also those that have no idea if their staff is familiar with SMM2 would leave only 9% (N=13) of the respondents that use CAD software as measurement tools and also possesses the required knowledge in the standard method of measurement.

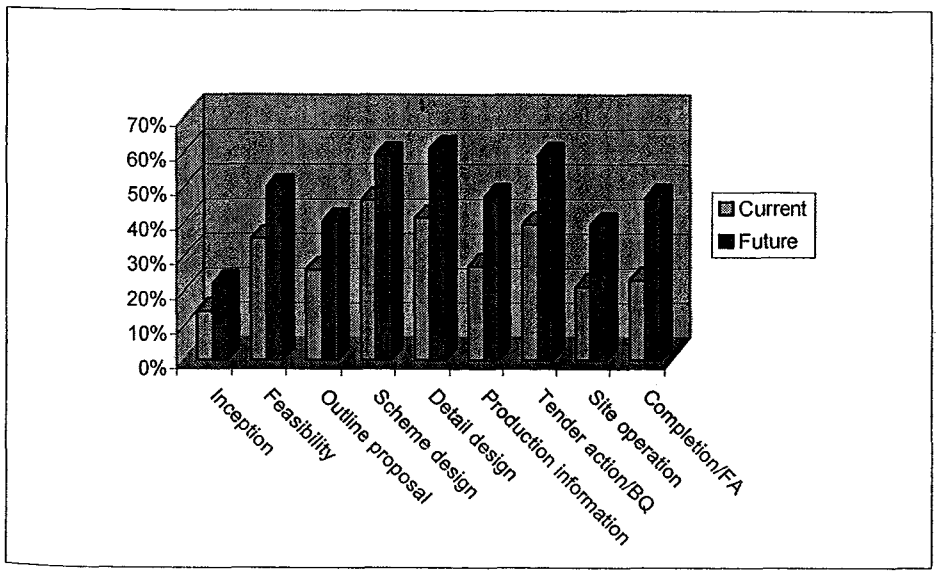
Table 4.4: Cross-tabulation between using CAD software as quantities measurement tools with staff that are familiar with SMM2

Use CAD as quantities measurement tools.	Staff familiar with SMM2			Total
	Yes	No	No Idea	
Yes	13	13	6	32
No	3	98	4	105
Total	16	111	10	137

4.5 Use of CAD software as measurement tool in different stages of work

Although currently the respondents indicate that the use of CAD software as measurement tools in all stages of work is less than 50% but the indication is that the usage will increase in the future. The survey indicates a rise in the use of CAD software as measurement tool in all stages of work as shown in Figure 4.1.

Figure 4.1 : Current and future use of CAD software as measurement tool



The highest increase (24%) is shown to be at the completion and preparation of final account stage followed by the detail design, production information and tender action/ bills of quantities stage (20%) as shown in Table 4.5. Although both shows an increase but from a quantity surveying point of view, tender action/BQ stage would definitely entails much more measurement than the completion/FA stage. This discrepancy between the volume of measurement work between architect and quantity surveyor may indicate that the architect do not have the intention to venture into bills of quantities production but to use the tools as a design check by calculating the floor areas.

Table 4.5: Anticipated increase in future use of CAD software as measurement tools in the various stages of work

Stages of Work	Current Use	Future Use	Increase
Inception	14%	22%	8%
Feasibility	35%	50%	15%
Outline Proposal	26%	40%	14%
Scheme Design	46%	59%	13%
Detail Design	41%	61%	20%
Production Information	27%	47%	20%
Tender Action/BQ	39%	59%	20%
Site Operation	21%	39%	18%
Completion/FA	23%	47%	24%

4.6 Soft copy of drawings provided to quantity surveyors for costing exercise.

Almost all of the architects that responded to the questionnaire (98%) indicated that practising quantity surveying firms did not accept drawings in soft copy for measurement purpose as they did not have the required measurement software. Some of the respondents even mentioned that the quantity surveying firms did know how to operate the CAD software, in part due to the lack of standard protocol management system, in part due to the reluctance of the latter to invest in the required software.

Overall, almost all of the respondents (99%) concurred on the importance of quantity surveyors in the Malaysian construction industry. Even with the advent of CAD based measurement software, the traditional roles of the quantity surveying profession, especially in tender documentation, costing and contracts, is still required by the industry.

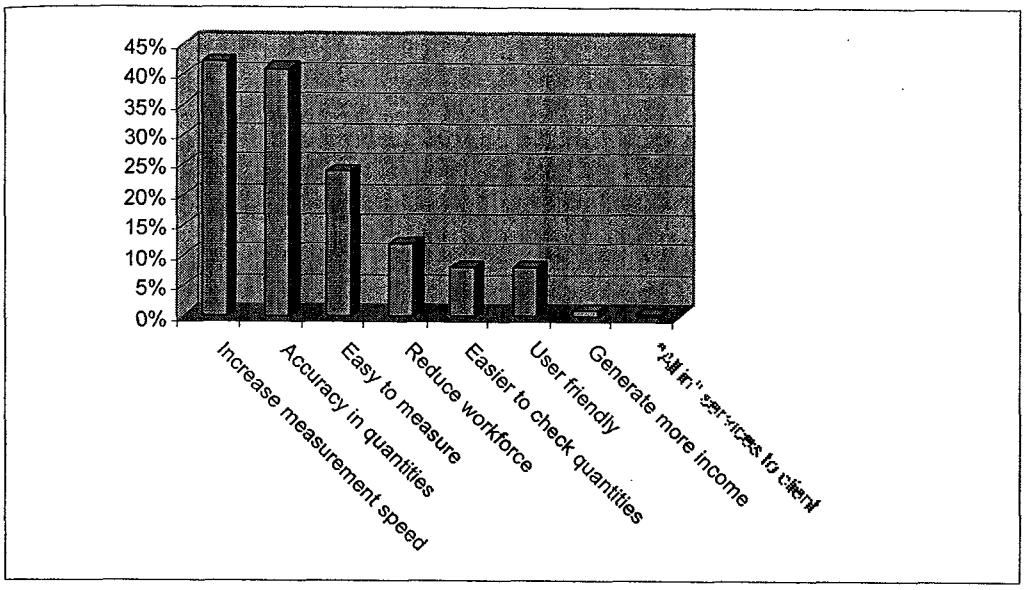
4.7 Advantages of CAD software as quantities measurement tool.

The advantages of using CAD software as a quantities measurement tool according to respondents are as follows (Figure 4.2):

(a) Speed up the measurement process (42%)
(b) Accuracy in quantities (41%)
(c) Make measurement an easier task (24%)
(d) Reduce workforce in measurement (12%)
(e) Easier to do checking in quantities (8%)
(f) User friendly, easy to learn and use (8%)
(g) To generate more income – additional scope of work (1%)
(h) Provision of "all-in" services, which include quantities measurement (0.3%)

Similar to the quantity surveyors, the architects also concur on the advantages of CAD software as quantities measurement tool with one difference. Where the quantity surveyors found it not user friendly, the architects think otherwise. This could be due to the familiarity the architects has with the software as compared to the quantity surveyors who are new to it. The last two advantages indicate that architects have no interest to provide and "all-in" type of service that also includes quantities measurement. This shows that there is no threat from the architect in trying to take over the job of a quantity surveyor.

Figure 4.2: Advantages of CAD software as measurement tool



4.8 Disadvantages of CAD software as quantities measurement tool.

The disadvantages of using CAD software as a quantities measurement tool according to respondents are as follows (Figure 4.3): -

(a) Cost software very expensive (50%)

(b) Limited usage in certain stage. (21%)

(c) Difficult to trace mistake. (8%)

(d) Too many procedure to operate program (7%)

(e) Quantities measurement process more complicated (5%)

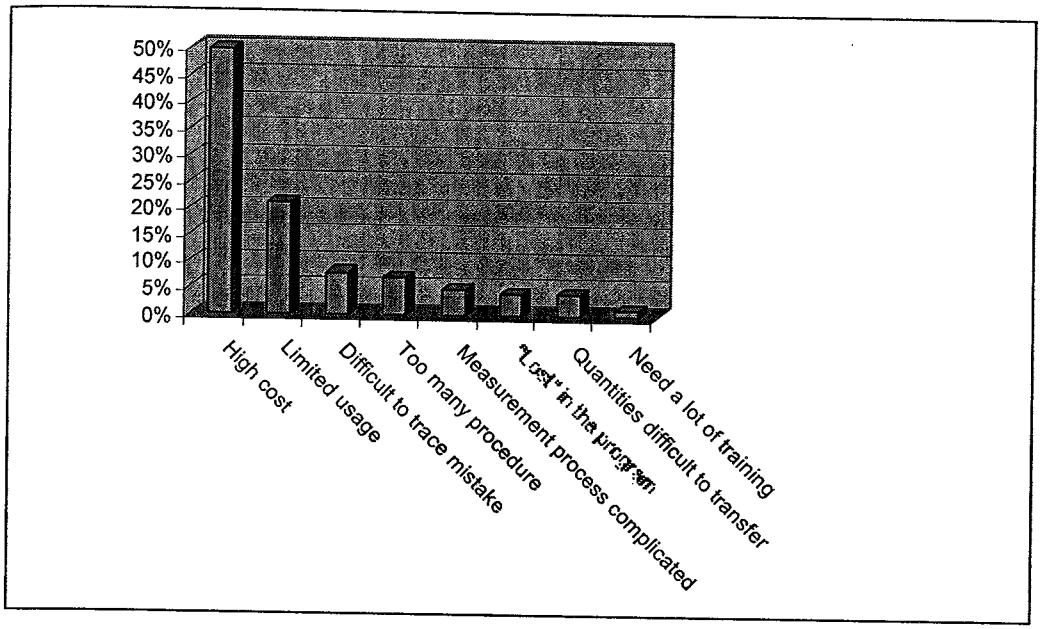
(f) "Lost" in the program when operating (4%)

(h) Quantities difficult to transfer (4%)

(i) Need a lot of training (1%)

The architects showed a different opinion on the disadvantages of CAD software as quantities measurement tool as compared with the quantity surveyor. The architects are mainly concerned with the high cost of the software (50%) and also the limited use of the software in only obtaining quantities (21%). These two factors are seen to be the major barriers while the other factors listed are minor.

Figure 4.3 Disadvantages of CAD software as measurement tool



4.9 Conclusion

The survey yielded several insights into the use of CAD software as measurement tools by the architects as follows.

1. 97% of the respondents has adopted the use of CAD software in their architectural office due to the derived time saving as the software could reduce drawing production time and thus improve productivity.
2. Although the architects surveyed used CAD software intensively for drawing production, more than half (67%) do not incorporated measurement package due to high cost and also the availability of quantity surveyors to prepare the quantities.
3. From the respondents that use CAD software as measurement tool, only 9% has knowledge in SMM2. Industry standard bills of quantities are produced using the measurement rules as set out in SMM2. It is safe to construe that firms without such knowledge do not prepare bills of quantities.
4. A check on the use of CAD software as measurement tools in the various stages of work as define by RIBA shows that, the architects surveyed do utilise this tool, albeit on a small scale. Although there are indication of increase of use in the future, the feeling is that the architects is not focusing in using it as a tool for bills

of quantities production but more towards floor area calculation for purpose of design checks.

5. Even quantity surveyors are not measuring quantities digitally from CAD drawings as evidenced by the survey that found 98% of the quantity surveying firms do not accept digital CAD drawings for measurement purposes.
6. The architects concur with quantity surveyors on the advantages of using CAD software as measurement tool but differ on the disadvantages.

CHAPTER 5

CONCLUSION AND RECOMMENDATION FOR FURTHER RESEARCH

CHAPTER 5

CONCLUSION AND RECOMMENDATION FOR FURTHER RESEARCH

5.1 Introduction

This is a study on the impact of CAD software to the quantity surveying field. The aim of the study was to investigate the benefit and threat of CAD software to the quantity surveying profession in Malaysia. The advantages and disadvantages of quantities measurement using CAD software were reviewed. Data was collected using postal questionnaire survey to two groups of respondents, namely the quantity surveyors and architects. Only this two was chosen because of their use of CAD software in their daily work. Qualitative date was also obtained via interview from the quantity surveyors to obtain further clarification to the questionnaires. This chapter provides highlights from each chapter, discusses the achievement of the objectives and suggests recommendations for further research.

5.2 Highlights from the Chapters

Chapter 1 introduces the background for this study. Measurement, which is the process of extracting quantities from drawings for the purpose of estimating the cost of construction, is the sole responsibility of quantity surveyor. This process is time consuming, as the quantity surveyor has to measure each and every line to obtain the quantity needed in accordance to the Standard Method of Measurement that is in use by the industry. With the advent of computer, it is inevitable that this technology will be use to make the measurement process easier. The most common use of the computer is to compute the dimension measured manually to obtain the required quantities. These quantities are then transferred to the bills of quantities format. As such the common software utilized here is the spreadsheet for computation and word processing for typing of the bills of quantities. With the advancement of technology, CAD software has the ability to extract quantities directly from digital CAD drawings.

Chapter 2 discusses the use of computers by quantity surveyors in measurement work. Studies have found that the use of computers have time and cost savings implication. Although CAD software has numerous benefits such as increase in measurement time, ease of locating the elements by using the layers in the file and increase accuracy, there are also limitation in the use of CAD software. The limitations pertain to the need to follow a standard convention in the production of drawings such as using "polyline", "cut and paste" function and standardized layer naming system.

Chapter 3 reports on the findings from the survey conducted to obtain the opinion of quantity surveyors that have used CBMS for quantities measurement. The survey found that cost is not the major barrier in using CBMS but unfamiliarity with the software that result in the need for extensive training. This factor is unattractive to employers to use CBMS for quantities measurement. Nevertheless, majority that have measured using CBMS agreed that it gives higher accuracy, easier to edit quantities, measurement can be performed faster and enable a reduction of workforce. The first objective

Chapter 4 reports on the findings from the survey conducted to obtain the data on the usage of CAD software for quantities measurement by architects. The survey found that although majority of the respondents use CAD software in their daily work but only very few use it for quantities measurement. Of the few that do, it is only for simple area calculation and enumerating sanitary wares and fittings. The general feeling is that architect utilized CAD software mainly for production of drawings and not for quantities measurement.

5.3 Achievements of Research Objectives

The first objective of this study is to identify the strength and weakness of CAD software for use by quantity surveyors. This objective is to achieve the first part of the aim that is the identification of benefit of CAD software. In order to identify the abovementioned factors, feedback was obtained from quantity surveyors that have used CAD software in quantities measurement, which is in the form of CBMS. A second opinion was also acquired from the architects on the strength and weakness of CAD software. Both quantity surveyors and architects concur on the strength of CAD software in quantities measurement which are, produces more accurate quantities, measurement can be

executed faster than manual method, measurement procedures is made easier and require less manpower for measurement work.

The findings also concur with the literature that using CAD software made measurement especially irregular shape easier and faster and more accurate. However, the study did not manage to pick up the benefit of layering in quantities measurement as mentioned in the literature. The strength of CAD software in quantities measurement points to the potential to help quantity surveyors to achieve a higher quality of work and increase productivity.

The weaknesses of CAD software as indicated by quantity surveyors are too many procedures to remember, lack of flexibility, need to train new staff to use the software, difficult to check the accuracy of the quantities, not user friendly and lack of standardization in layer naming. The general consensus is that the weakness of the software is difficult to use and new users require training.

The second objective of this study is to identify the usage of CAD software measurement function by architects. This objective is to achieve the second part of the aim of this study that is the identification of threat to quantity surveyors due to use of CAD software. Due to the ability of CAD to extract quantities, it is feared that other professional that uses CAD will be able to do the work of a quantity surveyor, which is quantities measurement. As architects are the most likely competitors due to their extensive usage of CAD, a survey was conducted to determine if they are a threat to the quantity surveying profession. The survey found that architects used CAD intensively for drawing production and not for quantities measurement. Although the architects indicated that they will increase the use of CAD software in the future in all stages of work, the consensus is that the architects are not focusing in using it as a tool for bills of quantities production but more towards floor area calculation for purpose of design checks.

5.4 Recommendation for Future Research

Not withstanding the interesting findings of this study, for more in-depth understanding of the topic, it is suggested that future researches to be conducted in the following areas.

1. Detail study of the measurement process using CAD software to identify critical criteria in production of drawings that will facilitate the measurement process.
2. Strategies to encourage quantity surveyors to switch to CAD technology for quantities measurement.

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Part 1: Respondent's organisation profile

Name of organisation : _____

Address : _____

Telephone : _____

Fax : _____

E-mail address : _____

Part 2: General details of respondent's firm

1 How may employee does your firm employ?

- ☐ More than 50 staff
- ☐ 21-50 staff
- ☐ 11-20 staff
- ☐ 1-10 staff

2 When was your firm established?

- ☐ More than 20 years
- ☐ 11-20 years
- ☐ 6-10 years
- ☐ 1 - 5 years

3 Which computer-aided taking-off system does your firm use?

- ☐ CADMeasure
- ☐ AutoCad
- ☐ Autodesk
- ☐ Others,please specify

.....

4 How long have your firm been using this software?

- ☐ More than 10 years
- ☐ 6-10 years
- ☐ 3 - 5 years
- ☐ 1 - 2 years

APPENDIX 1

QUESTIONNAIRE FOR QUANTITY SURVEYORS

5 Does your firm use the web facilities to transfer/receive documents such as CAD drawings electronically?

- ☐ Yes
- ☐ No

6 Currently how many % of Bills of Quantities are measure with this software?

- ☐ Less than 10%
- ☐ 25%
- ☐ 50%
- ☐ More than 50%

Part 3: Usage of computer-aided taking-off system

7 Do you think your computer-aided taking-off system meets your requirement in obtaining quantity in accordance SMM2?

- ☐ Yes
- ☐ No

8 What type of training on the software have you received?

- ☐ In house training
- ☐ External company training
- ☐ Manuals / Tutorial only
- ☐ No formal training

9 Do you think that you are competent with the software?

- ☐ Yes
- ☐ No

10 What are the most common problems encountered?

- ☐ Too many procedures to remember
- ☐ "Lost" in the software when operating
- ☐ Others,please specify

.....

11 In which stage in the RIBA Plan of work is the computer-aided taking off system most suitable?

☐ Pre-Contract

Please specify

.....

(e.g. estimating stage)

☐ Post-Contract

Please specify

.....

(e.g. Production Bills of Quantities stage)

12 Do you think that it is easier to edit or revise the measurement by your computer-aided taking-off system as compare to manual taking-off?

☐ Yes

Why?

.....

☐ No

Why?

.....

13 Do you think that computer-aided taking-off system help you to take-off faster ?

☐ Yes

Why?

.....

☐ No

Why?

.....

14 Do you think that computer-aided taking-off system help you to take-off more accurately?

☐ Yes

Why?

.....

☐ No

Why?

.....

15 In your opinion, what are the advantages of using computer-aided taking-off system as a tool of measurement in the following aspects?

☐ Speed up the taking-off process

☐ Makes taking-off an easier task.

☐ Reduce workforce in taking-off.

☐ Accuracy in quantities

☐ Easier to do checking of quantities

☐ User friendly, easy to learn and use

☐ Others,please specify

.....

16 In your opinion, what are the disadvantages of using computer-aided taking-off system as a tool of measurement in the following aspects?

☐ Has limited usage in certain stage (e.g. estimating,BQ,VO).

☐ Difficult to trace mistakes

☐ Taking-off process is more complicated

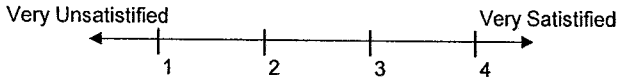
☐ Need a lot of training in order to use it

☐ Cost of software is very high

☐ Others,please specify

.....

17 How would you assess your company's Taking-off software?
(please circle the appropriate answer)



	General				
a	Comprehensibility of software	1	2	3	4
b	Availability of software manual	1	2	3	4
c	User-friendly of menu's system	1	2	3	4
d	After sales/tecnhnical service support	1	2	3	4
	Operation				
a	Length of time required for data entry	1	2	3	4
b	Ease in making correction to existing data	1	2	3	4
c	Procedure for editing (easy)	1	2	3	4
d	Multiple use for single data	1	2	3	4
	Documentation / Printout				
a	Report format	1	2	3	4
b	Report variety (able to produce different types of report)	1	2	3	4
c	Others:				
	.....	1	2	3	4
	.....	1	2	3	4
	.....	1	2	3	4

18 What improvement would you like to see in the package that you are using?

.....
.....
.....
.....
.....
.....

Part 4: Layer structure within construction CAD files.

19 Indicate the problems encountered in the layering structure within CAD files ?(to freeze and hide elements in the drawing that are irrelevant to your measurement works while you are doing taking-off)

- ☐ No Standardisation of Colours
- ☐ No Standardisation in Layering Name
- ☐ Incompatibility between taking-off software & CAD software
- ☐ No Standardisation in the segregation of elements by layers (doors,windows)
- ☐ Others,please specify

.....

Part 5. Proposed usage of computer-aided taking-off system

20 The QS profesion should be actively involved in utilising, developing and promoting the use of this system?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree

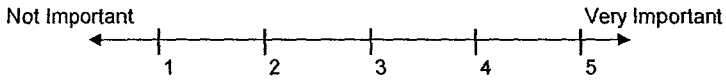
21 In your opinion, what is the main reason that quantity surveyors should use CAD taking-off system?

- ☐ To save time in measurement, so that can cope with increased workload
- ☐ To save costs in overheads, documentation charges
- ☐ Others,please specify

.....

22 Do you think this system has the potential to be used in quantity surveying firm?

- ☐ Yes
- ☐ No



23 If the answer to Question 22 is No, please indicate the reason stated below:

- ☐ The software feature is not applicable to measurement
- ☐ It is too expensive
- ☐ Hard to get CAD drawing in soft copy
- ☐ Work can be handled manually
- ☐ Others,please specify

.....

APPENDIX 2

QUESTIONNAIRE FOR ARCHITECTS

PART I: GENERAL QUESTIONS

Name of firm : _____

Telephone : _____

Fax : _____

E-mail address : _____

Name of respondent : _____

Designation of respondent : _____

Year of the firm established : _____

Please indicate in number full time employee involved in architectural practice does your firm employ (excluding administration and clerk)

_____

PART II: APPLICATION OF CAD IN ARCHITECTURAL FIRM.

1 Which Computer-Aided Draughting (CAD) system does your firm use?

_____

2 How long have your firm been using this software? (approximately indicate in years)

_____

3 In your opinion, do you think that the architectural profession in Malaysia should use the CAD technology in daily practise?

☐ Yes

☐ No

☐ No Idea

PART III: MEASUREMENT TOOL IN CAD SYSTEM

4 Does your CAD system incorporate a quantities measurement package?

☐ Yes

☐ No (Please proceed to question No:8)

☐ No Idea

5 Does your firm using CAD system as a quantities measurement tool?

☐ Yes

Why?

☐ No

Why?

---

6 Are your staff familiar with Standard Method of Measurement II (SMM2)?

☐ Yes

☐ No (Please proceed to question No:8)

☐ No Idea

6 Do you think your CAD system meets your requirement in obtaining quantity in accordance with market requirement (SMM2)?

☐ Yes

☐ No

☐ No Idea

7 In which stage in the RIBA Plan of work is the CAD system as measuremnet tool used in your company? *(you can indicate more than one)*

☐ Inception

☐ Feasibility

☐ Outline proposal

☐ Scheme design

☐ Detail design

☐ Production information

☐ Tender action / Production of Bills of Quantities

☐ Operation on site

☐ Completion

8 **In future** which stage do you think your firm will use CAD system as a quantities measurement tool to obtain quantity for project use?

- ☐ Inception
- ☐ Feasibility
- ☐ Outline proposal
- ☐ Scheme design
- ☐ Detail design
- ☐ Production information
- ☐ Tender action / Production of Bills of Quantities
- ☐ Operation on site
- ☐ Completion

9 In your opinion, what are the advantages of using CAD system as a quantities measurement tool in tl following aspects? *(you can indicate more than one)*

- ☐ Speed up the measurement process
- ☐ Makes measurement an easier task
- ☐ Reduce workforce in measurement
- ☐ Accuracy in quantities
- ☐ Easier to do checking in quantities
- ☐ User friendly, easy to learn and use.
- ☐ To generate more income - additional scope of works
- ☐ Provision of "All-In" services to client which includes quantities measurement
- ☐ To fullfill Client's requirement

☐ Other, please specify

---

0 In your opinion, what are the disadvantages of using CAD system as a measurement tool in the following aspects?

☐ Has limited usage in certain stage

☐ Difficult to trace mistakes

☐ Taking-off process is more complicated

☐ Need a lot of training in order to use it

☐ Cost of software is very high

☐ Too many procedures to remember

☐ "Lost" in the software when operating

☐ Other, please specify

---

1 Does your firm provide soft copy drawings to Quantity Surveyors to do their measurement?

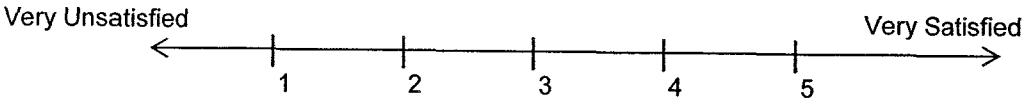
☐ Yes

☐ No

Why?

---

12 How would you assess your company's CAD measurement software? (please circle the appropriate answer)



General

a	Comprehensibility of software	1	2	3	4	5
b	Availability of software manual	1	2	3	4	5
c	User friendly of menu's system	1	2	3	4	5
d	After sales / technical services support	1	2	3	4	5

Operation

a	Length of time required for data entry	1	2	3	4	5
b	Ease in making correction to existing data	1	2	3	4	5
c	Procedure for editing (easy)	1	2	3	4	5
d	Multiple use for single data	1	2	3	4	5

Documentation / Printout

a	Report format	1	2	3	4	5
b	Report variety (able to produce different types of report)	1	2	3	4	5
c	Others: _____	1	2	3	4	5

_____ 1 2 3 4 5

PART IV: RING FENCING OF QUANTITY SURVEYING SERVICE PROVIDERS

13 Do you agree Bills of Quantities production skill important for a quantity surveyor?

☐ Yes

☐ No

Why?

_____

☐ No Idea

14 Do your firm doing any costing exercise for your client?

☐ Yes (if yes, please indicate accordingly)

☐ Inception

☐ Feasibility

☐ Outline proposal

☐ Scheme design

☐ Detail design

☐ Production information

☐ Tender action

☐ Operation on site

☐ Completion

☐ No

Why?

_____

YOUR COOPERATION IS HIGHLY APPREACIATED.

If interested in in-depth interview, please provide the following details.

Contact No: (H/P) _____

(Office) _____

E-mail address _____

Please attach your business card

PUBLICATION LIST

Paper presented at the 7th QS Congress, Kuala Lumpur, 2005 - Ong, C. T., Abdul Aziz, A.R. and Lim, Y. M. (2005). Automated Bills of Quantities using CAD: Threat to the Quantity Surveyor?

Paper presented at Micra Conference, 2005 – Ong, C. T., Lim, Y. M. and Abdul Aziz, A.R.,(2005). Taking-Off with CAD: Illusion or Reality?

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Paper presented at the 7th QS Congress, Kuala Lumpur, 2005 - Ong, C. T., Abdul Aziz, A.R. and Lim, Y. M. (2005). Automated Bills of Quantities using CAD: Threat to the Quantity Surveyor?

Automated Bills of Quantities using CAD: Threat to the Quantity Surveyor?

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Abstract

Ever since the early 1980s, some scholars had predicted that the CAD will replace the role of Quantity Surveyors. A study was conducted to determine the validity of this view. Postal questionnaires were sent out to all the architectural firms in Malaysia to obtain feedback on the application of CAD. It is found that almost all of the firms use the software. However none of them produce Bills of Quantities using the CAD software, even though the software has measurement capabilities. Hence the continual need for the Quantity Surveyors profession to produce Bills of Quantities. In response to another part of the questionnaire, the respondents affirm the valuable contribution of Quantity Surveyors in the industry, not only in producing BQ but also in the other major role of providing contractual advice. The study recommends that the Quantity Surveyors should be more sensitive to the advancement of CAD software particularly how the use of CAD functions to lighten the Quantity Surveyors workload in the production of Bills of Quantities and also enhance value for money for the clients. In short CAD software should be exploited by the Quantity Surveyors to enhance and improve efficiency and productivity.

1.0 Introduction

For the last decade, many articles speculated on the impact of CAD software on the quantity surveying profession. Brandon (1983) said that, by using the CAD software to generate bills of quantities, it would affect the role of the QS in preparing the tender documents.

This issue has raised concern among QS where CAD software is seen as a threat to the quantity surveying profession. McGregor (1989) however, stated that CAD software is able to not only generate bills of quantities but also to provide a cost database. With the availability of a cost database in CAD software, other parties are also able to do estimating and cost planning.

Taking into consideration the issue at hand and the rapid development of IT in the building industry, will the job of QS be fully taken over by computers? A decade after Brandon's prediction, what is the impact of CAD software towards the quantity surveying profession? Is the prediction proving to be true or the opposite?

2.0 Statement of problems

Measurements are often considered as a difficult process and time consuming. This is because measurement and careful quantity examination must be carried out in preparation bills of quantities. Based on studies of his own workers ((quantity surveyors, assistant quantity surveyors and technical assistant), Smitch (1999), realised that about 80% of their time was spent doing measurement, another 20% for preparation of tender documents and pricing.

Besides being time consuming, manual measurement from drawings raises the issue of precision. According to Wheeler (1992), measurement from drawing should be avoided because of inconsistent results. This is due to the fact that the position of the human eye is not build to be at a 90-degree angle with the scale rule while reading measurements. Another factor is the scale of drawings which may not be accurate after printing.

As stated by Curran (1987), the computer can measure quantities automatically and its measurement is more accurate compared to measurement that is done by a quantity surveyor.

Despite this, many quantity surveying firms have not realized that by using CAD software, it will lighten their work. A study by Jaffri (1994) showed that the usage of CAD software by quantity surveying firm in Malaysia is still at the infancy level.

Having briefly described some of the issues surrounding the application of CAD software by the quantity surveyors, this paper reveals the findings of a research that looked into the extent of usage of quantity measurement CAD software in architectural industry Malaysia in the hope of gauging the level of external threat to the quantity surveying profession in the foreseeable future.

3.0 Objectives

The aim of this study is to shed some light on the level of usage of quantity measurement CAD software in the daily practices among the Malaysian architectural fraternity.

4.0 Research Methodology

This research utilised a postal questionnaire method to gather primary data. The postal questionnaire survey method was employed due to the population size of the respondents. The full list of registered architectural firms in Malaysia for 2004 was obtained from Lembaga Akitek Malaysia (LAM). In all, 1,269 questionnaires were sent out to all the firms registered with LAM. A census was used to capture the richness of diversity of the architectural firms in Malaysia, from the sole proprietor to the corporate categoreis (see table 1). Ahmad (2003) discovered that even though postal questionnaire survey is a common method used in Malaysia, the percentage of obtaining good response rate is very slim. Still this research managed to achieve a high response rate of 19.8%. The profile of the respondents is shown in table 2. In addition, one-to-one interviews were conducted with 6 firms to obtain qualitative data. Majority of the respondents (i.e. 67.96%) were directors or principals of their firms. Statistical Package for Social Sciences (SPSS for window version 11.5) was used for data transformation and analysis for this study.

Type of Firm	Total sub-population (%)
Sole Proprietor	20.31%
Partnership	20.69%
Corporate	28.47%

Table 1: Responding company by type of firm.

Designation of respondent	Total (%)
Principal / Director / Sole Proprietor	67.96%
Architect	31.07%
Draughtsman	0.97%

Table 2: Respondents by position

5.0 Major Findings

The major findings derived from the responses are presented under the following headings:-

(a) Overall support for application of CAD system in architectural firm
(b) Quantities measurement package incorporate in CAD system
(c) Advantages and disadvantages of using CAD system as quantities measurement tools.
(d) Soft copy of drawings provided to quantity surveyors for costing exercise.
(e) Overall support of quantity surveyors role in construction industry.

5.0 (b)Application of CAD technology in architectural firms

No:	Response	Percentage (%)
1.	Agree with application of CAD technology in architecture daily practice.	96.8%
2.	Disagree with application of CAD technology in architecture daily practice.	-
3.	No idea	3.2%

Table 3: Response to the question whether CAD technology should be used in the architecture daily practice.

The results showed strong industrial support (i.e. 96.8%) for the application of CAD technology in daily practice (see Table 3), the reasons cited being:

(a) Time saving in editing drawings (72.3%)
(b) Time saving in preparing drawings (61.4%)
(c) Better productivity (32.3%)
(d) Cost saving in preparing drawings (25.1%)
(e) Better appearance in drawings (15.6 %)

For those who did not support the application of CAD technology in daily practice, the main reason are as follows:
(a) Lacking of IT exposure (77.8%)
(b) Not involved in design stage (12.5 %)

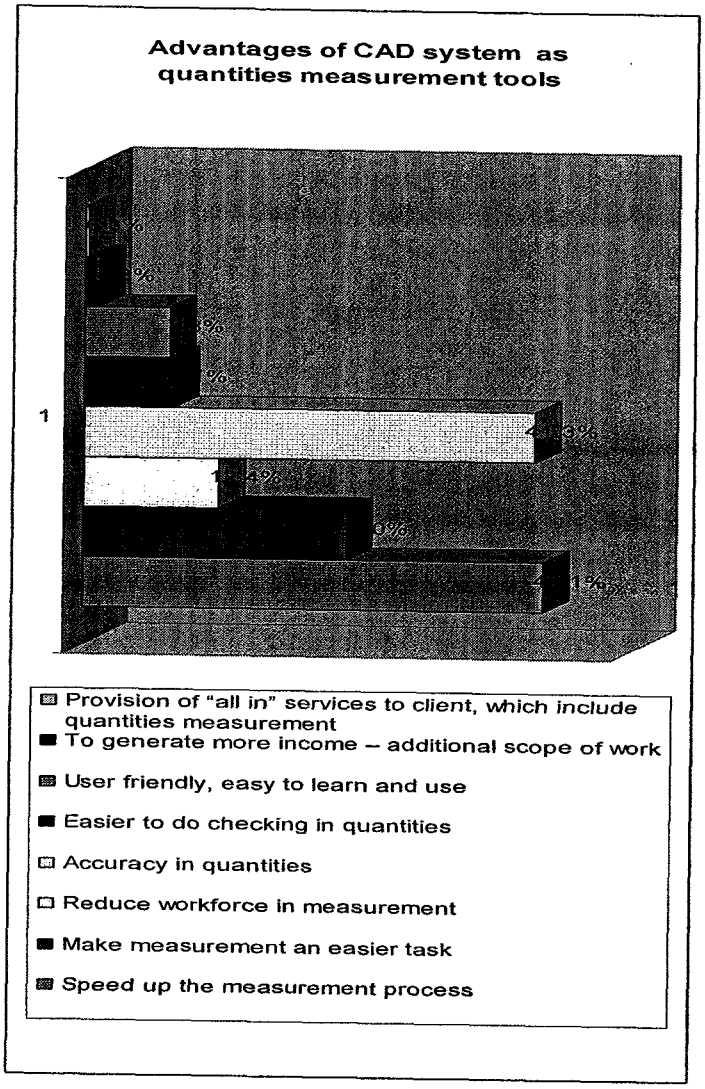
5.0 (c) Quantities measurement package incorporate in CAD system

No:	Response	Percentage (%)
1.	Yes	30.1%
2.	No	61.2%
3.	No Idea	8.7%

Majority (61.2%) of the respondent firm's CAD system did not incorporate quantities measurement package. When probed further, the reason given was high cost and risks involve in ICT investments. Architecture firms, like any other businesses, have to ensure that the software package would give them the best return on investment. Furthermore, quantity surveyor will be appointed for the big project. Of the firms that use quantities measurement package in their CAD system, it was primarily utilised for basic area measurement and enumerating sanitary wares. None of the responding firms prepared bill of qualitities using the software.

5.0 (c) Advantages of CAD system as quantities measurement tools.

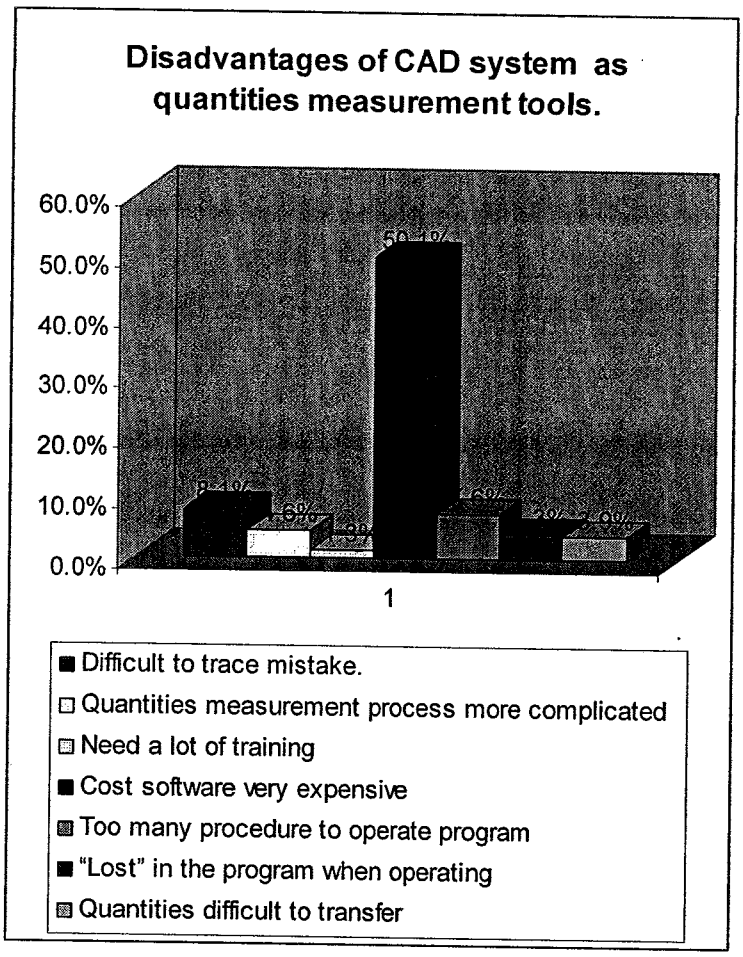
The advantages of using CAD system as a quantities measurement tool according to respondents are as follows:
(a) Speed up the measurement process (42.1%)
(b) Accuracy in quantities (41.3%)
(c) Make measurement an easier task (24.0%)
(d) Reduce workforce in measurement (12.4%)
(e) Easier to do checking in quantities (8.1%)
(f) User friendly, easy to learn and use (7.8%)
(g) To generate more income – additional scope of work (1.3%)
(h) Provision of "all in" services to client, which include quantities measurement (0.3%)



5.0 (d)Disadvantages of CAD system as quantities measurement tools.

The disadvantages of using CAD system as a quantities measurement tool according to respondents are as follows: -

(a) Cost software very expensive (50.1%)
(b) Limited usage in certain stage. (21.3%)
(c) Difficult to trace mistake. (8.1%)
(d) Too many procedure to operate program (7.6%)
(e) Quantities measurement process more complicated (4.6%)
(f) "Lost" in the program when operating (4.3%)
(h) Quantities difficult to transfer (3.9%)
(i) Need a lot of training (1.3%)



5.0 (e) Soft copy of drawings provided to quantity surveyors for costing exercise.

Almost all of the architects that responded to the questionnaire (97.6%) indicated that practising quantity surveying firms did not accept drawings in soft copy for measurement purpose as they did not have the required measurement software. Some of the respondents even mentioned that the quantity surveying firms did know how to operate the CAD software, in part due to the lack of standard protocol management system, in part due to the reluctance of the latter to invest in the required software.

Overall, almost all of the respondents (99.2%) concurred on the importance of quantity surveyors in the Malaysian construction industry. Even with the advent of CAD measurement software, the traditional roles of the quantity surveying profession, especially in tender documentation, costing and contracts, is still required by the industry. Hence speculation of the demise of quantity surveyors in the Malaysian construction industry is baseless.

6.0 Conclusion

As the research has found, the utilisation of quantities measurement package in CAD software does not signal the imminent demise of QS profession in the foreseeable future. The survey found the limited use of the software by the architectural profession in Malaysia. There are advantages and disadvantages to associate with the application of CAD measurement software. At the moment, the architects in Malaysia apply CAD measurement software for simple functions, such as generating area measurement and enumerating sanitary wares.

Presently, CAD software is able to generate quantities for certain elements in a building. However there are still teething problems in respect of other elements. Presently therefore, there are limitations associated with CAD software in respect of generating bill of quantities. Furthermore, as yet, there is no standard protocol that allows for data exchange between organisations. However, the quantity surveying fraternity must not be complacent. Quantity surveyors need to work towards ensuring that there is a seamless flow of information from the designers to the quantity surveyors, especially with respect to the information contains in CAD drawings. The education institutions in Malaysia must expose quantity surveying students to think laterally about CAD software so that they can play a positive role when they join the industry.

"The thing always happens that you really believe in; and the belief in a thing makes it happen" – Frank Lloyd Wright

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Taking-Off with CAD: Illusion or Reality?

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Abstract

Since 1980s, there are many speculations on the impact of CAD software on the Quantity Surveying profession. Brandon (1983) mentioned that the usage of CAD software to automatically produce Bills of Quantities might one day replace the need for Quantity Surveyors (QS) in this area. However, the Quantity Surveyors should not be intimidated by the CAD software but should endeavours to utilize the new technology to improve their productivity. Since then, the development of information technology (IT) has grown in leaps and bounds. What is the impact of CAD software towards the Quantity Surveying profession, 20 years after Brandon's prediction? Can CAD software automatically produce Bills of Quantities? This paper attempts to explore the strength and weaknesses of CAD software in producing Bills of Quantities especially in the measurement of quantities in accordance to Standard Method of Measurement II (SMM2).

1.0 Introduction

For the last decade, many articles speculated on the impact of CAD software on the quantity surveying profession. Brandon (1983) said that, by using the CAD software to generate bills of quantities, it would affect the role of the QS in preparing the tender documents.

This issue has raised concern among QS where CAD software is seen as a threat to the quantity surveying profession. McGregor (1989) however, stated that CAD software is able to not only generate bills of quantities but also to provide a cost

database. With the availability of a cost database in CAD software, other parties are also able to do estimating and cost planning.

Taking into consideration the issue at hand and the rapid development of IT in the building industry, will the job of QS be fully taken over by computers? A decade after Brandon's prediction, what is the impact of CAD software towards the quantity surveying profession? Is the prediction proving to be true or the opposite?

For new technology to be welcomed into the workplace, users must be able to accept it. To be accepted by users, technology must be seen as benefiting them by making their jobs less tedious or giving new skills and responsibilities. (Duncan Cartlidge, 2002).

Quantity surveying firms must realise that their success depends not only on their ability to contain cost and improve efficiencies, but also the ability to adapt to changes in information technology in order to maintain and enhance their competitive advantage and profitability over their competitors.

"Change is the law of life, and those who look only to the past or the present are certain to miss the future" – John. F. Kennedy

2.0 State of CAD technology

In the 1970s, CAD software was introduced into the construction industry. In the 1980s, PC based CAD software was used to mimic the processes of manual drafting and overlay graphics, replacing the drawing board.

In the 1990s, objected-oriented CAD software was introduced with the evolution of work process and technology. At the same time, the internet era has begun to be of relevance to the industry as effective communication of data between the design team and their client.

In the new millennium, continuous developments in object oriented modelling tools in the total building system has led to many software developers creating fully integrated products for the design team which embrace the unique nature of the construction industry. Such software development has also embedded the relationships between the participants of the design team and with it, allowed for data exchange management in the process. With such tools, making changes to the design will automatically update data in all documents, views, sections elevations, schedules, layouts leading to tremendous saving in time and risk of errors. (Wong, 1995).

Currently many architectural and engineering firms are utilising 2D CAD software in the preparation of drawings, be it for design or tender preparation or construction purposes. (Wong,1995). Some firms are employing 3D modelling for the purposes of design presentation and review in the form of building graphics. There are not many who have ventured into objects oriented modelling and to use it for design management.

There are many CAD software that are being developed and available in the worldwide market namely Autocad, Microstation, ArchidCAD, InteliCAD, Autodesk or Fast CAD software. Consequently, these software produce have also developed CAD based software for taking off.

CAD based software has been developed to directly measure quantities off 2D and 3D drawings. Some examples of CAD based software that could be used for taking-off:

- CADlink
- ArchidCAd
- CADMeasure
- Revit
- Triforma
- Autodesk

CAD based software would basically perform directs measurement of quantities from the object models produced by the designers for building elements to support tendering and contract administrative activities. These automatically abstracted

quantities are then transferred into BQ software for the BQ to be generated. According to Ong (2003) usage of CAD based software for quantities measurement is still in the infancy level in Malaysia.

3.0 The usage of CAD software by Quantity Surveyors Industry

Before the emergence of computers, papers were the main means of communication between negotiators in the design process. These may come in all kind of forms such as drawings, cost planning reports, bills of quantities, specifications etc. Details of a project will be handled by the architect or quantity surveyor. Now, the emergences of computers have altered the communication pattern in the design process. The usage of computer aided design (CAD) software has become a norm for designer to store many data in the computer. Thus, in a way, CAD software has become an important means of communication between the designer and the people (Brandon, 1992).

Currently, CAD software can be found in two forms; 2D draughting system and 3D draughting system. 2D draughting system produces two dimensional drawings such as plans, shapes and symbols in drawings, and enables shapes to be scaled and rotated. 3D draughting system involves a three-dimensional store and presents objects in real life, other than curves and various geometrical shapes. Each software does not only store data that contains specific details but also every aspect of the building that is related to the object (Smitch, 1999).

CAD software has been used in aiding the design process of the aeronautical and automotive engineering industry since the 1960s. Usage of CAD software in the building industry started in the 1970s and it has proven to be economical. (Tan, 2002). In the present day, almost all designers use CAD software in the design process. (Wong, 1995) A research was conducted by Edgil and Atkin (1987) on the usage of CAD software by quantity surveyors. The results show that quantity surveyors have yet to fully understand the usage of CAD software. In actual fact, CAD software is a very useful tool for all professionals in the building industry, including QS.

The advancement of CAD software usage is a challenge to QS. The pressure to become a cost consultant specialist in construction industry is increasing, since the scope of CAD software has expanded and is now able to generate quantities directly from CAD drawings. For example, the total area quantity of items such as windows, doors and sanitary fittings in units can be obtain / calculated by just a few commands or click of the mouse. As such production of designs by architects and cost estimation by QS can be done in a shorter time frame with the aid of CAD software. QS need to take the necessary steps to learning and adopting CAD software in their profession.

According to Brandon (1992), there are three main tasks that involves the usage of CAD to produce more accurate and quality work:

a. Bills of quantities production
b. Data management
c. Cost modelling

Bills of quantities production

This paper will focus only on measurement aspect in the Bills of Quantities production stage. CAD software can be used to measure certain items automatically straight from CAD drawings. So, QS may use CAD software to obtain certain quantities / calculations. For example, components such as windows, doors and sanitary fittings are easily designed or taken from the library of the software and it also can be counted easily using scheduling. Therefore, QS are able to produce work description details and quantities for such items easily.

CAD measurement similar to the conventional method also includes information on the length, area and volume of an object. Quantity surveyors are able to obtain these measurements accurately with ease using CAD drawings. This will also help in raising the accuracy of quantities stated in the bills of quantities.

With the advancement of CAD software, QS will benefit more compared to the traditional method. Therefore, QS should learn how to handle the usage of CAD software to improve and upgrade their services as value added services to clients.

5.0 Taking-off

Measurements are often considered as a difficult process and time consuming. This is because measurement and careful quantity examination must be carried out in preparation bills of quantities. According to Smitch (1999), in his study onto his workers (quantity surveyors, assistant quantity surveyors and technical assistant) realized that about 80% of the time spent to prepare a tender document is used for measurement. Another 20% of the time is used for document and pricing in the tender document.

Besides being time consuming, measurements from drawings are not encouraged because it raises the issue of precision. According to Wheeler (1992), measurement from drawing should be avoided because of inconsistent results. This is due to the fact that the position of the human eye is not built to be at a 90-degree angle with the scale rule while reading measurements. Another factor is the scale in drawings may not be accurate after printing. Although all of the above mentioned factor are critical points but in our current situation we are still practicing same manner in our industry. It is hope that through the new technology, QS can produce a more accurate and more reliable bill of quantities. (Brandon, 1992).

As stated by Curran (1987), the computer can measure quantities automatically and its measurement is more accurate compared to measurement that is done by a QS.

Despite this, many quantity surveying firms have not realized that by using CAD-based software, it will lighten the work of a quantity surveyor. A study that was implemented by Jaffri (1994) shows that the usage of QS specific software by quantity surveying firm in Malaysia is still at the minimum level.

6.0 Taking – Off From CAD Drawings

As part of the research scope, a preliminary experiment was conducted to explore the capabilities of CAD software in taking-off quantities from 2D CAD drawings. This preliminary experiment was based on a set of architectural CAD drawing comprising of plan view, elevations view and detail drawings of an apartment. Architectural Desktop 3.3 CAD software was used in this experiment.

For the preliminary experiment, six (6) major elements were identified. i.e. window, roof finishes, floor finishes, ceiling finishes, door and wall finishes as elements that will be measured using the selected software. The experiment was conducted with consultation from practicing architects in the industry. Out of the six elements, the unit of measurement for window and doors are in number and the unit of measurement for roof finishes, floor finishes, ceiling finishes and wall finishes are in area. As the method of measurement is similar for elements using the same unit of measurement, this paper will detailed the steps taken to measure only on two (2) of the six elements, which are floor finishes and window as shown in Figure 1.

Element	SMM2 Measurement rules	Steps taken for measurement using AutoCAD
Window	Measured in number basic by stating the size.(M.21)	- Use elevation (front, back, left, right). - Create a new layer (type in any name e.g. polyline) - Use command button or type in command in the command window - Zoom in on any elevation (command type "z") - Draw polyline (command type "pl" / command button) on items to be calculated. - Type area - Choose "add" by typing in "a" at the command window. - Choose "object" by typing in "o" at the command window - Click on an objects polyline that has been drawn earlier. - Calculation of the objects area and perimeter is shown in the command window. - Click on another objects polyline. - The area and perimeter of the object is shown in the command window other the total area of both object. - The same process is repeated for all the objects that have to be calculated.
Floor finishes	Floor finishes measured in area (m2) basic.	- Use floor plan. - Create a new layer (type in any name e.g. polyline) - Use command button or type in command in the command window - Zoom in on any part of plan (command type "z") - Draw polyline (command type "pl" / command button) on items to be calculated. - Type area - Choose "add" by typing in "a" at the command window. - Choose "object" by typing in "o" at the command window - Click on an objects polyline that has been drawn earlier. - Calculation of the objects area and perimeter is shown in the command window. - Click on another objects polyline. - The area and perimeter of the object is shown in the command window other the total area of both object. - The same process is repeated for all the objects that have to be calculated.

Figure 1 : Step by step instruction to take-off quantities using CAD software for windows and floor finishes

Basically all the elements identified can be measured by CAD software easily provided the object is drawn in polyline. If an object is not drawn using polyline, the CAD software would not be able to calculate the area of the object. In addition, to calculate the numbers of an object, the draughtsman should use the function "cut and paste" to ensure that the code for the similar objects are the same and the CAD software can then identify and calculate the numbers of repeated objects, e.g. windows.

From the preliminary experiment, it was found that the advantages of using CAD software are:

1. the process of taking-off is faster. For example, the area of irregular shape of a building can easily be measured in just a few clicks. Whereas, if the irregular area measurement is measured manually, the irregular shape will be divided into a few regular shapes and the areas of each shape is calculated and totalled to get the area of the whole irregular shape. Therefore compared to the manual method, taking-off using CAD is faster.
2. the layering concept in CAD software will assist the taker off in the ease of viewing and identifying the different type of floor finishes. Different floor finishes can be separated using various colours or hatch patterns and the exact area of the different type of floor finishes is then calculated by clicking on the objects. Area of floor finishes in separate location but is of the same type can be easily obtained by commanding the software to calculate area for all objects that contains the same code of the selected hatch pattern.
3. taking off is more accurate as CAD drawings are draughted in actual size and thus errors in quantities due to usage of wrong scale is not possible. Printed or photocopied drawings might be inaccurate, as the drawings size on the paper will more or less differ.

The disadvantages of using CAD software in taking-off are:

1. The CAD software can easily measure only objects drawn in polyline.
2. The usage of CAD software is limited to taking-off quantities only. To generate Bills of Quantities, the quantities obtained has to be transferred manually or exported to another software that can generate quantities in a bills of quantities format. The requirement for the two-step method is cumbersome and mistakes may occur during transfer of data.
3. As the drawings are in 2-D, taking-off is also limited to unit of measure that required 2 dimensions only. E.g. to measure a pitch roof, the quantities will have to be derived separately. The same problem applies to elements that are measured using the unit of measure in cube.
4. Architect must provide CAD drawings that are systematically drawn using the proper CAD conventions such as polyline and "cut and paste". Otherwise the CAD software will not be able to generate the correct quantities. The same also applies to the method of layering and naming the layers.
5. sketch drawings could not be measured using CAD software.

7.0 Conclusion

QS should see new technology as an opportunity rather than a threat (Duncan Cartlidge, 2001). CAD software is not considered to signal the imminent demise of QS profession, but it is clear that it will be an effective catalyst in bringing about change in the industry. Quantity surveying education needs to respond to the challenges that CAD software represents.

Based on the preliminary experiment, it is found that the CAD software is able to generate the quantities easily for certain elements in a building while problems are encountered in taking-off quantities for other elements. While taking-off quantities with CAD software is a reality to all the QS in this industry, for it to be implemented successfully, there is a need for cooperation between the designers and quantity

surveyors. This is to ensure that there is a seamless flow of information from the designers to the quantity surveyors especially with respect to the information contains in CAD drawings. Without a standard protocol in the industry, the likelihood of massive conversion to CAD taking-off is not apparent in the near future.

However, it is important for the QS to realize that there is no threat to them from CAD software. There is only opportunity. (Martin Jarrett, 1989) These professionals should be encouraged and educated to think laterally about CAD software and how they assist the profession to play a positive role for the future of the industry.

"The thing always happens that you really believe in; and the belief in a thing makes it happen" – Frank Lloyd Wright

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Appendix "A" - Experiment on some element measured by AutoCAD version Architectural Desktop 3.3

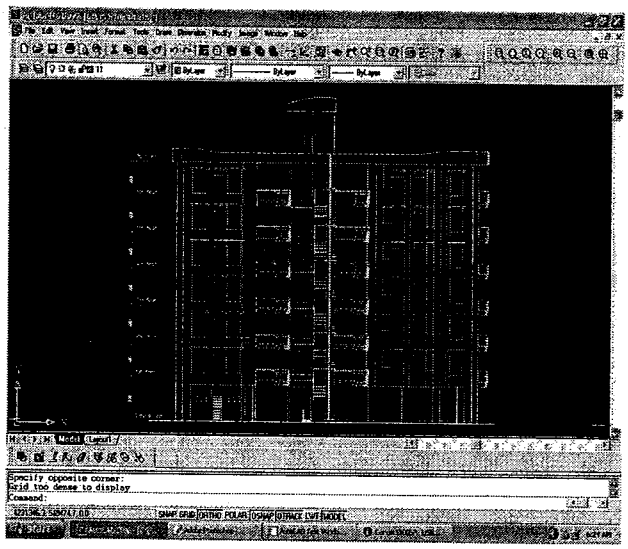

Figure 2: Windows are shown in blue colour line.

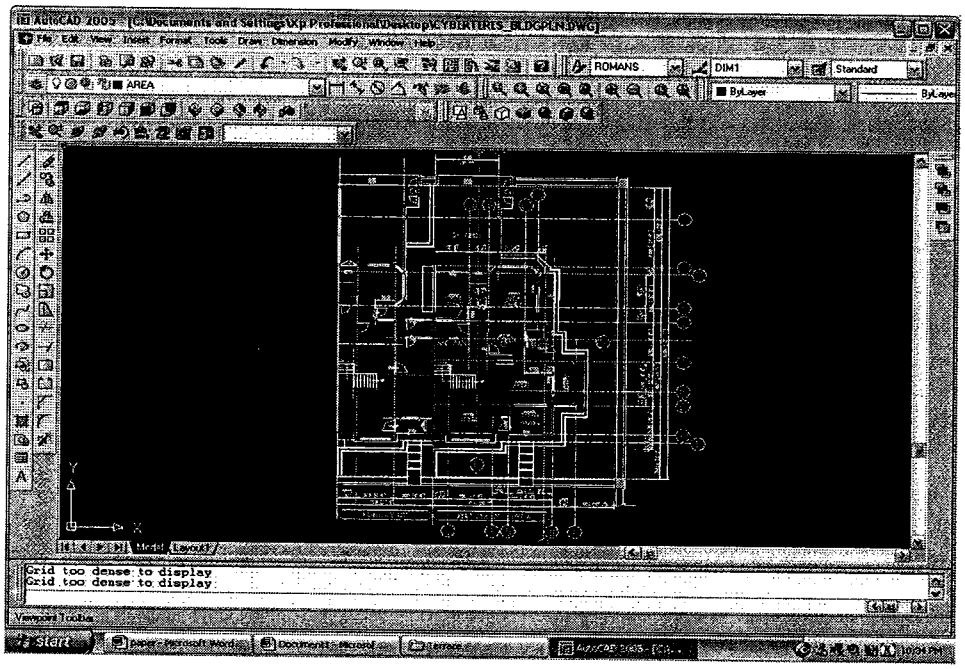

Figure 3: Picture above shown a floor plan

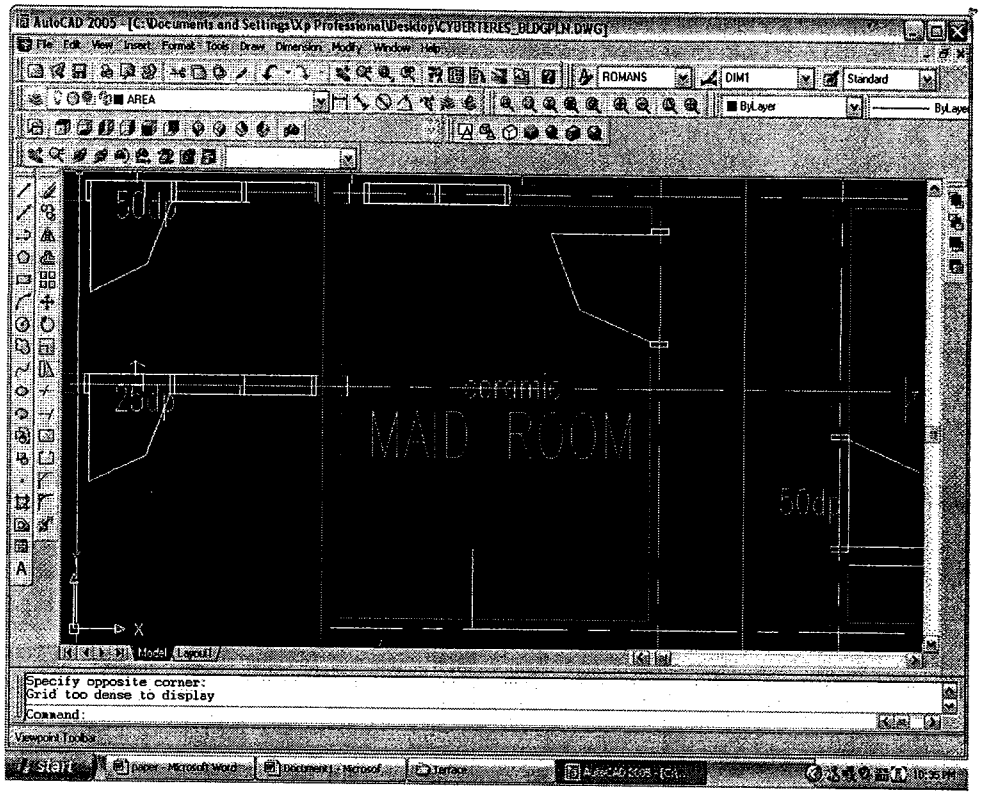

Figure 4: Maid room is chose as specimen in this experiment

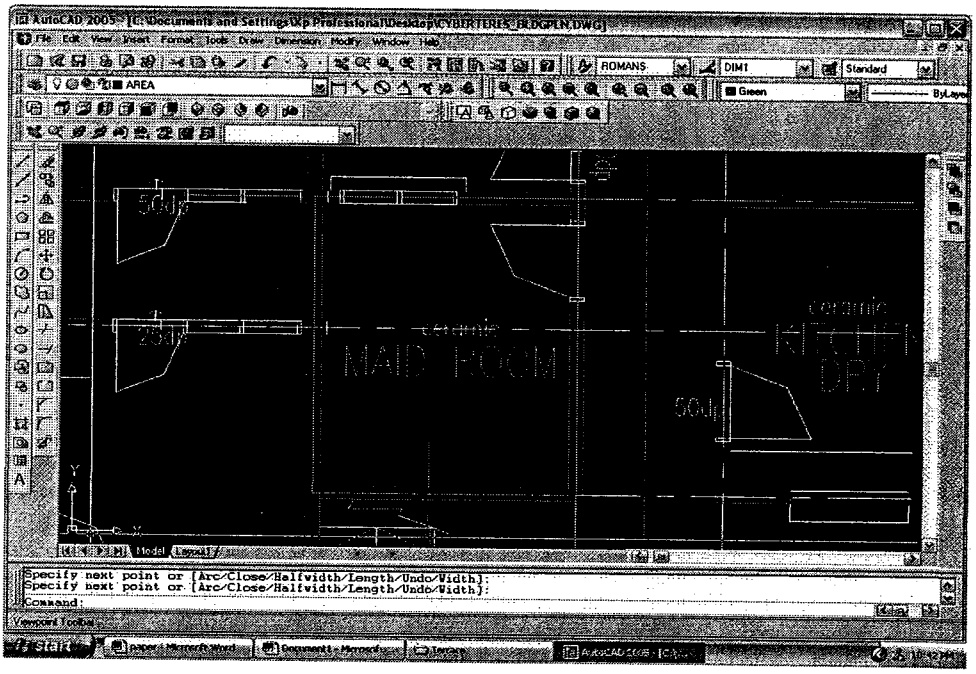

Figure 5: Floor area is measured by using poly line (green colour) as per instructed

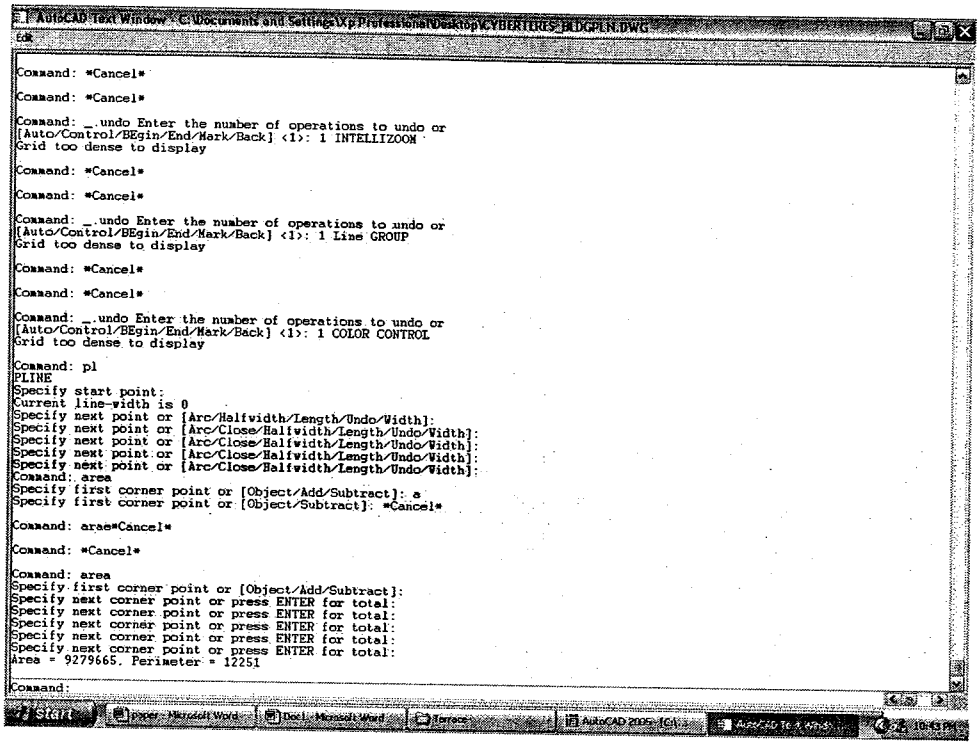

Figure 6: Area is shown at above.

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