Construction Supply Chain Management and Coordinated Design Drawings: An outlook of the construction industry and sustainable urban planning

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1 INTRODUCTION

This paper examines the utilisation levels of Information and Communication Technologies applied in the construction industry and urban planning. It focuses on the potential application of Construction Supply Chain Management system amongst organisations in the construction industry and the readiness of application of Coordinated Design Drawings for new township developments.

2 ICT APPLICATION IN MALAYSIAN CONSTRUCTION INDUSTRY AND URBAN PLANNING

Applications of Information and Communication Technology (ICT) have been on the increase since the last three decades. Many sectors of the economy, including the built environment and the construction industry, have reaped great benefits from the variety of ICT applications and apparatus. In the drive towards sustainability in the physical and socio-economic developments, ICT may play the roles of increasing the efficacy and effectiveness of managing the environment. The marriage of advancement of computer and telecommunication technologies enable sharing of information, bridging of distance and information gaps, better and well-informed decision making as well as quick-response to the current crises through the availability of supply and and reliability of real-time information.

In Malaysia, however, the trend has been on the uprise only since the Multimedia Super Corridor idea was first mooted in the 1990s. Multimedia Super Corridor is a physical space of 15 km by 50 km streching from Kuala Lumpur city centre in the north to Kuala Lumpur International Airport, Sepang in the south. The corridor will eventually be supported by broadband wireless communication facilities and other flagship ICT applications. Some of these applications include (Mohd Nasir, 2002):

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- Computer Aided Design (CAD);
- Geographical Information System (GIS);
- Traffic Management Control (TMC) and Intelligent Transport System (ITS);
- Database Management System (DMS);
- Facility Management System (FMS);
- Electronic submission of planning application on-line (E-submission);
- Construction Supply Chain Management system (CSCM); and
- Coordinated Design Drawings.

In many developed and developing countries, these applications are becoming the norms for organisations related to the industry and urban planning. Singapore, for example, has been implementing the e-submission of plans for urban regeneration projects for many years (Urban Redevelopment Authority, 2000). Meanwhile, other countries are still exploring the potential benefits of ICT. Malaysia, for instance, has only recently been introduced to the Integrated Tranport Information System which encompasses Advanced Traffic Management System (ATMS) and the Advanced Traveller Information System (ATIS) to manage traffic conditions along major roads in the city of Kuala Lumpur (ITS Consortium, 2003). Additionally, in Putrajaya and Cyberjaya, the electronic method of layout plan submission (E-submission) has been in place for almost five years.

Sustainability of physical and socio-ecnomic development also demands that development projects to be undertaken with the greatest care for the natural environment and resources. Achieving this, which is one of the aims of Malaysia's Vision 2020, poses some challenges to urban planning and the construction industry. This is true of Malaysia, whereby increasing population and economic prosperity warrant some new establishment of townships, more often than not, in the outskirt of cities and in suburban areas.

This paper examines the varying degrees of utilisation of ICT in the construction industry and urban planning practices. Focusing on only two of the applications listed above: Construction Supply Chain Management system (CSCM) and Coordinated Design Drawings (CDD), this paper further explores the levels of awareness, acceptance and willingness of related organisations to undertake these applications in their daily operations.

There exist two main activities in Malaysian urban planning namely forward planning and development control. In forward planning, development plans indicating future trends of physical growth based on the nation's socio-economic policies are prepared. Before undertaking these physical development and construction of buildings, a planning permission should be sought from the local authorities. The applications for planning permission and building construction (plans) are usually accompanied by several plans and reports explaining in detail, amongst others, types of development being proposed, their impacts on existing landuse, the manners in which they are to be carried out, whether or not minimum required standards employed so as to ensure the well-being of end users.

The development actors involved at the pre-planning application stage are physical planners, architects, land surveyors, landscape architects, civil and structural engineers and electrical and mechanical engineers. During post-planning application or after securing planning permission, landscape architects, architects, constructors, engineers and quantity surveyors will play their respective roles to see to it that the building plans have the appropriate approval from the authorities. According to *Appendix A*, the minimum duration of active involvement by these professionals is 53 weeks. About 17 weeks are for outline permission of conversion of land use, 12 weeks for planning permission approval (without conditions), 10 weeks for approval of full conversion of use and subdivision, and 6 weeks of building plans approval. Additional 8 weeks are required for licencing and sales or advertisement purposes. Normally, land clearing and contruction works take about 2 to 3 years e.g. in a housing project. In practice, however, this may take longer time.

Since the process involves high levels of interactions between different professions, information regarding the various stages of development need to be shared in order to keep these professionals up-dated with the most current changes (Baharudin, 2003). Currently, there exists very little integration and sharing of information amongst the professionals that sometimes conflicts might arise due to ignorance and unawareness of changes to plans or details of the development and construction processes. This greatly warrants effective and efficient management and dissemination of information.

An integration and sharing of information, in particular reports and plans of physical development and building construction, have been practiced in both the United Kingdom, to a greater extent, and Malaysia, to a lesser extent. In Putrajaya, Malaysia, for example, actors of development prepare and share development and construction information before finally submitting them to the local authority via internet platform. The process is known as e-submission. Currently, the major benefits decrease in the number of trips generated due to the need to visit to and meeting at the local authorities offices and the number of face-to-face discussions held amongst the professionals themselves (Abdul Rahman, 2002). The benefits of less paperwork and printing have also been reaped. Major changes in plans and reports can easily be communicated through electronic means. The local authority can establish a 'one-stop-centre' for development control process without having to reproduce reports and plans on papers to be circulated to other agencies and authorities within and outside the organisation (Abdul Rahman, 2002). All the information, up-dated reports and plans are easily accessible to those relevant actors and authorities through designated the inter- and intra-net channels.

In order to illustrate this more clearly, the paper presents two case studies: CSCM in the UK and CDD in Malaysia. They are to illustrate the interesting and distinctive approaches used to propogate further applications of ICT in both fields as well as the unique circumstances and fortunes limiting the introductions and implementations. Citation of these cases: the supply chain in the construction industry and the urban development sector (new township planning applications), will assist the study in translating the benefits of ICT into substitutions for journeys-to-work; thereby reducing travel demand, lessening air and noise pollutions and eventually promoting safer, healthier and more sustainable urban development.

3 CONSTRUCTION SUPPLY CHAIN MANAGEMENT

3.1 Definition

Supply chain is a term used to explain the life cycle processes supporting physical, information, financial, and knowledge flows for moving products and services from suppliers to end-users. Understanding the supply chain is certainly important to those involved in related process and system improvement. In the context of the contruction industry, supply chain can be identified as system through which design teams and builders working together to deliver an end-product to their clients. As such, construction supply chain management may be defined as a field of study that concerns in improving the system implemented to ensure improved project performance along various metrics such as speed, cost, rehability, quality. The supply chain management in construction offers a way to integrate the traditional islands between the members of the construction team and thereby reducing the time and cost.

3.2 Application and Implementation

The construction industry is a very fragmented industry. Numerous projects have derailed from their original schedule, thereby increasing the project cost to unrealistic values. One of the reasons is the traditional model of planning, scheduling, controlling and contracting, where each functions as different islands. At the best they try to optimise individual activities, but seldom look at each other's activities. The construction supply chain process involves of different stages in the construction process. The work stages are as follows (RIBA, 1973 cited in Seeley, 1997):

- Briefing Stage (comprising of inception and feasibility)
- Design Stage
- Outline proposal
- Scheme design
- Detail design
- Production information
- Project contracts/ Tendering Stage
- Bills of Quantities
- Tender action
- Project planning
- Construction

The construction supply chain process involves many different team members. The members of the construction supply chain are the clients, architects, planners, quantity surveyors, engineers, landscape architects, interior designer, main contractor, sub-contractors and the suppliers. Each team members is a link in a chain of activities, adding value at each stage, designed to satisfy end-customer demand in a win-win situation. The process also embraces all the information technology necessary to support and monitor the activities. Since the members of the construction supply chain process are fragmented across many diverse disciplines, each using different systems, and approaches to comply with clients' requirements, poor management and communication problems often occur.

The control of time, cost and waste is of paramount concern to all parties involved in construction projects. Many problems related to issues of control result from inadequate communication of information within the supply chain. The amount of information flow in any construction project from start to finish should not be underestimated. Different types of information / data are required by various people in the construction supply chain in various formats. Amongst identified problems are: fragmentation of professional expertise, lack of information sharing, lack of awareness of available technology for integration, inefficient manners of managing information and an overall ineffective coordination along the construction supply chain.

For the construction industry to be competitive, it needs ICT applications encompassing all the professionals and stages involved. It is inevitable that conflicts may arise during communications between parties (Eddie W.L. Cheng *et al.*, 2001). This is an area where ICT helps to support and achieve efficient and effective communication between members of the construction supply chain.

The construction industry has widely used information technology to improve the capability and efficiency of many aspects of the construction process. Large amount of investments have been made and focused on providing ICT support for specific activities within the construction process. At present, the integration of the construction process through electronic sharing and communication of information is not widespread (Construct IT Bridging The Gap, 1997). This is indeed the major area of opportunity. An application of ICT is to automate different parts of the construction process. ICT can ensure a collaborative information technology, which tends to support improvements in communication and interaction between project partners. Currently, the industry utilises ICT as a tool to provide support for specific tasks, but yet as a coordinating tool to integrate activities or provide more efficient communications along the stages as a way to save time, costs and other conflicts. Traditionally, before the usage of ICT, project information was passed on linearly – lack of integration and coordination between sequential stages.

Information technology applications in construction are widely available and are also widely exploited, but the production side of construction industry is still resistant to the attempts to computerise site activities. The use of ICT in the construction supply chain process has so far concentrated on discrete applications. Members of the construction supply chain should now work together towards implementing ICT as a strategic advantage. ICT potentially provides new strategic opportunities and if used effectively can bring great benefits to the construction supply chain process. The members of the construction supply chain should consider where their opportunities lie now to take advantage of the competitive situation. Tendering and supplier selection is amongst the important stages in a construction supply chain process. Time is usually limited and a constraint in doing these two activities. Implementing ICT is seen as a medium to improve these two processes strategically. There are many benefits that can be achieved in implementing ICT in the construction supply chain process. It is an integrating solution for problems of fragmentation and clients would be able to receive a more timely and accurate information on their project. Moreover, it enables new and improved service in the supply chain, e.g. collaborative extranets are seen as a medium to improve the tendering and supplier selection process. ICT also adds value to clients' investment from an improved construction process as this also means better quality in the end product. They would also be able to save time and in construction by saving time it would also mean save cost.

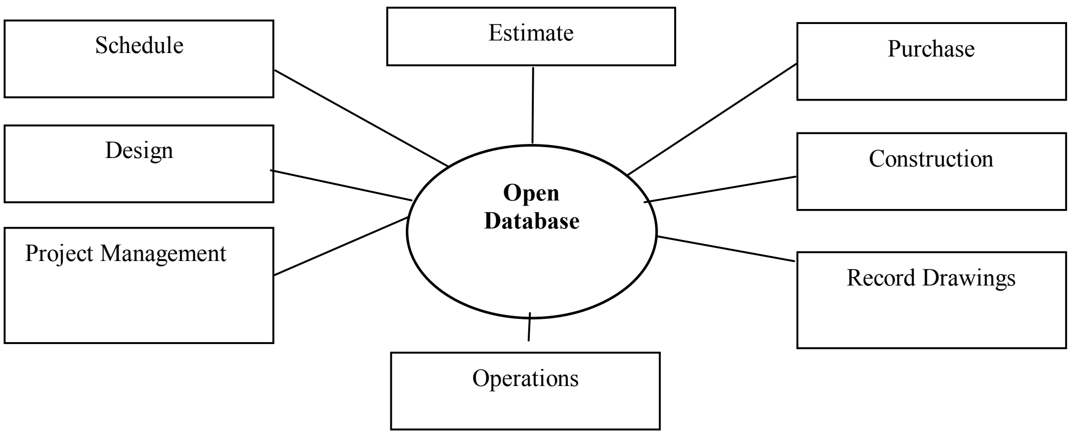

Figure 4.2: Integrated and Collaborative Information System (Frederick E. Gould *et al.*, 2002)

ICT may be utilised at Project Applications stage. Some of the benefits include providing database platform to support all the project and product information. It also has a potential role in 3D presentation to allow complete product description. ICT links design information, component lists with cost estimates. It also links project database with facilities management applications. Use of intelligent databases through ICT will provide some of the necessary data manipulation and control facilities.

At the Briefing Stage, it may assist in modelling client's requirements and provide performance benchmarks and cost trade offs, Life cycle cost can be modelled using ICT. ICT is able to create visualisation modelling techniques that will allow clients to visualise different design options (e.g. usage of virtual reality). Meanwhile, at the Design Stage, ICT helps integrate suite of knowledge based engineering into the project database and industry knowledge base. 3D CAD systems can be used to model basic geometry with associated product information. Project database used as interface to knowledge based analysis and design tools. Project database would also be able to provide facility to access impact of design changes and allowing 'what if' analysis by consultants, contractors and clients. Project database then would be able to automatically inform design team members of changes, which affect parts of design for which they are responsible, automatic access to industry knowledge base for standard component lists. The next stage in construction supply management is the Project Contracts/ Tendering Stage. At this stage, ICT create interfaces between technical and commercial applications. It also provides parallel costing which can be attached to design packages. This allows cost implications of design decisions to be assessed. ICT based estimating models to support human judgement may also be developed. ICT helps store standard contract information on project database or provide access to this through industry knowledge base.

On-site communication may also benefit from ICT application. Site communication infrastructure could support email and videoconferencing. Visual links would allow remote access to 'virtual team' for any changes in design. This would also include the availability of 3D models on site. Contractor 'head office' information would be able to be brought to site using better communication links. Site communication would be able to use wireless networks to control transmission of information around site. The following stage is Supplier Management. ICT is able to provide communications infrastructure between suppliers and contractors. Project planning information can be shared electronically with suppliers direct from planning systems. Electronic order and payment management are also some of ICT benefits.

A typical construction supply chain process usually involves an ad hoc team of different firms, each of which will only deal with a certain aspect of the project. Very often, each firm would only be interested in improving their own activity. This is one of the reasons why many of the currently available ICT applications are directed at a single activity, such as drawing production or cost estimation. The construction supply chain process will result in a unique product e.g. a specific building for a specific context of site conditions and client's requirements (Sun, 2002). The use of collaborative ICT would definitely create a good sharing information environment. And since there are a lot of different teams working together in the supply chain, this environment would definitely create a better understanding and communication interaction between all parties involved.

Collaborative ICT relationships in the construction supply chain in general have a number of advantages. They include being able to develop and provide a good background for improved production control within each contractor and supplier in the supply chain; giving a better and clearer understanding between all parties involved and having the ability to manage their resources across project, as well as creating a good information-sharing environment. The exchange of information between the various parties involved in the supply chain is a vital issue. This is because information sharing is the most important thing in the construction process in enabling the project to progress effectively.

The progress of ICT in the construction industry and the use of integrated and collaborative ICT systems in the process of planning, evaluation and construction phases have brought about great benefits to the industry. Implementing a dedicated and fully integrated construction management system enables the members in the construction supply chain to gain significant competitive advantages. A reduction in travel demand, which indirectly lessens air and noise pollution, a cost reduction for both the client and themselves and greater business efficiencies are three of the advantages offered by ICT. Other benefits range from better communication and understanding between members of the team to an in crease in profitability and an on-time or often early completion of projects. Eventually, all these will lead to overall customer satisfaction and better environment.

3.3 The Readiness of the Industry

3.3.1 Assessment

A set of assessment tables have been designed as an assessment tool in assessing the effectiveness usage of ICT and being able to identify the current level of awareness and readiness of the organisations to accept ICT along the construction supply chain process. Selected samples are to select the most relevant descriptions which fit their firms' current level of application based on the assessment categories below. The various selection of degree of ICT application may be further explained by *Appendix B*.

Category 1: Level of ICT usage in the organisation

A.	ICT applications exist mainly in financial operations, i.e. within financial developments
B.	ICT application is being concentrated in financial operations, but steps are also being taken in using ICT for some business activities such as using standalone word processing systems, spreadsheets, etc. No exchange of information is performed between your organisations and others.
C.	Organisation has started using specific in-house I.S. / ICT systems applications in support of core business functions such as using RIPAC for the preparation of Bills of Quantities and CAD in designing.
D.	Organisation is implementing E-business techniques across the supply chain; i.e. e-tendering, materials can be ordered online with the use of internet.

Category 2: Level of ICT infrastructure in the organisation

A.	ICT applications are independent and unconnected within departments, i.e. each department are using different types of software applications according to their own needs whereby there is no means of sharing information across organisations.
B.	Organisation has implemented commerce-enabled extranets, in establishing and maintaining a one to one relationship with other organisation and clients at very low cost through the web. Project information can be shared and exchanged between supply chain members via the internet.

Category 3: Level of ICT awareness and training in the organisation

A.	Organisation is still not willing to change and is comfortable with the traditional method of running their core business functions manually.
B.	Organisation is realising the needs of ICT to support their core business functions, BUT they are only focusing on individual skills needed for individual projects.
C.	ICT applications are not only seen as a support to their core business functions, but are also seen as a strategic advantage for the organisation to stay competent in the construction industry, i.e. the usage of virtual reality, interactive web-sites, videoconferencing and others.

Category 4: Level of ICT as a communication tool in the organisation

A.	ICT applications such as electronic messages are being used extensively via the organisation's intranet; i.e. team leaders are able to communicate with supply chain members easily.
B.	Organisations in the construction supply chain are using electronic mail via the organisation's intranet in order to share and exchange information within the organisation.

Category 5: Level of ICT in the coordination of data and storage

A.	The ICT applications implemented are still not properly coordinated throughout the organisation; sometimes the purpose, function and data stored are still overlapping.
B.	Some old-developed systems are still being used in uncontrolled, uncoordinated manner even though new systems are centrally developed, installed and operated by ICT functions.
C.	There is a central project database to be used by members of the construction supply chain (database maintained with proper systematic referencing, etc)

Category 6: Level of ICT in the management support system in the organisation

A.	Organisation is developing decision support systems (DSS) and executive information systems (EIS) for the use of senior management.
B.	Organisation is successfully using knowledge management systems (KMS) to manage organisational learning and business know-how, i.e. organisations relying on internet or intranet web sites, knowledge bases and others as key technologies for gathering, storing and distributing business knowledge.

In assessing the organisation's current level of ICT readiness, an analysis is made of the result obtained from the categories of assessments. This is elaborated in Appendix B. For example, if the user selected option A from category 1, option A from category 2 and also option A from category 3 and they either select the column *don't agree* or *don't know* from categories 4, 5 and 6, then the current level of ICT readiness can be classified as Level 1.

LEVEL OF ICT READINESS	DESCRIPTION OF LEVEL
Level 1	• The organisation only uses ICT for financial operations and according to each group's needs in isolation of the rest of the organisation. • Has limited understanding of the value and potential of ICT
Level 2 *Occasional*	• An increase of ICT application systems being developed but concentration is still more on operational systems. • Many of the ICT application systems still overlap in purpose. • There is a possibility of network sharing between groups. • All data are stored in units' systems, except data needed for organisational reporting are transferred to central systems.
Level 3 *Responsive*	• In-house ICT applications covering most major operations areas with office automation exists but in an isolated stand-alone manner. • Technical infrastructure consists of unconnected systems where no shared applications exist. • Some ICT applications have been put together by users, and old user-developed systems are being used in uncontrolled, uncoordinated manner even though new systems are centrally developed, installed and operated.
Level 4 *Planned*	• All needed operational ICT is mostly in place and some DSS start to appear. • Office automation of an organisation is integrated and standardised organisation-wide. • Existence of an organisation-wide network, where all groups are connected and the central ICT function provides communication services for all groups in the organisation. • Central coordination in the use of ICT throughout the organisation. • Shared applications and information systems are being utilised
Level 5 *Strategic*	• Strategic ICT applications are developed with external-oriented data along with DSS and EIS. • New systems intended to provide strategic advantages to the organisation and supply chain, where ICT is used to add value to organisational end-product or services. • Most systems are decentralised but with central coordination and control. • DSS and EIS systems are developed for the use of senior management.
Level 6 *Integrated*	• Using inter-organisational systems with outside entities (government, suppliers, etc), with the use of Internet and e-commerce technology. ICT is integrated with all the supply chain members and other business partners. • Intranet provision improves effectiveness. • No geographic constrains on the provision of information. • Existence of diverse hardware architecture according to each member's needs. • GSS and KMS systems are developed and successfully used.

Table 3.3: The description of levels of ICT (Saleh, 2002)

From the categorisation and assessment, scenarios may be built. For instance a Highly Optimistic Scenario is a situation whereby half (30 percent) of the trips are related to exchange of digital information that could be transmitted and disseminated via the inter- and intra-net, and firms having very high acceptance towards application of CSCM and CDD; therefore can be wholly substituted by utilisation of CSCM and CDD. The scenarios reflects an advanced state of technological awareness and readiness to apply ICT in the industry, possibly 50 years from now. The same method is applied for the different scenarios, each with their own characteristics and conditions governing the rate of trip substitution as a result of ICT applications within the individual firms.

Three different organisations in the construction supply chain were given the assessment categories (1 to 6) to determine their level of ICT readiness via electronic mail. Each organisation was assessed according to six categories, as follows:

- Level of ICT usage in the organisation

- Level of ICT infrastructure in the organisation
- Level of ICT awareness and training in the organisation
- Level of ICT as a communication tool in the organisation
- Level of ICT in the coordination and storage of data
- Level of ICT in the management support system in the organisation

The answers given by each respondent were then compared with the table of indicators as per Appendix B. This can roughly determine their level of ICT readiness.

Case Study 1 : Based on the comparisons made, the research can roughly say that the level of ICT readiness is level two. They are not really ready to integrate ICT throughout the construction supply chain. Although there have been an increase in the number of ICT development in their organisation, but concentration is still on operational systems in the financial area, while only a small number of core business-oriented systems are being developed. Many of the ICT application systems are still overlapping in purpose, function and data stored. Their organisation is realising the need of ICT to support their core business functions, but till now, they are only focusing on individual skill needs rather than using ICT as a strategic advantage to stay competent in the construction industry.

Case Study 2 : Results obtained from the second case study showed that they can be categorised as in level 4. Their operational ICT is mostly in place and there is an existence of organisation wide network, where all groups are connected and the central ICT function proves to provide communication services for all groups in the organisation. The second case study shows that the organisation is well planned in terms of ICT implementation and should be ready to start collaborative ICT between all members of the construction supply chain. Integrated collaborative ICT between the members of the construction supply chain can help to save cost and time as well as producing better end-product through coordinated communication network. Misinterpretation of information that often leads to conflicts can be also be reduced whereby everyone gets the same information at the same time.

Case Study 3 : Results found that organisation three still consists of unconnected systems where no shared applications exist. Systems have been implemented in most operational areas, but the ICT applications are still independent and unconnected within departments and other members. As comparisons are made using the table of indicators, results show that the third organisation can be categorised as Level 3.

3.3.2 Summary

The results from the survey show that there are a variety of ICT readiness levels in the current construction supply chain in the United Kingdom. Some are moving forward towards strategic advantage of ICT implementation, while there are organisations that are still left behind in terms of readiness, awareness and their willingness. The construction supply chain is still lacking in using ICT as a tool in the management support system. They have to work really hard in improving their level of ICT readiness in moving forward towards strategic advantage ICT.

ICT has been seen as an important tool in ensuring good flow of the construction supply chain process. Members in the construction industry have also now realised the need for aligning strategies, people, processes and technologies in their business environment. Implementation of collaborative information technology in the construction supply chain process would definitely be a success if all stakeholders decide to work together as a team.

4 COORDINATED DESIGN DRAWINGS

4.1 Definition

The advantages of computerised design drawings outweighed the advantages of manual/paper-based drawings in many aspects. The respective advantages and disadvantages of paper-based system and the Computer Aided Design drawings are illustrated below:

	PAPER BASED SYSTEM (Manual Drawings)	COMPUTER AIDED DESIGN (Computerized Drawings)
Information Management	• Difficult to retrace drawings • Does not have drawings back up • Accessible by any person (no security on the drawings) • Have to redraw the standards parts and components • Analysis has to be done manually	• Finding drawings in seconds • Backing up important work without risks of deterioration • Preventing unauthorised access to drawings • Accessing libraries on standard parts and components • Computer-aided analysis
Networking Communi-cations	• Does not provide any networking capabilities • Not very effective in terms of project management • Difficult to coordinate progress of the design teams • Less productivity (abortive work)	• Several users at different locations can access the same data or drawings • Managers can continuously supervise and maintain the progress of the project • Different teams can work simultaneously rather than being delayed by one another • Better communication means less abortive work
Editing and Updating Functions	• Have to erase or even redraw the whole drawings • Less accuracy • The drawing scale cannot be changed • Calculation of diameters, perimeters, areas and co-ordinates be done manually • More laborious	• Can edit and automatic update drawings instantly • Greater accuracy • Drawings can be plotted at any scale • Automatic calculation of dimensions, perimeters, areas and co-ordinates • Less laborious

Table 4.1: Differences between paper-based system and the computer aided design system

The compilation of design information from a multidiscipline team of consultants inputted into a single database forms a Coordinated Design Drawings or CDD (AJC Planning Consultants, 2000). Currently, AJC Planning Consultant is undertaking the compilation and coordination of the drawings from other professionals for the preparation of CDD plan (Baharudin, 2003). Information included in the CDD is based on inputs from the surveyor, civil engineer, electrical engineer, architect and landscape architect. Overlaying of design information allows a CDD to identify design issues and conflicts between services prior to construction works.

The application of CDD is one of the tasks that AutoCAD can perform. The application of CDD will further enhance the benefits of CAD. The reason why AutoCAD software is recommended to be used in the production of CDD -instead of other software such as Microstation and MapInfo-, is because most of the drawings prepared by the consultants in Malaysia are drawn using AutoCAD (Baharudin, 2003). Furthermore, even the submission of plans to the local authority is in AutoCAD format. Nevertheless, there are a few consultants, who use MapInfo for drawing purposes. However, the number is small. Thus, based on familiarity and its nation-wide application of the AutoCAD software, it would be recommended that the production of CDD also be done in the AutoCAD format. Appendix C illustrates the various layers of plans that form the final Coordinated Design Drawings.

4.2 Application and Implementation

Studies on planners and architects revealed that cooperation between the design team is vital in realising sustainable development initiatives. This can be done through the production of CDD in the design process (AJC Planning Consultants, 2000). With the ability of CDD, better environment can be planned in manners that promote the idea of sustainable living initiatives as in the case of Kota Kemuning new township development (Baharudin, 2003). However, the implementation of sustainable development initiatives can only reach its prime goal, if all the parties work closely with concerted effort – from the designers to developer and from the government officials administering the community amenities to the residents themselves.

The standardisation and unification of formats for drawings are essential to reduce errors and increase coordination of drawings. As a general rule, standards are not mandatory, but are for voluntary application. However, they can be a determining factor for individual firms to be receptive towards CDD and other ICT applications. Baharudin (2003) in his work has highlighted the input components of professionals involved in producing CDD. They are shown in Table 4.2 overleaf.

Professional Input	CDD elements
1. Surveyor's input	Precomp Plan
2. Town Planner's Input	Overall layout plan Data on the Socio Economic Sector: - Existing Population - Population Projection Data on the Physical Development Sector: - The suitable building height - Green linkages
2. Civil and Structure Engineer's Input	Roads Drainage Traffic Management Water Supply Sewer
3. Mechanical and Electrical Engineer's Input	Power Telephone Street Lighting
4. Architect's Input	Site Plan
5 .Landscape Architect's input	Soft Landscape Hard Landscape
6. Construction Stage- All actors	Construction Materials and Specifications

Table 4.2: The common task of each professional within the design team and CDD elements (AJC Planning Consultants, 2000)

4.3 The Readiness of the Industry

Sustainable development initiative is exemplified by the effort put by the developer (HICOM-GAMUDA Development Sdn. Bhd.) with full cooperation from the consultants as well as support from the local authority (Shah Alam City Council). The developer has made it compulsory for the consultants to prepare CDD throughout the project, in this case study, the Kota Kemuning new township. From the interview conducted with the developer, the officer highlighted that development of Kota Kemuning was made easier with the application of CDD, as it draws up the sequence of job effectively which could avoid problems during construction period.

Since the goal of Kota Kemuning, Shah Alam, is to provide residents with all the conveniences and amenities, with appealing quality life, it is inevitable that the development necessitates thorough and detailed planning and designing. Thus, Kota Kemuning has taken the initiatives by applying CDD in the development process. Photos of the developments are supplied in Appendix D.

It is crucial to get the professionals' opinion on CDD as it will be the basis for the formulation of any efforts towards the development on the application of CDD. In this study, three professional parties have been interviewed, from the public and private sector to the developer's point of view on CDD (Baharudin, 2003). Those are the Shah Alam City Council (SACC), AJC Planning Consultant (project manager), and HICOM – GAMUDA Development Sdn. Bhd. respectively.

SACC has been selected since Kota Kemuning is under SACC jurisdiction. It is, thus, appropriate that the authority's expert opinion on the development of Kota Kemuning be recorded. AJC Planning Consultant is the pioneer of the idea and preparation of CDD. In fact, it is the only planning consultant that applies CDD in its development projects. Moreover, the current user manual, procedure and guidelines on CDD are prepared by the firm. Therefore, input from AJC Planning Consultant is essential. HICOM – GAMUDA Development Sdn. Bhd. has taken the initiative to make it compulsory for all the appointed consultants to apply CDD. Hence, information on the effectiveness of CDD in terms of cost and time formed the basis for selecting HICOM – GAMUDA Development Sdn. Bhd. as a sample.

4.3.1 The Local Authority

In Baharudin's work (2003), an interview was conducted on *Shah Alam City Council* (SACC), the Local Planning Authority for new township of Kota Kemuning. SACC, which was formerly known as Shah Alam Municipal Council, was established in 7th December 1978. This is due to the declaration of Shah Alam as the capital state of Selangor Darul Ehsan. Initially, SACC was fully operational on 1st January 1979. Shah Alam was upgraded from a municipal to city authority on the 10th October 2000. Ever since, the responsibility of SACC has become more significant in shaping the development of Shah Alam. At the same time, it is also reponsible to accommodate the increasing needs of the community, inline with the vision: to *`develop Shah Alam as a beautiful, competitive, and harmony with the environment towards creating a comprehensive community with sustainable development'.*

From time to time, the area of jurisdiction or SACC has increased accordingly. Starting with only 19.68 km^2 in 1960, the area has increased gradually. The latest survey which was conducted on 2nd January 1997, recorded that, SACC covers an area of 290.3 km^2.

Since CDD is initiated by the consultants and developer, the local authority was not well informed on what CDD was all about. SACC, for example, was not aware that CDD has been applied in Kota Kemuning. The reason being, CDD is the own initiatives of the developer with commitment from the consultants whose aims is to develop a more livable and pleasant living environment. Furthermore, CDD currently is not one of the requirements in the application for planning permission. This might be due to the none-existence of standards on CDD which is applicable to all relevant parties in the built environment including the local authority.The local authority only requires the consultants (urban planners) to submit the proposed layout plans. This layout plan needs to comply with the standards and guidelines prepared by Federal Town and Country Planning Department (FTCPD) as well as the local authority's requirements. According to the Town Planning Officer of SACC, the proposed layout plan itself should have actually identified whatever conflicts or disagreements of the alignment and placement of utilities and other facilities.

The proposed layout plan was not in CDD form during the preparation process. As such, for example, when the appropriate alignment and placement of utilities and facilities were due for inspection and scrutinisation, it was difficult for the urban planners to incorporate these into the layout plans. Moreover, coordination and integration of other professionals' drawings into the layout plan have been proved to be difficult due to the absence of CDD application. As a result, contractors will encounter problems during the construction phase. This, somehow will have an effect on the adherence to the project schedule.

4.3.2 Professional Consultants

AJC Planning Consultant is one of the prominent urban planning firms in Malaysia. It offers a wide range of services, from the preparation of development plans, environmental impact assessor to the physical planning and urban design services. Within 10 years, the firm has undertook numbers of development projects, several Structure Plans and Local Plans, National Physical Plan, Bandar Botanic, Valencia, Bukit Rimau, Bukit Jelutung, Kota Kemuning, to name but a few. Amongst the projects, Kota Kemuning, located on the outskirt of the city of Shah Alam, can be considered as the best, as it was awarded the Planning Innovation and Concept Award 2000 by the Malaysian Institute of Planners (MIP).

Believing that *planners is a man with a vision*, much effort has been introduced by the consultants in their development project, with the goal of improving the quality of the living environment. One effort is promoting the use of Coordinated Design Drawing (CDD).

CDD was introduced due to the increasing awareness on the *degradation of the living environment* in the country (AJC Planning Consultant, 2003). In many housing development projects of the last decade, the end products have not really made the residents *happy* in many senses. These are due to the improper planning of the facilities and utilities (except for the high cost housing development). The reason behind the scenario is that, during the period the nation had experienced a rapid economic development, with many new housing schemes being constructed haphazardly to accommodate the increasing population. As a result, the quality of the end products was compromised. Ad-hoc planning of facilities and utilities have created improper neoghbourhoods environment.

Furthermore, in those days, developers were not fully aware of the roles of urban planners. Architects have been holding the most important role as they were the ones who handled and managed the projects, right from the planning stage to the construction stage. The engineers, on the other hand, will handle the engineering part. It was difficult to coordinate the progress of each professional since there were no specific party who are going to oversee and monitor at the project as a whole (Baharudin, 2003).

Accordingly, much effort has been put by the Malaysian Institute of Planners (MIP) in promoting the profession of urban planners, It was only then that developers began to realise the importance of urban planners' roles. Since the architects were only concern about the aesthetic values of their product, and the engineers concern only about the practicality of the product but not on the aesthetic value, urban planners seems to be the most appropriate professionals to manage a project as they are able to look into both aesthetic and practicality of the designs. At the initial stage of the development of wetland in Kota Kemuning, for example, the engineers proposed a concrete drain (practical but not aesthetic). In contrast, the urban planner proposed a wetland (practical and aesthetical). Finally, the developer agreed with the urban planner's proposal and the developer later found out that the wetland did not only reduce the construction costs but could also be utilised for purposes such as recreational and waterfront parks (Baharudin, 2003).

Despite the capability of urban planners, the coordination issues between professionals will still exist if each professional continue to work on their own without considering the requirement of other parties. With the introduction of CDD, the issues pertaining to the *degradation of the living environment* may be dealt with efficiently. CDD conveys to the design team the planner's vision of the project This means that planners will lead the project from the start. Planners need to clearly highlight to the design team what to be achieved after being briefed by the developers and clients. The task of the design team then, is to translate these visions into three dimensional forms. Through CDD, good usage of zoned land can be ensured. For example, if the area is zoned as green areas, that particular area will be properly landscaped without any 'unwanted' elements on it.

CDD does not add extra costs to resources and time. In fact, a project that is not applying CDD may incur even more costs and time compared to those adapting CDD. For example, when a non-CDD project encounters some conflicts during the construction period, the contractors will have to report to the developers and then to the design team to redo the plan. This will definitely consume more time for redrawing of plans. Furthermore, it will also increase the construction costs as the developers may have to eliminate the conflicts and then reconstruct it. Through CDD, these conflicts can be detected and even resolved prior to the construction period.

4.3.3 Developers

HICOM-GAMUDA Development Sdn.Bhd. is one of the renown developers in Malaysia. A joint-venture company, both have been in the *industry* long enough to understand the scenarios of built environment field (Baharudin, 2003). DRB HICOM is one of the leading local companies who has experienced numerous achievements, be it in manufacturing sector or the construction industry. Similarly, GAMUDA Land is no stranger to the built environment field. Over the years, GAMUDA Land has developed numbers of townships. The merging of these organisations for the development project of Kota Kemuning, has resulted in even greater impacts. With both organisations striving towards creating a livable modern township, it is inevitable that Kota Kemuning be the most suitable project to exemplify their objectives. With the application of CDD in this project, it will assist these organisations to reach their targets successfully.

Unlike the town planner's point of view on CDD, the developer's part on CDD will focus on the practicality of CDD. Currently, upon planning approval, the appointed consultants will have to prepare CDD with the supervision of the urban planners. Developers will require each of the consultants to provide their inputs, the engineers with the common infrastructure and local infrastructure, the landscape elements and the overall planning from the urban planners.

Prior to the preparation of CDD, there are a few information needed such as the existing contours, the design level or the ultimate level and the existing road system if any. Based on all the above information, planners will prepare a sketch of the layout plan, and circulate the layout plan to the other consultants (Baharudin, 2003). The engineers will then, include the proposed contours and road system, while the landscape architects will come out with the preliminary landscape design concept. After three meetings between consultants and developer, one portion of CDD will be completed. CDD for a 20 acre-piece-of-land will take about only one week to be completed. Thus, it means CDD actually does not consume time contrary to beliefs that that it would delay or prolong the construction period of the project. Cost wise, the consultants were paid on time charge basis, the longer the preparation of CDD takes, the more the developer will have to pay. Nevertheless, developer is willing to bear the costs on the production of CDD rather then putting more money on the reconstruction of any conflicts during the construction period. Another advantage that the developer gained from CDD was that CDD's ability to smoothen the stages of construction (Baharudin, 2003). Through CDD, developer can easily draw up the flow of the task for each consultant.

So far, CDD has gained positive responses from all the consultants involved in the development of Kota Kemuning. The main reason was firstly, due to the fact that CDD was the developer's requirement. Secondly, it did not consume time and cost. Thirdly, the consultants were in general satisfied with the results of CDD. But most importantly was that the sequence of job or tender have been strictly adhered to. If these factors were not carefully *dealt with* earlier, the whole idea of having CDD would be useless.

It is therefore recommended that other developers to follow the examples set by HICOM-GAMUDA which made CDD compulsory to be prepared by the consultants. But, what needs to be done first is to prepare a comprehensive standard on CDD so that it will be applicable to be used by the other developers.

4.3.4 Summary

Based on the information collected from the private and government sectors, it can be deduced that CDD is a significant tool in improving the living environment quality. The main objective of any town planner in designing the development is to fulfill as many as possible the needs of the community and minimise conflicts between stakeholders. Therefore, CDD will assist them in ensuring a more livable environment. Furthermore, since CDD is able to resolve any conflicts prior to the construction works, it has given a great advantage to the developer to see to it that resources are efficiently utilised with minimal costs. This is because with CDD, developer is able to avoid reconstruction of works which could increase the project cost and possibly delay the project's progress.

5 SUBSTITUTION OF TRIP AND SUSTAINABLE URBAN PLANNING

The construction industry and the field of built environment are two major sectors contributing to the physical development of the countries, both in the UK and Malaysia. In the case of Malaysia some 5,000 firms are registered with the governing bodies. The nature of their jobs include attending meetings and discussions with the agencies or the authorities, meetings and discussions with their counterparts and most importantly those with their clients.

It may be assumed that for a development project with a lifespan of one year, many trips will be generated by these professionals as a result of the above face-to-face meeting requirement. Based on Appendix A, the professionals will be required to attend meetings, be involved in discussions and up-dating their plans and proposals which required face-to-face meeting prior to the applications of CSCM and CDD.

Based on the assumption that journeys have to be made by these professionals in the absence of these technologies, one may further assume that the number of trips made are positively correlated with the number of professionals involved and the number of meetings or discussions or exchanging the up-dated plans and reports. Based on Appendix A, the calculation for a ywar's project would require professionals working for individual firms to make a trip per week for whole project duration, say a year. For a cluster of 7,000 professionals working in some 2,500 firms handling one project per annum and each project requiring them to communicate face-to-face and travel once a week, it may assumed that some 130,000 trips were to be generated. Using different scenarios as proposed in Syaed Khuzzan Al-Habshi (2002), calculations on the number of trips reduction may be made if an assumption is made that these trips could be substituted by ICT applications such as CSCM and CDD. The scenarios are categorised into six, reflecting the different levels of readiness for ICT application and implementation:

The calculations are illustrated by the following Table 5.1:

Level Of ICT Readiness	Percentage Of Potentially Substituted Trips	Total Substituted Trips
Level 1 + (Resistance scenario, needs 50 years to fully adapt to ICT)	1	1,300

Level 2 *Occasional+* (Highly pessimistic scenario, needs 30 years to fully adapt to ICT)	3	3,900
Level 3 *Responsive+* (Pessimistic scenario, needs 20 years to fully adapt to ICT	5	6,500
Level 3 *Responsive* + (Moderate scenario, needs 10 years to adapt to ICT	10	13,000
Level 4 *Planned* + (Optimistic scenario, needs 5 years to adapt to ICT	20	26,000
Level 5 *Strategic+* (Highly optimistic scenario, needs 2-3 years to fully adapt to ICT	30	39,000
Level 6 *Integrated* + (Ideal scenario, can immediately adapt to ICT)	50	65,000

Table 5.1: Scenarios of potential substitution of generated trips as a results of ICT applications amongst built environment professionals in Malaysia.

The estimated figures may be used to further project the number and rates of reductions in vehicle emissions and other polluting impacts be them quantifiable or non-quantifiable. However, these are not within the realm of this study. It is also recommended that up-dating of information on the number of firms and the development planning and construction activities be carried so as to reveal a more reliable and valid estimation of the real impacts that ICT have on the industry.

Additionally, the utilisation of ICT applications such as CSCM and CDD also promotes better planning for the environment of the new townships. The example of Kota Kemuning and UK showed that the adoption of CDD and CSCM as tools for integrating or coordinating technical/design drawings brought some new perspective towards the management of the public and semi-private spaces in the residential areas. In effect, these have been the very purpose of urban planning, i.e. to enable for the provision of integrated infrastructure and amenities to physical development such as these and to reduce conflicts resulted by the various interests and professionasl involved in the planning, development and construction of projects.

6 CONCLUSIONS

The surge of information and communication technologies have been received with mixed feelings by the built environment community. This minute and limited study illustrated the awareness, acceptance and utilisation levels of ICT in two countries with contrasting background and circumstances. Examples of the construction industry in the UK and new township development in Malaysia have illustrated these. Whilst the study revealed that some of the professionals, authorities and clients indicated strong willingness of acceptance and applications of ICT in both the construction industry and urban planning practices, these were conditioned by the current states of available hardwares and the utilisation of certain software which are in compliance with others used by rest the players in the industries. In the case of CDD, the AutoCAD software application in firms or organisation and the existence of nationally recognised standards for CDD are important factors in determining the level of applications of these concerted and coordinated efforts of multi-layering of technical drawings. A pro-active approach taken by the developer HICOM-GAMUDA requiring submission of coordinated drawings to the authority also contributed to the success of the project (Baharudin, 2003).

The clear messages conveyed by this paper, however, are that ICT applications do open up new platform for integration and coordination of the professionals' outputs, be it in terms of information sharing or on-line discussions and decision makings. Furthermore, the scenarios building of the potential substitution of trips generated, as a result of the conventional method face-to-face meeting, has illustrated how some of the reduction in trips may contribute towards better and healthier living environment. Additionally, with CSCM and CDD as support tools to coordinate judgemental disparities and conflicts amongst the professionals, more new townships and building constructions will be undertaken in environmentally friendlier manners leading to more sustainable built environment (Baharudin, 2003 and Syed Khuzzan Al-Habshi, 2002).

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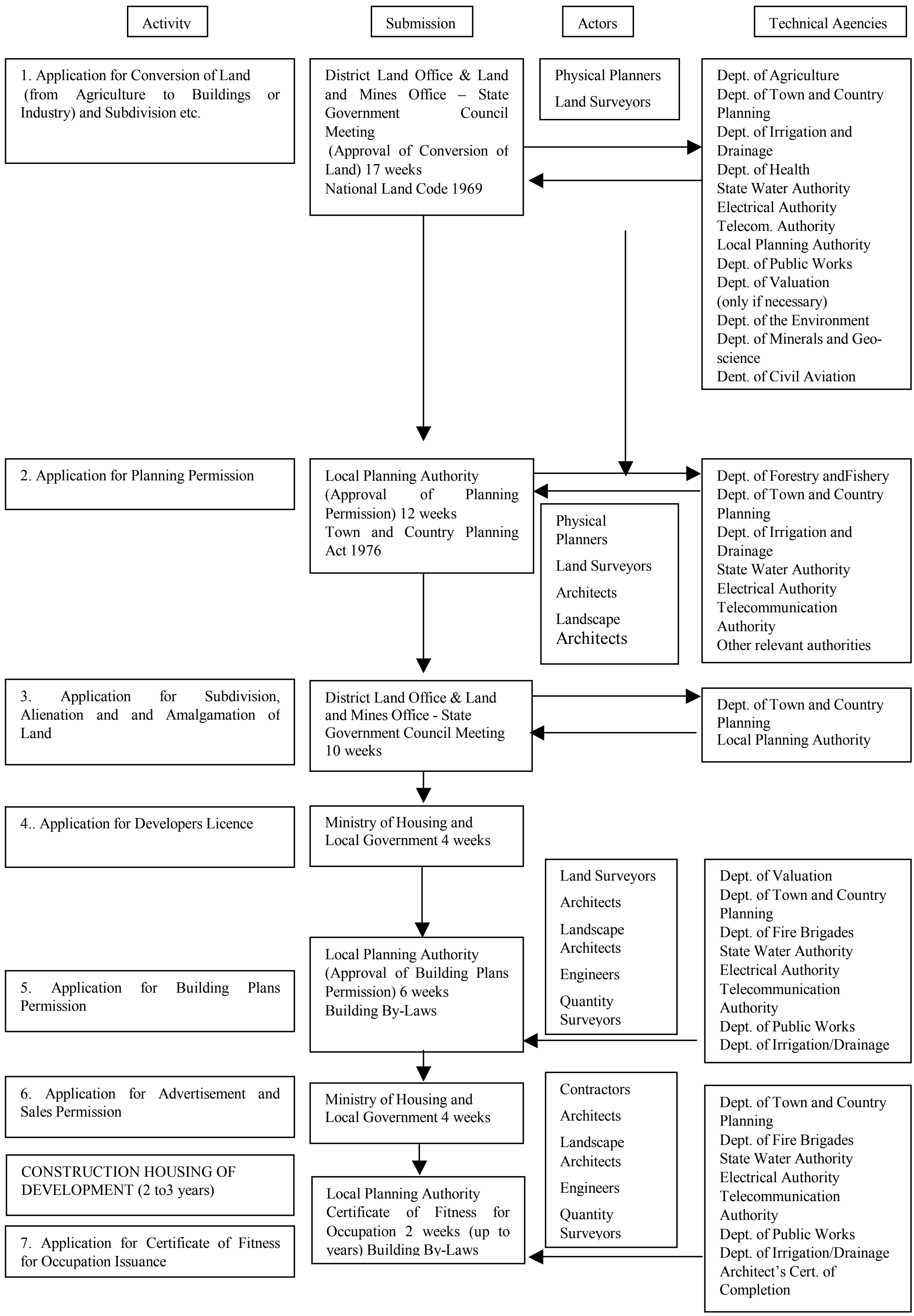

Appendix A: A Typical Planning and Building Layout Application Process (Federal Town and Country Planning Department, 2000)

Table 1: Level of I.T. usage in the organisation

Description	Strongly Agree	Agree	Don't Agree	Don't Know
E. I.T. applications exist mainly in financial operations, i.e. within financial developments				
F. I.T. application is being concentrated in financial operations, but steps are also being taken in using I.T. for some business activities such as using standalone word processing systems, spreadsheets, etc. No exchange of information is performed between your organisations and others.				
G. Organisation has started using specific in-house I.S. / I.T. systems applications in support of core business functions such as using RIPAC for the preparation of Bills of Quantities and CAD in designing.				
H. Organisation is implementing E-business techniques across the supply chain; i.e. e-tendering, materials can be ordered online with the use of internet.				

Table 2: Level of I.T. infrastructure in the organisation

Description	Strongly Agree	Agree	Don't Agree	Don't Know
C. I.T. applications are independent and unconnected within departments, i.e. each department are using different types of software applications according to their own needs whereby there is no means of sharing information across organisations.				
D. Organisation has implemented commerce-enabled extranets, in establishing and maintaining a one to one relationship with other organisation and clients at very low cost through the web. Project information can be shared and exchanged between supply chain members via the internet.				

Table 3: Level of I.T. awareness and training in the organisation

Description	Strongly Agree	Agree	Don't Agree	Don't Know
D. Organisation is still not willing to change and is comfortable with the traditional method of running their core business functions manually.				
E. Organisation is realising the needs of I.T. to support their core business functions, BUT they are only focusing on individual skills needed for individual projects.				
F. I.T. applications are not only seen as a support to their core business functions, but are also seen as a strategic advantage for the organisation to stay competent in the construction industry, i.e. the usage of virtual reality, interactive web-sites, videoconferencing and others.				

Table 4: Level of I.T. as a communication tool in the organisation

Description	Strongly Agree	Agree	Don't Agree	Don't Know
C. I.T. applications such as electronic messages are being used extensively via the organisation's intranet; i.e. team leaders are able to communicate with supply chain members easily.				
D. Organisations in the construction supply chain are using electronic mail via the organisation's intranet in order to share and exchange information within the organisation.				

Table 5 Level of I.T. in the coordination of data and storage

Description	Strongly Agree	Agree	Don't Agree	Don't Know
D. The I.T. applications implemented are still not properly coordinated throughout the organisation; sometimes the purpose, function and data stored are still overlapping.				
E. Some old-developed systems are still being used in uncontrolled, uncoordinated manner even though new systems are centrally developed, installed and operated by I.T. functions.				
F. There is a central project database to be used by members of the construction supply chain (database maintained with proper systematic referencing, etc)				

Table 6 Level of I.T. in the management support system in the organisation

Description	Strongly Agree	Agree	Don't Agree	Don't Know
C. Organisation is developing decision support systems (DSS) and executive information systems (EIS) for the use of senior management.				
D. Organisation is successfully using knowledge management systems (KMS) to manage organisational learning and business know-how, i.e. organisations relying on internet or intranet web sites, knowledge bases and others as key technologies for gathering, storing and distributing business knowledge.				

Assessing the organisation's current level of I.T. readiness

After interviewing the user and from the result obtained from the table of assessments, a table of indicator would help in classifying the current levels of I.T. readiness for each organisation. For example, if the user selected option A from table 1, option A from table 2 and also option A from table 3 and they either choose don't agree or don't know from table 4, 5 and 6, then the current level of I.T. readiness can be classified as level 1.

Table Indicator for Level 1

Table 1	Table 2	Table 3	Table 4	Table 5	Table 6
A	A	A	-	-	-

Table Indicator for Level 2

Table 1	Table 2	Table 3	Table 4	Table 5	Table 6
B	A	B	-	A	-

Table Indicator for Level 3

Table 1	Table 2	Table 3	Table 4	Table 5	Table 6
B C	A	B	-	A B	-

Table Indicator for Level 4

Table 1	Table 2	Table 3	Table 4	Table 5	Table 6
D	-	-	A	C	-

Table Indicator for Level 5

Table 1	Table 2	Table 3	Table 4	Table 5	Table 6
D	B	C	B	C	A

Table Indicator for Level 6

Table 1	Table 2	Table 3	Table 4	Table 5	Table 6
D	B	C	B	C	B

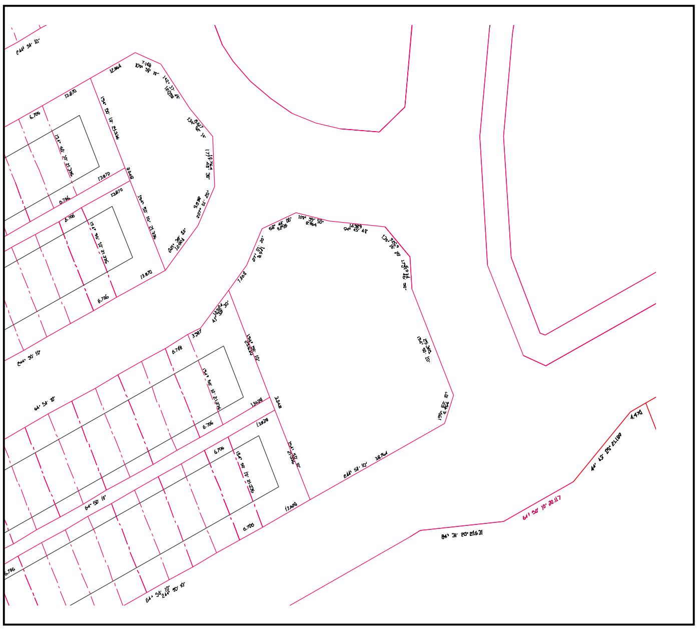

Figure 4.1: Input from Surveyor

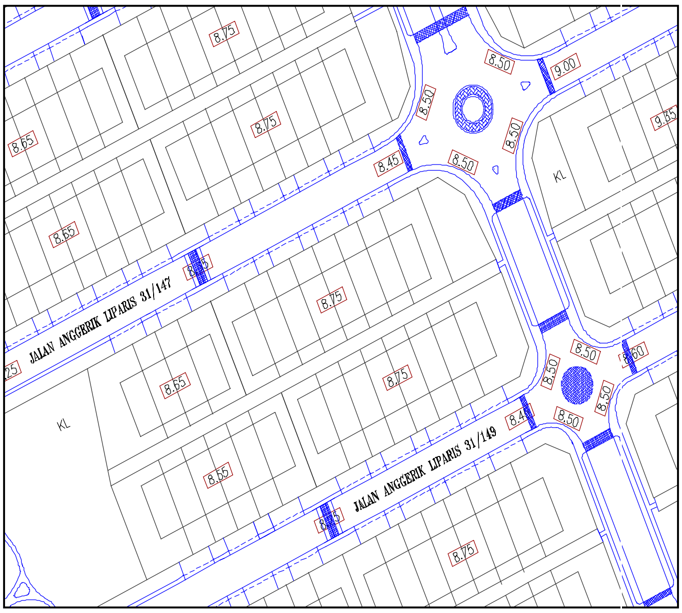

Figure 4.2: Input from Civil Engineer on road

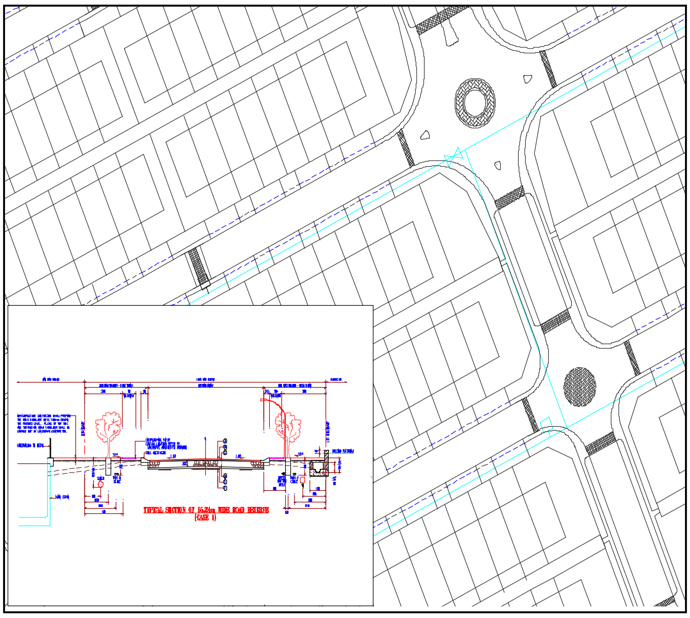

Figure 4.3: Input from civil engineer

- Drainage plan

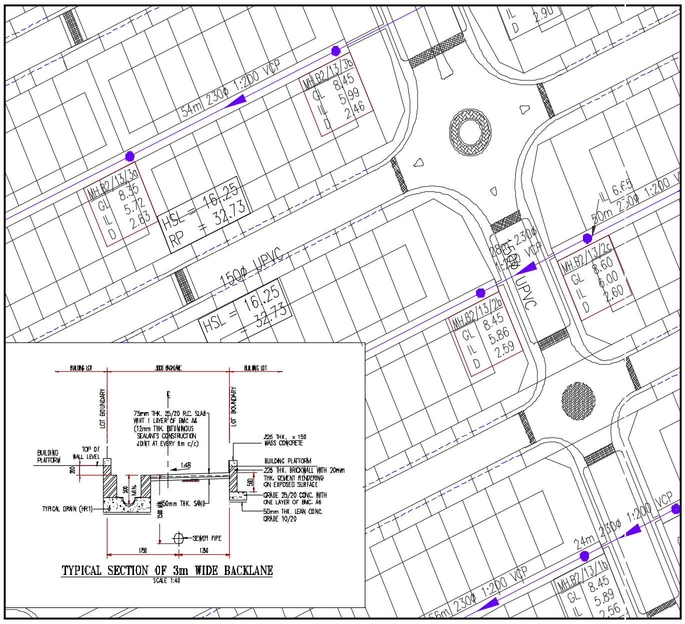

Figure 4.4: Input from civil engineer

- Traffic management

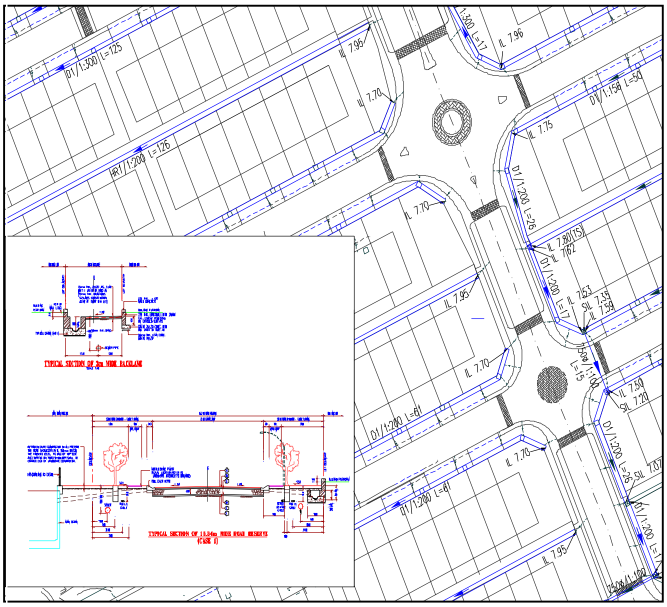

Figure 4.5: Input from Civil Engineer on Drainage

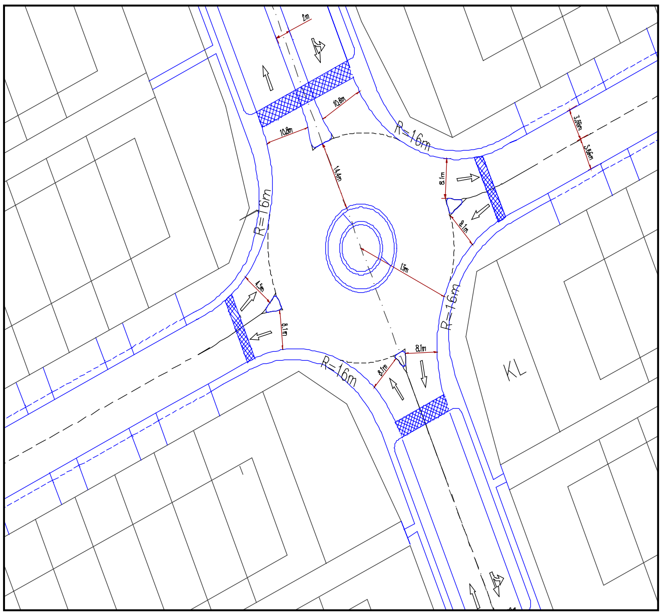

Figure 4.5: Input from Civil Engineer on Traffic Management

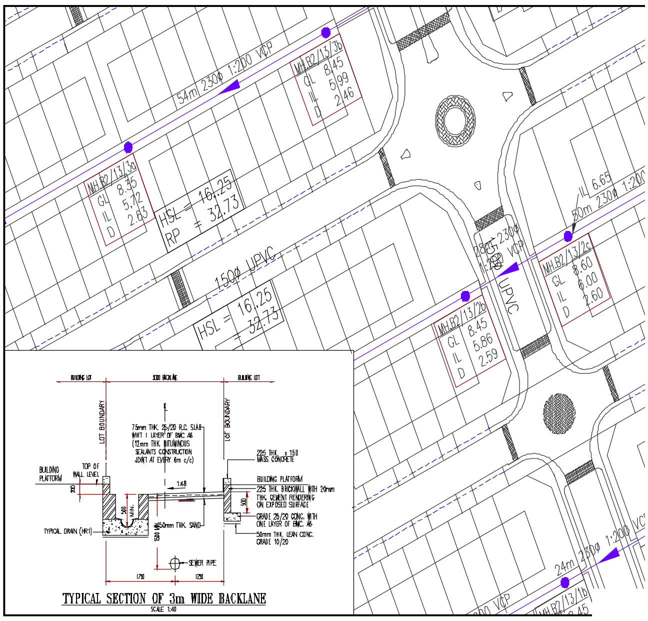

Figure 4.7: Input from Civil Engineer on Sewer

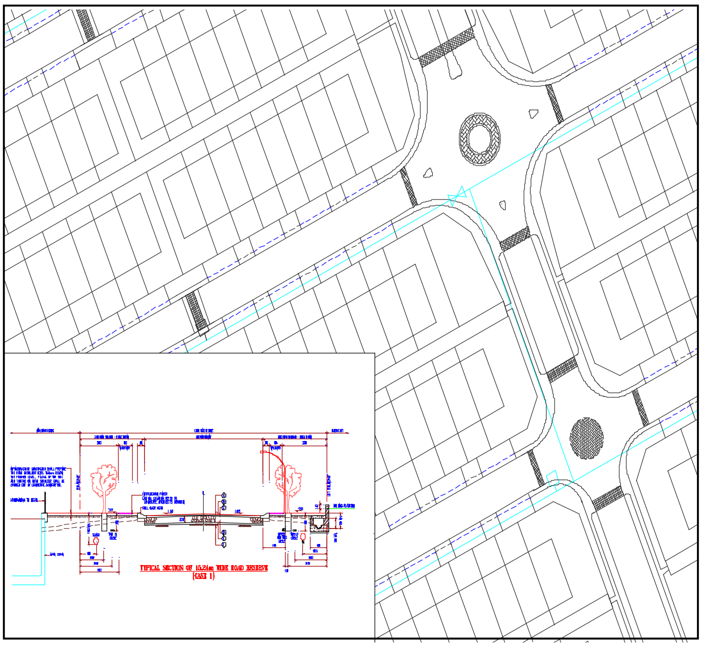

Figure 4.8: Input from Civil Engineer on Water Supply

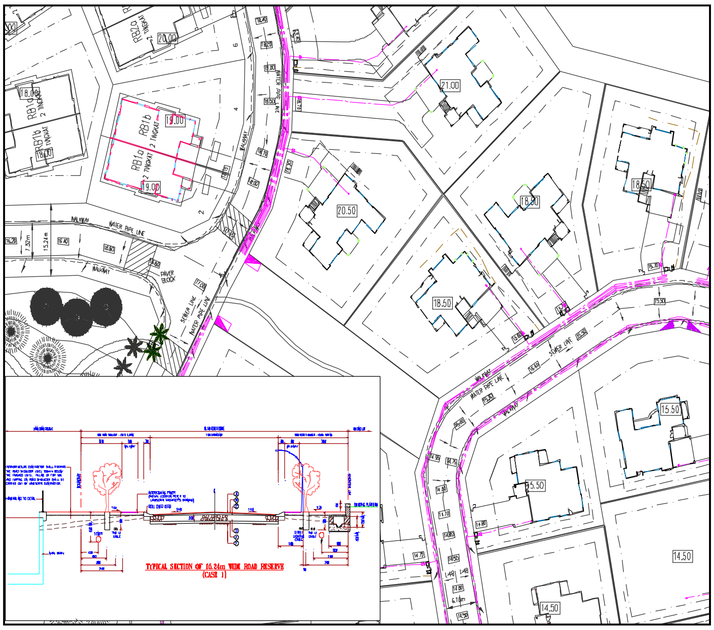

Figure 4.9: Input from Electrical Engineer on Power Supply

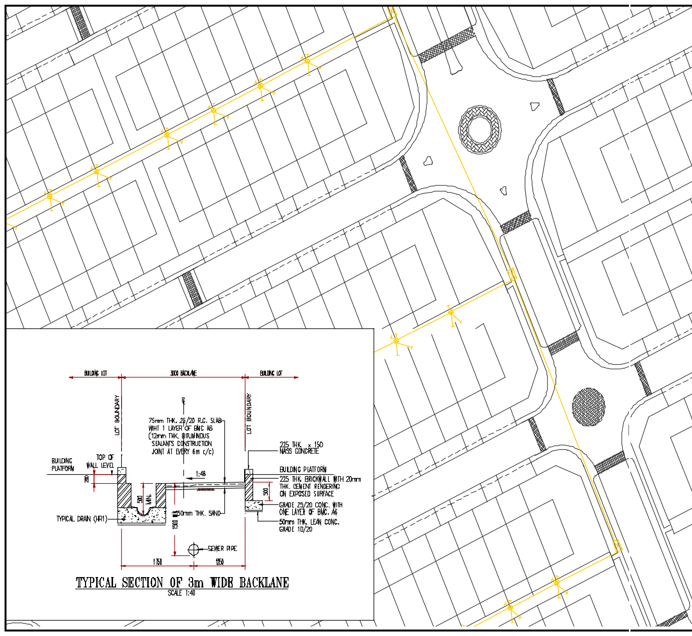

Figure 4.10: Input from Electrical Engineer on Telecommunication

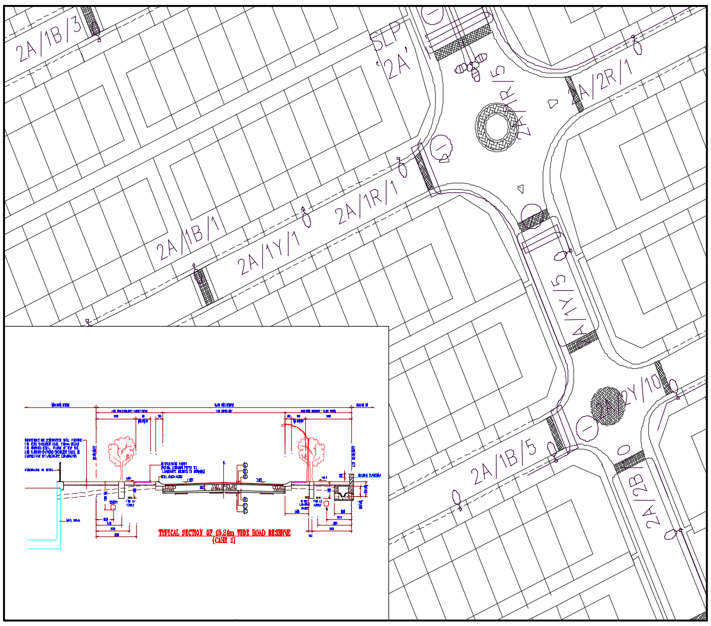

Figure 4.11: Input from Electrical Engineer on Street Lighting

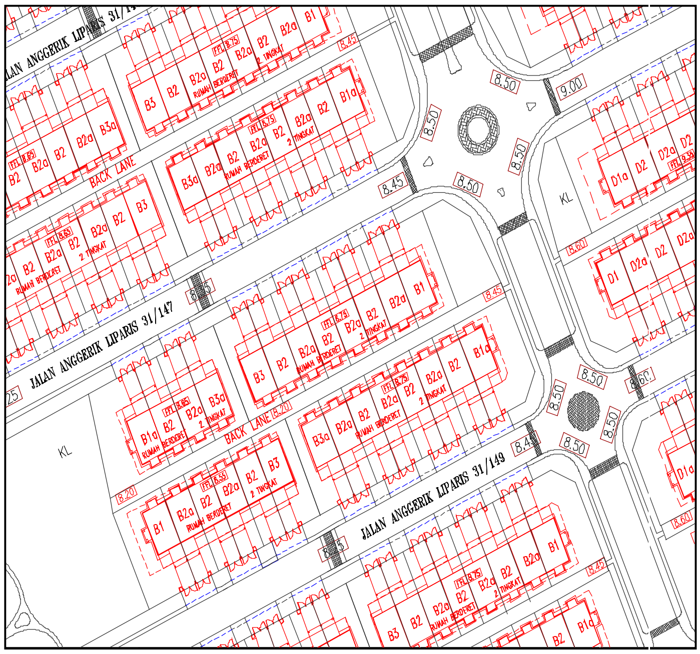

Figure 4.12: Input from Architect on Site Plan

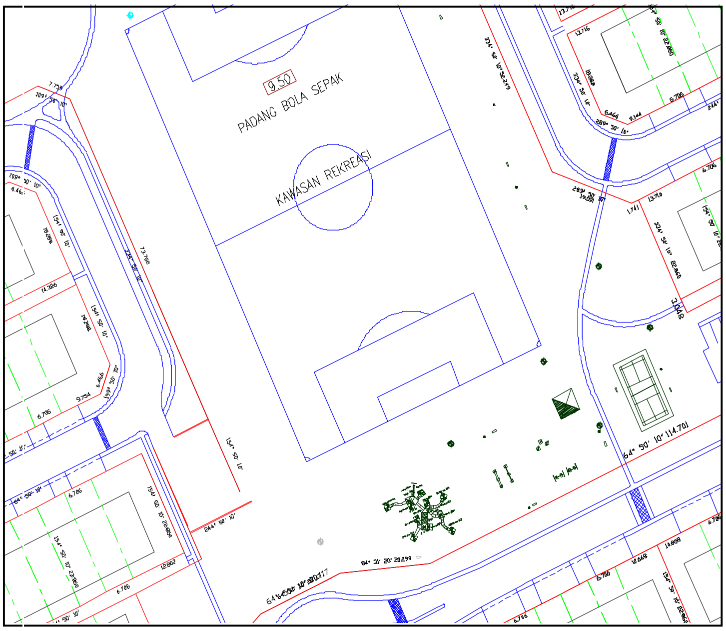

Figure 4.13: Input from Landscape Architect on Hardscape

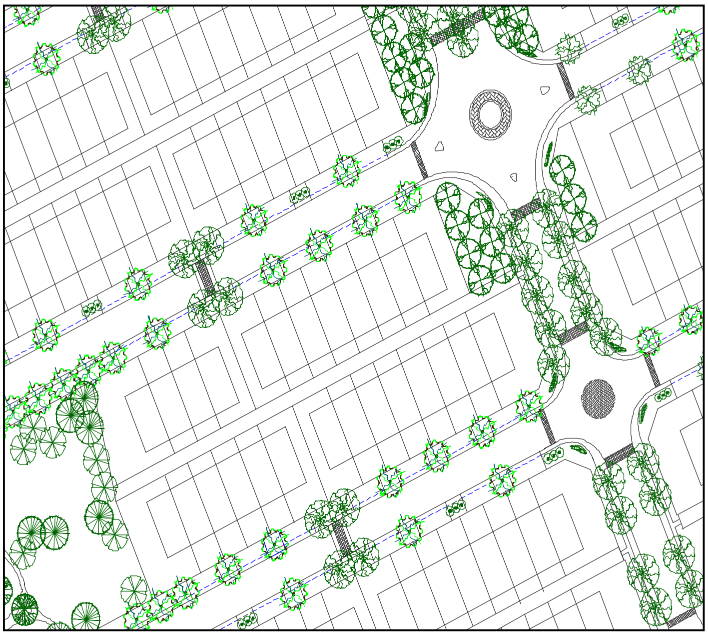

Figure 4.14: Input from Landscape Architect on Softscape

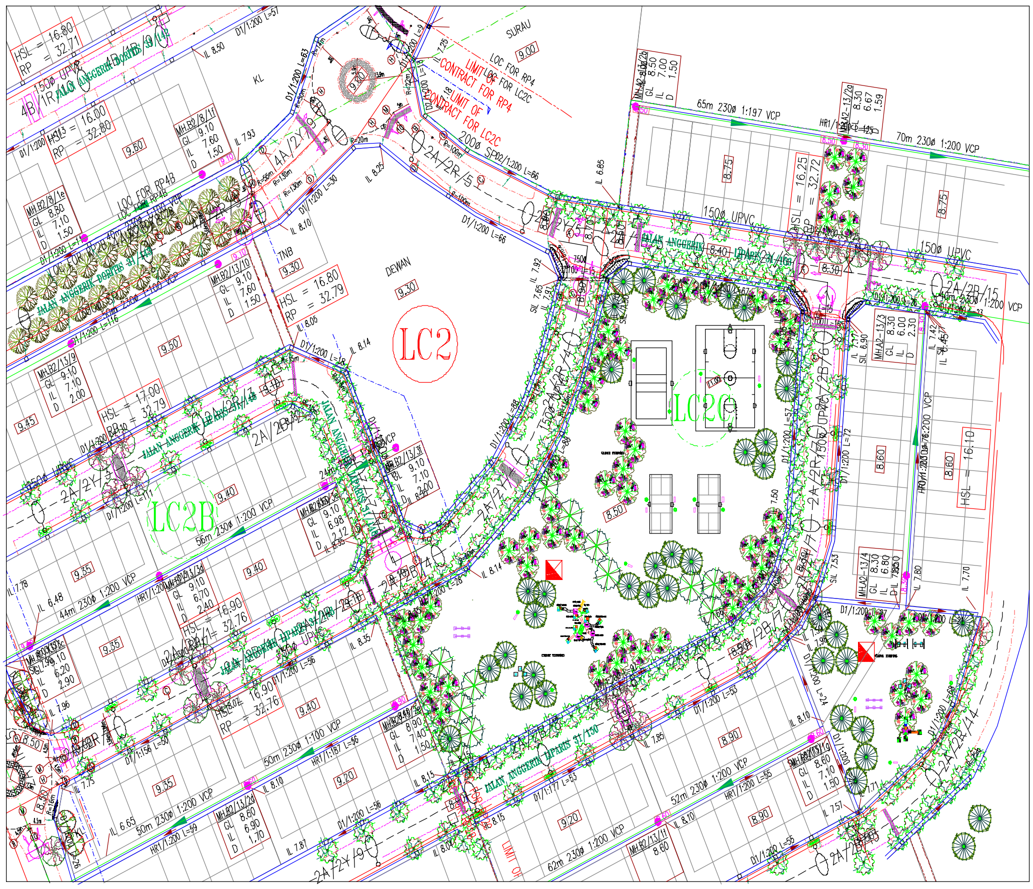

Figure 4.15: Example of a completed CDD plan

Source: AJC Planning Consultant, 2002