

University of Southern Queensland  
Faculty of Engineering and Surveying

**ROLE OF A PROJECT MANAGER IN A  
RESIDENTIAL DEVELOPMENT HOUSING  
DEVELOPMENT IN SINGAPORE**

- **Analyse the use of bar code in tracking drawing during the construction of a residential development in Singapore**

A dissertation submitted by

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Analyse the use of bar code in tracking drawing during the construction of a residential development in Singapore

Cheong Siew Hong

## **ABSTRACT**

The complexity of client's demand together with ever increasing complexity of building and in particular technology development has resulted in specialization of the construction industry.

These demand and changes has also altered the requirement which a project manager must possess ie experience, resources and specialist support. In order for a project manager to meet the objectives set out ie time, cost and quality, he or she has to possess the relevant requirements in order to manage the highly complex and demanding project.

The way and procedure in which building plans are distributed and tracked amongst consultants and contractors is one area which needed to be improved in order to meet up with the technological development. Bar code system was identified as one of the tool to improve the tracking of drawing as it has been proven to be successful in improving the asset and inventory management in construction related and non-construction related industries.

The three objectives for the research into using bar code system to track drawing are:

1. To survey the standards drawing list.
2. To identify the type of bar code that is suitable for use in this project.
3. To prepare concept plan and carry out trial.

The methodologies used in this research are:

1. Data collection
2. Case study
3. Field visit
4. Conduct scale down trial
5. Seek specialist advice.

Researches were carried out on the three objectives and a concept plan for the bar code system was formulated. The concept plan was implemented using free demonstration software downloaded from the internet. Site visit and consultation with specialist in bar code was carried out to supplement the implementation plan.

Through research and implementation of the concept, we concluded that it is possible to keep track of drawing using bar code. This system gives valuable improvement in time, cost and quality. If full scale implementation is carried out, the system can be fine tuned and even improved to include distribution of drawing or plans via the internet

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Signature

29 OCT 2004

Date

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| <b><u>TABLE OF CONTENTS</u></b>  | <b>PAGE</b> |
|--|-------------|
| <b>ABSTRACT</b>  | i           |
| <b>DISCLAIMER</b>  | ii          |
| <b>CERTIFICATION</b>   | iii         |
| <b>ACKNOWLEDGEMENT</b>   | iv          |
| <b>TABLE OF CONTENTS</b>   | v - vii     |
| <b>LIST OF FIGURES</b>   | viii - ix   |
| <b>LIST OF TABLES</b>  | x           |
| <br><b>CHAPTER ONE – INTRODUCTION</b>  |             |
| <b>1.0 Introduction</b>  | 2           |
| <b>2.0 Background</b>  | 3 - 15      |
| 2.1 Nature of Industry   | 3 - 4       |
| 2.2 Requirement of a project manager   | 4 – 7       |
| 2.3 The role and function of a project manager<br>in the residential development | 7 - 8       |
| 2.4 Sequence of work in the development of a<br>Residential development          | 8 - 10      |
| 2.5 Management and Administration in<br>Residential Housing Development          | 10 - 11     |
| 2.6 The Present Practice of Project<br>Management                                | 11 - 12     |
| 2.7 Need for Improvement in Project<br>Management                                | 12 - 14     |
| 2.8 Technology Used in Project Management  | 15          |
| <b>3.0 Aim</b>   | 15          |
| <b>4.0 Objectives</b>  | 15          |

## **CHAPTER TWO - METHODOLOGY**

|            |  |         |
|------------|--|---------|
| <b>5.0</b> | <b>Methodology Used</b>                              | 17 - 18 |
| 5.1        | Objective One: To survey the standards drawing list. | 17      |
| 5.2        | Objective Two: To identify the type of bar code.     | 17 - 18 |
| 5.3        | Objective Three: To conduct field visit and trial.   | 18      |

## **CHAPTER THREE – RESEARCH**

|            |   |         |
|------------|---|---------|
| <b>6.0</b> | <b>Research for objective one</b>           | 20 - 38 |
| 6.1        | Project Management Software                 | 20      |
| 6.2        | Web Based Project Management                | 20      |
| 6.3        | Tracking of Drawing                         | 21      |
| 6.4        | Dissemination of drawings information       | 21 – 25 |
| 6.5        | Survey of standard drawing list             | 25 – 37 |
| 6.6        | Usage Pattern and Environment               | 37 - 38 |
| <b>7.0</b> | <b>Research for objective two</b>           | 39 – 43 |
| 7.1        | Types of Bar Code System                    | 39 – 41 |
| 7.2        | Selection of Bar Code System                | 41 - 43 |
| <b>8.0</b> | <b>Research for objective three</b>         | 44 – 59 |
| <b>8.1</b> | <b>Bar Code Case Study</b>                  | 44 – 50 |
| <b>8.2</b> | <b>Concept Plan for tracking of drawing</b> | 51 - 59 |

## **CHAPTER FOUR – IMPLEMENTATION**

|            |  |                |
|------------|--|----------------|
| <b>9.0</b> | <b>Implementation of research project</b>                      | <b>61 - 92</b> |
| 9.1        | Site Visit To Building And Construction Authority of Singapore | 61 - 63        |
| 9.2        | Trial Using Limited Edition Bar Code Demonstration Software    | 65 - 77        |
| 9.3        | Trial Using Limited Edition Bar Code Printing Software         | 78 - 90        |
| 9.4        | Consultation with specialist in bar code industry.             | 91 – 92        |
| 9.5        | Summary of Implementation                                      | 92             |

## **CHAPTER FIVE – RECOMMENDATION**

|             |                                      |                |
|-------------|--------------------------------------|----------------|
| <b>10.0</b> | <b>Recommendation and Conclusion</b> | <b>94 – 95</b> |
| 10.1        | Recommendation                       | 94 – 95        |
| 10.2        | Conclusion                           | 95             |

## **CHAPTER SIX – RISK ASSESSMENT**

|             |                        |                |
|-------------|------------------------|----------------|
| <b>11.0</b> | <b>Risk Assessment</b> | <b>97 - 99</b> |
|-------------|------------------------|----------------|

## **CHAPTER SEVEN – RESOURCE ANALYSIS**

|             |                          |            |
|-------------|--------------------------|------------|
| <b>12.0</b> | <b>Resource Analysis</b> | <b>101</b> |
|-------------|--------------------------|------------|

## **CHAPTER EIGHT - APPENDICES**

|             |                          |                  |
|-------------|--------------------------|------------------|
| <b>13.0</b> | <b>Appendices</b>        | <b>103 - 105</b> |
| <b>14.0</b> | <b>List of reference</b> | <b>106</b>       |



## **LIST OF FIGURES**

- 1. Figure One - Chain of command in a design and build contract.**
- 2. Figure Two – Chain of command in a design bid and build contract.**
- 3. Figure Three - Flow of information in design and build procurement contract.**
- 4. Figure Four - Flow of information in design-bid and build procurement contract.**
- 5. Figure Five - Example of linear bar code symbols.**
- 6. Figure Six - Example of two dimensional bar code symbols.**
- 7. Figure Seven - General Concept layout showing link in project management team.**
- 8. Figure Eight - Goods Dispatch Operation.**
- 9. Figure Nine - Goods Receipting Operation.**
- 10. Figure Ten - Information Exchange Loop.**
- 11. Figure Eleven - Layout diagram for building plan reception counter.**
- 12. Figure Twelve - Network diagram for BCA Submission Planning System.**
- 13. Figure Thirteen – Network diagram for tracking of drawing from tender stage to as build stage.**
- 14. Figure Fourteen – Data Input Operation.**
- 15. Figure Fifteen - Drawing Changes Operation.**
- 16. Figure Sixteen - Message Feature of some barcode software.**
- 17. Figure Seventeen – Message Feature of some barcode software (cont'd).**
- 18. Figure Eighteen – Sample of bar code label obtained from BCA.**
- 19. Figure Nineteen – Sample of part plan processed using the bar code system.**
- 20. Figure Twenty - Sample of New Asset Template.**

21. **Figure Twenty One – Sample of Transaction History Page Template.**
22. **Figure Twenty Two – Sample of Check Out Template.**
23. **Figure Twenty Three – Sample of Check In Template.**
24. **Figure Twenty Four – Sample of Edit Asset Template.**
25. **Figure Twenty Five – Sample of Attachment Template.**
26. **Figure Twenty Six – Sample of Security Privilege Template.**
27. **Figure Twenty Seven – Sample of Bar Code Label Template 1.**
28. **Figure Twenty Eight – Sample of Bar Code Label template 2.**
29. **Figure Twenty Nine – Sample of Page Set Up Introduction Template.**
30. **Figure Thirty – Sample of Layout and Printer Setting Template.**
31. **Figure Thirty One – Sample of External Data Source Template.**
32. **Figure Thirty Two – Sample of Data Source Selection Template.**
33. **Figure Thirty Three – Sample of Data Table Collection Template.**
34. **Figure Thirty Four – Sample of Data Column Selection Template.**
35. **Figure Thirty Five – Sample of Configuration Summary Template.**
36. **Figure Thirty Six – Sample of Add Text & Bar Code Template.**
37. **Figure Thirty Seven – Sample of Object Source Template.**
38. **Figure Thirty Eight - Sample of Save & Print Template.**
39. **Figure Thirty Nine – Bar Code Label for Construction Drawing.**
40. **Figure Forty – Bar Code Label for Amended Construction Drawing.**

## LIST OF TABLES

1. **Table One** - **Extract of structural drawing list.**
2. **Table Two** - **Tabulation for total quantity of characters, symbols and numbers used for structural drawings.**
3. **Table Three** - **Extract of architectural drawing list.**
4. **Table Four** - **Tabulation for total quantity of characters, symbols and numbers used for architectural drawings**
5. **Table Five** - **Extract of Interior Design drawing list.**
6. **Table Six** - **Tabulation for total quantity of characters, symbols and numbers used for Interior Design drawings**
7. **Table Seven** - **Extract of landscape drawing list.**
8. **Table Eight** - **Tabulation for total quantity of characters, symbols and numbers used for landscape drawings.**
9. **Table Nine** - **Extract of Mechanical and Electrical drawing list.**
10. **Table Ten** - **Tabulation for total quantity of characters, symbols and numbers used for Mechanical and Electrical drawings.**
11. **Table Eleven** - **Summary of total characters, symbols and numbers required to be used in drawing title.**
12. **Table Twelve** - **Summary of usage pattern and environment.**
13. **Table Thirteen** - **Comparison between linear and two dimensional bar code.**
14. **Table Fourteen** - **Summary of drawing criteria and bar code features.**
15. **Table Fifteen** - **Summary of features of bar code reader.**
16. **Table Sixteen** - **Determination of Asset or Inventory.**
17. **Table Seventeen** - **Example of data to be loaded into data bank.**
18. **Table Eighteen** - **Example of data to be loaded when there is are changes in the drawing.**
19. **Table Nineteen** - **Reproduction of table seventeen.**

**CHAPTER ONE**  
**INTRODUCTION**

## **1.0 INTRODUCTION**

Anthony Walker cited in Project Management in Construction that records of buildings in Middle Ages shows that a master mason is responsible for acquiring and organizing labour and material for technicalities of construction on the basis of outline from the client. These master mason's concept slowly changes in the sixteenth century and during the Industrial Revolution where demand for building to accommodate workers and building for the different industries created change in organizational pattern of building works.

This resulted in a distinction between architect and engineer being more prominent and the practice of work awarded on contract or "bargain" practice began to emerge. The separation of architect from builders became apparent in First World War. Slowly but progressively up till the Second World War where demand of building grows in complexity and the industry becoming more sophisticated, the pattern of organization of project remains unaltered. The ease with which variation could be introduced coupled with extensive use of sub contractors give rise to recognition for more cooperation in building industry.

With the progression and increasing complexity of building industry, not only is there a need for the pattern of organization to realign themselves to this progress but the tools we used in managing and administering a construction have to align themselves to this progress and complexity.

Hence as a project manager representing the client, the ability to stay on top of the job will no longer rely on the skill and experience of the manager. He has to have the tools to help him stay ahead of the progress and increasing complex building industry. This is especially true in coordinating the work of the sub contractor and controlling the variation of a project. One way that a project manager can stay on top of the job is to have a firm grasp of the movement of building plan from tender stage to construction stage.

There are many project management tools available in the construction industry to help a project manager keep track of the progress and data in a building project. However, most of these tools not only serve as tracker of building plan but also monitor the cost, quotation etc. Some of this function which is already performed by the client's consultant. This will result in duplication of work and will eventually give rise to confusion. Confusion is the last thing we want to happen as this will result in abortive cost and delay in the progress of work.

Therefore the purpose of this research is to look into using bar code system to keep track of drawing from tender stage to as built stage.

## 2.0 BACKGROUND

### 2.1 Nature of Industry

This aim of this report is to research the feasibility of using the bar code system to keep track of drawings from tender stage to as built drawing stage in a residential development in Singapore. It is hoped that this will assist the project manager in meeting the objectives of time, quality and cost in a residential development among an ever changing consumer environment.

The abstract below from the book “Project Management in Construction” by Anthony Walker spells out the challenges facing a project manager in an ever changing environment in the construction industry and in particular in the area of technology development. In addition to these development and changes, the complexity of a client’s demand will mean that the project manager must not just possess the skills but also the necessary tools to organize the various contributors in construction development.

*The complexity of client’s demand together with increasing complexity of building and particularly in technology development has over the years resulted in specialization within the construction industry.*

*The profession associated with construction have emerged as a separate skill (ie architectural, structural, IT etc), as have many specialist contractor within the main contractor.*

*The key to the management of construction projects is therefore the way in which the contributors are organized so that their skills are used in the right manner at the right time for maximum benefit of the client.*

*The way in which the industry and its skills and professions have evolved has compounded the problem of organizing effectively. Specialisation has been accompanied by the creation of independent companies offering specializations, and the complexity of construction has led to greater interdependency between the specializations and hence between companies.*

*It is against this background that the conventional solution to project organization has attempted to cope with increasing complexity and uncertainty. The strain has shown through the increasing use and development of alternative approaches such as design and build, management contracting and construction management. What these approaches have not provided, however, is a framework for designing organizations to suit the particular project and conditions in which it has to be executed.*

(Walker 2002, pp 3-4).

As such the objectives of project management should also be that of the client to in order to give maximum benefit to the client. These should also be the objectives of contractors and professionals involved in developing the project.

These will relate directly to the project and will be:

- Function satisfaction
- Aesthetic satisfaction
- Completion on time
- Completion within budget
- Value for money

Since the objectives of both the professional such as architect, engineers and quantity and contractors are in line with those of the clients, then for practical reasons the responsibility to ensure that these objectives are met should lie with the client (Walker, 2002 pp. 9-10).

As mentioned by Chris Henderickson in his book that the knowledge of the owner in the construction industry will help in knowing which is the most beneficial and appropriate approach in organizing project management for a particular project. That the owners should be concerned with the life cycle costs of constructed facilities rather than simply the initial construction costs as meeting the functional requirements for the new facility satisfactorily is important to the success of the project. Owners must also be very concerned with the quality of the finished product as well as the cost of construction itself (Chris Hendrickson. Project Management For Construction. Online. Internet. 15 May 2004. Available via <http://www.ceu.cmu.edu/pmbook/>).

## **2.2 Requirement of a Project Manager**

Nature of the industry is such that the activities and roles played by all parties in managing a project are closely intertwined. Any effect on one party will affect the other party and ultimately the client. Obviously at the end of the day, if the effect on the client is such that it causes the project to be delayed or the cost of the project to overrun, then there will be a domino effect on all parties that are part of this web. Therefore acknowledging that the client has a leading role in project management is not a matter of choice but rather a matter based on economic and survival.

Hence we can safely say that project management role in a residential should be best played by the client itself if the objective of a development is to be met.

As far as exerting authority over the project team is concerned, the abstract below best sums up why the project management must be carried out by the client.

*The project manager, in the broadest sense of the term, is the most important person for the success or failure of a project. The project manager is responsible for planning, organizing and controlling the project. In turn, the project manager*

*receives authority from the management of the organization to mobilize the necessary resources to complete a project.*

(Chris Hendrickson. Project Management For Construction. Online. Internet. 15 May 2004. Available via <http://www.ccu.cmu.edu/pmbook/>)

Having said that the role of a project manager needs to be from client side, we have to take into consideration that a residential construction development is very broad based and complex and requires specialist skill. Hence a project manager must be someone who has the experience to understand the basic mechanism of a residential construction development and have the necessary resources to run this mechanism.

This leads us to the following three requirements that a client project manager must possess in order to make him effective in his work:

1. The project manager must have the necessary experience in managing the development.

In the field of engineering, the competency of an engineers can be defined by his accreditation ie whether he is a certified professional engineers recognized by a professional engineering board. In the case of a project manager, this can be defined by his years of experience or bench mark set by an accredited organization. In the local context, this can be done by making sure that the project manager is a member of Society of Project Manager.

2. The project manager must have the resources to support him in his role.

The firm that the project manager works in plays an important role in the success of a residential condominium development. As mentioned in “Management – Australia in a Global Context”, management involves four activities:

- a. Planning and decision making
- b. Organisation
- c. Controlling
- d. Leading

It was mentioned that once the manager has set a goal - in this case is to complete the development of a condominium - the next function is to organize the people and resources necessary to carry project. Therefore it is important that the firm the project manager works for provides him with the necessary people and resource (Davidson & Griffin, 2000 pp. 9-10).

3. The project manager must have the specialist support at his disposal.

As mentioned an organization is no more separate from the environment that a fish are separate from the water in which they swim and which sustain their life (Davidson & Griffin, 2000 p 80).



The environment can be in the form of:

- a. Political-legal dimension
  - Government Safety Standard
  - General posture towards business regulation
  - Import tariffs/protection
- b. Sociocultural dimension
  - Growing consumer demands for quality
  - Demographic shifts in the number of single adults
  - Increased cooperation between management and labour
  - Varying consumer tastes
- c. Technological dimension
  - Increased emphasis on robotics
  - Improved computer assisted design techniques
  - More efficient operating system
- d. International dimension
  - International competition
  - major operations in other countries
  - Significant ownership by others

Therefore it is important to understand this environment and manoeuvre among them (Davidson & Griffin, 2000 p 80).

Similarly for a project manager after having been advised by the marketing team on changes on marketing trend, the design of the development has to be reviewed so that it is line with the new trend. This trend being set by this consumer demand and failure to heed the trend will mean building houses that nobody wants to buy. There are times when after certain prevalent court ruling, issues that were once “grey” may not appear to be so. Hence if this is not handled properly, it may become a potential liability. A project manager may have to review the design or work done on site so as to ensure that the development is not subject to similar fate. Not heeding this will mean lawsuit from unhappy home buyer.

All these reviews including others which are stimulated by the need to maintain one position in relation to that of its competitor may boils down to ensuring one’s survival in a fast changing and competitive market.

To meet all these fast changing needs during a time when a building is being built will mean making changes on certain works that have been built or reviewing design on works that have not been build (which means this part of work can’t be built until the review is finalized). All these changes will naturally mean existing drawings have to be revised or new set of drawings to be issued to the contractor.

The specialist support a project manager receives can be in many forms such as the services of external consultants such as architect, engineers and quantity surveyor or tools such as computer software (Microsoft Project or Microsoft Excel).

## 2.3 **The role and function of a project manager in the residential development.**

2.3.1 The project manager is that individual who is directly responsible for production activities on a specific project at any given time. He is the one who provides the day to day leadership he; is the front line problem solver; he maintains the integrity of construction with respect to the plans, specifications, and codes; he enforces policy, and he often provides direction for one or more superintendents.

The role and function of a project manager are dependent in large on the whether he is working for a big company, the management skill of the company he is working in or the profit centers of the company.

In large company, a project manager may be able to garner in house support such as technical or design adviser whereas for a small company everything have to rely on the experience of the project manager himself.

A company that has many years of track record may have an established system or procedure in managing project thereby cutting down the learning curve of a new project manager.

The profitability of a project or profit margin may also affect the role of the project manager especially when he or she is under pressure to cut cost to meet the profit target under poor marketing sentiment.

Generally the role of the residential project manager includes the following:

1. to maintain positive control over one or more construction projects on a day to day basis.
2. to manage production resources.
3. to coordinate construction activities
4. to minimize risk
5. to support customer services
6. to participate in a public relations program
7. to assist in the area of product development.

The above seven basic roles which project manager provides arises as a result of the four basic managements requirement. These functions are:

1. planning
2. organizing
3. directing
4. controlling of activities (Dennis J. Rouke, 1996).

2.3.2 construction manager As with any other matter, the role and function of a person must ultimately lead him to meeting the objective or objectives he is tasked to perform. In of residential housing development, the primary objectives that a project must achieve are:

1. Cost
2. Time
3. Quality

The project that he or she is in charge of must be completed within the given budget and time frame and meeting the quality bench mark set.

Therefore in order to meet these objectives, he has to ensure that drawings are issued on time to contractors, design requirement are captured accurately and any changes during the midst of construction are made known to the contractors as quickly as possible. In addition, he has to ensures that at the end of the project, all changes made to the design are reflected accurately in the as-built drawings prior to handling over to the condominium management council.

A mechanism to ensure a proper flow of drawings from the designer to the builder will cut down the risk of delay in the progress of work and while at the same time maintain the quality of work. Abortive cost due to building based on outdated or superceded drawings or delay in completion of work will also be minimized.

In addition, this mechanism will help ensure that changes made to the design whether due to site constrain or design review are captured accurately in the as-built drawings prior to handing over to the condominium management council.

At this point in time, it is best that we understand the basic flow of activities in the development of a condominium.

## **2.4 Sequence of work in the development of a residential development.**

2.4.1 The way residential condominium development contract is being awarded has changed over times. From an open tender system whereby public tender is awarded, it has developed into a core contractor system.

Here contractors who have the same vision and goal as the developer are invited to participate as core contractors. Any tender to be called shall only be limited to the same group of contractors. In this way, there are incentives for a contractor to perform well knowing that any slag in performance will result in them being de-listed from this core. In this way, the developer will have better control over the contractor and hence able to meet the quality and speed that he wants. Naturally, with competition being confine just to the core group of contractor will mean higher price.

Other form of development sees contractor and developer jointly developed a piece of land. Here the contractor will enjoy the profit as well as share in the problem the project may bring with it. Hence indirectly, there is an incentive for the contractor to perform better knowing that he cannot run away from the job even when it is completed. However, the down side of this arrangement is that in the eye of the public, there to be a conflict of interest as the element of enforcement which a developer usually plays is now gone.

We shall now briefly look at the process of a development.

- 2.4.2 Prior to understanding the basic sequence of work in a residential development, we shall first outline some of the important document in the development.

The document and obligations established by law covers:

1. Contract Documents and Drawings which spells out the rights and obligation of the contractor and developer.
2. Sales and purchase agreement which covers the rights and obligation of the developer and buyer.
3. Approved building plans and permits issued by building authority.
4. Warranty for building material eg ten years warranty for water proofing for roof.

- 2.4.3 The basic activities that are common if not same for all residential development usually covers the following steps:

Step One : Award of land tender or purchase of land from private owner.

Step Two : Approval of project development expenditure

Step Three : Appointment of Civil and Structure Engineers who will in turn help to appoint the topographical surveyor and soil specialist.

Step Four : In the meantime, architect, quantity surveyor, mechanical and electrical engineers and landscape etc are also appointed.

Step Five : Concept Design Development shall commence from this stage onwards.

Step Six : Once the concept design is approved by the management, the detail design shall commence.

Step Seven : Once the detail design is accepted by all parties, the quantity surveyor and the relevant consultants shall proceed to prepare the tender document and drawing.

- Step Eight : Once the tender drawing and document are ready, calling of tender for the various works eg Main Building Tender, Lift Tender, Air Condition and Mechanical Ventilation Tender, Swimming Pool Pump System Tender etc shall proceed.
- Step Nine : After the award of tender to the successful main contractor or nominated sub contractor, the contract drawings shall be issued to them.
- Step Ten : Once the successful contractors take possession of the site, construction drawing shall be issued to them to start work. The construction drawings will capture all addendums that were raised during the tender process.
- Step Eleven : During construction stage, certain element of the building may require the contractor to submit shop drawings.
- Step Twelve : Upon completion of the project, the contractors are required to Prepared and issued as built drawings to the consultants and client.
- Step Thirteen: These as built drawings are than passed on to the managing agent of the condominium and some drawings are required to be submitted to the building authority eg as built structural plans.

Hence it is important that a project manager must not only have technical, engineering or managing skill. He has to have the management and administrative skill in managing the non technical aspect of project management.

## 2.5 **Management and Administration in Residential Housing Development**

- 2.5.1 An effective project manager must not only be sound in construction technology, building code of practice but must be a good manager and administrator. As mentioned below in the book “Construction Management for the Residential Project Manager” by Dennis J. Rouke.

*The foundation of construction management is based on both management practice and the administration of company policy. In order to be effective, a professional construction manager will become knowledgeable about both management and administration.*

(Dennis J. Rouke, 1996)

As mentioned above, a project manager must not only be sound in the technical aspect of building construction but also must be familiar with matters which concern the management and administration in residential housing development. The project manager must also be familiar with the following requirement that

relates to fundamentals of management and administration in housing development:

- a. the document and obligations established by the law;
- b. the general objectives, procedures and activities of accounting and
- c. the process and procedures that constitute effective management practice (Dennis J. Rouke, 1996).

However, the project manager must not only be concerned with documents established by law but also documents established by contract. Contractual documents may eventually be turned into document require by laws in in the event of a legal disputes with contractor or house owner.

This leads to the process and procedure in which these plans are managed during the construction of a residential housing development.

To under how plans are being processed and manager we must understand the whole sequence of work for a housing development beginning from design stage to tendering and finally construction and hand over stage.

## **2.6 The Present Practice of Project Management.**

The present practice of project management revolves around a framework of co-ordination amongst main contractor, sub-contractors, architects, M&E engineer, landscape architect, resident engineer, clerk of works and other consultants.

A proper system of chain of command are set up to ensure that this framework of co-ordination is being properly and tightly enforced.

This chain of command would also depend on the type of procurement practice that is being used for the project. It can be design and build or design-bid-build type of procurement.

- 2.6.1 In the design and build procurement system, the chain of command for co-ordination of work during construction are shown in the figure one.

Here the Employer's Agent will report direct to the client's project manager. The Employer's Agent which is an architect will be employed by the client. The quantity surveyor is the only consultant that is still under the direct control of the Employer's Agent. The resident engineer and clerk of work will still report direct to the employer's agent.

Other consultants such as M&E engineers, Landscape architect etc will be under the direct payroll of the main contractor. All sub contractors will report direct to their respective consultant under the main contractor.

2.6.2 In the design-bid and build procurement system, the chain of command for coordination of work are shown in the figure two.

Here the architect will report direct to the client's project manager. The quantity surveyor, M&E engineers, Landscape architect etc will report to the architect. The resident engineer and clerk of works will report to the architect and consultants.

The main contractor will report to the architect and consultants.

All sub contractors will be nominated to the main contractor. They will report concurrently to the architect, consultants and main contractor.

## 2.7 **Need for Improvement in Project Management**

As we can see from section 1.6, the present state of project management relies on a frame work whereby various parties involved in the project communicate with one another.

This form of communication whether in the form of normal day to day corresponding or request for information or confirmation of verbal instruction have to follow the chain of command spelt.

Any experienced project manager will tell you that the chain of command established are based on the term and conditions established in the contract. Side stepping this chain of command may result in giving the contractor an excuse for accusing us of violating the terms and condition of the contract.

However, to follow it will sometimes mean a long route to achieve something which can merely be done by just a phone call. This long route or route to get an act to be carried out or an information to be disseminate to all if carried out properly will usually serves its purpose. However, if the information gets distorted or missing or somewhere along the route someone held on to it, will results it delay or disruption to work on site.

To ensure a seamless route to dissemination of information and a concurrent propagation of information, improvement has to make on the chain of command. At the same time, care has to be taken to retain the contractual obligations and duties that are spelt out in the contract.

## CHAIN OF COMMAND IN A DESIGN AND BUILD CONTRACT

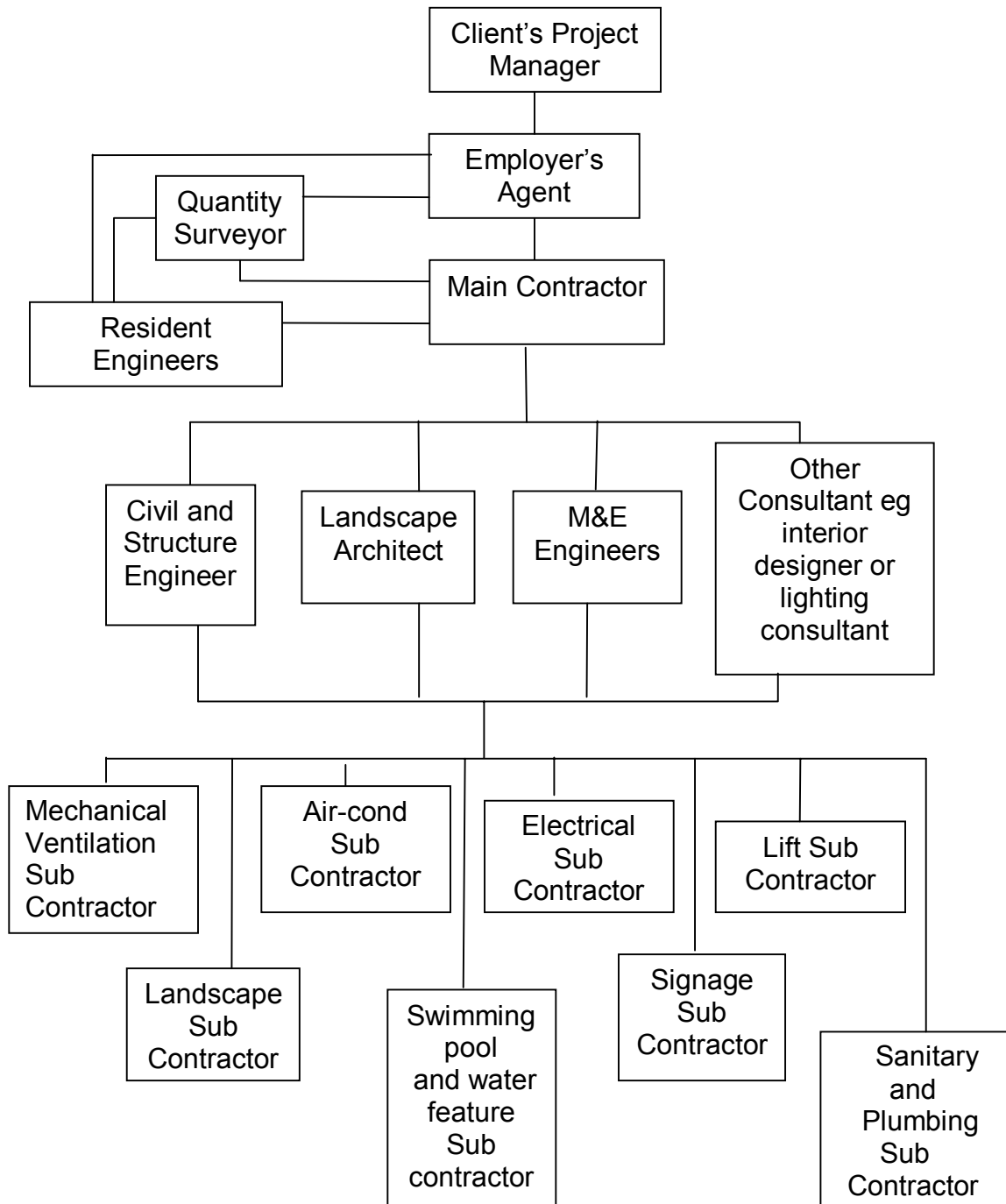


Figure One



**CHAIN OF COMMAND IN A DESIGN BID AND BUILD CONTRACT**

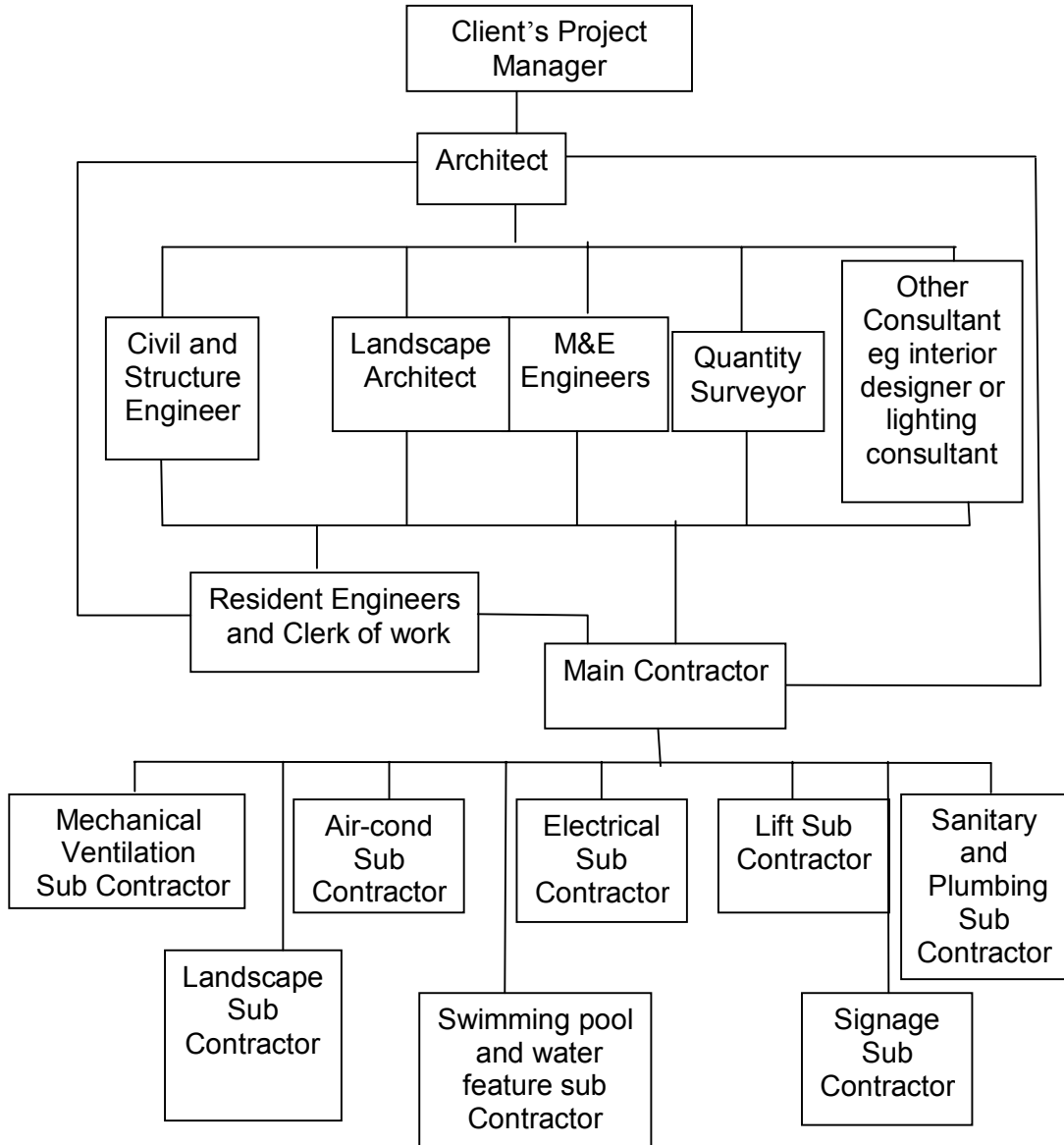


Figure Two

## **2.8 Technology Used in Project Management**

There are many software packages available in the market available which can help a project manager to manage a construction development project effectively. There are organizations which used bar codes to keep track of their inventory or flow of goods. However not many companies or organisations specifically used bar codes to keep track of drawings from tender stage to as built drawings stage.

Bar code is an automatic identification (Auto ID) technology that streamlines product identification and data collection.

The first concept of bar code was developed about 65 years ago in the mid 1930s by a group of student headed by Wallace Flint at the Harvard University Graduate School of Business Administration.

In 1949, Norman Joseph Woodland and Bernard Silver invented what is know today as the Bull's Eye symbol which they patented and titles as "Classifying Apparatus and Method.

Bar code was not commercialized until 1996. In 1997, a Kroger store in Cincinnati installed one of the first scanning system, the products codes were represented by bull's eye barcode(Adams Russ. Bar Code 1. Online. Internet.16 July 2004. Available via [www.adams1.com](http://www.adams1.com)).

## **3.0 AIM**

The aim of this report is to investigate the use of a bar code system to keep track of drawings from tender to as built stage and also at the same time identify its weakness if any.

It is hoped that through this research, the flow of drawing within a project team shall be seamless and information flow are as accurate and timely as possible.

## **4.0 OBJECTIVES**

4.1 The objectives for this research is to select the most suitable type of bar codes system to be used. Any disadvantages or setback of the using bar codes system that are identified during this research will also be taken note of.

4.1.1 Objective One: To survey the standards drawing list.

4.1.2 Objective Two: To identify the type of bar code that is suitable for use in this project

4.1.3 Objective Three: To prepare concept plan and carry out a trial.

## **CHAPTER TWO**

### **METHODOLOGY USED**

## 5.0 **METHODOLOGY USED**

The methodology used for the three objectives are shown below.

### 5.1 **Objective One: To survey the standard drawing list used in residential development and identify the pattern of characters and numbers used as drawing numbers**

- a. To collect data on the drawing list used for development of residential condominium and identify the following:
- b. Total characters, symbols and numbers used to denote the drawings title, drawing number and drawing status.
- c. Identify the usage pattern of drawings in order to understand the type of environment they are subjected to.

### 5.2 **Objective Two: To identify the type of bar code that is suitable for used in tracking drawing in a during the construction of a residential development in Singapore**

This shall be carried out by collecting data on the three different type of bar code and identifying their characteristics.

Based on their characteristics, it is matched to the requirement of a drawing list and also the environment this drawing is to be used in.

Requirement of a drawing list can be listed as:

- a. characters for listing the drawing should be alpha numeric such as TAC/ARCH/ID/MB/A/01

In this case, there are altogether 12 characters, two numerals and four signs.

1. TAC stands for company name.
  2. ARCH stands for architectural trade.
  3. ID stands for Interior Design
  4. MB stands for master bath room.
  5. A stands for type A unit
  6. 01 stands for drawing number one.
- b. environment shall be the type of surface the bar code will be stick on and the condition it will be used in eg office environment, site environment or outdoors.

In the case of construction drawings, we can safely say that it is used in the outdoor and site environment whereas for tender drawings it is used in door.

**5.3 Objective Three: To conduct field visit to Government Institution in order to understand how bar code are used. Prepare a concept plan on tracking drawing during development of a residential development and conduct a trial on it.**

- a. To carry out field visit or review case study or understand the how bar codes are used in library etc and take note of problem and limitation.
- b. Prepare a concept plan using information gathered in objective one and two.
- c. Seek assistance and advice from system engineer in drafting a concept plan.
- c. If resource is available, to conduct a scale down trial on concept plan by loaning equipment or soft ware.

**CHAPTER THREE**

**RESEARCH**

## **6.0 RESEARCH FOR OBJECTIVE ONE**

To identify the type of bar code that is suitable for used in tracking drawing during the construction of a residential development in Singapore

First we shall look into the various tools or software that a project manager is able to obtain in the market to assist him in managing his project.

### **6.1 Project Management Software**

There are some software based project management tools available in the market that provides a user with quick and easy access to up-to-the-minute costs, contracts and document information.

These project management tools come with a fully integrated financial and operations software. It allows integration of accounting, estimating, and purchasing systems. It allows users to issue and see all prime contracts, sub contracts, updated plans and drawings, change orders, purchaser orders, meeting minutes, requests for information and other project related document.

It has the ability to document and coordinate the distribution of current drawings and sketches to all interested parties.

It has tools that create and track common project documents, such as RFIs, meeting minutes, submittals and transmittals.

Features such as control of changes order, issue prime contract, sub contract or purchase order are just some of the few you can find in this software.

### **6.2 Web Based Project Management**

There are similar tools which are able to perform the function of software based project management tool except that they are via the internet. This type of management tool even allows for real monitoring of site activities through a web based camera. Monitoring of work can be done of site via web camera.

In addition, consultants can comment on drawing electronically and issue it electronically to others via the net.

Calling of tender can be done electronically via the net with document loaded up in PDF format. Signing of contract document can be done electronically via electronic signature.

The drawback for this package is that the files to be downloaded may be very big and also all parties involved have to have the computers and servers with the appropriate specification and capacity to serve this function.

### **6.3 Tracking of drawing**

Having seen the capability and features of software and web based project management tools.

Most of these management tools cover a wide range of other services like keeping track of meetings minutes, project accounts, etc which make it not very user friendly to use. These additional tools are not necessary as the information can be easily obtained from consultants such as the quantity surveyor or architect.

What is needed is a stand alone system that tracks the movement if shop drawings and users friendly to operate without duplicating the function which consultants such as quantity surveyor and architect is performing.

This system must have the capability to disseminate information pertaining to drawing amongst the project team remains via an alert system.

At this point in time, it is best that we understand how drawings are transmitted during the construction stage through the various parties in a project team for the design and build and design-bid and build procurement system.

### **6.4 Dissemination of drawings information**

6.4.1 In design and build concept, the information flow between client's project manager, Employer's Agent, main contractor, sub contractor, other consultants, resident engineer and clerk of works are not as complicated as the conventional design bid and build.

Here the information flow to main contractor, main contractor's consultant or sub contractors from the Employer's Agent is via the main contractor.

Similar any information flow from sub contractor, other consultants or main contractor to Employer's Agent shall be direct by or via the main contractor to the Employer's Agent.

Any decision made by the Employer's Agent will be made known to the client's project manager, quantity surveyor, resident engineer and clerk of work.

Information can be in the form of shop drawings, construction drawing, part plan or request for information (RFI) or confirmation of verbal instruction (CVI).

Site direction or notification shall be sent via the resident engineer and clerk of works to the main contractor after consultation with Employer's Agent. This direction shall also be made known to the client's project manager, quantity surveyor and Employer's Agent.



The flow of information in either direction ie from Employer's Agent to main contractor or vice versa is illustrated in figure three.

- 6.4.2 In design-bid and build concept, the information flow between client's project manager, main contractor, sub contractor, other consultants, resident engineer and clerk of works is slightly more complicated.

Here the information flow to main contractor or sub contractors from the architect is direct. Similarly other consultants such as landscape architect, M&E engineer etc are not required to deal with the sub contracts via the main contractor.

Similarly any information flow from sub contractor or main contractor to either consultants or architect may be direct without going through the main contractor.

The main contractor or sub contractors will keep others in the project team informed of whatever he sent to the architect, other consultants etc.

Any decision made or information given by the architect to the main contractor will be made known to the client's project manager, other consultants, resident engineer and clerk of work.

Similarly decision made or information given by other consultants will be made known to the client's project manager, architect, resident engineer and clerk of work.

Information can be inform of shop drawings, construction drawing, part plan or request for information (RFI) of confirmation of verbal instruction (CVI).

Site direction or notification shall be sent via the resident engineer and clerk of works to the main contractor after consultation with architect or other consultants.

The flow of information in either direction ie from Employer's Agent to main contractor or vice versa is illustrated in figure four.

## FLOW OF INFORMATION IN DESIGN AND BUILD PROCUREMENT CONTRACT

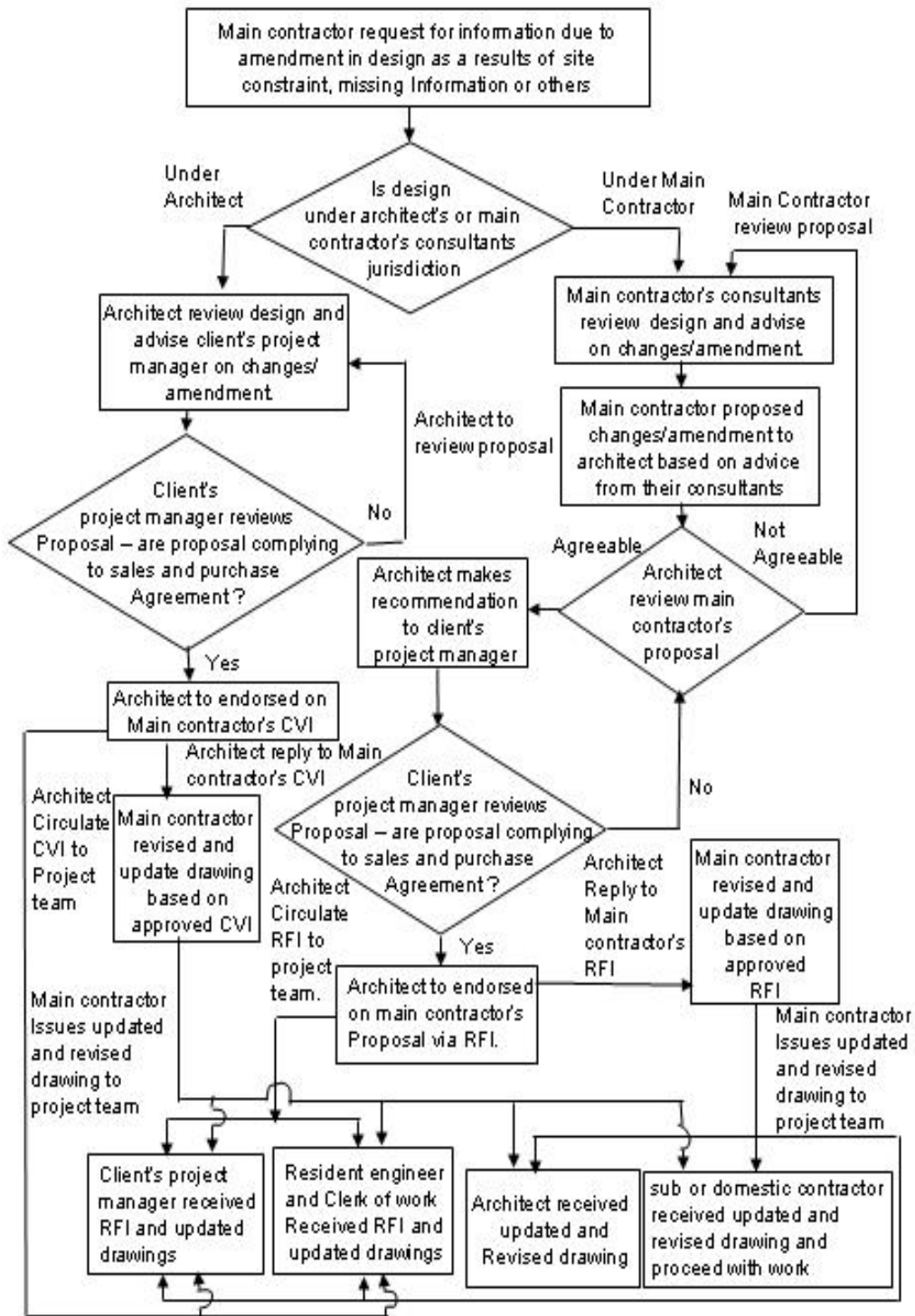


Figure Three

## FLOW OF INFORMATION IN DESIGN-BID AND BUILD PROCUREMENT CONTRACT

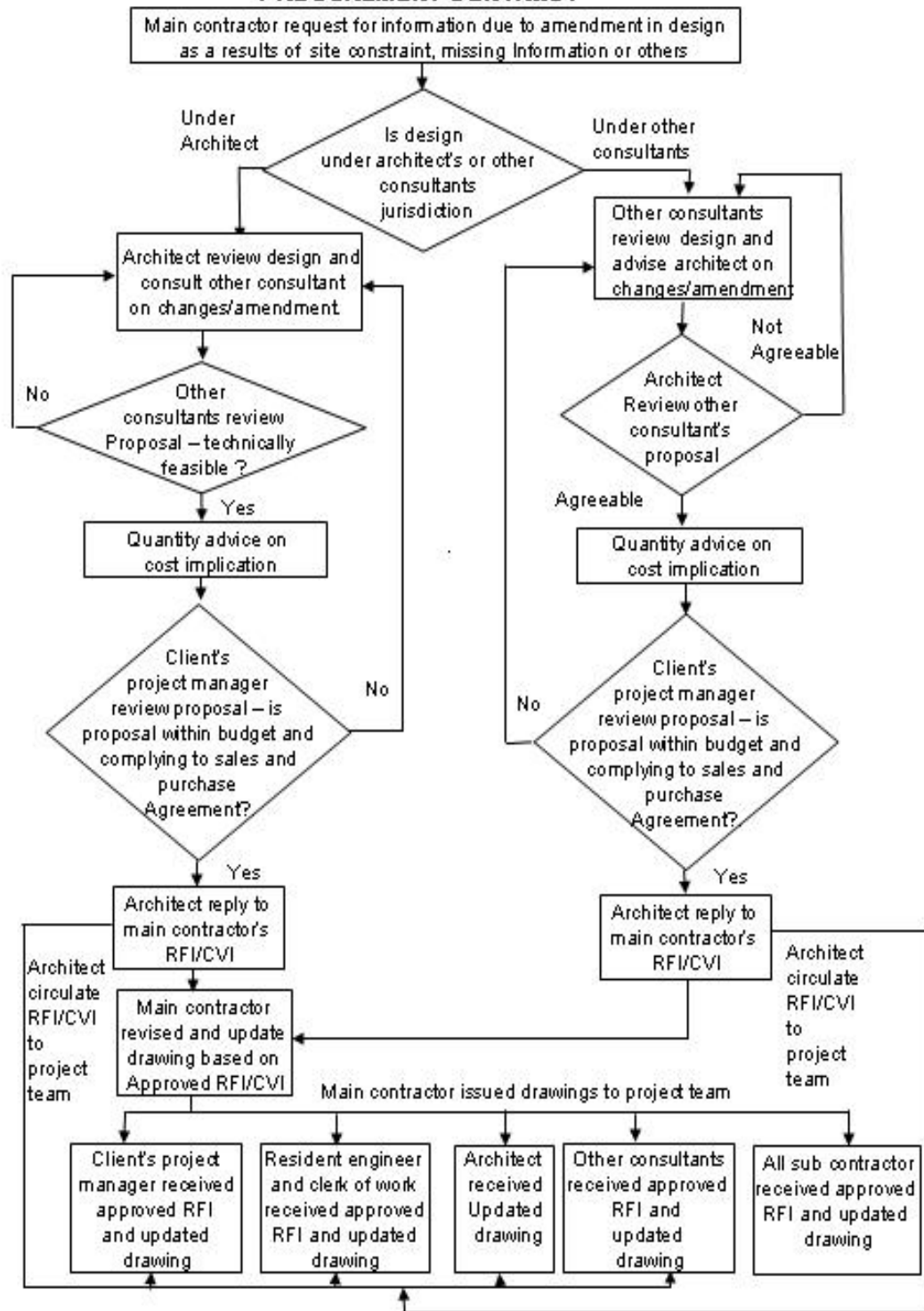


Figure Four

- 6.4.3 We can see from section 6.4.1 and 6.4.2 how information flows from one party to another or how they are being disseminated among the project team, contractors and sub contractors.

It is important that this information reaches the recipient on time and in an accurately manner. Any delay in the flow of information from one party to another or the dissemination of information from one party to another may results in abortive work or delay in progress.

If we look back to sections 2.3.2, we are reminded that the objectives of a project manager in a residential development are cost, time and quality. Likewise, it is important for a project manager to be versatile in the administration and management aspects of project management so that all documentation are administered and managed in an orderly and systematic manner.

We shall now take a look at the basic standard set of drawings that are needed to for the construction of a four hundred dwelling unit condominium development.

## **6.5 Survey of standard drawing list.**

The purpose of this survey is as follows:

- a. to identify a standard drawing list for a residential development from design stage right up to as built drawings stage.
- b. list down the number of characters and numbers that is usually used as the drawing/number title.
- c. list down the additional information needed to characterized the status of the drawing eg tender stage, contract stage, as built stage or revision A etc.
- d. Identify the usage pattern of drawings in order to understand the type of environment they are subject

- 6.5.1 The standard drawing list for a four hundred unit condominium development usually consist of type of drawing:

### 1. Structural Plan

- a. Piling Plan.
- b. Sub structural and Super structure Plan.
- c. Roof Plan.

### 2. Architectural Plan

- a. Building Elevation Plan.

- b. Site Plan and Key Plan
- c. Floor Plate plan for individual floors.
- d. Lift Lobby Plan
- e. Internal Unit Layout Plan.
- f. Window Detail Plan.
- g. Doors and Grilles Plan.
- h. Carpark layout plan
- i. Railing Detail Plan for staircase, balcony etc.
- j. Water proofing Plan

### 3. Interior Design Plan

- a. Kitchen Cabinet, Wardrobe and Vanity Counter Plan.
- b. Ceiling Plan
- c. Tile Setting Out Plan.
- d. Bathroom, Kitchen and Yard Layout Plan.

### 4. Landscape Plan.

- a. Planting Plan
- b. Tile setting out plan for swimming pool and environmental deck.
- c. Hardscape plan for water feature, Jacuzzi and spa.
- d. Children's Playground Plan.

### 5. Mechanical and Electrical Plan

- a. Electrical Plan
- b. Security System Plan
- c. Air-conditioning Plan
- d. Mechanical Ventilation Plan
- e. Lighting Layout Plan
- f. Lift Plan
- g. Fire fighting system plan.
- h. Water Tank Plan
- i. Sanitary and plumbing System Plan.
- j. Water feature and swimming pool pump system plan.

The drawing list varies from project to project depending on the class, design and size of the condominium. If the development is designed with a pitch roof, than additional drawing are required for roof truss and roofing sheet.

If the development is small and are meant for lower rung market buyer than there may not be a swimming pool hence requirement for swimming pool drawing.

However, for research purposes we shall look use the above list in section 6.5.1. We shall first take a look at some of the sample of a drawing list for structural work and identify the type of characters, symbols and numbers that are needed to be used

as drawing title/number.

Listed in table one are extract of some piling, substructure and superstructure plans. Reader have to take note that in an actual construction project, the quantity of drawings for structural works alone may amount to about two hundred over plans. What is shown in the extract and for purpose of this research are just some typical drawings.

Based on the drawing list for structural works, we shall take the drawing with the longest description as a sample ie Item 13 (SS/1120). Considering other details like project title, types of drawing such as tender drawing or construction drawing and drawing number and revision we tabulate the total number of characters, symbols and numerals that is required. Tabulated in table two are the total quantity of characters, symbols and numbers are used for this drawing.

The total quantity of characters, symbols and numbers will be used later on as one of the data to assist in determining the most appropriate type of bar codes that is suitable for use in this research.

The actual number of plans for architectural work in an actual construction project can total up to about one hundred and twenty plans. For the case of interior design, landscape and mechanical and electrical drawings, the actual quantity of plans is about one hundred and fifty, twenty five and two hundred plus respectively. Again this numbers will varies form project to project.

Tabulated in tables three and four are extract of architectural drawing and the tabulation for total quantity of characters, symbols and numbers required for a plan. This is based on item 37 ie drawing number S99092A/WD/A2-28-01 of the drawing list.

Similarly for interior design, we select drawing number TAC/WD/TL/BLK 51-01/07 and this is tabulated in tables five and six.

Landscape drawing SXTH-17 is chosen and this is tabulated in tables seven and eight.

Mechanical and Electrical drawing and mechanical drawings PEE/453/WAT/CAR-01, are chosen and tabulated in tables nine and ten.

The total quantity of characters, symbols and numbers are than summarized in table eleven. From here, we will be able to judge which type of drawing needs the most characters, symbols and numbers to describe it.

From table eleven, Mechanical and Electrical needs the most character, symbols and numbers to describe it ie 280.

However if based on worse case scenario when all types of drawing are taken into consideration and judged, the most characters, symbols and numbers we need to use is 295.

## EXTRACT OF STRUCTURAL DRAWING LIST

| Project : Proposed 400 Units Condominium Development |   |   |
|--|---|---|
| Drawing Schedule and Issue Record                    |   |   |
| Structural Drawing                                   |   | Revision Record   |
| Sketch Drawing : <input type="checkbox"/>            | Tender Drawing : <input type="checkbox"/>       | Day   |
| Prelim Drawing : <input type="checkbox"/>            | Construction Drawing : <input type="checkbox"/> | Month   |
| Building Drawing : <input type="checkbox"/>          | Others : <input type="checkbox"/>               | Year  |
| 1  | S/0001  | GENERAL NOTES   |
| 2  | S/0002  | GENERAL DETAILS   |
| 3  | S/0003  | GENERAL NOTES (FOR PILING)                                    |
| 4  | S/0004  | TYPICAL DETAILS (FOR SLAB)                                    |
| 5  | S/0110  | PILING:OVERALL LAYOUT   |
| 6  | S/0111  | PILING:LAYOUT (PART 1 OF 2)                                   |
| 7  | S/0151  | PILECAP:DETAILS (SHEET 1)                                     |
| 8  | S/1000  | BEAMS AND SLABS:BASEMENT 2 OVERALL LAYOUT                     |
| 9  | S/1001  | BEAMS AND SLABS:BASEMENT 2 LAYOUT (PART 1 OF 2)               |
| 10   | S/1021  | BEAMS AND SLABS: ENTRY RAMP (BLOCK 51)                        |
| 11   | S/1100  | BEAMS AND SLABS: 1ST STOREY OVERALL LAYOUT                    |
| 12   | S/1102  | BEAMS AND SLABS: 1ST STOREY LAYOUT (PART 2 OF 2)              |
| 13   | S/1120  | BEAM AND SLABS: 22KV/LV POWERGRID SUBSTATION LAYOUT (SHEET 1) |
| 14   | S/1200  | BEAMS AND SLABS: 2ND STOREY OVERALL LAYOUT                    |
| 15   | S/1201  | BEAMS AND SLABS: 2ND STOREY LAYOUT (PART 1 OF 2)              |
| 16   | S/1902  | BEAMS AND SLABS: LOWER ROOF LAYOUT (PART 2 OF 2)              |
| 17   | S/1920  | BEAMS AND SLABS: UPPER ROOF OVERALL LAYOUT                    |
| 18   | S/2000  | SLABS: BASEMENT 2 OVERALL REINF LAYOUT                        |
| 19   | S/2010  | SLABS: BASEMENT 1 OVERALL REINF LAYOUT                        |
| 20   | S/2020  | SLABS:ENTRY AND EXIT RAMP TOP AND BOTTOM REINF LAYOUT         |
| 21   | S/2100  | SLABS:1ST ENTRY OVERALL TOP & BOTTOM REINF LAYOUT             |
| 22   | S/2101  | SLABS:1ST STOREY TOP & BOTTOM REINF LAYOUT (PART 1 OF 2)      |
| 23   | S/2103  | SLABS:1ST TO 6TH STOREY DETAILS (SHEET1)                      |
| 24   | S/2111  | SLABS:1ST STOREY SECTION DETAILS                              |
| 25   | S/2120  | SLABS:22KV/LV POWERGRID SUBSTATION TOP & BOTTOM REINF LAYOUT  |
| 26   | S/2900  | SLABS:LOWER ROOF OVERALL TOP REINF LAYOUT                     |
| 27   | S/2901  | SLABS:LOWER ROOF TOP REINF LAYOUT (PART 1 OF 2)               |
| 28   | S/2910  | SLABS:LOWER ROOF OVERALL BOTTOM                               |
| 29   | S/3101  | BEAMS:1ST STOREY SCHEDULE (BLOCK 51 TO 53)                    |
| 30   | S/4001  | COLUMNS:SCHEDULE (BLOCK 51)                                   |
| 31   | S/4051  | HOUSEHOLD SHELTER/LIFT WALL:LAYOUT & DET (SHT 1 OF 14)        |
| 32   | S/4081  | HOUSEHOLD SHELTER/LIFT:ELEVATION (SHEET 1 OF 6)               |
| 33   | S/4090  | WALL:BASEMENT DETAILS   |
| 34   | S/4091  | WALLS:ENTRY AND EXIT RAMP DETAILS                             |
| 35   | S/5001  | STAIRCASE:DETAILS (TYPICAL)                                   |
| 36   | MCS/C2133/9004                                  | ROAD AND DRAINAGE LAYOUT PLAN                                 |
| 37   | MCS/C2133/9005                                  | SECTION   |
| 38   | MCS/C1233/9006                                  | LONGITUDINAL SECTION  |
| 39   | 02/GUILLE/S-01                                  | PROPOSED STRUTTING SYSTEM (SEQUENCE OF WORKS)                 |
| 40   | 02/GUILLE/DTL-01                                | TYPICAL DETAILS (1) (B)                                       |

TABLE ONE

**TABULATION FOR TOTAL QUANTITY OF CHARACTERS, SYMBOLS AND NUMBERS USED FOR STRUCTURAL DRAWINGS**

|    | Description              | Characters | Numerals  | Symbols   |
|----|--------------------------|------------|-----------|-----------|
| 1  | Project Heading          | 42         | 0         | 1         |
| 2  | Drawing Schedule         | 29         | 0         | 0         |
| 3  | Structural Drawing       | 17         | 0         | 0         |
| 4  | Sketch Drawing : □       | 13         | 0         | 2         |
| 5  | Prelim Drawing : □       | 13         | 0         | 2         |
| 6  | Building Drawing : □     | 15         | 0         | 2         |
| 7  | Tender Drawing : □       | 13         | 0         | 2         |
| 8  | Construction Drawing : □ | 19         | 0         | 2         |
| 9  | Others : □               | 6          | 0         | 2         |
| 10 | Day                      | 3          | 2         | 0         |
| 11 | Month                    | 5          | 2         | 0         |
| 12 | Year                     | 4          | 4         | 0         |
|    |                          |            |           |           |
| 13 | Drawing Numbers          | 2          | 4         | 1         |
| 14 | Drawing Title            | 47         | 3         | 4         |
| 15 | Revision Record          | 0          | 0         | 8         |
|    |                          |            |           |           |
|    | <b>TOTAL</b>             | <b>228</b> | <b>15</b> | <b>26</b> |

TABLE TWO



## EXTRACT OF ARCHITECTURAL DRAWING LIST

| Project : Proposed 400 Units Condominium Development |   |   |
|--|---|---|
| Drawing Schedule and Issue Record                    |   |   |
| Architectural Drawing                                | Revision Record                                 |   |
| Sketch Drawing : <input type="checkbox"/>            | Tender Drawing : <input type="checkbox"/>       | Day   |
| Prelim Drawing : <input type="checkbox"/>            | Construction Drawing : <input type="checkbox"/> | Month   |
| Building Drawing : <input type="checkbox"/>          | Others : <input type="checkbox"/>               | Year  |
| 1  | S99092AWD/SP/A1-01                              | Site Plan and Location Plan                   |
| 2  | S99092AWD/B2-1/A1-02                            | Basement 2 Plan                               |
| 3  | S99092AWD/B1-1/A1-03                            | Basement 1 Plan                               |
| 4  | S99092AWD/1 <sup>st</sup> -1/A1-04              | 1 <sup>st</sup> Storey Plan                   |
| 5  | S99092AWD/RP-1/A1-05                            | Roof Plan                                     |
| 6  | S99092AWD/SA-1/A1-06                            | Section A-A Plan                              |
| 7  | S99092AWD/SE-1/A1-07                            | Southern Elevation Plan                       |
| 8  | S99092AWD/IE-1/A1-08                            | Internal Elevation Plan                       |
| 9  | S99092AWD/A2-01-01                              | Power Grid Substation/Refuse Compactor        |
| 10   | S99092AWD/A2-02-01                              | Entrance Driveway                             |
| 11   | S99092AWD/A2-03-01                              | Guardhouse                                    |
| 13   | S99092AWD/A2-04-01                              | Tennis Court                                  |
| 15   | S99092AWD/A2-05-01                              | Steam Bath                                    |
| 17   | S99092AWD/A2-06-01                              | Refuse Chute/Chambers                         |
| 18   | S99092AWD/A2-07-01                              | Typical Household Shelter                     |
| 19   | S99092AWD/A2-08-01                              | Boundary Wall and Gate                        |
| 20   | S99092AWD/A2-09-01                              | Block 1 Unit Layout Plan                      |
| 21   | S99092AWD/A2-10-01                              | Block 1 staircase, Lift 2A and 2B Plans       |
| 22   | S99092AWD/A2-11-01                              | Waterproofing Key Plan                        |
| 20   | S99092AWD/A2-12-01                              | False Ceiling Plan                            |
| 21   | S99092AWD/A2-13-01                              | Column Guard Plan                             |
| 22   | S99092AWD/A2-14-01                              | Windows and Doors Schedules Plan              |
| 23   | S99092AWD/A2-15-01                              | Sliding Doors to balcony                      |
| 24   | S99092AWD/A2-16-01                              | Curtain Wall with ledge and railing           |
| 25   | S99092AWD/A2-17-01                              | A/C Ledge with railing                        |
| 26   | S99092AWD/A2-18-01                              | Typical door and window detail                |
| 27   | S99092AWD/A2-19-01                              | Typical curtain wall detail                   |
| 28   | S99092AWD/A2-20-01                              | Typical detail of canopy at drop off point    |
| 29   | S99092AWD/A2-21-01                              | Grating detail for drain                      |
| 30   | S99092AWD/A2-21-01                              | Guardhouse detail                             |
| 31   | S99092AWD/A2-22-01                              | Water proofing detail                         |
| 32   | S99092AWD/A2-23-01                              | Breeching Inlet access panel detail           |
| 33   | S99092AWD/A2-24-01                              | Parking Lots layout plan.                     |
| 34   | S99092AWD/A2-25-01                              | Roadmarking and parking lots sign             |
| 35   | S99092AWD/A2-26-01                              | Letter Box Detail                             |
| 36   | S99092AWD/A2-27-01                              | Signage Detail                                |
| 37   | S99092AWD/A2-28-01                              | Condominium Management Layout Plan and Detail |
| 38   | S99092AWD/A2-29-01                              | Function Room Layout Plan and Detail          |
| 39   | S99092AWD/A2-30-01                              | Layout and Ceiling Plan for Lift Lobby        |
| 40   | S99092AWD/A2-31-01                              | Tiling Plan for lift lobby.                   |

TABLE THREE

**TABULATION FOR TOTAL QUANTITY OF CHARACTERS, SYMBOLS AND NUMBERS USED FOR ARCHITURAL DRAWINGS**

|    | Description              | Characters | Numerals | Symbols |
|----|--------------------------|------------|----------|---------|
| 1  | Project Heading          | 42         | 0        | 1       |
| 2  | Drawing Schedule         | 29         | 0        | 0       |
| 3  | Structural Drawing       | 17         | 0        | 0       |
| 4  | Sketch Drawing : □       | 13         | 0        | 2       |
| 5  | Prelim Drawing : □       | 13         | 0        | 2       |
| 6  | Building Drawing : □     | 15         | 0        | 2       |
| 7  | Tender Drawing : □       | 13         | 0        | 2       |
| 8  | Construction Drawing : □ | 19         | 0        | 2       |
| 9  | Others : □               | 6          | 0        | 2       |
| 10 | Day                      | 3          | 2        | 0       |
| 11 | Month                    | 5          | 2        | 0       |
| 12 | Year                     | 4          | 4        | 0       |
|    |                          |            |          |         |
| 13 | Drawing Numbers          | 5          | 10       | 4       |
| 14 | Drawing Title            | 40         | 0        | 0       |
| 15 | Revision Record          | 0          | 0        | 8       |
|    |                          |            |          |         |
|    | TOTAL                    | 224        | 18       | 25      |

TABLE FOUR

## EXTRACT OF INTERIOR DESIGN DRAWING LIST

| Project : Proposed 400 Units Condominium Development |   |  |
|--|---|--|
| Drawing Schedule and Issue Record                    |   |  |
| Interior Design Drawing                              |   | Revision Record  |
| Sketch Drawing : <input type="checkbox"/>            | Tender Drawing : <input type="checkbox"/>       | Day  |
| Prelim Drawing : <input type="checkbox"/>            | Construction Drawing : <input type="checkbox"/> | Month  |
| Building Drawing : <input type="checkbox"/>          | Others : <input type="checkbox"/>               | Year   |
| 1  | WC/K/SD-01                                      | Typical kitchen cabinet sectional detail                                       |
| 2  | WC/K/SC-02                                      | Servery counter sliding glass panel Typical Drawing                            |
| 3  | WC/K/CH/DTL-03                                  | Kitchen cooker hood typical plan, section and elevation.                       |
| 4  | WC/K/P/A-04                                     | Type A2, A2p and A2w – Kitchen cabinet layout plan.                            |
| 5  | WC/K/E/A-05                                     | Type A2, A2p and A2w – Kitchen cabinet elevation 1                             |
| 6  | WC/K/E/A-06                                     | Type A2, A2p and A2w – Kitchen cabinet elevation 2                             |
| 7  | WC/K/E/A-07                                     | Type A2, A2p and A2w – Kitchen cabinet elevation 3                             |
| 8  | Blk 51-01                                       | Block 51 1 <sup>st</sup> storey layout plan                                    |
| 9  | WC/WD-01  | Type WD-01 – wardrobe plan and elevation                                       |
| 10   | WC/WD-02  | Type WD-02 – wardrobe plan and elevation                                       |
| 11   | WC/WD-03  | Type WD-03 – wardrobe plan and elevation                                       |
| 13   | WC/WD-04  | Type WD-04 – wardrobe plan and elevation                                       |
| 14   | WC/WD-05  | Type WD-05 – wardrobe plan and elevation                                       |
| 15   | WC/VC/EP-M01                                    | Vanity Cabinet Master Bathroom Plan and Elevation                              |
| 16   | WC/VC/EP-C02                                    | Vanity Cabinet Common Bathroom Pan and Elevation                               |
| 17   | WC/VC/FS-03                                     | Supporting Frame Detail For Vanity Cabinet                                     |
| 18   | WC/VC/SD-04                                     | Typical Vanity Cabinet Section Detail  |
| 19   | TAC/WD/TL/BLK 51-01/07                          | 1 <sup>st</sup> storey living and dining room tiling layout plan for block 51. |
| 20   |   |  |
| 21   | TAC/WD/ID5-A2-01                                | Kitchen Ceiling Plan and layout for type A2.                                   |
| 22   | TAC/WD/ID5-A2-2                                 | Elevation 1 and 2 for Type A2  |
| 23   | TAC/WD/ID5-A2-3                                 | Elevation 3 Type A2  |
| 24   | TAC/WD/ID5-A2-4                                 | Elevation 4 Type A2  |
| 25   | TAC/WD/ID5-MB-A2-01                             | Typical Master Bath Layout and Ceiling Plan for Type A2                        |
| 26   | TAC/WD/ID5-MB-A2-02                             | Typical Master Bath Elevation 1 and 2  |
| 27   | TAC/WD/ID5-MB-A2-03                             | Typical Master Bath Elevation 3 and 4  |
| 28   | TAC/WD/ID5-CB-A2-01                             | Typical Common Bath Layout and Ceiling Plan for Type A2                        |
| 29   | TAC/WD/ID5-CB-A2-02                             | Typical Common Bath Elevation 1 and 2  |
| 30   | TAC/WD/ID5-CB-A2-03                             | Typical Common Bath Elevation 3 and 4  |
| 31   | TAC/WD/ID3-Lobby 51-01                          | Basement 2 – Lift Lobby floor pattern layout plan                              |
| 32   | TAC/WD/ID3-Lobby 51-02                          | Basement 2 – Lift Lobby reflected ceiling plan                                 |
| 33   | TAC/WD/ID3-Lobby 51-03                          | Basement 1 – Lift Lobby floor pattern layout plan                              |
| 34   | TAC/WD/ID3-Lobby 51-04                          | Basement 1 – Lift Lobby reflected ceiling plan                                 |
|  |   |  |
|  |   |  |

TABLE FIVE

**TABULATION FOR TOTAL QUANTITY OF CHARACTERS, SYMBOLS AND NUMBERS USED FOR INTERIOR DESIGN DRAWINGS**

|    | Description              | Characters | Numerals  | Symbols   |
|----|--------------------------|------------|-----------|-----------|
| 1  | Project Heading          | 42         | 0         | 1         |
| 2  | Drawing Schedule         | 29         | 0         | 0         |
| 3  | Structural Drawing       | 17         | 0         | 0         |
| 4  | Sketch Drawing : □       | 13         | 0         | 2         |
| 5  | Prelim Drawing : □       | 13         | 0         | 2         |
| 6  | Building Drawing : □     | 15         | 0         | 2         |
| 7  | Tender Drawing : □       | 13         | 0         | 2         |
| 8  | Construction Drawing : □ | 19         | 0         | 2         |
| 9  | Others : □               | 6          | 0         | 2         |
| 10 | Day                      | 3          | 2         | 0         |
| 11 | Month                    | 5          | 2         | 0         |
| 12 | Year                     | 4          | 4         | 0         |
|    |                          |            |           |           |
| 13 | Drawing Numbers          | 52         | 3         | 0         |
| 14 | Drawing Title            |            |           |           |
| 15 | Revision Record          | 0          | 0         | 8         |
|    |                          |            |           |           |
|    | <b>TOTAL</b>             | <b>231</b> | <b>11</b> | <b>13</b> |

TABLE SIX



**TABULATION FOR TOTAL QUANTITY OF CHARACTERS, SYMBOLS AND NUMBERS USED FOR DRAWINGS**

|    | Description              | Characters | Numerals  | Symbols   |
|----|--------------------------|------------|-----------|-----------|
| 1  | Project Heading          | 42         | 0         | 1         |
| 2  | Drawing Schedule         | 29         | 0         | 0         |
| 3  | Structural Drawing       | 17         | 0         | 0         |
| 4  | Sketch Drawing : □       | 13         | 0         | 2         |
| 5  | Prelim Drawing : □       | 13         | 0         | 2         |
| 6  | Building Drawing : □     | 15         | 0         | 2         |
| 7  | Tender Drawing : □       | 13         | 0         | 2         |
| 8  | Construction Drawing : □ | 19         | 0         | 2         |
| 9  | Others : □               | 6          | 0         | 2         |
| 10 | Day                      | 3          | 2         | 0         |
| 11 | Month                    | 5          | 2         | 0         |
| 12 | Year                     | 4          | 4         | 0         |
|    |                          |            |           |           |
| 13 | Drawing Numbers          | 4          | 2         | 1         |
| 14 | Drawing Title            | 44         | 0         | 2         |
| 15 | Revision Record          | 0          | 0         | 8         |
|    |                          |            |           |           |
|    | <b>TOTAL</b>             | <b>240</b> | <b>10</b> | <b>24</b> |

TABLE EIGHT



**TABULATION FOR TOTAL QUANTITY OF CHARACTERS, SYMBOLS AND NUMBERS USED FOR MECHANICAL AND ELECTRICAL DRAWINGS**

|    | Description              | Characters | Numerals  | Symbols   |
|----|--------------------------|------------|-----------|-----------|
| 1  | Project Heading          | 42         | 0         | 1         |
| 2  | Drawing Schedule         | 29         | 0         | 0         |
| 3  | Structural Drawing       | 17         | 0         | 0         |
| 4  | Sketch Drawing : □       | 13         | 0         | 2         |
| 5  | Prelim Drawing : □       | 13         | 0         | 2         |
| 6  | Building Drawing : □     | 15         | 0         | 2         |
| 7  | Tender Drawing : □       | 13         | 0         | 2         |
| 8  | Construction Drawing : □ | 19         | 0         | 2         |
| 9  | Others : □               | 6          | 0         | 2         |
| 10 | Day                      | 3          | 2         | 0         |
| 11 | Month                    | 5          | 2         | 0         |
| 12 | Year                     | 4          | 4         | 0         |
|    |                          |            |           |           |
| 13 | Drawing Numbers          | 9          | 5         | 4         |
| 14 | Drawing Title            | 63         | 0         | 1         |
| 15 | Revision Record          | 0          | 0         | 8         |
|    |                          |            |           |           |
|    | <b>TOTAL</b>             | <b>251</b> | <b>13</b> | <b>16</b> |

TABLE TEN

**SUMMARY OF TOTAL CHARACTERS, SYMBOLS AND NUMBERS REQUIRED TO BE USED IN DRAWING TITLE**

|   | Type of Drawing           | Characters | Numerals  | Symbols   | Total      |
|---|---------------------------|------------|-----------|-----------|------------|
| 1 | Structural Drawing        | 228        | 15        | 26        | 269        |
|   |                           |            |           |           |            |
| 2 | Architectural Drawing     | 217        | 18        | 26        | 261        |
|   |                           |            |           |           |            |
| 3 | Interior Design           | 231        | 11        | 13        | 255        |
|   |                           |            |           |           |            |
| 4 | Landscape                 | 240        | 10        | 24        | 274        |
|   |                           |            |           |           |            |
| 5 | Mechanical and Electrical | 251        | 13        | 16        | 280        |
|   |                           |            |           |           |            |
|   | <b>HIGHEST NUMBER</b>     | <b>251</b> | <b>18</b> | <b>26</b> | <b>295</b> |

TABLE ELEVEN

**6.6 Usage Pattern and Environment**

6.6.1 In section 3.0, we have mentioned that the aim of this research is to keep track of drawing from tender drawing to as-built drawing. In section 2.4.3, we read how drawings are transformed from step seven to steps thirteen. This transformation produces the following type of drawings:

- a. Tender Drawing
- b. Contract Drawing



- c. Construction Drawing
- d. As Built Drawing

From here we can identify under the type usage pattern and environment they are used in. Here we classified the usage pattern as either for bidding, construction or reference. The environment under which it is used shall be classified as either long term, medium term or short term and whether indoor or outdoor.

6.6.2 As we can see tender drawings are used for bidding purposes and hence it is used under indoor environment. Since tendering process takes about one to two months to complete, they can be classified as short term usage.

For contract drawing, it is usually the final copy after the award of tender and prior to start of construction and therefore it can be considered used for in indoor. Again from award of tender to compilation of contract drawing and document, it takes about one or two months to complete and hence we can classified it as short term duration.

Construction program for four hundred unit condominium development project usually takes about two and a half to three years to complete and hence it can be considered as medium term duration. Since construction drawing is used in the site, it can be considered as under outdoor environment.

Last but not least is the as built drawing which are meant for reference during maintenance or when renovation work need to be carried for the development. We can consider it to be indoor since most of the time they are used as reference and usage is long term as long as the building is around.

Tabulated in table twelve is a summary of the usage pattern and environment the drawing is used under.

**SUMMARY OF USAGE PATTERN AND ENVIRONMENT**

| TYPE OF DRAWING      | USAGE PATTERN | ENVIRONMENT |
|----------------------|---------------|-------------|
| Tender Drawing       | Short Term    | Indoor      |
| Contract Drawing     | Short Term    | Indoor      |
| Construction Drawing | Medium Term   | Outdoor     |
| As Built Drawing     | Long Term     | Indoor      |

TABLE TWELVE

Therefore based on table twelve, the harshest environment that drawing is subject to is long term and out door. Since we are tracking drawing from tender stage to as built stage, we can safely said that the surface that the bar code are to be stick on is paper.

## **7.0 RESEARCH FOR OBJECTIVE TWO**

Having identified the drawing list, the quantity of characters, numbers and symbols, the usage pattern and environment, we shall now proceed to select the most suitable type of bar code to be used.

Bar code comes into many types such as linear, 2-dimension or 3-dimension to name a few. They are also used in a wide variety of industry. They are used in hospital, library, military organization, government department and in transportation.

### **7.1 Types of Bar Code System**

#### **7.1.1 Linear Bar Code**

Bar code comes in many forms and with the most popular being the Linear Bar Code which generally functions as identification codes for products. They generally encode information such as product numbers, invoice number. The actual information is stored separately in a computer.

For example a bottle of 100% Pure White Sesame Oil of 700 grams has a 13 digit bar code 888 8807 10031 0. This consist of

- a. 888 which is the country code for Singapore,
- b. 8007 which is the company code eg Chee Seng Oil factory,
- c. 10031 is the Product Code for 100% Pure White Sesame Oil and
- d. 0 is the check digit.

There are many different bar code symbologies and each has its own rules for character (eg letter, number, punctuation) encodation, printing and decoding requirements, error checking and other features.

These numbers are used to reference the master record in the computer which stores such data. Shown in figure five are some examples of linear bar code.

Example of Linear Bar Code Symbols

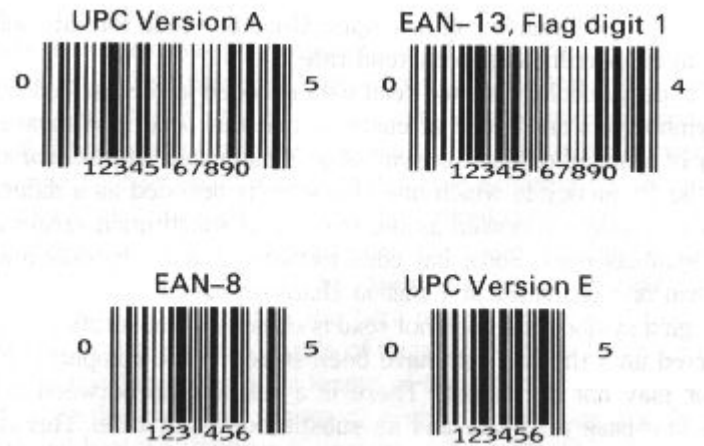


FIGURE FIVE

7.1.2 Two Dimension Bar Code

Two dimensions bar code serves the same function as Linear Bar Code and takes up significantly less space. In addition, two dimensions bar code can function as the database itself and therefore assures complete portability for two dimensions labeled items.

Table thirteen shows a comparison between linear and two dimensions bar code.

**COMPARISON BETWEEN LINEAR DIMENSION AND TWO DIMENSION BAR CODE**

| Item                     | Two Dimensional Code          | Linear Bar Code           |
|--------------------------|-------------------------------|---------------------------|
| Information capacity     | Approximately 2000 characters | Approximate 20 characters |
| Information Type         | Alphanumeric, Kana, Kanji     | Alphanumeric              |
| Storage Density (*)      | 20 to 40                      | 1                         |
| Data Restoration Ability | Yes                           | No                        |

(\*) Storage comparison for an area with identical size, with the bar code taken a criterion “1”.

TABLE THIRTEEN

There are two types of two dimensions code, they are known as Stacked Code and Matrix Code. Some examples of two dimensions are shown in figure six.

#### Example of Two Dimensional Bar Code Symbols



FIGURE SIX

#### 7.1.3 Three Dimension Bar Code

They are the same as Linear Bar Code except that they are embossed on the surface of articles. They are used for surface where printed labels do not stick or adhere or otherwise easily destroyed by hostile or abrasive environment.

They are read by using the difference in height of the symbols (Tan Jin Soon. Introduction to Bar Code. Online. Internet. 16 July 2004. Available via [www.itsc.org.sg](http://www.itsc.org.sg)).

### 7.2 Selection of Bar Code System

#### 7.2.1 Selection of a suitable bar code

We have seen in section 6 that a typical drawing will requires about 251 characters, 18 numerals and 26 symbols to name its title, drawing number, type of drawing and status of review. The total quantity of characters, numerals and symbols required are

The worse case scenario environment and usage pattern where drawing is subjected to was also identified ie long term and outdoor.

With these criteria, we shall select the most suitable type of bar codes to be used. Tabulated in table fourteen are the summary of the drawing criteria and the bar codes features.

Based on table fourteen, we can deduce that 2-Dimensional bar code system is the most suitable system to be used.

**SUMMARY OF DRAWING CRITERIAS AND BAR CODE FEATURES.**

|   | Information Capacity | Information Type          | Storage Density          | Data Restoration Ability |
|---|----------------------|---------------------------|--------------------------|--------------------------|
| Linear Bar Code                         | 20                   | Alphanumeric              | 1                        | No                       |
| 2 Dimension Bar Code                    | 2000                 | Alphanumeric, Kana, Kanji | 20 to 40                 | Yes                      |
| Requirement For Drawing                 | 295                  | Alphanumeric              | Optional                 | Optional                 |
| Do Bar Code Meet Requirement            | Yes                  | Yes                       | Optional                 | Optional                 |
| Which Type of Bar Code Meet Requirement | 2 Dimensional        | 2 Dimensional             | Linear and 2 Dimensional | Linear and 2 Dimensional |

TABLE FOURTEEN

7.2.2 Selection of a suitable bar code reader

Bar codes are read by sweeping a small spot of light across the printed bar code symbol. The sweep starts at the white space before the first bar and continues passed the last bar and ends in the white space which follows the last bar.

The words "reader" and "scanner" are often used interchangeable to describe the device which is used to read a bar code.

There are three basic types of bar code scanning devices.

a) Contact Wand

The first type of scanner is the contact wand. These scanners resemble a "wand" or "pen". These scanners are inexpensive, and rugged, but must be kept in contact with the symbol throughout the scan. If the symbol is on a curved surface or in a difficult to reach space, contact wands will be difficult to use to successfully read the symbol.

b) Active non-contact scanner

The second type is the active non-contact scanner which generally uses a beam of focused light to read the bar code. Active non-contact scanners may be stationary as are found in grocery stores or they may be hand held. Industrial versions of active non-contact scanners, however, often keep the beam of light fixed on a single spot and are arranged so that the symbol is moved across the field of view of the scanner. The hand-held laser scanner is an active non-contact type which is

very popular for some applications. The major advantage is that the scanner can read bar code from several feet away. If the symbol is printed large enough, the laser scanner can read the symbol from as far away as 30 feet. In a warehouse this ability can be a definite advantage. But hand-held laser scanners are more expensive than other bar code readers. They also have moving parts which can be sensitive to rough use.

c) Passive non-contact scanner

The third type is the passive non-contact scanner which uses a small video camera or photoelectric strip to convert an optical image of the symbol to a video signal which is then decoded. Commonly called a "CCD scanner", these devices are priced midway between the contact wand and the non-contact laser scanners, are rugged, and do not require contact with the symbol for successful reading. However, these scanners have a limited depth of field and generally must be held within a few inches of the symbol (Adams Russ. Bar Code 1. Online. Internet. 18 September 2004. Available via www.adams1.com).

In section 6.6.2, we have mentioned that the harshest environment that drawings are subjected to in the outdoor environment. In addition project management is a highly mobile job, requiring commuting between the site office and the actual building under construction as well as to the the head quarters. Hence using this two criteria ie outdoor environment and mobility, we shall select the most suitable type of reader.

Summarised in table fifteen are the features of the three types of readers.

**SUMMARY OF FEATURES OF BAR CODE READER**

| Type of Reader      | Cost           | Surface Contact             | Suitable Environment   | Mobility              |
|---------------------|----------------|-----------------------------|------------------------|-----------------------|
| Contact Wand        | Inexpensive    | In contact                  | Rugged Use             | Hand Held             |
| Active Non contact  | More Expensive | Up to 30 feet reading range | Sensitive to rough use | Hand Held or Desk Top |
| Passive Non Contact | Mid Way        | Up to a few inches          | Rugged use             | Hand Held             |

TABLE FIFTEEN

In order to meet the two criteria we have mentioned above, Contact Wand and Passive Non Contact Readers are the most suitable. Since Contact Wand requires "In Contact" to surface when reading the bar code, it is preferred that the Passive Non Contact Reader be chosen.

Having chosen the two dimensional bar code system and a Non Contact Passive Reader, we shall proceed to formulate a concept plan for this research project.

## 8.0 RESEARCH FOR OBJECTIVE THREE

We look back at section 2.7 where we have briefly touched on the chain of command in a design and build and design-bid and build procurement contract. Here we get to understand the chain of command in a project team and members of the project team.

Moving further to section 6.4.2, we get to know how changes in drawing or how drawing information are disseminated within the project team. We touched on the duty of main contractor or architect to keep all members in the team informed of changes in design or drawing.

These will requires formulating a plan whereby all members in the project team are linked to one and another via a system. This system shall also serves as a channel for information to be propagated to one another whenever there a member triggers any changes.

### 8.1 Bar Code Case Study

The chain of command that we have read about in section 2.7 and how information are disseminated on 6.4.2 may be achieved by linking them to a system shown in figure seven. Every line in the figure that links two boxes together is two ways.

For example, the communication line between the architect and client project manager is two way. The architect also has a two way communication with the consultants and main contractors.

#### GENERAL CONCEPT LAYOUT SHOWING THE LINK IN PROJECT MANAGEMENT TEAM

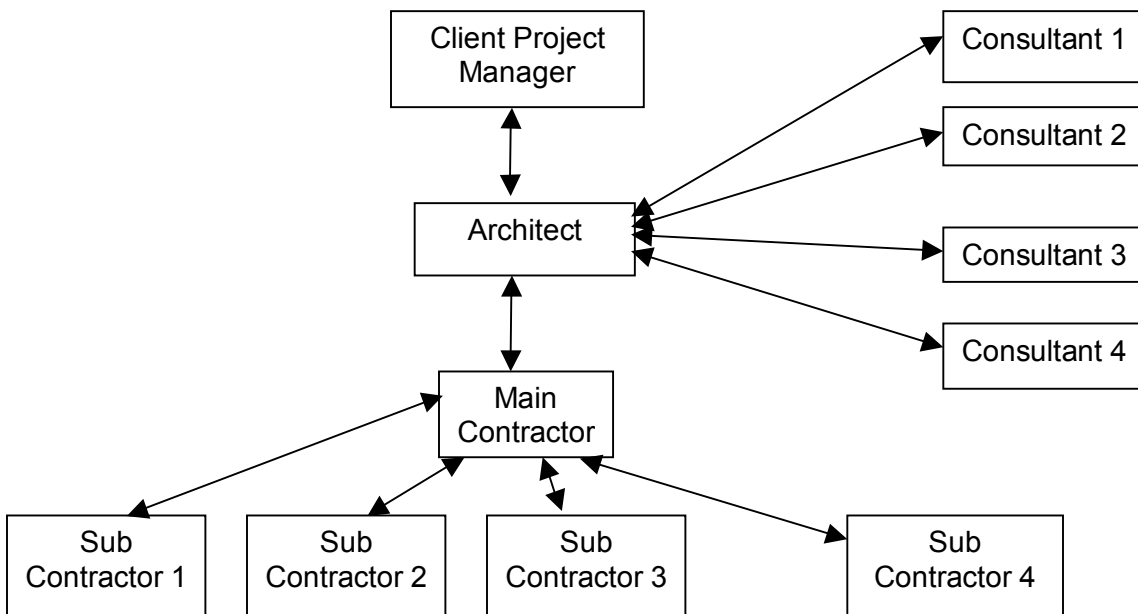


Figure Seven

8.1.2 Prior to drafting out a concept plan for this research, let us look at one case study and one actual system using bar code to improve the way of doing thing.

First we look at a case study by Australian Department of Industry, Science & Tourism and Tradegate ECA (EAN International – The Global Language of Business. Online. Internet. 1 Sept 2004. Available Via <http://www.ean-int.org>).

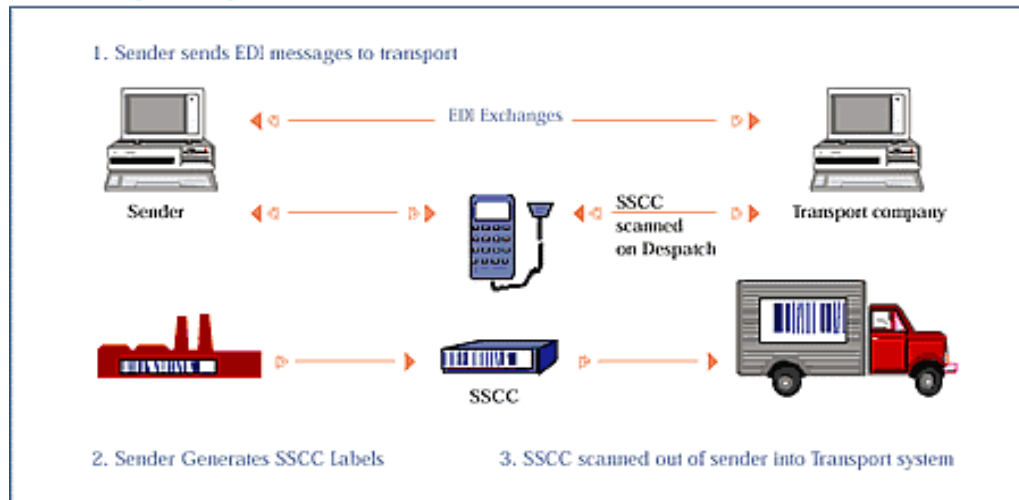
DOMEDI (EDI for the domestic transport industry) is a trade/transport community project sponsored by the Australian Department of Industry Science and Tourism. The aim of the project is to streamline the domestic transport flows by reducing the amount of paperwork involved and increasing the level of information available to the participants so that accurate transport decisions can be made. DOMEDI covers road, rail, air and sea transport.

The supply chain process starts with purchase order information sent from the buyer (receiver) to the seller (sender). Goods are then arranged ready for shipment. The despatch information is prepared and sent. After sending information to the receiver, the sender informs the transport provider of a consignment with transport instructions. This eliminates the need for billing.

The goods dispatch operation starts with when the sender applies the bar code to containers with reference numbers as contained in the messages. The bar code labels are scanned from the sender location into the transport system as shown in figure eight.

The sender creates the messages and labels and by scanning the bar code confirms the goods despatch. The transport provider may also provide advanced notice of the delivery of goods.

### Goods Despatch Operation



Source: "DOMEDI, trucks online", Department of Industry, Science and Tourism of Australia

FIGURE EIGHT



The sender (and the transport operator) notifies goods deliveries to receivers. The bar code is scanned from the transport system and transferred into the receivers' location as shown in figure nine.

The receiver obtains a copy of this information for confirmation of goods delivery, thus eliminating the need for sending a copy of the consignment note to the receiver.

### Goods Receiving Operation

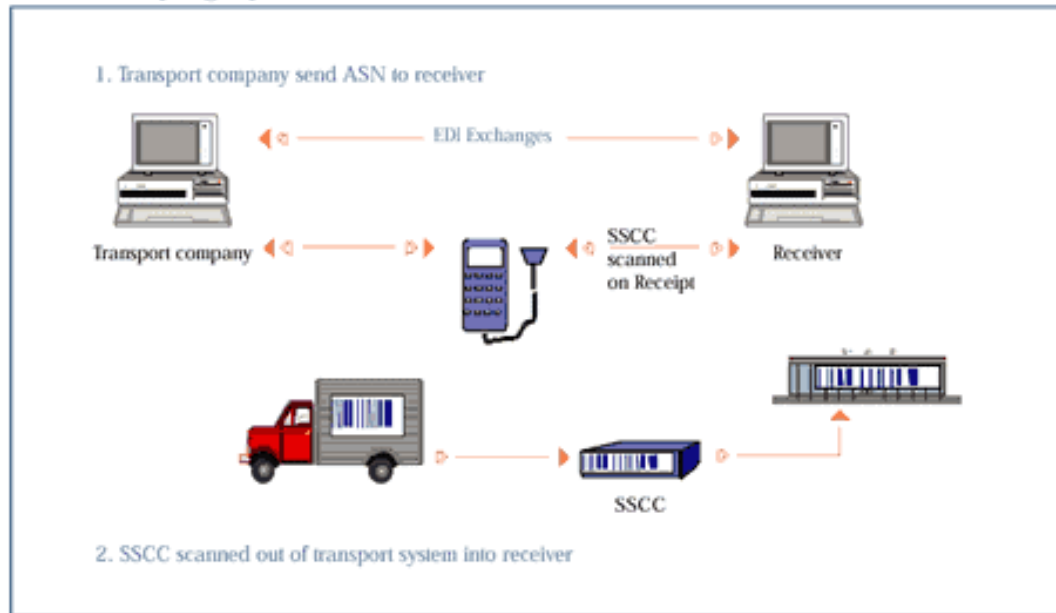


FIGURE NINE

The receiver can then send confirmation of delivery to the sender for notification of goods condition.

Senders can now make payment to transport companies on receipt of invoices. Goods delivered will generate invoices from the sender. Remittances will then be generated by buyers or goods recipients in response to the received invoices.

In figure ten, we can see how the information is being looped in this case study. It is hope that with this case study, we will have a rough idea on how to formulate a concept plan for this research project.

Now we shall proceed to section 8.1.3 to look at an actual system used to keep track of building plan submission by the Building and Construction Authority of Singapore.

# Information Exchange Loop

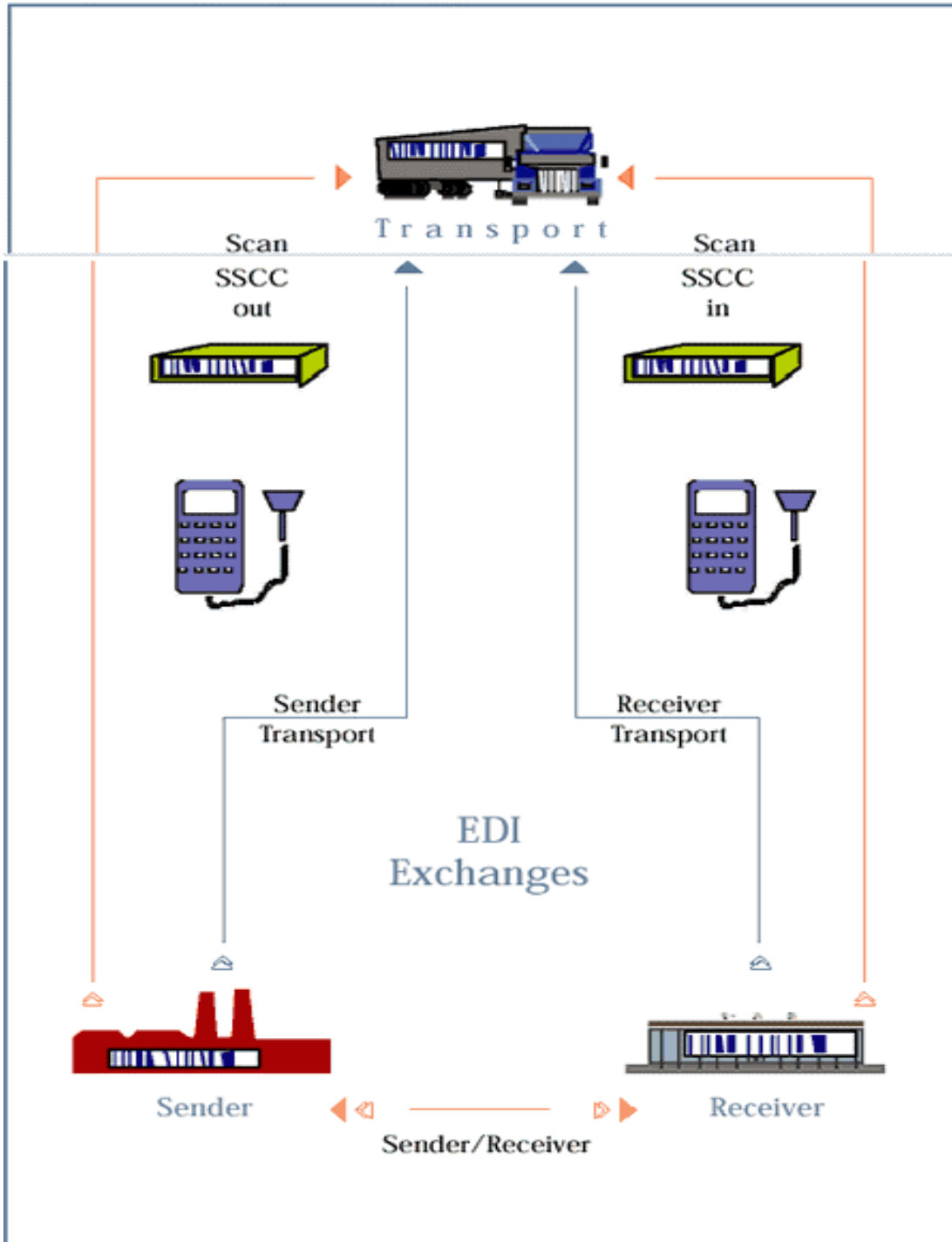


FIGURE TEN

- 8.1.3 The use of bar of barcodes to registered drawing started in 1 January 1999 when the Building and Construction Authority of Singapore (BCA) used it in BSPS (BCA Submission Planning System) to record and update Building Plans or Amendment of Building Plans submitted by architect or engineers.

The process in which these plans are registered is shown in the following steps:

1. Each plan submitted by architect or engineer will be received at the reception counter.

At the reception counter the following information will than be keyed into the data bank and bar code labels pasted on the first batch of each set plans and on first page of each volume of calculations:

- a. Project Reference Number.
  - b. Type of Submission.
  - c. Name of Processing Officer
  - d. Date of Procession.
2. With all information printed on the barcodes, the dispatch section will know where to send these plans to as not all officers are seated on the same floor.

The BSPS will be replaced by a new system called the Integrated Submission Processing System (ISPS) sometime early next year.

This is a form of submission which is done electronically through the Internet. (Source: Building and Construction Authority of Singapore).

The BCA Submission Plan System network is briefly shown in figure twelve.

Figure thirteen is a brief network layout plan showing how the system works. Since the whole BSPS is housed in the same building, information are transferred via the Intranet.

For the case of our research since the project team are located in each individual offices or in the site, we need to transfer information via the Internet. As such issue such as security breech caused by hacking etc have to be looked into. However, this shall not be discussed in this research report.

Having understood how the above two cases study works, we shall proceed with formulating an actual network for our research.

**LAYOUT DIAGRAM FOR BUILDING PLAN RECEPTION COUNTER**

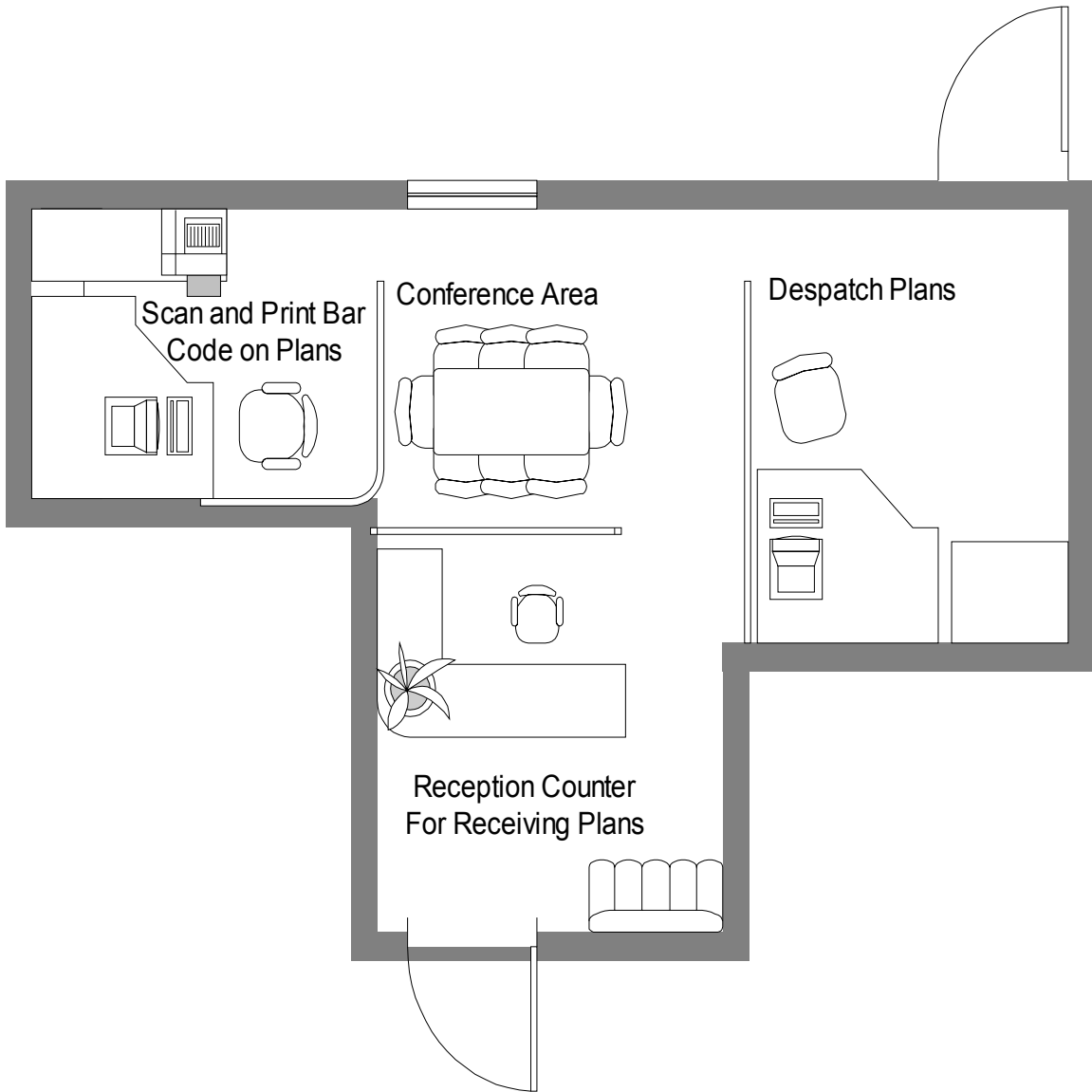


Figure Eleven

**NETWORK DIAGRAM FOR BCA SUBMISSION PLANNING SYSTEM**

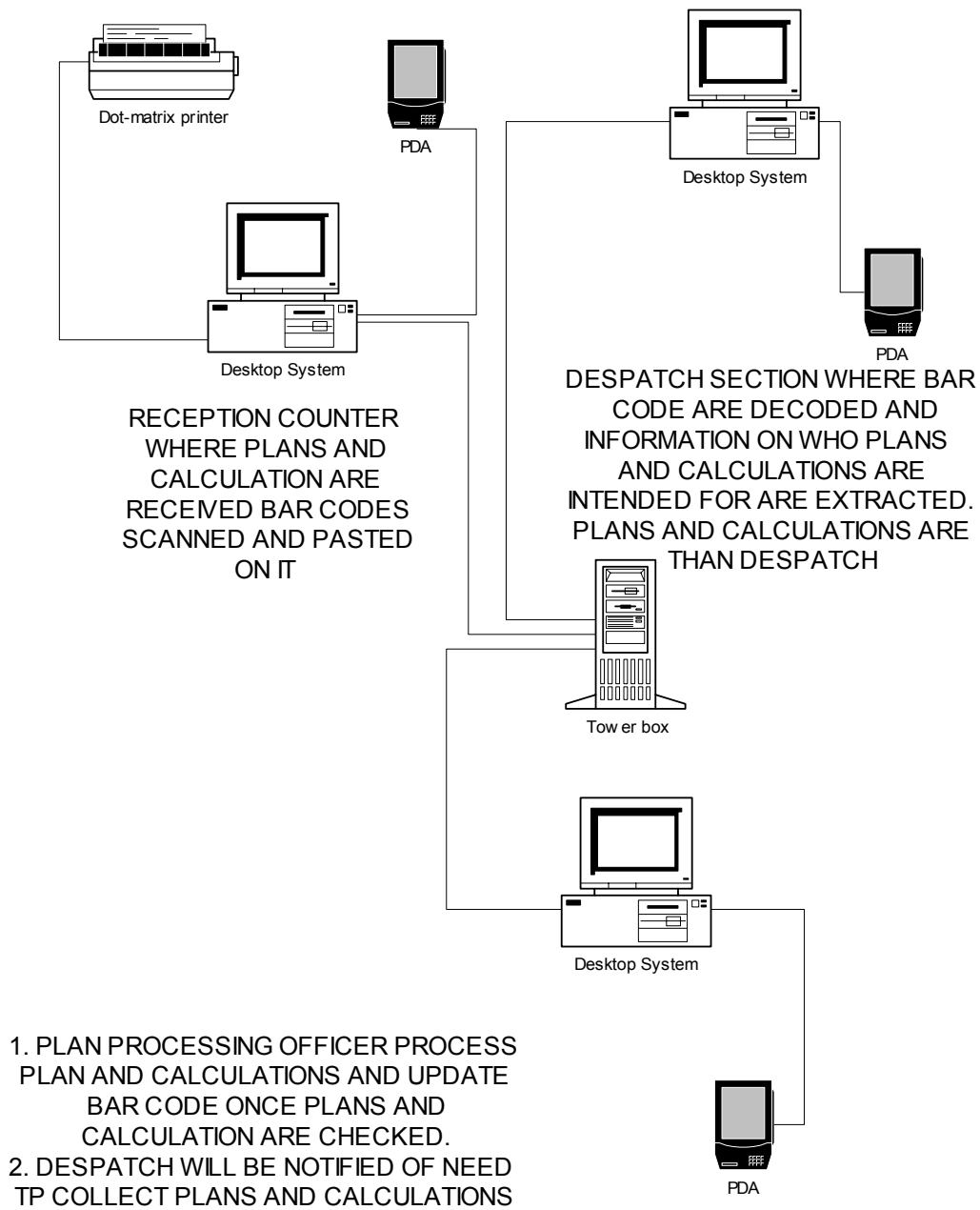


Figure Twelve

## **8.2 Concept Plan for tracking of drawing from tender stage to as built stage using bar code.**

8.2.1 Based on the two case studies, we can conclude that the principle of tracking a drawing from tender stage to as built drawing stage in the development of a condominium involves the following steps:

1. A platform in the personal computer of the operator (in this case it is the architect, project manager, main contractor etc)to facilitate input of information into a central data system(in the above case study, we called it a transport system).
2. Scanner for reading the information from the bar code label.
3. An equipment to generate the production of message and bar code label.
4. A back end server to receive information from the operator (in the above example, it is the transport system which receives information from the sender, receiver and transport company).
5. An internet line to link all these users and central data system together.

Let us first of all determine whether drawing is considered to be asset or inventory so that the proper and correct system of tracking it are employed.

Based on the information gathered from Wasp technologies (Wasp Technologies. Online. Internet. 25 Sept 2004. Available Via <http://www.waspbarcode.com>), asset or inventory can be differentiated based on the table sixteen.

Having understood the concept or network of tracking goods and drawings from the two case studies in section 8.1, we shall now proceed to formulate the network for the research project. Based on the steps spelt out in section 8.2.1, the components needed are as follows:

1. A software to drive the system and to store the data ie drawing number, drawing title and status of drawing.
2. A personal computer to serve as the server for inputting, updating and storing the data base.
3. A software to generate and print the bar code labels.
4. A dedicated printer or existing printer to print the bar code.
5. A mobiles scanner to scan the status or description of a drawing into the system.
6. A software or engine to generate the status of drawing.

The network diagram for tracking of drawings for this research report is shown in figure thirteen..

**DETERMINATION OF ASSET OR INVENTORY**

| Description  | Asset | Inventory | Drawing   |
|--|-------|-----------|---|
| Objects used internally such as computers, tools and educational materials             | Yes   |           | Yes, amongst project team                           |
| Objects temporarily stored to be distributed at a later date (as in warehouse)         |       | Yes       | No, to be used as “as built drawing”                |
| Objects are for sale or resale   |       | Yes       | No  |
| Employees may check objects in and out for company use                                 | Yes   |           | Yes, when changes to drawing are being carried out. |
| Objects are permanent such as furniture and computers                                  | Yes   |           | Yes used as “as built drawing” later on.            |
| Objects are temporary and/or often replaced such as papers, pens and other Consumables |       | Yes       | No to be used as “as built drawing” later on.       |
| Employees must return  | Yes   |           | Yes, to be stored in site office for common used.   |
| Employees can sell or discard objects  |       | Yes       | No  |

TABLE SIXTEEN

**NETWORK DIAGRAM FOR TRACKING OF DRAWING FROM TENDER TO AS BUILT STAGE**

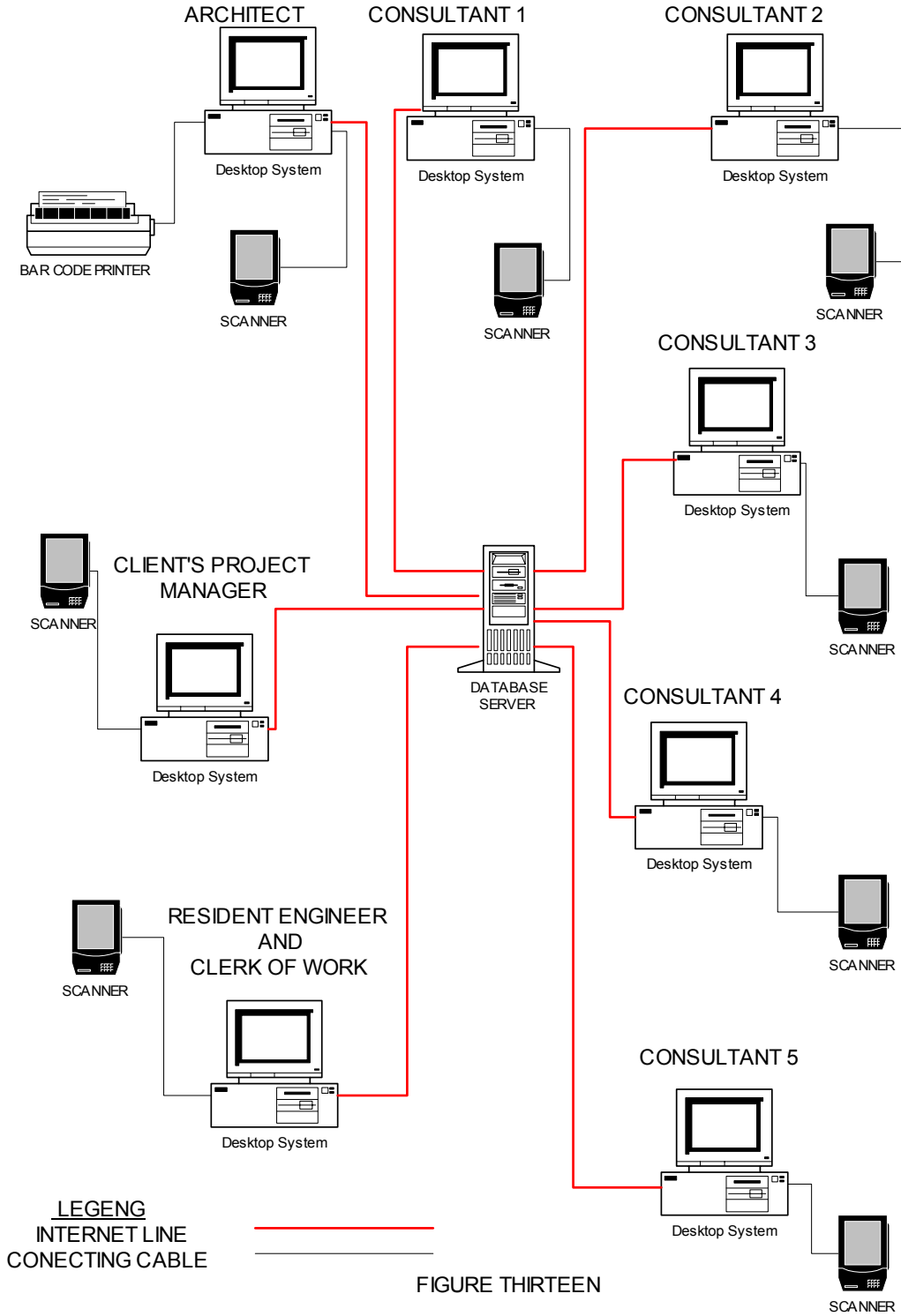


FIGURE THIRTEEN



8.2.1.1 The first stage will be the setting up stage begins where all data pertaining to the all drawings are loaded into the data base. Data to be loaded includes the project title, drawing schedule, drawing list, drawing number etc which were researched earlier in section 6.5.1. This is shown in table seventeen below.

During this stage, the user (either the architect or an IT specialist) will key in all the drawing information such as drawing number, title etc for a particular project via the application software platform. This is usually done after all tender drawings have been finalised. The data will be stored in the server. Once all these information are loaded into the system, the bar code labels will be printed out and pasted on the drawings. This shall be double confirmed to be correct by scanning it to check the information. Figure fourteen shows how this operation is being carried out.

8.2.1.2 All members of the project team will now be issued drawings that are relevant to their areas of responsibility. For example, the landscape consultants will be issued landscape drawing and client project manager will be issued all the drawings for the whole development.

If we go back to section 6.4, we will noticed that whether the contract is based on design and built procurement system or design bid and built procurement system, all changes shall be ultimately approved by the architect. Hence during this stage whereby there are changes needed to be done to the drawing, the architect may have to update the data bank for the relevant drawing that need to be changed. The change required could be due to site constraint or design review. This shall be updated in the data base. Figure fifteen shows graphically how this is done between the mechanical and electrical engineer and architect. Table eighteen shows the updated information which will be input into the data bank to reflect relevant changes.

In addition to updating only those information in shown in tables seventeen and eighteen. The architect may also key in important message into the data bank via the bar code since the two dimensional bar code are able to take up to 2000 characters messages ( refer back to section 7.1.2).

Shown in figures sixteen and seventeen are some screen shots of message storing features which some bar code software are capable of doing(Wasp Technologies. Online. Internet. 25 Sept 2004. Available Via <http://www.waspbarcode.com>).

**EXAMPLE OF DATA TO BE LOADED INTO DATA BANK.**

|  |   |  |
|--|---|--|
| Project : Proposed 400 Units Condominium Development |   |  |
| Drawing Schedule and Issue Record                    |   |  |
| Mechanical and Electrical Drawing                    |   | Revision Record                          |
| Sketch Drawing : <input type="checkbox"/>            | Tender Drawing : <input type="checkbox"/> | Day 01                                   |
| Prelim Drawing : <input type="checkbox"/>            | Construction Drawing : X                  | Month 01                                 |
| Building Drawing : <input type="checkbox"/>          | Others : <input type="checkbox"/>         | Year 2005                                |
| 1  | FP/GL/01                                  | Automatic Sprinkler Layout at Basement 1 |

TABLE SEVENTEEN

**DATA INPUT OPERATION**

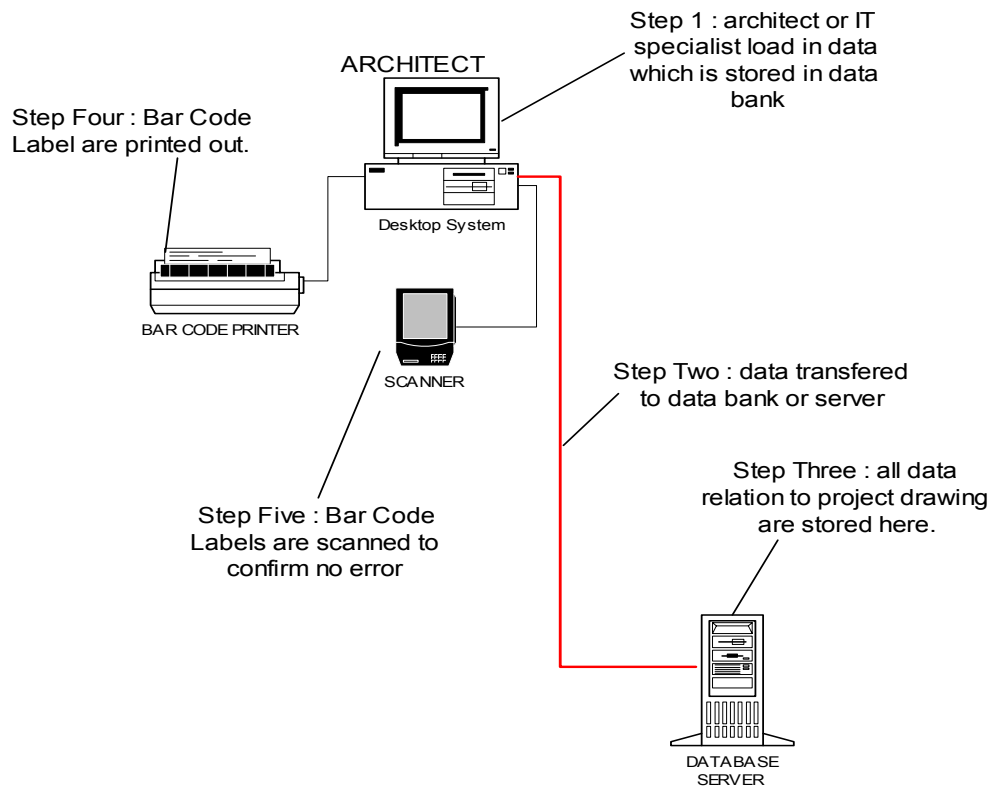


FIGURE FOURTEEN

**EXAMPLE OF DATA TO BE LOADED INTO DATA BASE WHEN THERE ARE CHANGES IN THE DRAWINGS.**

|  |   |  |                 |
|--|---|--|-----------------|
| Project : Proposed 400 Units Condominium Development |   |  |                 |
| Drawing Schedule and Issue Record                    |   |  |                 |
| Mechanical and Electrical Drawing                    |   |  | Revision Record |
| Sketch Drawing : <input type="checkbox"/>            | Tender Drawing : <input type="checkbox"/> | Day                                      | 01              |
| Prelim Drawing : <input type="checkbox"/>            | Construction Drawing : X                  | Month                                    | 01              |
| Building Drawing : <input type="checkbox"/>          | Others : <input type="checkbox"/>         | Year                                     | 2005            |
| 1  | FP/GL/01                                  | Automatic Sprinkler Layout at Basement 1 |                 |

TABLE EIGHTEEN

**DRAWING CHANGES OPERATION**

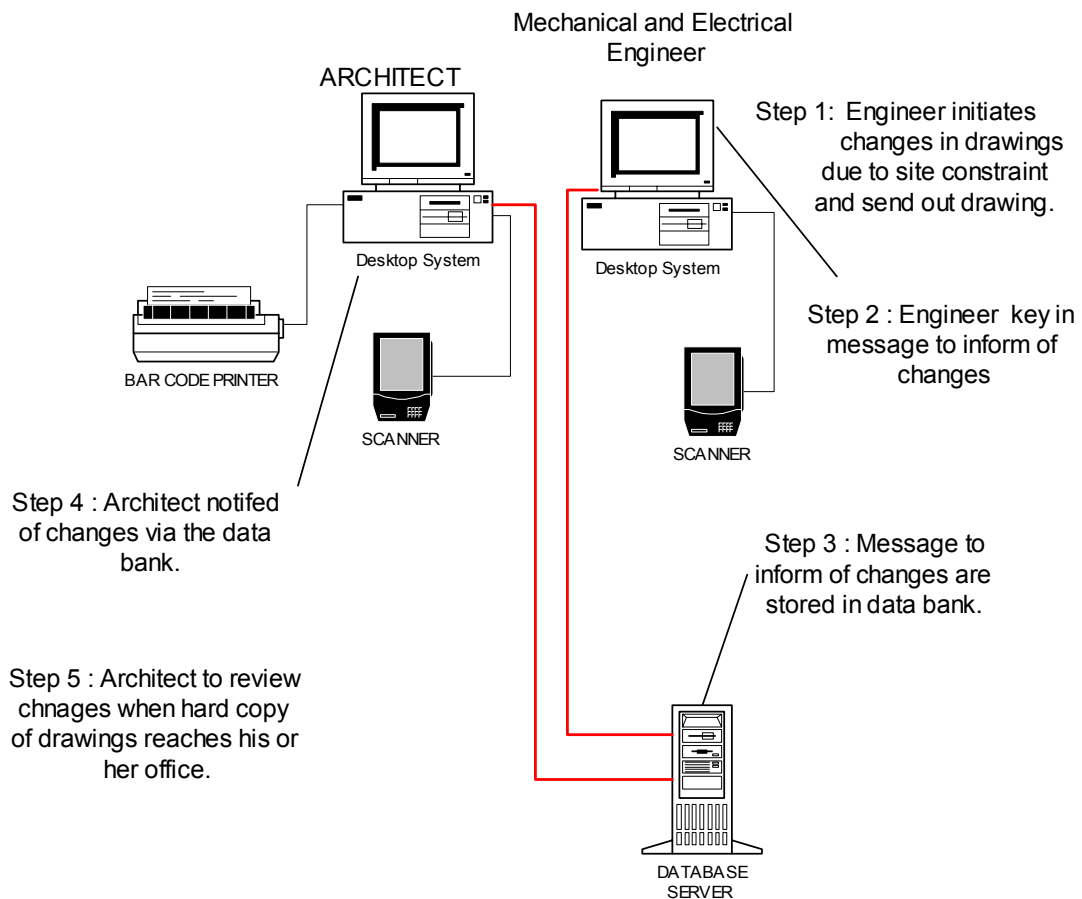


FIGURE FIFTEEN

## MESSAGE FEATURE OF SOME BAR CODE SOFTWARE

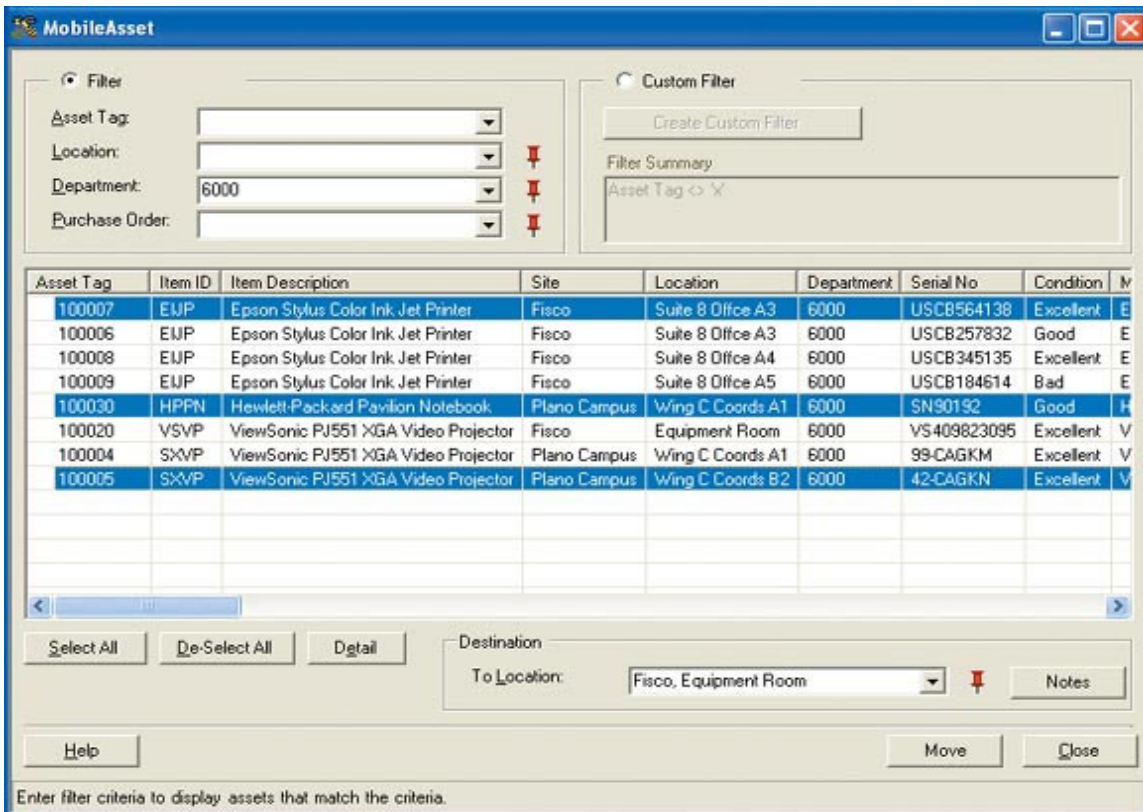
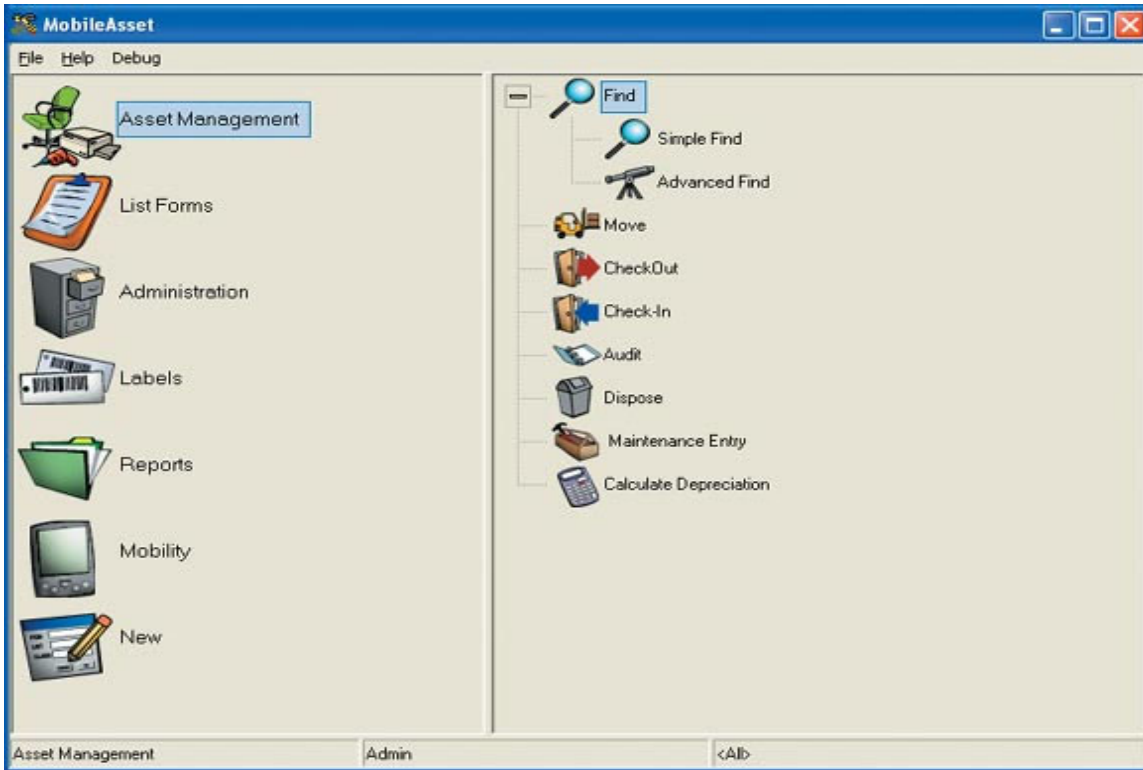
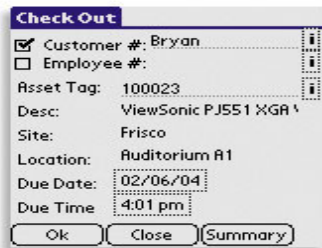
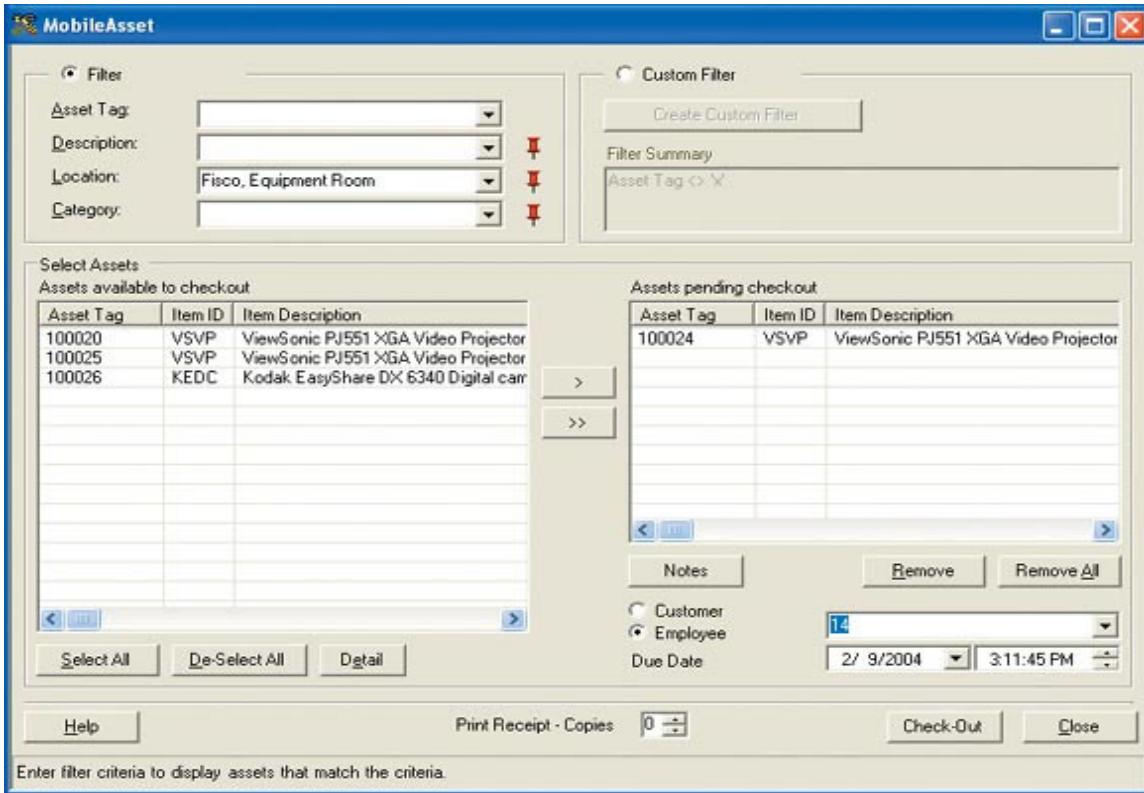


FIGURE SIXTEEN

**MESSAGE FEATURE OF SOME BAR CODE SOFTWARE (continued)**



ACTUAL PALM OS SCREEN SHOTS

FIGURE SEVENTEEN

8.2.2 In summary, the following features for the concept to keep track of drawing from tender stage to as built drawing stage have been discussed and also graphically explained:

1. Stage 1: Input of all data prior to commencement of construction by the architect or IT specialist.
2. Stage 2: Input of data when changes are required during the construction stage.
3. Stage 3: Input of message into the data bank.

As with all other research project, the concept plan needs to undergo a trial in order in order to understand the problem or shortcomings. However, to carry out a trial mean having to purchase and set up a system which covers the soft ware and hard ware. In lieu of this, a site visit to the Building and Construction Authority of Singapore was carried out to understand the advantages and disadvantage of using bar code system to keep track of drawing.

Free software that are able to simulate as close as possible a condition that is similar to the concept of this research is downloaded and trial carried out.

Finally, consultation is make with specialist in this field to ensure that the concept are workable.

**CHAPTER FOUR**  
**IMPLEMENTATION**

## **9.0 IMPLEMENTATION OF RESEARCH PROJECT**

Implementation of this research report using site visit, free demonstration software and consultation with specialist will be carried out to test out the concept mentioned in section 8.2.

As mentioned in the previous section, a site visit will be carried out to find out the improvement and shortcomings of using bar code system to keep track of drawings.

### **9.1 Site Visit To Building And Construction Authority of Singapore**

This visit was granted by section head of the planning submission department of Building And Construction Authority of Singapore on 28 September 2004.

A short briefing and question and answer session was conducted and appended are some of the findings.

- a. Is the system capable of recording short messages other than information in the drawing?

Answer: Since the bar code used by BCA is in linear, they are not able to store messages such as when a building plan has been approved or rejected by the processing officer. If this message is stored, the reception counter would be able to know the status of this plan.

- b. Is there an alert mechanism in the system whereby once a drawing has been amended or registered into the system, other parties can be informed of this happenings eg via email?

Answer: In the BSPS system, its role is just merely to register the drawings reference, officer name etc., there is no linkage to the actual planning processing system. There is no mechanism to alert or send messages to either the reception counter or planning officer of any update or status.

Any update etc is disseminated to other officers by manually scanning form or letter into the PC and sending it via internal email to them.

- c. Is there a password required for entering into this system to ensure unauthorized entry?

Answer: Password for entry into the bar code system is based on company ID or company pass.

- d. Are there different levels of security access into the system eg. architect is allowed to make changes to the message, contractor is only allowed to read the message etc?



Answer: There are two level of password available for officer who are authorized to amend the data in the data bank and for those are authorized to view it only.

e. Is there a saving on manpower?

Answer: Not very substantial saving in manpower but other benefit are reap from using this system such as those mentioned in (f).

f. Dose the system improve the monitoring of drawings from submission to processing as compared to previous manual method?

Answer: There is improvement in the system eg in minimizing misplacement of plans during as compared to before 1999 when drawing was manually recorded.

g. What are the shortcomings of this system encountered so far?

Answer: The document is still dispatched to officer whose name is printed on the bar code even though that particular officer may be on vacation or medical leave.

After the briefing, a short tour was conducted to the front office where drawings are received and recorded in the bar code. A demonstration on how the bar code labels are generated was also carried out and shown in figure eighteen is a sample of the bar code label. Shown in figure nineteen is a sample of part plan that has been processed using the bar code system.

9.1.1 We have seen from the report for the above site visit that it is possible to carry out the following activities using the bar code system:

1. to register drawing number and record message using 2 dimensional bar codes.
2. there are levels of check to prevent abuse eg. password at different security level for viewing or editing of the system.
3. bar code system helps to minimize error such as misplaced drawing etc.

The shortcoming of bar code system used in BCA was also identified such as:

1. drawing being delivered to an officer who is not working.
2. inability to store message. However, this can be overcome by using 2-dimensional bar code.
3. a system to alert users of any changes or updates in the drawing.

9.1.2 With this site visit, we can conclude that bar code system is able to perform first four functions mentioned in section 8.2.1. The five functions are re-produced below.

1. A software to drive the system and also to store the data base ie drawing number, drawing title and status of drawing.
2. A personal computer to serve as the server for inputting, updating and storing the data base.
3. A software to generate and print the bar code labels.
4. A dedicated printer or existing printer to print the bar code.
5. An internet line to link all these users and central data system together.

To reinforce the results obtained in section 9.1, we will conduct trial.

### **BCA BAR CODE LABEL SAMPLE**

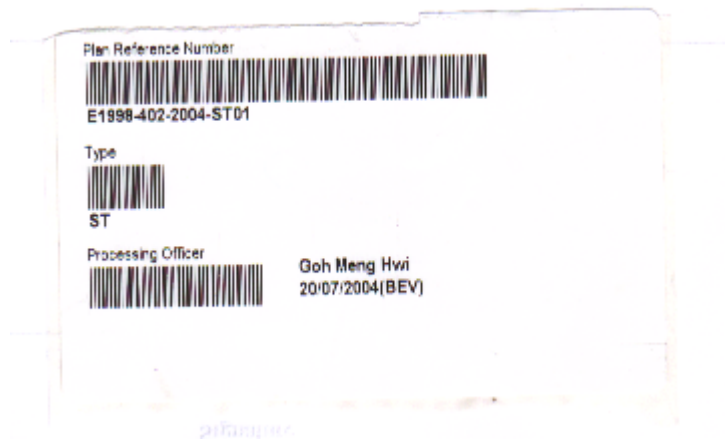


FIGURE EIGHTEEN

**SAMPLE OF PLAN PROCESSED USING THE BAR CODE SYSTEM**

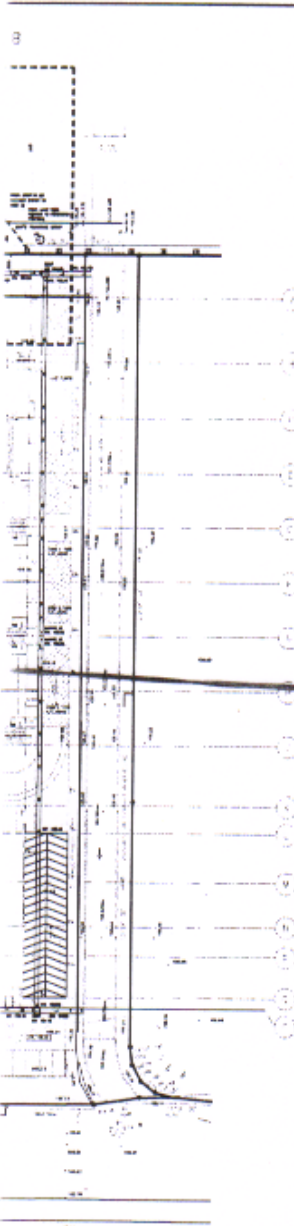



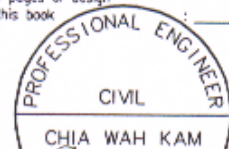
|   |  |
|---|--|
|   | <p style="text-align: center;">1 sheet of 2</p> <div style="border: 1px solid black; padding: 5px; text-align: center;"> <p><b>BUILDING AND CONSTRUCTION AUTHORITY</b><br/>             APPROVED UNDER SECTIONS 6 OF THE<br/>             BUILDING CONTROL ACT (CHAPTER 29)</p> </div> <p style="text-align: center;">Project Ref No: A/0953-001/1998 ST10</p> <p style="text-align: center;">for Commissioner of Building Control</p> <hr/> <p>Plan Reference Number<br/> <br/>             A0953-001-1998-ST10</p> <p>Type<br/> <br/>             ST</p> <p>Processing Officer<br/>  <b>Lee Hing Cheng</b><br/>             28/09/2004 (BEV)</p>   |
| <p><b>CERTIFICATION ON STRUCTURAL PLANS<br/>             OR CALCULATIONS BY THE ACCREDITED CHECKER</b><br/> <u>SENG BEE</u> (ACCREDITED CHECKER)<br/>             certify that I have carried out an evaluation,<br/>             and review of the detailed structural plans and<br/>             calculations presented herein and am satisfied that<br/>             no major errors in the key structural elements.</p> | <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center;"><b>STANDARD CERTIFICATION ON STRUCTURAL<br/>             PLANS AND DESIGN CALCULATIONS BY THE<br/>             QUALIFIED PERSON FOR STRUCTURAL WORKS</b></p> <p>In accordance with Regulation 9 of the Building Control Regulations<br/>             1. <u>CHIA WAH KAM</u> (Qualified person for structural works)<br/>             hereby submit the detailed structural plans and design calculations<br/>             prepared by me and certify that they have been prepared in accordance<br/>             with the provisions of the Building Control Regulations, the Building<br/>             Control Act and any other written law pertaining to buildings and<br/>             construction for the time being in force.</p> <p>2. I further certify that these detailed structural plans and design<br/>             calculations are in reference to Project Ref. No: <u>A-0953-001/1998</u></p> <p>3. Total number of structural plans submitted : <u>02</u><br/>             Total number of pages of design<br/>             calculations in this book : <u>08</u></p> <div style="text-align: center;">  </div> </div> |

FIGURE NINETEEN

## 9.2 Trial Using Limited Edition Asset Tracking Free Software

9.2.1 A trial was carried out by using free demonstration software entitled WaspAsset which was downloaded from <http://www.waspbarcode.com>.

The features of the software are as follows:

1. Track assets by site, location, department etc.
2. Check in and Check Out assets to track who has the asset and when it is due back.
3. Create bar code assets tag.
4. Attach any file to an asset – pictures, warranties, Users Manual and More.
5. Import and Export Asset Data for external processing.
6. Easy, One-click synchronization between PC and handheld data collector.
7. Secure logon to guard asset information and track who did what.
8. Available in single computer desktop edition or Network Edition (5 PCs).

9.2.2 A brief description of the trial carried out using data from mechanical and electrical drawing mentioned in table seventeen (reproduced below) is as follows:

### REPRODUCTION OF TABLE SEVENTEEN.

| Project : Proposed 400 Units Condominium Development |   |  |                 |
|--|---|--|-----------------|
| Drawing Schedule and Issue Record                    |   |  |                 |
| Mechanical and Electrical Drawing                    |   |  | Revision Record |
| Sketch Drawing : <input type="checkbox"/>            | Tender Drawing : <input type="checkbox"/> | Day                                      | 01              |
| Prelim Drawing : <input type="checkbox"/>            | Construction Drawing : X                  | Month                                    | 01              |
| Building Drawing : <input type="checkbox"/>          | Others : <input type="checkbox"/>         | Year                                     | 2005            |
| 1  | FP/GL/01                                  | Automatic Sprinkler Layout at Basement 1 |                 |

TABLE NINETEEN

### 9.2.2.1 Step1: Create New Asset or Record New Drawing.

The data shown in table nineteen which is pertaining to the drawing was keyed into the field box for the “New Asset” template as shown in figure twenty.

In actual practice, other drawings in the project are keyed into the asset record forming the set of drawing list for the whole project.

New Asset (or drawing list) is created by filling in the following field in the General Page of the New Asset Template:

- a. Asset Tag : fill in FP/GL/01
- b. Item ID : fill in FP/GL/01
- c. Site : fill in name of the site eg. Andrew Road
- d. Location : fill in Basement 1
- e. Department Code : optional Field
- f. Serial No.: optional Field
- g. Condition: Tender Drawing, Construction Drawing or As Built Drawing.
- h. Additional Info: here the architect or M&E engineers can include their comment etc for this particular set of drawing.

As this software is more customized to use in schools, factories etc to track physical assets, other page in the template may be ignored except the page “Transaction History”.

At the “Transaction History” page, data in the Edit Asset form will be displayed after one or more transaction have been performed eg when asset has been checked out (in this case drawing sent out). This page allows us to track of the history of this particular drawing ie when was it due to be commented. The template for Transaction is shown in figure twenty one.

## SAMPLE OF NEW ASSET TEMPLATE

The screenshot shows a software window titled "New Asset". At the top, there is a tab labeled "Asset". Below this, there are two input fields: "Asset Tag" with the value "FP/GL/01" and "Item Description" which is empty. A horizontal menu below these fields includes "General", "Depreciation", "Attachments", "Picture", "Maintenance", "Transaction History", and "Custom Fields", with "General" being the active tab. The "General" tab contains several fields, each with a dropdown menu and a pin icon to its right: "Item ID" (FP/GL/01), "Site" (Andrew Road), "Location" (Basement 1), "Department Code" (Optional), "Serial No." (Optional), and "Condition" (Construction). To the right of these fields is a large, empty rectangular area labeled "Item Information". Below the "Condition" field is a text area labeled "Additional Info" containing the text: "Here the architect or M&E engineers can include their comment etc for this particular set of drawing." At the bottom of the window, there are buttons for "Help", "Pin All", "Print Tag - Copies: 0", "OK", and "Cancel".

FIGURE TWENTY

## SAMPLE OF TRANSACTION HISTORY PAGE TEMPLATE

The screenshot shows a software window titled "New Asset" with a tabbed interface. The "Transaction History" tab is active, displaying a table with the following columns: Time, Type, Action, and ID. Annotations with arrows point to these columns: "Time of Transaction that has taken place eg when drawing are sent out (or check out is performed)." points to the Time column; "Type of transaction" points to the Type column; "Action taken" points to the Action column; and "ID eg FP/GL/01" points to the ID column. The table is currently empty. The window also features a "Print Transactions" button and a status bar with "Help", "Pin All", "Print Tag - Copies: 0", "OK", and "Cancel" buttons.

| Time | Type | Action | ID |
|------|------|--------|----|
|------|------|--------|----|

Time of Transaction that has taken place eg when drawing are sent out (or check out is performed).

FIGURE TWENTY ONE

### 9.2.2.2 Step 2: Check-Out Asset or Sending of Drawing.

In section 6.4, we see how drawing information are disseminated during the construction of a residential development under the different procurement system.

In this section, we learnt how amendments to drawings will not be finalized until all parties concerned have given their approval. As timely completion of the work is very important, there is usually a time given for consultants or architect to reply with their comments.

If the drawing requires feed back from the consultants eg in the case of a Request for Information (RFI) or Confirmation of Verbal Instruction (CVI), the architect can specify the time required for all comments to be reverted by activating the “Due Date” button. Drawing that is sent out was recorded by filling in the following fields in the “Check Out” template:

- a. Asset Tag: fill in FP/GL/01.
- b. Description: optional
- c. Location: fill in Basement 1
- d. Category: optional
- e. After filling the above fields, items available for sending (or in this case checking out) will appeared in the “Asset Available for Check Out” box.
- f. The item to be checked out ie FP/GL/01 is than selected and transferred to the “Asset Pending check out” box via clicking the “>” or “>>” buttons.
- g. Fields such as “Due Date”, “Customer” or “Employee” were filled in. Checking Out of Asset (in this case drawing being sent out) was activated by clicking the Check Out button.

When respective consultants received the drawing, by scanning the bar code, they will be able to know when the due date of reply and other information which architect has keyed in. This allows others to monitor the date and time of drawings were sent out and also the due date for them to reply.

With this, drawings that are sent out are recorded including the time and also the due date for other consultants to revert with their comments. Shown in figure twenty two is the template for the check out or sending out of drawing.



## SAMPLE OF CHECK OUT TEMPLATE

Check-Out

Filter

Asset Tag: FP/GL/01

Description: Optional

Location: Basement 1

Category: Optional

Custom Filter

Create Custom Filter

Filter Summary

Select Assets

Assets available to check-out

| Asset Tag | Item ID | Item Description | Site | Location | Date |
|-----------|---------|------------------|------|----------|------|
| FP/GL/01  |         |                  |      |          |      |

Assets pending check-out

| Asset Tag | Item ID | Item Description | Site | Location | Date |
|-----------|---------|------------------|------|----------|------|
|-----------|---------|------------------|------|----------|------|

Notes

Remove Remove All

Customer Employee

Due Date: 3/31/2004 10:53:53 AM

Help Print Receipt - Copies Check Out Close

Enter filter criteria to display assets that match the criteria.

These two buttons transfers item from available for check out to pending for Check out.

Once Item is ready for check out this button will be activated.

Due Date Button

FIGURE TWENTY TWO

### 9.2.2.3 Step 3: Check In Asset or Commented Drawing Replied.

Once the drawing has been commented by consultants, which in this case the drawing is FP/GL/0, the drawing together with the comments will be returned to the architect for approval.

The consultants responsible for returning the drawing shall fill in the Check-In Asset template to indicate the drawings has been sent out and returned to the architect. In this way, the architect shall be able to be notified of the progress and expect drawing to be on his table in a few days time.

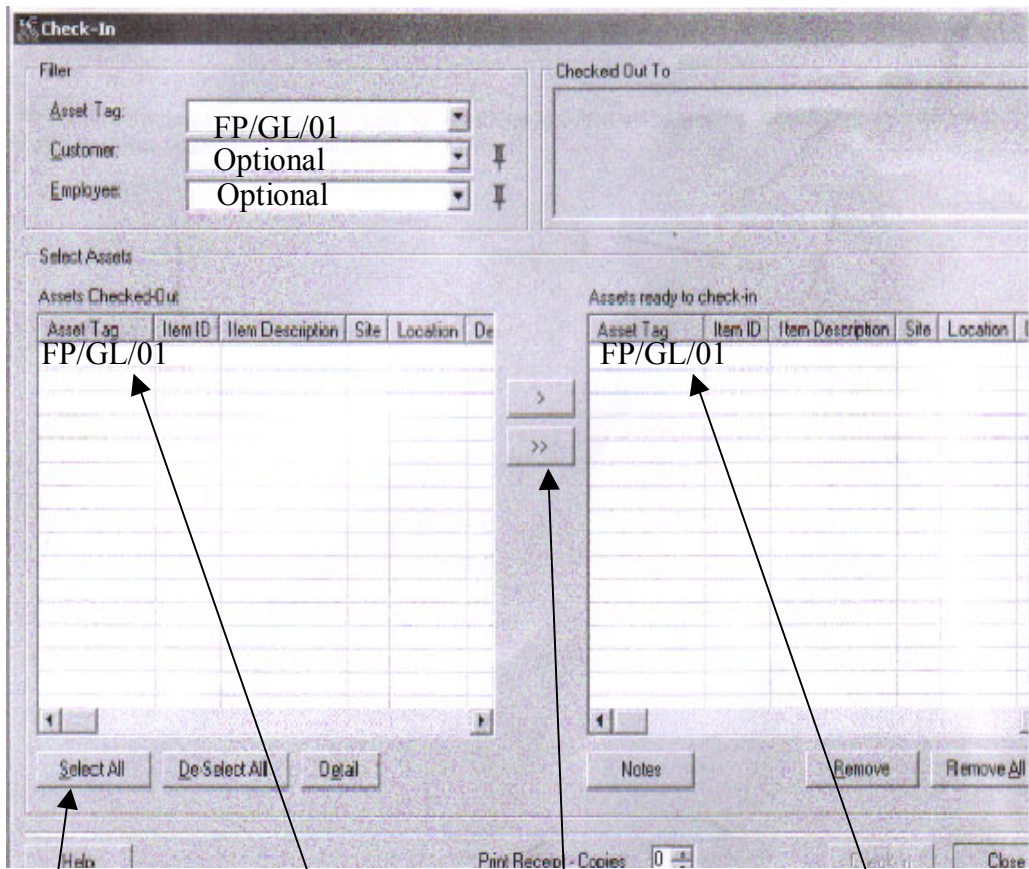
Checking in of Asset or returning of commented drawings were done by filling in the following field in the template:

- a. Asset Tag: fill in FP/GL/01.
- b. Customer: optional
- c. Employee: optional
- d. After filling the above fields, items available for returning (or in this case checking in) will appear in the “Asset Check Out” box.
- e. The item to be checked in ie FP/GL/01 is than selected and transferred to the “Asset Pending Check In” box via clicking the “>” or “>>” buttons.
- f. The “Detail” button allows us to start the “Edit Asset” button to view of modify the record prior to checking in.
- g. After all fields were filled in, “Check In” (or returning of commented drawing) was activated by clicking the “Check In” button.

This allows others to monitor the date and time of drawings were commented and replied and prepare them to look out for this drawing in their IN/OUT tray.

The templates for “Checking In” of asset (or replying of commented drawing) are shown in table twenty three.

## SAMPLE OF CHECK IN TEMPLATE



Item to be check in are selected by this button.

Item selected for checked in

Item selected for check in are transferred to the Asset Ready to check in box by these buttons.

Item to be check in

FIGURE TWENTY THREE

#### 9.2.2.4 Step 4: Edit Asset or Amendment of Drawing Record.

If there is any amendment to the drawings or if the tender has been called and awarded to the contractor. Editing be carried out to the drawing list to reflect these changes ie change from tender drawing to contract drawing.

Editing of drawing lists were done by filling in the following field in the template:

- a. Item ID: fill in FP/GL/01A
- b. Manufacturer: optional
- c. Model: optional
- d. Vendor Code: optional
- e. Class: Optional
- f. Category: Amended Construction Drawing

Assuming that the drawing need to be amended to suit site condition, this set of drawings will now become amended construction drawing. The Category Field will be amended to reflect this change as shown in figure twenty four.

A new label will also be printed and paste of these new draining so reflecting the changes. With these changes others with assess to the Network will by able to identify with the changes.

The date and time of changes and what the changes are will now be recorded and this recorded easily extracted just by scanning the bar code. In this case, future reference can be done easily just by scanning the bar code.

These changes can be further reinforced by scanning the title block of the contractor drawing into the system as shown in figure twenty five.

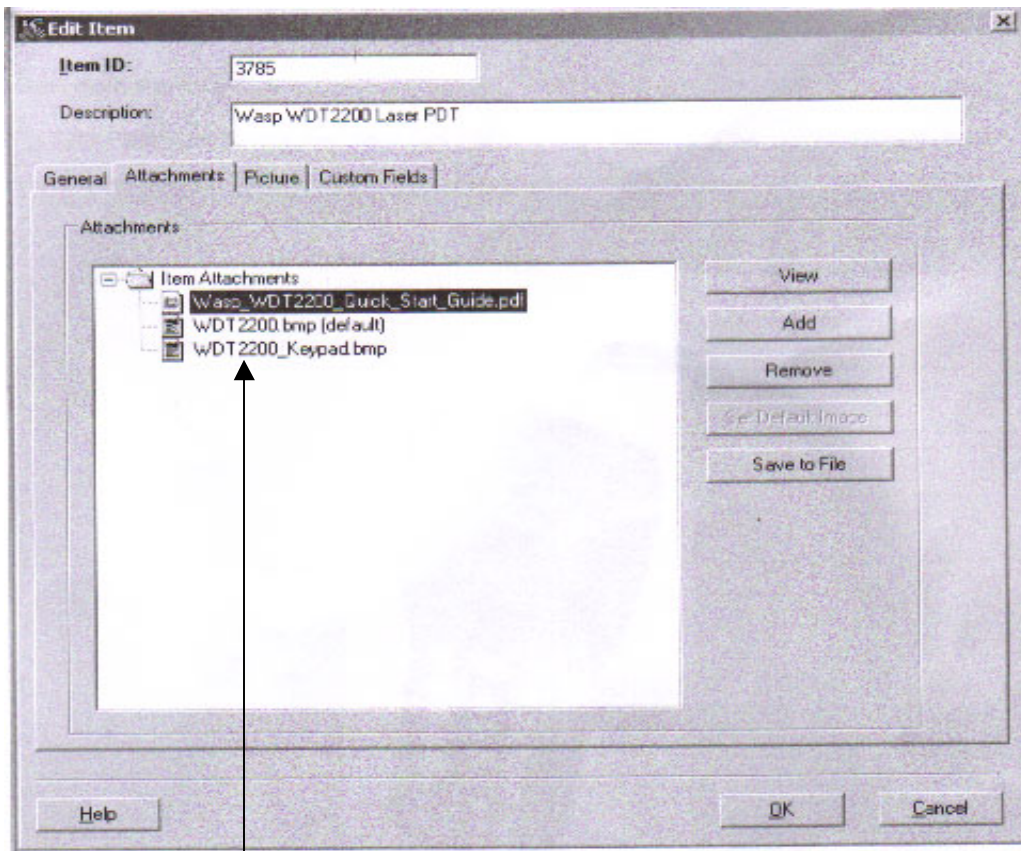
The Edit Template also comes with an “Attachment Page” where files can be attached eg. a scanned part plan with consultant’s comment or a auto cad file for a plan. Figure twenty five shows a sample of the template.

**SAMPLE OF EDIT ASSET TEMPLATE**

The image shows a software dialog box titled "Edit Item". At the top, there are two input fields: "Item ID:" containing "FP/GL/01A" and "Description:" containing "Optional". Below these are four tabs: "General", "Attachments", "Picture", and "Custom Fields", with "General" selected. The "General" tab contains several fields: "Manufacturer:" (dropdown menu with "Optional" selected), "Model:" (text input with "Optional"), "Vendor Code:" (dropdown menu with "Optional" selected), "Class:" (dropdown menu with "Optional" selected), and "Category:" (dropdown menu with "Amended Construct" selected). To the right of these is a "Dimensions" section with three text input fields: "Length:", "Width:", and "Height:". Below the dimensions is a "Weight:" text input field and a "Checkout Length:" spinner box set to "1". At the bottom of the dialog are three buttons: "Help", "OK", and "Cancel".

FIGURE TWENTY FOUR

## SAMPLE OF ATTACHMENT TEMPLATE



Attachment function allows part plan with consultant's comment to be attached or for actual plan in soft copy eg auto cad files to be attached.

FIGURE TWENTY FIVE

#### 9.2.2.5 STEP 5: Security Privilege.

Security Privilege are used to limit the number of people who is authorized to update the record of drawings being sent in and out. In addition, it also allows those who are not authorized to update the system to know what is going on eg clerk of work or main contractor. In this way, all will be kept in the picture of what is going on and hence there is no lost in real time as far as dissemination of information is concerned.

The architect or the project manager is the only people who are authorized to decide who should have what level of privilege. This can be done via the Administration Privilege.

Shown in figure Twenty Six is a sample of the Security Privilege Template.

#### 9.2.3 Review of trial using limited edition asset tracking free software.

The above five steps which we have just gone through using a limited edition trial is an attempt to simulate steps one and two of the concept plan which we have mentioned in section 8.2.1 and graphically represented in figure fourteen and fifteen.

We can see from this trial that the transmittal form for drawing can be electronically send to one another via the check in and check out template. However, manual dispatch of drawing is still required to be done.

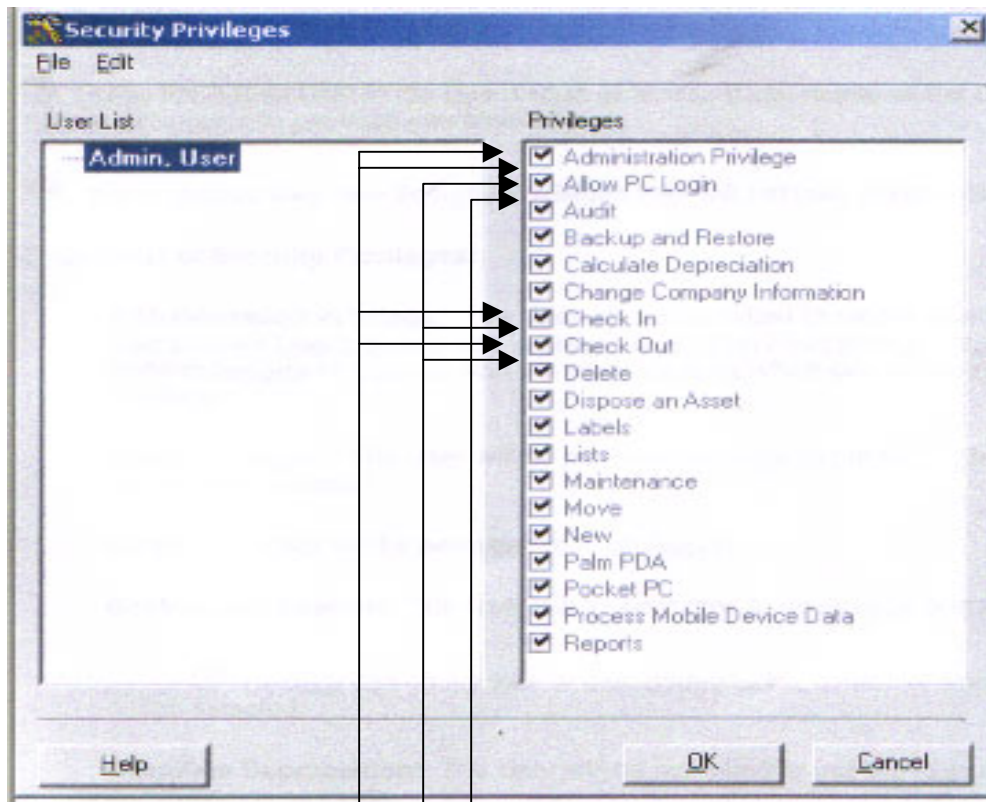
Nevertheless this system is has the advantage of:

- a. there is an advance warning of drawing being dispatch out when one log in into the system to view the transaction history.
- b. this transmittal or check in and check out template serves to record the movement of drawing and thus help us to keep track of its movement.
- c. the fact that this system make do away with hard copy of transmittal form(replaced by the check in and check out template) saves paper.
- d. Last but not least, the attachment function of the Edit Asset Template allows for part plan or full plan ( in auto cad format) to be sent out.

However we must take note that when a consultant or contractor is on leave, the drawing will still be sent to his or her table.

Having done this trial, we are now left with steps three to five of the concept to be test or put on trial.

### **SAMPLE OF SECURITY PREVILEGE TEMPLATE**



Administration Privilege,  
Log In, Check In and  
Check Out is limited to  
Architect and client's  
ProjectManager.

Log In, Check and Check Out of  
Drawing is only limited to  
Consultants and Main Contractor.

Log In only is limited to resident  
Engineer, clerk of work and sub  
contractor

FIGURE OF TWENTY SIX



### 9.3 Trial Using Limited Edition Bar Code Printing Free Soft Ware.

- 9.3.1 We have mentioned in the previous section that steps three to five of the concept plan mentioned in section 8.2 needs to be tested to determine whether it is feasible.

In this section we shall make use of free software to carry out a trial to determine the feasibility of step three and four of the concept plan ie equipment to generate the production of message and bar code label.

As this is a freeware, there are some limitations as far as simulation of actual condition is concerned. This software is only able to simulate Linear Bar Code and some other standard code. Simulation of 2 Dimensional Bar Code which this report has advocate in section 7.2 is not available in this freeware. However, in terms of principle and concept, if by using Linear Bar Code will bring with it success (despite of the fact that Linear Bar Code has inferiors storage capacity than 2 Dimensional Bar Code) than we can be sure that our concept will be workable if used with 2 Dimensional Bar Code.

The following steps illustrate how message are stored in bar code and how these label are produced and printed. As this is a limited edition freeware, the printed label is limited to those available in the freeware library.

#### 9.3.2.1 Step 1: Labels Set Up Operation.

The first step to production of bar code label is to choose the types of label used for the asset or inventory. In this case, we are using one label for our drawing (or asset as mentioned earlier).

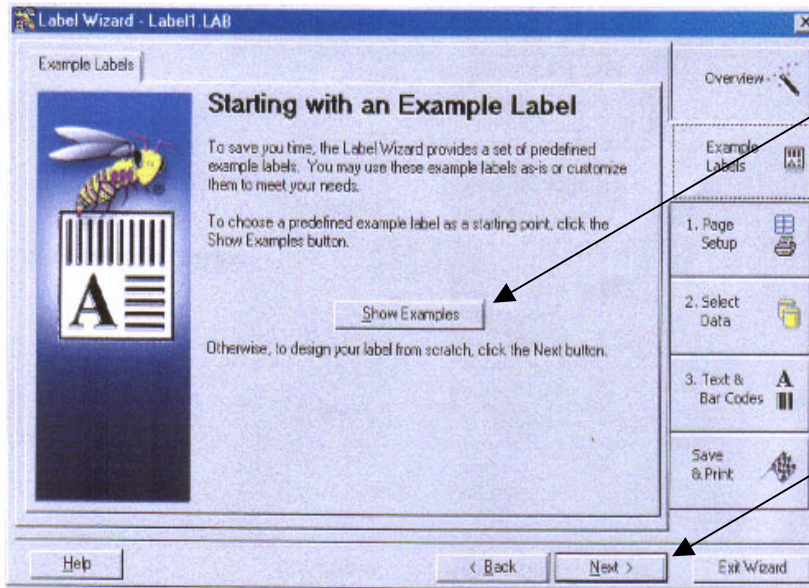
The label was chosen from the labels library as shown in figure twenty seven. The labels library is open by clicking on the Show Examples button.

From the labels library, we selected the type of label we want use by highlighting it. This is than confirmed by clicking the Open button shown in figure twenty eight.

If we wants a custom made label, we need to click the Next button at the bottom right hand of template 1 shown in figure twenty seven. This shall bring us to the next step which is the page set up shown in figure twenty nine.

The page set operation allows us to choose the quantity and size of labels we want to use. For the purpose of this research, we shall choose one label only.

## SAMPLE OF BAR CODE LABEL TEMPLATE 1

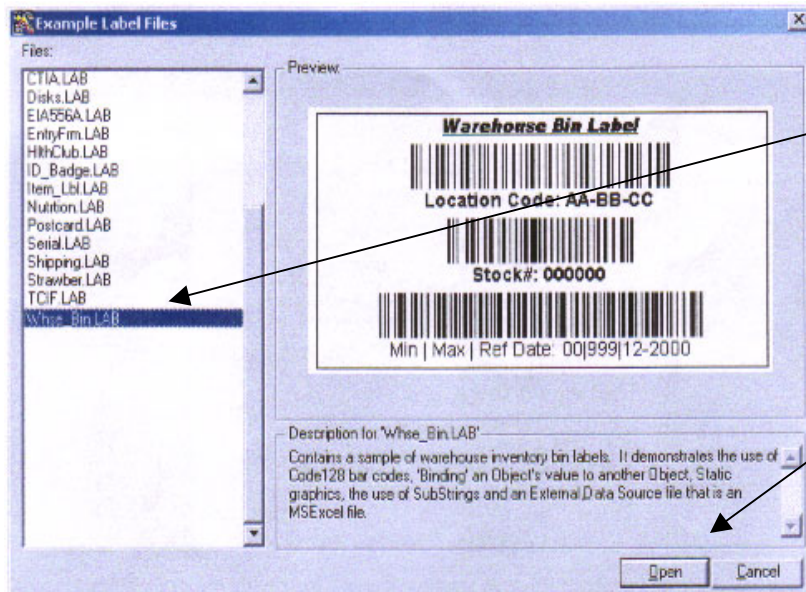


Click this Show Examples button to choose from the list of bar code label samples available in library.

Otherwise click Next button to construction custom made bar code labels.

FIGURE TWENTY SEVEN

## SAMPLE OF BAR CODE LABEL TEMPLATE 2



Bar code labels available from bar code label library. Click the choice to show label

Click Open to accept the choice of label

FIGURE TWENTY EIGHT

### 9.3.2.2 Step 2: Page Set Operation

When the Next button was clicked at the Bar Code Label template shown in figure twenty seven, the Introduction to Page Set Up page appears. We Clicked the Next button which brought us to the Layout and Printer Set Up page.

At the Layout and Printer Set Up page shown in figure thirty, the Layout of the bar code label was determined by clicking on the Set Up button.

Once the Set Up button was clicked, the Layout page shall appear as shown in figure thirty one. Over here we chose the size of the labels and the number of labels we required by first unlocking the Edit Lock button. Thereafter, the following field was edited to get what we required:

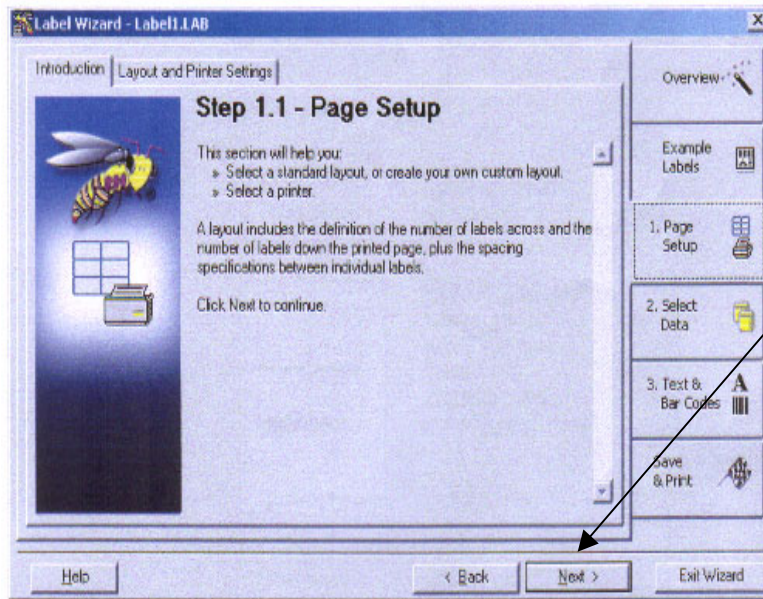
- a. number of Labels
  1. Across Field
  2. Down Field
- b. Label Size
  1. Width Field
  2. Height Field
- c. Page Margins and
  1. Left Field
  2. Right Field
- d. Space between labels.
  1. Horizontal Field
  2. Vertical Field.

Once this has been confirmed, we clicked the Ok button to bring us back to the Layout and Printer Settings page. Over here we click on to the Next button to proceed to the next step ie Introduction to External Data Source page as shown in figure thirty one.

Clicking the Next button of the Introduction page brought us to the Introduction Page of External Data Source set up page.

The external source data set up operation shall be discussed in the next step.

## SAMPLE OF PAGE SET UP INTRODUCTION TEMPLATE

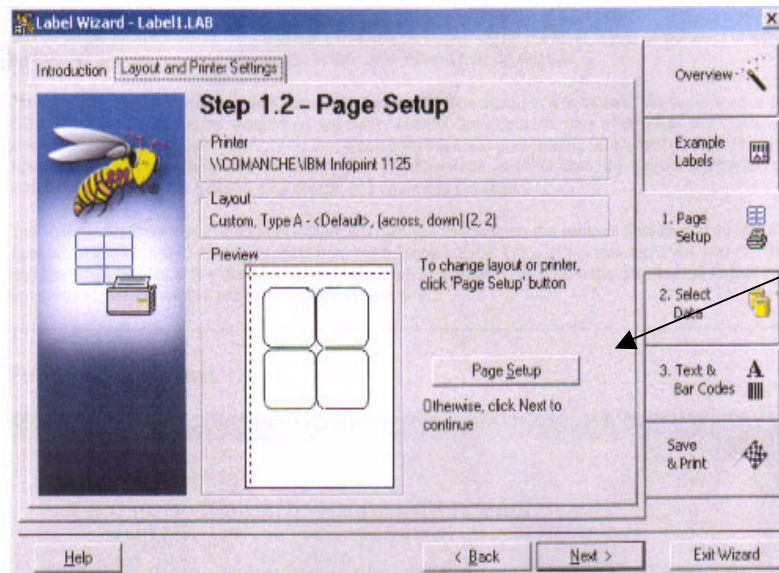


After clicking the Next Button in the Example Label page, we will come To the Page Set Up – Introduction Page.

Here we will click the Next button to proceed to the Layout and Printer Settings page.

FIGURE TWENTY NINE

## SAMPLE OF LAYOUT AND PRINTER SETTINGS TEMPLATE



Here by clicking The page Setup Button will bring us to the next page where we can determine the size and quantity of the bar code label.

FIGURE THIRTY

### 9.3.2.3

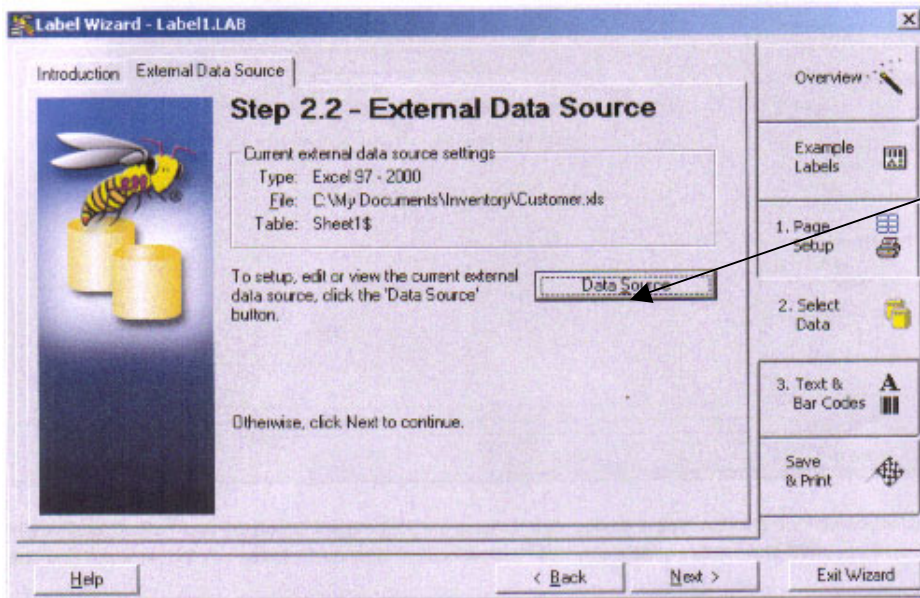
#### Step 3: External Data Source Operation

At the Introduction Page of External Data Source, the following operation was carried out:

1. Clicked on the Next button of the Introduction Page of External Source Data.
2. This will brought to the External Source Data Page where we shall clicked the Data Source button (see figure thirty one). This will brought us to the Introduction Page of Data Source Selection .
3. We skipped this page by clicking the Next button till we reached the Data Source Selection Page. We were prompted to select the File Type eg Excel File and File Name as the data source (see figure thirty two). Once this is done, we clicked the Next button to proceed to table Selection and Link Criteria.
4. Clicking on the Next button will brought us to Data Table Selection Page where we will be prompted on which sheet in the excel file we intend to use as Data. Here we shall select the sheet (see figure thirty three). Clicking the Next button will brought us to the Data Column Selection page.
5. At the Data Column Selection Page (see figure thirty four), we selected the relevant column we wants to us in the excel file sheet. Once this is done, will click the Next button again and this brought us to the Filter and Sort Pages which we shall ignore for this report. We clicked the Next Button to bring us to the Configuration Summary Page.
6. This page shall confirm the following data which we have selected:
  - a. Data Source Selection
  - b. Data table Selection
  - c. Data Table Links
  - d. Data Columns Selection

The Configuration Summary Page is shown in figure thirty five. Once all these stages are completed, we proceeded to the Text and Bar Codes Page by clicking on clicking the Exit button. The operation of the Text and Bar Codes Page shall be discussed in the next step.

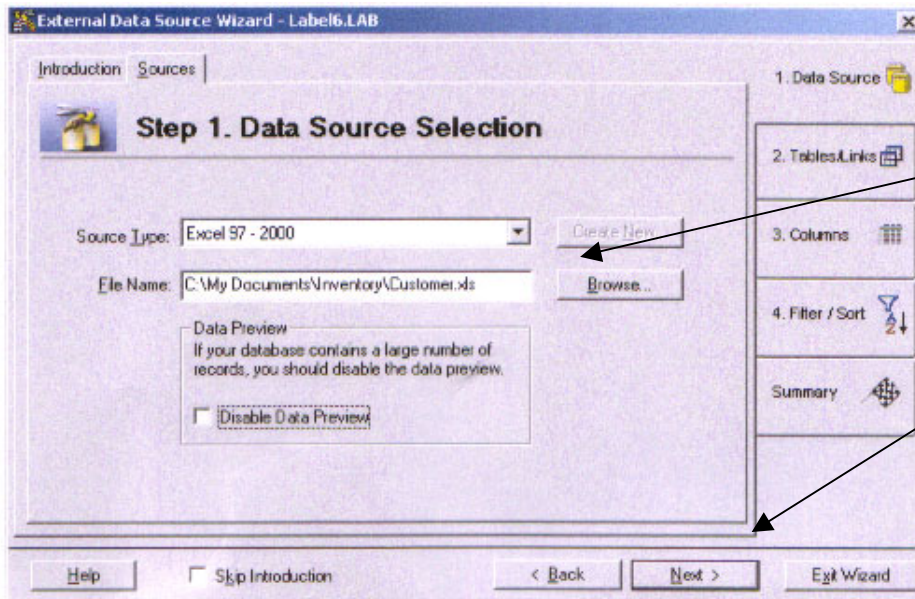
## SAMPLE OF EXTERNAL DATA SOURCE TEMPLATE



Clicking Data Source Button will lead us to the Data Source Selection Page.

FIGURE THIRTY ONE

## SAMPLE OF DATA SOURCE SELECTION TEMPLATE

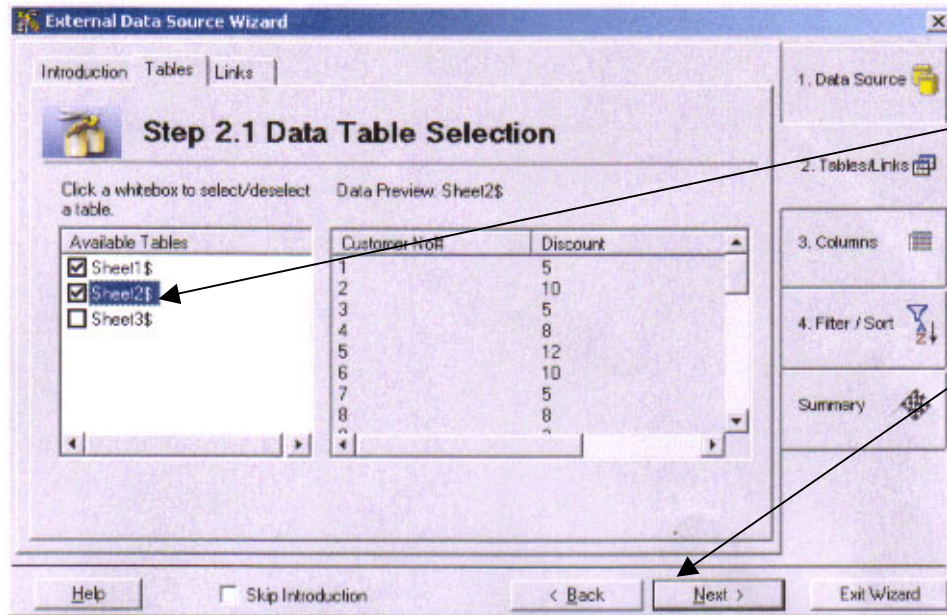


The File Type and File Name of External Data are Selected here ie in this case the file containing the Drawing list for FP/GL/01A.

Clicking the Next button will bring us to the Data Table Selection Page

FIGURE THIRTY TWO

## SAMPLE OF DATA TABLE COLLECTION TEMPLATE

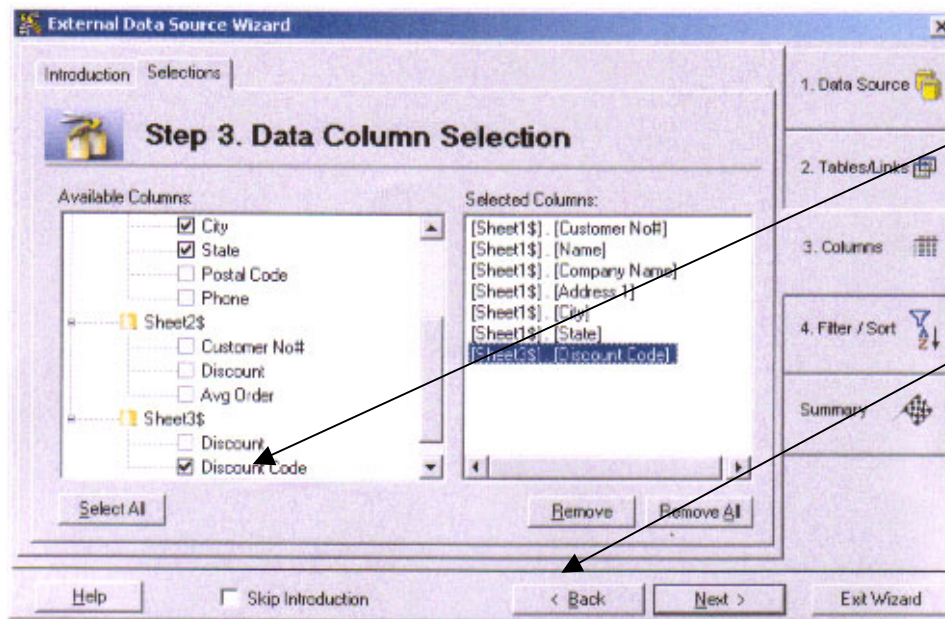


Selection of table (or sheet in excel file) is done by clicking the box

Clicking the Next button a few times Will bring us to Data Column Selection Page

FIGURE THIRTY THREE

## SAMPLE OF DATA COLUMN SELECTION TEMPLATE



Clicking the relevant Column will link the data to the bar code

Clicking the Next button will bring us to the Filter and Sort Criteria Creation which we shall skip.

FIGURE THIRTY FOUR

## SAMPLE OF CONFIGURATION SUMMARY TEMPLATE

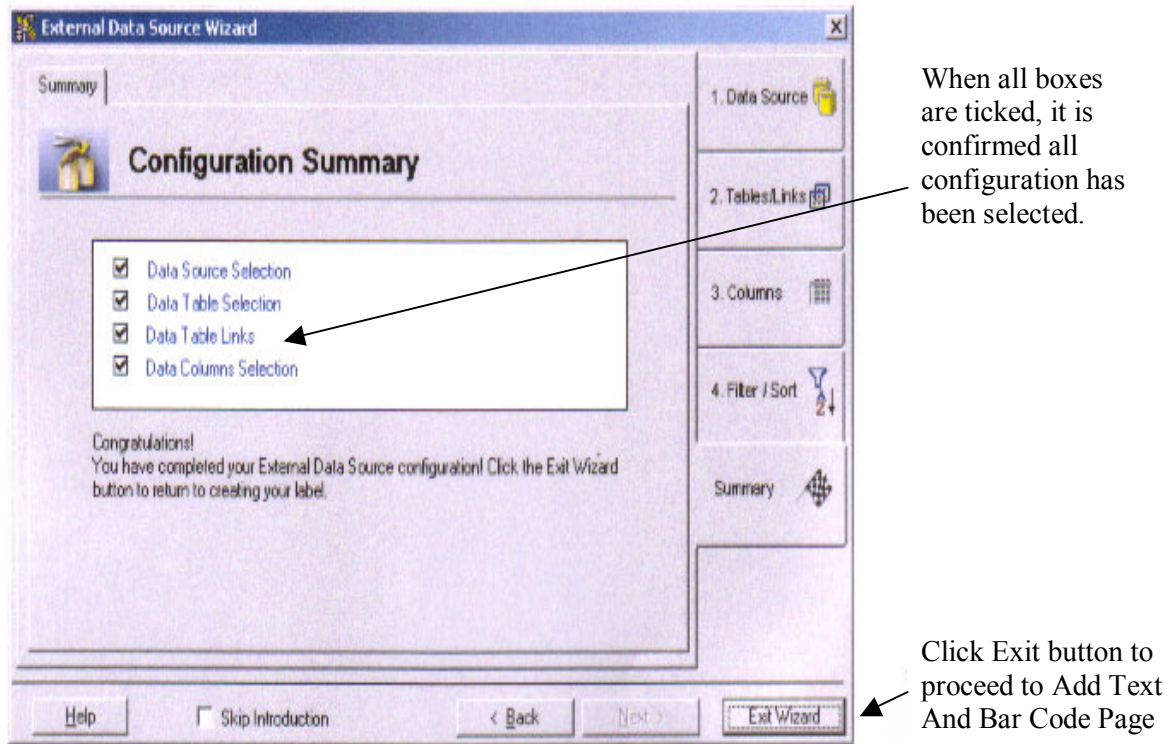


FIGURE THIRTY FIVE

So far we have briefly discussed on how to set up a page for bar code label. We have also look into setting up an external source. The last Step is to add text and bar codes to this label and map the external data to these labels.



#### 9.3.2.4 Step 4: Set Up Text and Bar Codes Operation

There are several different methods of creating and placing information onto label. We can choose from eight Source Types to create text for the label. The eight sources are as follows:

1. Static
2. Date/Time
3. Bind to Another Object
4. External Data
5. Serialization – Numeric
6. Serialization – Alphabetic
7. Serialization – User defined List
8. Prompt at Print Time.

We clicked the Add Text button as shown in figure thirty six to bring us to the Template shown in figure thirty seven. There are altogether eight sources of information which we can choose to be printed on the label. For this research, we shall used the following source to record the construction drawing FP/GL/01:

1. Static – here we will key in the drawing title FP/GL/01 under text 1.
2. External Data – here the data shall be linked to the excel file belonging to table nineteen under section 9.2.2. This is printed under text 2 “Project: Proposed 400 Units Condominium Development”.
3. Date/Time – here the date when drawing is issued it is recorded as “1/13/2005”.

Shown in figure thirty seven is the Object Source Page.

Once the text have been added, we clicked the Finish button and followed by a few times on the Next button till we reached the Save And Print Page as shown in figure thirty eight.

#### 9.3.2.5 Step 5: Save and Print.

In this page which we can see in figure thirty eight, when all required steps to for printing are carried, they will be confirmed with a tick in the box besides it. Once all the following steps are ticked, we clicked print.

1. Select the label layout upon which to print.
2. Chose a printer for printing the label
3. Configured an external data source
4. Added text, bar code and/or graphics.

We have mentioned earlier in section 9.3 that once all comments by consultants have been returned to the architect. The architect shall amend the drawing and send out an amended plan. This plan shall be known as Amended Construction Drawing and the date and time when this drawing is issued shall be recorded in the barcode label.

To produced the bar code label for the amended construction drawing, the five steps we have mentioned above were repeated except with slight changes to the following steps:

1. Step 3: External Data Source Operation – linking the source to the amended drawing list ie FP/GL/01A.
2. Step 4: Amending the Date/Time Source to reflect the date and time the amended drawing is sent out.

Appended below in figure thirty nine is the bar code label for construction drawing FP/GL/01 issued on 13 January 2005 and in figure forty is amended construction FP/GL/01A issued on 25 March 2005.

#### 9.3.1 Review of trial using limited edition bar code printer free soft ware.

In this trial, a lap top computer was used to run the bar code label generating program and a household printer was used to print the linear bar code label.

Hence we can conclude the following advantage:

- a. Bar Code Label can be generated using a desk top or lap top computer hence there is no need to invest money in buying sophisticated hardware.
- b. Similarly for printer, this can be done by using house hold printer as the label to be printed is of linear type.
- c. Records of time and date of drawing issued can be printed in bar code label and at the same time recorded in Data Source Template. This will help to minimize dispute.

We can conclude from this trial that steps three and four of concept plan mentioned in section 8.2 is feasible using our personal computer or lap top. It is

also feasible to record the drawing number, date and time of drawing being sent out.

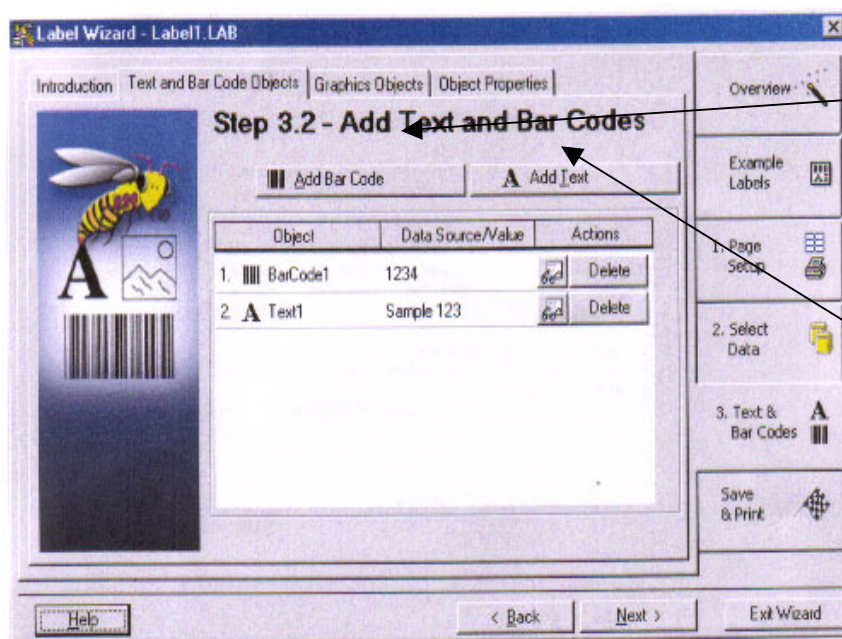
We are now left with the last step of the concept plan ie an internet line to link all these users and central data system together.

We have mentioned in section 5.3 that two of the methodologies are :

1. Seek assistance and advice from system engineer in drafting a concept plan.
2. If resource is available, to conduct a scale down trial on concept plan by loaning equipment or soft ware.

Methodology two has been conducted under sections 9.2 and 9.3. We shall now proceed to carry out methodology one to confirm that steps five is feasible.

### **SAMPLE OF ADD TEXT AND BAR CODE TEMPLATE**

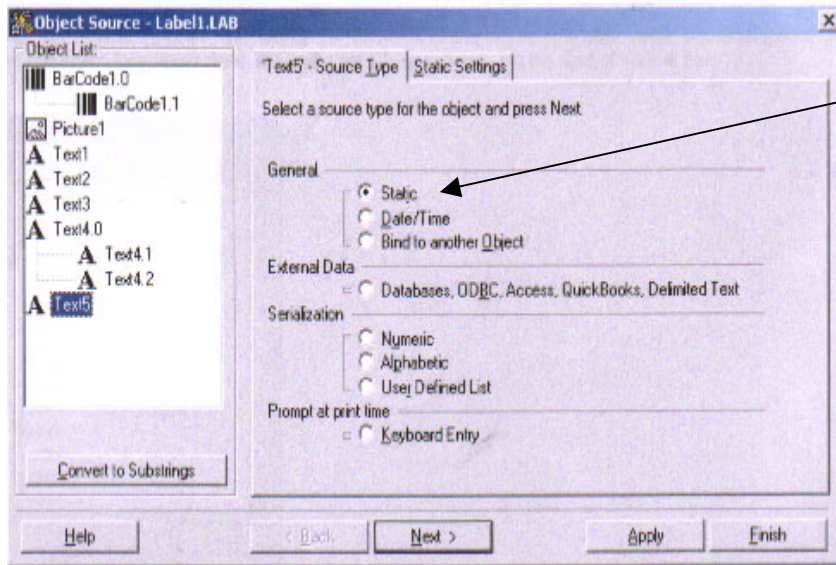


The types of bar code we have selected for the label can view over here

The text we have selected added are done by clicking this button

FIGURE THIRTY SIX

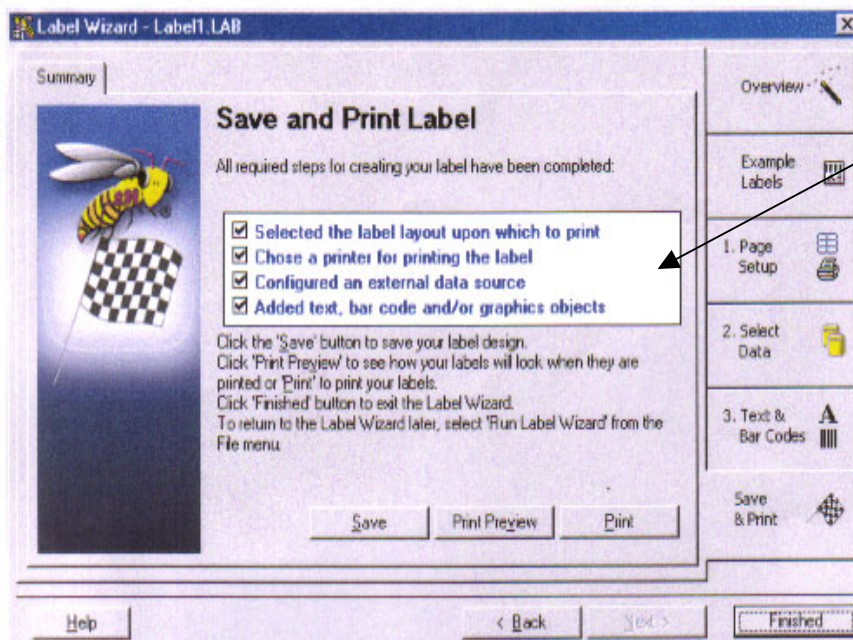
## SAMPLE OF OBJECT SOURCE TEMPLATE



There are eight possible source of information that can be placed on the bar code label eg Static, Date/Time Numeric etc.

FIGURE THIRTY SEVEN

## SAMPLE SAVE AND PRINT TEMPLATE



All boxes being ticked means all required steps to creating label has been completed.

FIGURE THIRTY EIGHT

**BAR CODE LABEL FOR CONSTRUCTION DRAWING FP/GL/01**

FP/GL/01

1/13/2005 17:58

'Text2:['FP-GL-01\$'].[Project : Proposed 400 Units Condominium Development]'



FIGURE THIRTY NINE

**BARCODE LABEL FOR AMENDED CONSTRUCTION DRAWING FP/GL/01A**

FP/GL/01A

3/25/2005 05:55 PM

'Text2:['FP-GL-01A\$'].[Project : Proposed 400 Units Condominium Development]'



FIGURE FORTY

#### **9.4 Consultation with specialist in the field of bar code.**

Consultation was done with specialist from various company and organization. Concept plan was sent to on of them for advice. The following section are some of advice given by them.

##### **9.4.1 Consultation with Digital Scanning Corporation Pte Ltd**

Digital Scanning Corporation Pte Ltd (DSC) is an international company with offices based in Singapore. Advice was sought from them on the feasibility of this research project and concept plan mention section 8.2 was sent to them for advice.

Digital Scanning Corporation Pte Ltd had advised that it is possible to track drawing using bar code subject to the following:

- a. there must be a back end database tracking all these records as barcode is just a data capture means.
- b. when the bar code label of a particular drawing is scanned, the information of the drawing can be retrieved from the database.
- c. since consultants, architect, client's project manager and contractors are stationed in different part of Singapore, it is possible to connect all parties into allow them to have assess to the same database via an internet.
- d. it is possible to use 2 dimensional bar code such as Data Matrix Code to capture 295 characters, numeral and symbols (refer to table eleven).
- e. the concept plan drawn out in section 8.2 is feasible except that the scanner has be to be linked to the computer terminal and all computer to be linked up.

##### **9.4.2 Consultation with Inforcomm Development Authority of Singapore**

Advice was sought from the Inforcomm and Authority of Singapoe (IDA) on feasibility of using bar code to keep track of construction drawing. The IDA replied that it is possible and relative easy. In fact IDA replied that BHP (Broken Hill Property) of Australia uses steel product are bar coded. In other advanced countries, bar code has been used to manage construction of buildings.

IDA further added that if any company in Singapore is interested in using bar code to keep track of construction drawing, they should apply to be a member Singapore National Article Council (SNAC). Thereafter, the SNAC will provide the necessary assistance and advice.

#### 9.4.2 Review of Consultation.

The last stage has seen both replies from DSC and IDA concurring that it is possible to use bar code to keep track of construction drawing and also to link all parties via the internet to a central database.

With this, we can conclude that step five of section 8.2 can be carried out. The only thing we have to bear in mind that since this is not a full and complete scale trial run, there may be teething problem that need to be addressed or fine tuned before we can say that this workable or suitable for use in the market.

However as far as concept is concerned, the implementations that has been carried out is more that enough to concluded that the concept mentioned in section 8.2 is workable.

#### **9.5 Summary of Implementation**

As mentioned in section 9.5, since full trial has not been carried out, we have to be mindful of teething that may crop up. These problems have to be looked into and resolved. Some of these problems are:

1. Security – since we are using internet, we have to have a security feature to prevent hacking or authorized entry eg using Firewall.
2. Contractual – what is the contractual implication if RFI and CVI are replaced using the bar code system. Will it rise to dispute in arbitration?
3. Resistance – resistance to change by party of contract who is still in favour of using the paper based system. How to coax them into participating in this system? To make it as a condition when they enter into an agreement to provide architectural or consultancy services for the client?

It is hope that when these and other teething problem are resolved via a full trial, the system can be implemented and thus bring with it changes and improvement to the construction industry.

**CHAPTER FIVE**

**RECOMMENDATION AND CONCLUSION**



## **10.0 RECOMMENDATION AND CONCLUSION**

### **10.1 Recommendations**

As mentioned in section 2.7 and 2.8, technology has slowly creep into the construction industry. The way building is being built has also undergone technological revolution. Toilet and staircase which were once built on site is now being built in factories in pre-cast form. Drawing which were once being drawn by hand is now being drawn using the Auto Cad. Similarly, the way to manage a condominium development has to be in tandem with these changes. To ignore it will only results in us being left behind while others leap frog forward.

Therefore there is need for the project management industry to move away from a paper based system whereby drawings are keep track of via transmittal and manual dispatch without any real time benefit. As mentioned in above, others in the construction industry has undergone changes and rely heavily on technology to do its work, therefore using technology to keep track of drawings is no longer just a necessity but is an urgent task.

This old system of keeping track of drawings not only relies heavily on the use of paper such as drawings transmittal to inform each and everyone in the project team of any changes in the drawing. It also relies heavily on manual dispatch to send out the drawings and transmittal. Manual dispatch is dependent on the dispatch clerk schedule and also the amount of documents the clerk has to send out for that day. Any unsent document may have to be sent the following day. As mentioned earlier in the report, misplaced drawings or plans is also a problem. The element of real time information is no longer there as compared to using bar code.

As mentioned in section 2.3.2, the basic objectives of a project manager are:

2. Time
3. Cost
4. Quality

Therefore it is important that a project manager achieved as much of his objectives as possible. If given tools or assistance to do his job, it is equally important that these tools or assistance will further help him to meet his objectives. Looking at the bar code system, we are able to identify some of the feature which can further improve the project manager's ability to meet these objectives.

#### **10.1.1 Improvement in Time Control**

The fact that drawing transmittal is being sent via the bar code tracking system via the internet give real time alert to other party to look out for the plans.

Although one may argue that in the bar code system, drawings are still manually delivered and hence there is not much gain in term of speed. However in section

9.2.2.4, the possibility of incorporating plans in softcopy form into the system will further improve the speed drawing are sent to one another.

#### 10.1.2 Improvement in Cost

Improvement in the speed of delivery of drawing to one another will help to speed up the construction process. Although one may argue that a breakdown in the system may mean a bottle neck will be created in the whole chain of drawing delivery system. However, the gain we have in using this system should not be put off just because of the possibility. Many things that we do in our everyday life make use of the internet eg internet banking etc. This has brought much convenience to our life.

#### 10.1.3 Improvement in Quality

The faster information are transmitted to one another and the least reliant on manual dispatch will means faster flow of information to workers on site and though less abortive work or mistake. This will certainly give rise to more project being built more accurately.

10.1.4 With so many benefits to reap from using this system, it will far outweigh the uncertainty this system may bring. Hence it is recommended the using bar code system to keep track of drawing be given a chance to be implemented and tried out in a construction project. It is only through so can we fine tune it and correct any error that may arise so that its full potential can be realised.

### 10.2 **Conclusion**

This research shows that it is possible to use bar code system to keep track of construction drawing from tender stage to as built stage. The various trial using free demonstration software, site visit and also consultation with specialist concluded that the concept of keeping track of drawing using bar code is feasible.

If more time permit and more resources are available the whole system assembled together put on trial for an actual construction project. Thereafter, we will be able to produce a system that is tried and tested.

**CHAPTER SIX**  
**RISK ASSESSMENT**

## 11.0 RISK ASSESSMENT

11.1. This research will requires trip to construction site and other places like library etc for field study.

In addition, it involves long hours of works using the personal computer. In view of this, we need to assess the risk that is involved and look into ways of managing it. Basically risk management covers the following three parts:

- a. Risk Identification
- b. Risk Evaluation
- c. Risk Control

11.2 We will first assess the risk involved through identification and evaluation. Appended in the table are some of the risk that will may arise during the course of research and when the research proposal re actually implemented for use. The steps that we need to take to control it will also be discussed in the table below.

|   | RISK IDENTIFICATION   | RISK EVALUATION   | RISK CONTROL   |
|---|---|---|--|
| 1 | <p>During Field Trip To Construction Site.</p> <p>a. falling objects during hoisting of material or from uncompleted building.</p> <p>b. sharp objects on floor or heavy object dropping on our feet.</p> | <p>a. head injuries or injuries to other part of body.</p> <p>b. leg, feet or toe injuries.</p> | <p>a. wear safety helmet at all times and avoid going near hoisting platform.</p> <p>b. to inform contractor and get their permission every time we need to carry out field research so that they can record our attendance. This is to avoid complication in even of accident and making claim from insurance company.</p> <p>a. wear safety boots at all times.</p> <p>b. similar to above, inform contractor if we need to enter the construction site.</p> |

|   | RISK IDENTIFICATION  | RISK EVALUATION   | RISK CONTROL   |
|---|--|---|--|
| 2 | <p>During field trip to library, supermarket to evaluate concept.</p> <p>a. Wet and slippery floor</p> | <p>a. Injuries such as sprain back or limbs sustain in supermarket due to slippery floor in fishery section.</p> <p>b. Injuries sustain due to falling books or fall from high shelf.</p> | <p>a. To inform librarian or supermarket manager and get their permission before visiting them.</p> <p>b. To wear proper anti skid footwear.</p> <p>a. To use proper ladder when retrieving books.</p>                                     |
| 3 | <p>a. Prolong usage of computer during preparation of dissertation or project appreciation.</p>        | <p>a. Straining of eyes due to prolong usage of personal computer.</p>  | <p>a. To rest the eye for five minutes after every thirty minutes or based on health authority recommendation.</p> <p>b. Avoid looking too near the screen. Usually at least a feet away or as per recommendation by health authority.</p> |
| 4 | <p>a. During trial and actual usage of the research proposal.</p>                                      | <p>a. Scanner may cause injuries to the eye due to prolong exposure.</p>  | <p>a. Avoid holding scanner near eye.</p>  |

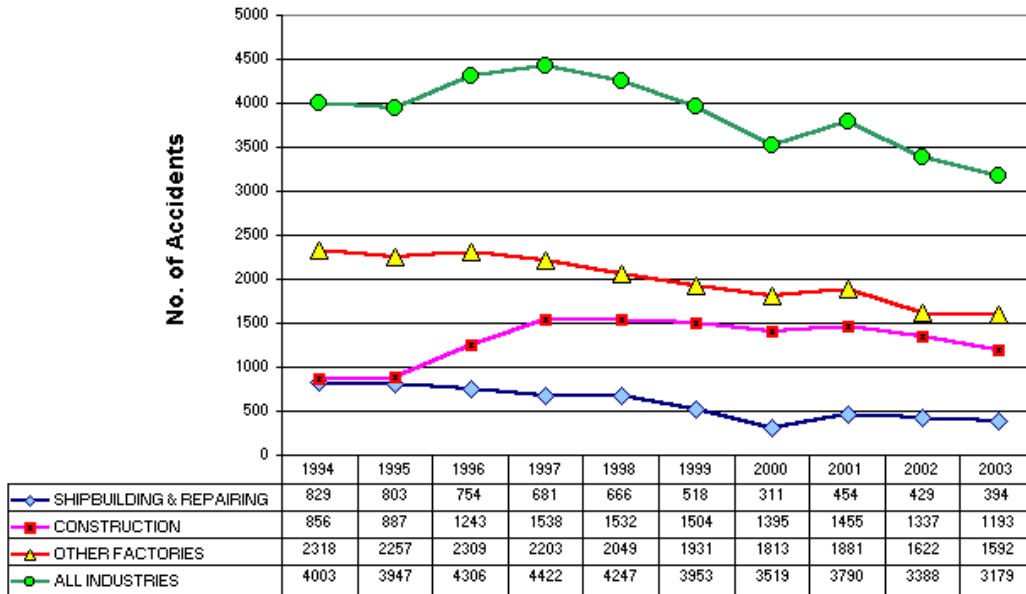
The Factories Act which forms the basic framework which stipulates the minimum provisions on occupational safety, health and welfare for persons employed in factories and other places ([www.mom.gov.sg](http://www.mom.gov.sg)).

This act can be found in the web page of the Ministry of Manpower at [www.mom.gov.sg](http://www.mom.gov.sg).

11.3 Building construction is one the more hazardous industry and therefore it is important that safety awareness be instilled throughout the course of this research.

The following charts are safety survey done across the different industries from 1994 to 2003. As can be seen, the number of accidents for construction has not reduced very much as compared to others.

**NUMBER OF INDUSTRIAL ACCIDENTS BY INDUSTRY  
1994-2003**



(Source: [www.mom.gov.sg](http://www.mom.gov.sg))

**CHAPTER SEVEN**  
**RESOURCE ANALYSIS**

## **12.0 RESOURCE ANALYSIS**

12.1 The resources requires basically are broken down into four parts. They are as follows:

- a. Literature resources which can either be sourced from the internet or the library.
- b. Field resources such as visit to construction site or the library. This should not pose a problem as right now my work involves taking charge of a 398 dwelling units condominium development.

Library visit or case study should not be a problem as it is supposed to be a place for learning. This library use bar code to keep track of books.

- c. Advice and help in preparing the necessary concept plan may be a little time consuming and difficult as not all companies have the time to meet and advice on the plan.

To overcome this, the following alternative sources which are non-profit organization can be approach for help and advice.

- i. Singapore Article Number Council (SANC) is a non-profit council appointed by Singapore Trade Development Board in 1987 to implement and administer an international article numbering system (EAN♦UCC System) in Singapore.
  - ii. Infocomm Development Authority of Singapore plays a leading role in establishing Singapore as an info-communications hub. It will develop, promote and where necessary, regulate the market. The Telecommunication Authority Singapore and the National Computer Board merged to form IDA in December 1999.
- d. Hardwares and softwares to carry out a trial after the finalization of the concept. The hardwares such as scanner may have to be loan. The software part may be a problem if it is no a standard software. In this case, the item may need to be purchased or sponsored.

Of the four parts that are identified, part © and (d) may need more time, effort and immediate attention to resolve



**CHAPTER EIGHT**

**APPENDICES**

## **13.0 APPENDICES**

1. The timeline is shown in excel file “Time Line For Bar Code”.
2. The project specification which is revised to “C” is shown on the next page followed by project reference.

# TIMELINE FOR BAR CODE SYSTEM

TIMELINES FOR ACTIVITIES FOR ENROLLMENT S1 AND S2 (COMPLETION IN OCT 2004) - EXTERNAL

|  | Start      | Finish     | JULY |      |      |      | AUGUST |      |      |      | SEPTEMBER |      |      |      | OCTOBER |      |      |      | NOVEMBER |      |      |      |
|--|------------|------------|------|------|------|------|--------|------|------|------|-----------|------|------|------|---------|------|------|------|----------|------|------|------|
|  |            |            | wk 1 | wk 2 | wk 3 | wk 4 | wk 1   | wk 2 | wk 3 | wk 4 | wk 1      | wk 2 | wk 3 | wk 4 | wk 1    | wk 2 | wk 3 | wk 4 | wk 1     | wk 2 | wk 3 | wk 4 |
| 1 Submission of project specification and appreciation       | 2/18/2004  | 2/18/2004  |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| 2 Prepare and Submit Extended Extract                        | 4/7/2004   | 10/12/2004 |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| a identification of type of bar code to use                  | 4/8/2004   | 5/12/2004  |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| b review the different type of bar code                      | 7/12/2004  | 10/12/2004 |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| c field visit to construction site and library               | 11/18/2004 | 11/18/2004 |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| d prepare report for field visit                             | 12/18/2004 | 12/18/2004 |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| e submit interim research paper to supervisor for review     | 13/18/2004 | 15/18/2004 |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| f prepare concept plan                                       | 17/18/2004 | 19/18/2004 |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| g seek consultation on concept plan                          | 18/18/2004 | 22/18/2004 |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| h amend concept plan   | 23/18/2004 | 24/18/2004 |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| i carry out trial on plan                                    | 25/18/2004 | 30/18/2004 |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| j finalize report for extended extract                       | 31/18/2004 | 1/9/2004   |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| k seek supervisor's comment on report                        | 2/9/2004   | 7/9/2004   |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| l amend finalize extended extract                            | 8/9/2004   | 9/9/2004   |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| m submit extended extract to USG                             | 10/9/2004  | 10/9/2004  |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| 3 Residential School   | 21/9/2004  | 27/9/2004  |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| a first seminars   | 21/9/2004  | 27/9/2004  |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| b power point/software demo tutorials                        | 21/9/2004  | 27/9/2004  |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| c present paper at project conference                        | 21/9/2004  | 27/9/2004  |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| 4 Dissertation   | 28/9/2004  | 1/11/2004  |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| d submit dissertation for comment                            | 27/9/2004  | 11/10/2004 |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| e submit amended dissertation following supervisor's comment | 12/10/2004 | 22/10/2004 |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| e final checking, printing, binding and convert to PDF       | 23/10/2004 | 27/10/2004 |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |
| f submit final dissertation                                  | 28-10-2004 | 28-10-2004 |      |      |      |      |        |      |      |      |           |      |      |      |         |      |      |      |          |      |      |      |

## PROJECT SPECIFICATION

University of Southern Queensland

FACULTY OF ENGINEERING AND SURVEYING

ENG 4111/4112 Research Project  
PROJECT SPECIFICATION

FOR : CHEONG SIEW HONG

TOPIC : ROLE OF A PROJECT MANAGER IN A RESIDENTIAL HOUSING DEVELOPMENT IN SINGAPORE

SUPERVISOR : Ms Jo Devine

ASSOCIATE SUPERVISOR : Ms Lenny Chew  
Assistant Director (Corporate Service)  
Ministry of Foreign Affairs

ENROLMENT : ENG 4111 – S1, X, 2004  
ENG 4112 – S2, X, 2004

PROJECT AIM : The project aim is to research into the use of bar code in tracking drawing during the construction of a residential development in Singapore

PROGRAMME : Issue C, 29 July 2004.

1. To identify the type of bar code that is suitable for use in this research.
2. To survey the standard drawing list.
3. To prepare concept plan and carry out a trial.

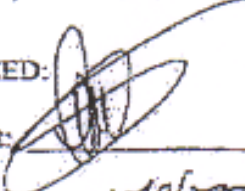
AGREED:

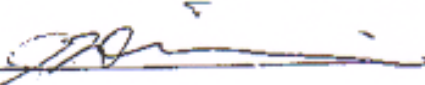
Student:

Dated:

Supervisor:

Date:

  
10/8/2004

  
17.8.04

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