VISUAL BASIC APPLICATION IN BUILDING COST ESTIMATION AND SCHEDULING OF A RESIDENTIAL BUILDING IN PRIMAVERA

A PROJECT

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CERTIFICATE

This is to certify that the work which is being presented in the project title "VISUAL BASIC APPLICATION IN BUILDING COST ESTIMATION AND SCHEDULING OF A RESIDENTIAL BUILDING IN PRIMAVERA" in partial fulfilment of the requirements for the award of the degree of Bachelor of technology and submitted in Civil Engineering Department, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by Aditya Chauhan(121666) and Vaibhav Munjal (121675)during a period from July 2015 to JUNE 2016 under the supervision of Mr. SANTU KAR (Assistant Proffesor), Civil Engineering Department, Jaypee University of Information Technology, Waknaghat.

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ABSTRACT

Visual basic applications are becoming increasingly popular in solving engineering related problems. Among the strong features of spread sheets are their instinctive cell-based structure and easy to use capabilities. Excel, for example, is a powerful spread sheet with VBA robust programming capabilities that can be a powerful tool for civil engineering concepts. Visual basic application can do basic calculations such as cost estimates, schedule and cost control, and mark-up estimation, as well as structural calculations of reactions, stresses, strains, deflections, and slopes. Spread sheets can solve complex problems, create charts and graphs, and generate useful reports. This project highlights the use of Excel spread sheet and VBA in civil engineering concepts and creating useful applications. The focus is on concepts related to construction management and building cost estimation using CPWD schedule of rates and to develop a user friendly cost estimation model that can help in estimating cost with reduction errors encountered during manual cost and reduction in time so that estimate can be delivered in no time. This project helps us to incorporate the basic concept of estimation with the help of excel and visual basic application. They need to therefore have an idea about the project construction costs, the time required to finish construction of a project in its conceptual phase, and about the implementation of feasibility study. Because due to associated risks, construction cost estimates and schedules are vital to any project. The research's objective is to develop a methodology that can be used to create an integrated computer model using Visual Basic Applications that helps owners and designers generate construction cost estimates, and derive the baseline schedule for any proposed building project in primavera at its feasibility stage.

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ABBREVATIONS

- **VBA**:Visual basic application

- **CIEPM**: Computer Integrated Enterprise Project Management

- **BCIS**: Building Cost Information System

- **WBS**:Work Break Down Structure

- **OBS**:Organization Break Down Structure

- **EPS:** Enterprise project schedule

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Through this PROJECT, we aim to introduce a generic computer aided building cost estimation model based on functional elements for construction sector projects which will be used in feasibility and schematic design phases using excel and VBA coding and scheduling to be done using primavera. The research design was based on the building functional elements method and a building cost estimation model based on functional elements works on a cost database was suggested. Underlying principles and basic steps of cost estimation based on functional elements was explained by means of computer-based cost estimation process. In order to automate the manual building cost estimation process, the software based on functional elements was developed. The software is currently in the testing phase and is being used for educational purposes. Making use of both public sector and current market prices in the cost estimation process, increasing number of projects stored in the database for more accurate results, estimating costs of different types of projects and estimating the structural functional element percent more precisely are suggested for future research. As the number of the similar projects in database is increased, the accuracy of the cost estimation is also increased. Estimators and graduate students can use the software to estimate building cost of residential projects in feasibility and schematic design phases.

It is primarily a visualization tool, which has improved the ability to exchange complex ideas among project participants. It has become easy to generate and reuse the information for construction projects. This is a 'CIEPM' (Computer Integrated Enterprise Project Management) concept which allows the meaningful extraction of project management data, information and knowledge from the participants beyond their imagination. A number of viewpoints have been given by the researchers to the practitioners for adopting this new technology for their own benefits.

1. 2. NEED OF STUDY

As the industrial development directly affects the construction sector, the projects are getting more complicated and their scales are getting larger. Hence it is getting more difficult to complete the projects within quality standards, budgeted cost limits and on time. The risk and uncertainties met by managers during the construction process result in some difficulties, thus the decisions to be taken may be delayed. One of these difficulties is caused by the lack of cost data whenever needed and in demanded quality Primavera products are the project management standards for the detailed planning and precise control of short-duration, high-

intensity plant shutdowns in industries such as Construction, petroleum, chemicals and utilities. Demanded quality. However, building cost estimation is an important issue due to the incomplete nature of the project data in the schematic design phase.

These are the basic steps for any estimation model and estimation are:

- Collecting building construction cost data.
- Processing data and transforming it into building cost information.
- Storing and retrieving the cost data and information.
- Connecting private and public sector data as well as information through a database.
- Saving time and minimizing mistakes, by avoiding reproduction of the information that has already been stored somewhere in the sector.
- Estimating schedule using primavera and detailing

Almost every construction company has its own computer. It has become a powerful tool for those who use it. The problem is that many builders don't take time to use this great technology. Many large construction companies are set up with estimating programs and integrated systems that cost thousands or even tens of thousands of dollars to purchase – more money than most small-to-medium size builders can afford. However, there are inexpensive ways to do computer estimating. One way is to use computerized spreadsheets which have the power of programs costing thousands of dollars..

The benefits of having computer spreadsheets are :

- They are in expensive
- They are easy to use
- They can be customized as per requirement anytime

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1.3. OBJECTIVE

- To study the use of Visual Basic Application in construction projects.
- To estimate the cost of a residential building using Visual Basic Application.
- To prepare a schedule of construction program of residential building using Primavera.

1.4 PROJECT SCOPE

Successful estimates are the lifeblood of a project. Accurate quantities and costs are needed for strong cost controls. To be a good estimator, a person must study and practice sound principles of estimating. Computers have greatly changed the way estimators prepare estimates. Computers and soft- ware packages, if used properly, can increase the productivity of the estimator while decreasing errors. Estimating soft- ware includes spread sheet packages such as Excel, estimating software such as Timberline, and take-off packages, such as On-Screen Take-off**.** This includes defining the scope of work, scheduling the bidding activities, and assigning the activities to the members of the estimating team. Calculate the scheduled completion of a project using primavera and linking various activities through multiple and several types of relationships. To study data from HPPWD departmentregarding a residential building create a data base system through primavera that allows us to estimate quickly and correctly the total duration of project.

Computers have greatly changed the way estimators prepare estimate time required to complete the project. Computers and soft- ware packages, if used properly, can increase the productivity of the estimator while decreasing error

1.5 METHEDOLOGY:

Setting up a computer spread sheet is much the same as doing an estimate by hand. It takes a little longer to set up the first time, but once it's created, all of the estimates that you do afterwards can be done in a fraction of the time. Once your estimating spreadsheet is set up, you only need to enter quantities for materials and labor. Many quantities can be automatically calculated by formulas that you create. Line items on an estimate can be automatically extended, totals calculated, and summaries given. When price changes occur, they can be easily updated on your spreadsheet. Preparing cost estimates and baseline schedules heavily depend on data; therefore data collection has to be carried out to develop the proposed model. Since the collected data of actual projects previously constructed is not sufficient to cover all project types, published data is the only remaining alternative. Therefore, all the data used in this research is

collected from 2011 CPWD schedule of rates, in this schedule of rates all rates are given in per sq. Metre and needs to be multiplied by plinth area and some services need to be multiplied by length as these services rates are in per metre.

So These approaches vary from one to the other. They are dependent on the availability of information from similar projects built in the past and the experience of the estimators and schedulers who are dealing with these methods. The steps involved in designing a cost and time model are determined by 1- categorizing owners and investors main goals during the feasibility stage of construction projects, 2- collecting all necessary data, 3- identifying the components needed for the cost and schedule models This research considers that the accuracy of estimating project cost is a major aim during the feasibility stage of a project, also particularly to have an idea about the budget required to implement and finish the project. This accuracy differs from one estimator to another based on experience levels, a factor which plays an important role in construction management. On the other hand, the levels of accuracy and quality are not always stable because these indices fluctuate depending on different factors, such as: project scope, project complexity, project environment and management attributes. This model provides for a substantial level of accuracy when a feasibility study is being undertaken

CHAPTER 2

LITERATURE REVIEW

2.1: GENERAL

Through are thorough research on the current topic, we were able to design a user friendly database entry system. The research parameter included the following research papers:

1. Visualisation of repetitive construction techniques in excels by Jose. F Lunch published in 2009 described how coding in excel helps in reduction of errors in repetitive estimation techniques. This paper describes a course in computer programming that is being offered to freshmen and sophomores in civil engineering at NC State. Visual Basic (VBA in Excel).

2. Computing in Civil Engineering by Y.Y Su and LY Lu published in 2007. It helped us to understand the traditionally collecting operational data involves manual steps. Thus leading to errors. Thus from this review paper, we learnt about the usefulness of VBA coding. Typical civil engineering problems are used to present the programming concepts. Especially in the instance of VBA, students learn how to combine the use of spread sheet functions with VBA code. The paper includes an overview of the course and examples of the materials covered and the teaching techniques employed.

3. Computing in IT Research in Civil Engineering by Raja R.A Issa published in 2007. It describes the various coding techniques and how to link a spread sheet to a user form in excel using VBA coding Cost, time, quality and good will are common objectives of any construction project. However, Cost and time are considered the most important parameters to take into account at the feasibility Stage of a building project. These parameters are of high importance to owners and decision Makers because they provide insight into the budget and time needed to finish the construction Project.

4. Concepts for successful estimating J.D Bledsoe published in 1995 using userform to extract data and creating a database for estimation Therefore, the cost and time values rely on many factors such as, the estimators experience and historical data from previous construction projects and the accuracy of the estimate that specifies the success or failure of the project..

5. Understanding IT in Construction by R. Howard and M. Sun published in 2004 understanding how VBA works and how it can be utilised in building cost estimation. Computer programming is an essential and integral part of any engineering program. Engineering students in their junior and

senior years face the task of solving problems by using numerical approaches. Good programming skills will enable them to tackle these problems easily.

6. Cost Estimating Principles by R.I. Carr published in 1989, give us a rough idea of estimate using excel. Detailed cost estimating by its very nature requires attention to detail and consistency in Methods of preparation. Those who prepare estimates benefit if they are able to focus on detail while at the same time keeping an eye on the larger picture of how construction items interface.

7. Cost Studies of Building by A. Ashworth published in 1988 explains how VBA Programming code can carry out repetitive operations. The ability to relate construction details and specifications to actual construction processes is useful, especially for processes and sequences not typically Drawn and detailed in construction documents, such as excavation, form work, sheeting And shoring, false work, and a variety of general conditions..

8. E-Learning in Civil Engineering by Martin Ebner published in 2007 describes how implementation of VBA programme helps in cost summary. This paper discusses how modern technologies can be used in the field of Civil Engineering Education and will show a lot of practical examples of today's effort in this field.

9. CPWD Schedule of Rates published in 2011 helps us to form the basic outline of our project and to derive out the necessary cost required for estimation.

10. Bechor, T. et al. A contingency model for estimating success of strategic information systems planning. Information and Management, 47, 1(2010), p. 17-29

11. Barber, P. et al. Quality failure costs in civil engineering projects. // International journal of quality and reliability management, 17, 4-5(2000), p. 479-492In the construction, due to the characteristics of this industry and several other factors, cost of poor quality has emerged to be a key issue.Poor quality breeds several undesirable effects throughout the entire construction project supply chain. When poor quality activities made during the construction processes and are discovered, necessitating costly rework and if undetected.

12. Low, S.; Yeo, H. A construction quality costs quantifying system for the building industry .The papers are classified according to major aspects which cause in reporting different outcomes and create confusion. This categorization provides a better understanding in regards to the differences about the aspects considered by previous research is on construction poor quality costs and to analyze them in a more meaningful way and point out promising future research directions.

13 Beatham, S.et al. An integrated business improvement system (IBIS) for construction , 9, 2(2005), p. 42-55

14 Chan, A. Key performance indicators for measuring construction success. Benchmarking , 11, 2(2004), p. 203-221

15 Lam, E.; Chan, A.; Chan, D. Benchmarking design-build procurement systems in construction. Benchmarking

2.1.2 Definition of Cost Estimate

Estimating the cost of any construction project at the feasibility stage is of great importance because based on these estimates owners and decision makers may decide on dismissing or continuing the process. The following paragraphs illustrate the information required for the cost estimating process.

2.1.3 Factors That Influence Project Cost Estimates

The factors that affect a construction project are divided into two types: monitor factors and characteristic factors. Monitor factors are factors that can be dominated by estimators to improve the performance estimation such as material and equipment. Characteristic factors are those that affect cost estimation but without the domination of estimators such as market condition, project complexity, weather, size of contract, site constraints, resources availability.

2.1.3 Factors That Influence Using Primavera

Primavera uses standard windows interfaces, client/server architecture, web-enabled technology, network based databases. It stores all projects in a single database system, which allows greater flexibility, increased efficiency, consistency and repeatability and hence saves organizations time and money. Application of Enterprise Project Management (E.P.M.)– For big, complex and multi-level projects in any organization, it is necessary to have strong coordination and standardization, centralized resource management, higher-level reporting about projects and resources.

2.2 : SUMMARY

A comprehensive literature review in the area of conceptual cost estimating, baseline scheduling and reviewing the above mentioned research papers led to completion of the project. Comprehensive literature review with regards to CPWD schedule of rates and its application in estimation was carried out Various regression techniques in VBA coding and excel were carried to develop a coherent data entry system To review previous mentioned research paper and to take up various practices stated in them and to develop a user friendly programme using this data for costestimation. The illustrious use of Excel for the management of construction information. In Excel, a data list is a simple structure of columns and rows that contain data. Entering data into a large spread sheet list may become extremely tedious and prone to error.

CHAPTER 3

VBA CODING FOR COST ESTIMATION

3.1 USE OF EXCEL IN CIVIL ENGINEERING

Among the strong features of spreadsheets are their intuitive cell-based structure and the simple interface that easy to use even for first time users. Underneath the structure and the interface is a host of powerful and versatile features, from data entry and manipulation to a large number of functions, charts, and word processing capabilities. Newer spreadsheet versions have also added many productivity features for Internet connectivity, workgroup sharing, programmability options, and a number of add-in programs. With their wide use, spreadsheets have been used as tools for developing computer models in domains such as construction, for which ease of use, versatility, and productivity are the main issues. In this paper, a spreadsheet program, Microsoft Excel 2007, is used to develop applications to solve civil engineering problems. Several powerful and infrequently used Excel features are available and can be used to develop practical and powerful models for teaching civil engineering concepts. These features include data lists, data menu options, data filtering, referencing and searching lists, basic spreadsheet functions such as "Vlookup", and pivot table reports. In Excel, a data list is a simple structure of columns and rows that contain data. Entering data into a large spreadsheet list may become extremely tedious and prone to error. The "Data-forms" menu option in Excel provides a simple way for editing or deleting existing records in a list or adding new records. Sorting the data helps bring similar records together for visual inspection or other purposes such as preparing reports and charts. Using the "Data, Sort" menu option, the list's data can be arranged in an order that is chosen by sorting the records. Filtering the data is also a useful way to view a subset of the records that compose a list. To filter a list is to extract records from it, based on criteria set by the user. Referencing and searching the list is another important part of the data management process. In realistic systems, where several lists of data are available, a link needs to be established among them (similar to the relational database concept). One simple and important spreadsheet function ''Vlookup'' can be used to link separate lists of information by making a reference to where the original data are. Accordingly, it is possible to determine the a cost of a certain project item, for example, by using a Vlookup function to search the original list and determine its associated rate per hour value. The "Match", "Index", and "Offset" are other functions that provide further control over the data in a list. Reporting is another essential requirement for obtaining summary data. In Excel, the pivot table wizard provides an automated report generator.

In addition to the features and functions of Excel, its programming capabilities, called visual basic for applications (VBA) are very powerful and can be used to solve complex civil engineering problems. Excel can also be used in linear programming, where the solver is used, and where the spreadsheet's graphing capabilities are used both to represent the feasible set and the objective function, and to interactively animate the objective function or constraint movements. Excel can also be used in simulation, where stochastic simulation may be facilitated through the use of an add-in, and a decision support system may thus be built from scratch.

3.2 BACKGROUND OF BUILDING COST ESTIMATION

Since 1950's, efforts have been made in order to understand the cause-effect relation between the design parameters and the building cost, and to develop models in order to estimate the building cost. Cost modeling may be defined as a symbolic formation of a system and the content of it is defined with the factors affecting the cost [Holm, 2005].

According to their historical developments the cost models can be classified in three different groups. The first-generation models originated from functional elements of building oriented cost planning approach in England at the end of 1950's extensively used until the end of 1960's. The second-generation models derived from the regression analysis and have been used since mid 1970's [McCaffer, 1975]. The third-generation models started to develop in the beginning of 1980's and generally based on Monte Carlo simulation technique [Touran, 1992].
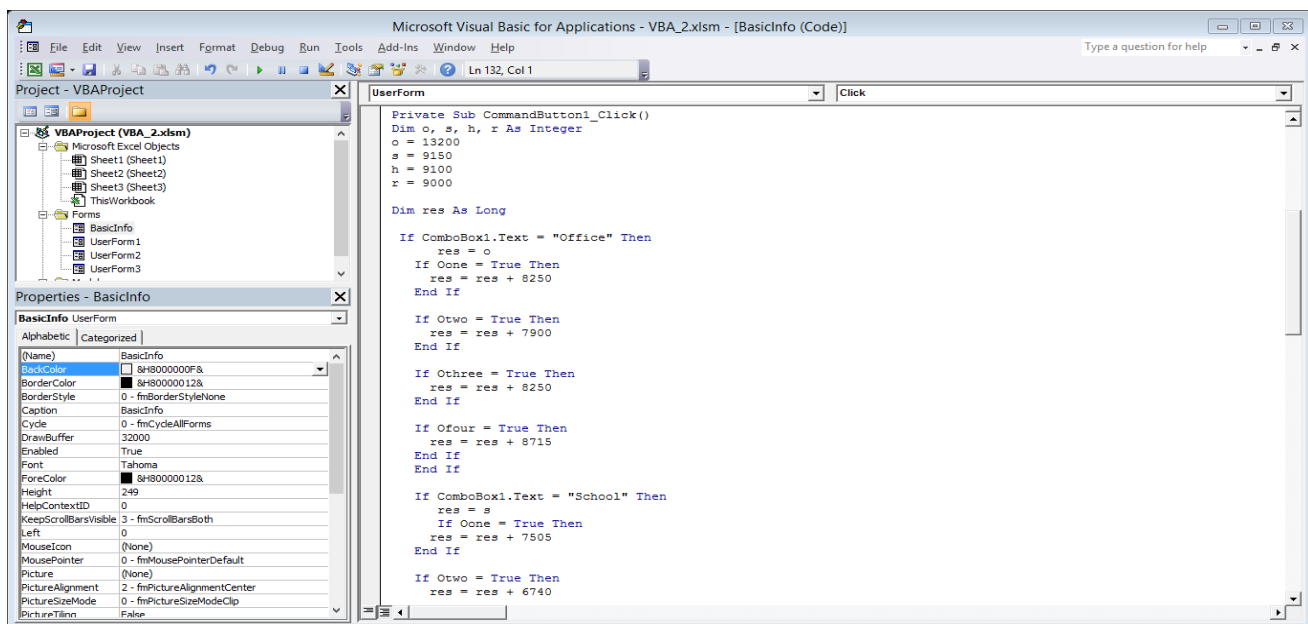

FIG 3.1: Depicting the basic coding done at the start of the project

The purposes of this coding abstract are as follows:

- Gives an evaluation of capital costs for a particular piece of work.

- Forms the basis for planning and monitoring by defining the scope of work and links the

  Spread sheet data to the user form for cost estimation The cost models can also be divided into two groups: deterministic and probabilistic models. In deterministic models, it is assumed that the values can be qualified with any kind of variables and all these are exactly known or can be estimated accurately. On the other hand, in probabilistic models, it is accepted that although the values of some variables are not absolutely certain they can be calculated.

The cost estimation models can also be classified according to their characteristics. In general, the first one is the traditional cost estimation models based on quantities; e.g. mono-priced cost estimation models used in the schematic design phase (such as unit, square, cube and building envelope models), resource based models used in the construction phase, models based on functional elements and building operational units. The second one is the untraditional models that is to say, models comprising new techniques and practices; e.g. the experimental models, regression models and simulation models.

Some of the recent works on cost estimation models are as follows. Chan and Park, studied to identify factors that contribute to project cost, to construct a predictive project cost model using the principal component technique and to assess the relative importance of determining factors [Chan and Park, 2005]. Serpell, examined to assess the quality of an estimate through the application of expertise and experience with the help of the knowledge-based assessment model (Serpell, 2004). Oberlender and Trost, presented results of a research effort that developed an estimate scoring system to measure the impact of four determinants on estimate accuracy, who was involved in preparing the estimate; how the estimate was prepared; what was known about the project; and other factors considered while
preparing the estimate (Oberlender and Trost, 2001). Trost and Oberlander, studied to establish a model which enables estimators and business managers to objectively evaluate the accuracy of early estimates (Trost and Oberlander, 2003). Ellis et.al., examined to add to the qualitative exploration of Value Management by investigating
the attitudes and experiences of Value Management facilitators within major UK cost consultancies (Ellis et.al., 2005). Yu, proposed PIREM (Principal Item Ratios Estimating Method) which integrates several existing conceptual estimating methods including parametric estimating, ratios estimating, and cost significant model with advanced nonlinear mapping techniques, and adopts a scheme that separates unit prices with the quantities of a cost item (Yu, 2006). Lowe et.al., described the development of linear

regression models to predict the construction cost of buildings. Liu and Zhu, attempted to identify the

critical factors for effective estimation at various stages of typical construction projects and developed a theoretical framework that identifies the critical factors for effective cost estimation during each project phase of a conventional construction project.

3.3 FACTORS AFFECTING CHOICE OF MODEL

Traditional building construction process is known as design–bid–build in which phases follow one another. In order to use the limited resources in a rational way, it is necessary that cost estimation should be done efficiently in each phase of the process. As the level of details differentiates in each phase of the project, the cost estimation models applicable for each phase shall be different as well. Model can be chosen consistent with the detail level of the decisions in each phase. On the other hand, participants of the building construction process, needs and uses, cost estimation for different purposes. Owner wants to know how much the profit shall be, how much capital is required for the project. The owner tries to estimate the roughest cost rapidly. On the other way, the designer needs the cost estimation to determine which schematic design alternative is the most suitable solution. Finally, the contractor needs more detailed and reliable cost estimation in order to determine the tender price and to manage the cash flow.

A computer-aided building cost estimation model based on functional elements
The excel software consists of several building cost analysis and two different building cost estimation models. Some of them are based on traditional cost models, whereas some of them are cost estimation models developed and modified for Turkish construction sector [Tas and Yaman, 2005]. In this paper one of them, the cost estimation model based on functional elements is examined.

The cost estimation model based on functional elements is one of the main modules of the software developed within the framework of the research project. The model is based on building cost estimation in the feasibility and schematic design phase using historical data of the similar projects.

In the background of the model, it is assumed that a building is built from different component groups, in other words functional element groups and each of them fulfils a specific function. Therefore, it is assumed that the total building cost is also the sum of the costs of each functional element group.

Total building cost can be calculated in a number of steps respectively. The first step is dividing a building into its functional elements by means of a classification system. Then, the total quantity of each functional element is measured on the construction documents, in other words technical drawings.

The total quantity of each functional element in the project is multiplied with the historical unit cost of each functional element of the similar projects.

The steps of the model are explained in detail as follows:

3.3.1*:* Project data entry

The first step is entering the project data for which the building cost to be estimated. These are the characteristics of the project and the parameters that should be entered:

- To estimate the building cost,
- To store and retrieve the estimation,
- To modify the estimation stored,
- To make a query among the similar projects stored in the database.

The project data that should be entered are:

A project number given by the user,

- The local code (or zip code) of the city where the project shall be carried out,
- A short description of the project,
- Owner of the project,
- Function code of the project. It indicates the function of the project, such as residential, educational, commercial building etc. It can be selected simply by the user among the function codes entered within the framework of the research project,
- Total (gross) construction area of the project. If total gross construction area is known exactly the user can enter it directly or if the area is not exactly known it can be entered as a range of estimated values. The unit must be in square meter,
- The date of estimation,
- Number of storey in the project. If number of storey is known exactly the user can enter it directly or if the number of story is not exactly known it can be entered as a range of estimated values,
- Work type code of the project. It indicates the type of the work such as a new building construction, completion of an old project, restoration or renovation. It can be selected simply by the user among the work type codes entered within the framework of the research project,
- The code which indicates the price type and time period (quarter) of unit cost of functional elements, either current market price or public sector price. It is the code that indicates whether the cost calculation shall be made using current market prices or the prices that is annually published by

CPWD

3.3.2*: Quantity entry of each functional element group

The second step is the entry of estimated quantities of each functional element group in the project. Functional elements of a building are divided into nine different groups using "BMBS cost classification system based on functional elements" developed within the framework of the research projects.

The BMBS cost classification system based on functional elements has been developed reviewing similar classification systems, such as BCIS (Building Cost Information System). The nine building functional element groups of the BMBS cost classification system based on functional elements are as follows:

1 – Slab on ground,

2 – Floors and stairs,

3 – External walls,

4 – Windows,

5 – External doors,

6 – Internal walls,

7 – Internal doors,

8 – Roof,

9 – Superstructure.

The model can be used in two ways according to the detail level of cost data available for the project. In other words, shall the model be used in the schematic design phase or in feasibility phase of construction In feasibility phase the user has not sufficient project data, in other words only approximately total construction area and number of storeys is known. In this case the user can use the historical data. The user can make a query among the similar projects in the database using the project data entered previously. The query results in the average quantities of each functional element group of similar projects in the database. The user may modify the quantities given by the query.

In the schematic design phase the user can measure the quantity of functional element groups on the drawings and enter total quantities of each group. This operation should be repeated for each functional element group. In both cases, the estimated cost of the superstructure (structural elements of the building e.g. columns, beams, foundations etc.) is determined as a percent of the total cost of all functional element groups. A query can be made using the project data entered previously. The user may modify the percent given by the query.

3.3.3: Setting the average unit price of each functional element group

As the user enters the quantity of each functional element group a new window is opened. In group headings for each functional element group, the alternatives of functional elements, in other words composite elements are shown and can be selected by the user.

A composite element can be defined as a building component that is a part of a building and fulfils different functions. Each composite element alternative for a functional element group consists of all the layers covering an area of one square meter. An example of one of the floor composite element alternatives is shown in Figure 2. Each layer of a composite element is related to one or more building operational unit.

As shown in the user form, the user can easily browse the code no, the definition and the unit cost of each composite element alternative in the database. The user can select more than one alternative, use them together in a functional element group and calculate an average unit price for the group.

For example, assume that the user has a schematic design drawing of a residential project which has 1,000 m^2 floor area. Once the user enters 1,000 m^2 as the total quantity of "load bearing structure and services" functional element group, a new window is opened and the floor covering alternatives and their unit cost is shown. The user may select the services and load bearing structure as per requirnment and according to the project requirnment. In order to calculate the average unit price of "Floor & services" functional element group, the user should enter the estimated percent of this floor covering alternative in total floor area.

Fig 3.2: Primitive Design of log form design for data entry and calculations.

The composite element alternatives can either be created on the basis of "CPWD schedule of rates and various regression on spreadsheet" or on the basis of unit price analysis developed by the user using current market prices. For each functional element group, the user may either select and use available composite element alternatives stored in the database, or create his own alternatives using his experience and knowledge.

One of the most important issues is updating unit cost of the composite element alternatives in the database due to the inflation. However, the unit cost of the building operational units and composite element alternatives can easily be updated, as the cost calculation system of the software is based on current prices of inputs (i.e. material, equipment and labour unit prices).

3.3.4: Estimation of the total building cost

Total building cost is estimated by multiplying total quantity of each functional element group with the average unit price calculated. The estimated cost of each functional element group can be seen on the screen as shown in Figure. It enables the user to make modifications among the composite element alternatives within project budget limits,

It must be noted that the cost of the structural system is not included in the cost estimation process so far. At this point, the user has not only the estimated total cost of each functional

element group, but also percent of the structural system historical cost in total building cost of the similar projects. It is the result of the query which is made using the project data entered. The user may also modify the percent given by the query.

By multiplying the percent and the cost of all functional element groups calculated so far, the structural system cost can be estimated.

The final total building cost estimation must be concluded by adding the estimated structural system cost and the cost of all functional element groups

3.3.5: Revision of the total building cost estimation

The model allows the user to make revisions as the result of the first estimation trial is not in the project budget limits. In this case, the user saves the first estimation trial then he may go on the second and the third trials.

The user can modify the project data to enlarge or narrow down the query range of the similar projects stored in the database.

Alternatively the user can save the project data as in the first trial and make some modifications on the composite element alternatives to move around the limits of the project budget. The software has the flexibility to create numerous new alternatives among the existing composite element groups.

3.4 STEPS TAKEN FOR COST ESTIMATION

3.4.1: Setting up a Summary Sheet:

The summary sheet is a quick overview of all the costs of construction broken down into major work categories such as excavating, framing materials, framing labor, and roofing. The summary sheet is similar to the Cost Summary Breakdown Sheets that banks and mortgage companies give out with their construction loans. When creating your summary sheet on a spreadsheet, it should be organized the way you are accustomed to seeing it. Most summary sheets are divided into project overhead and hard costs. They are usually organized according to the sequence of construction. Information or formulas can be entered into cells in the spreadsheet. Cells are where the rows and the columns intersect. Each cell can be formatted. You can change the width or height of a cell, the style of font, currency, date, time, color, justification (left, center, right), and/or a number of other formatting options. The summary sheet can also be used for cost control. As invoices are paid or draws are taken, variances to the original budget estimate can be monitored and corrections can be made to control costs.

TABLE 3.1: Representing the summary sheet for log form 3 and its utilities and services that are enlisted

services	offices/colleges	school	hostel	residential 1,2,3,4,5
internal water supply for type of building	rs 15/per mtr	rs2o/per mtr	rs25/mtr	rs 30/mtr
external service connection		rs7/mtr	rs7/mtr	5%
internal electric installation	rs45/mtr	rs 45/mtr	rs45/mtr	rs45/mtr
power wiring and plugs	rs10/mtr	rs10/mtr	rs10/mtr	rs10/mtr
telephone conduits	rs3/mtr	rs3/mtr	rs3/mtr	rs3/mtr
computer conducting	rs3/mtr	rs3/mtr	rs3/mtr	rs3/mtr
lightening conductors	0.00%	0.00%	0.00%	0.00%
quality assurance	rs5/mtr	rs5/mtr	rs5/mtr	rs5/mtr
type of water tank rcc	rs15/ltr	rs21/ltr	rs17/ltr	rs 9/ltr
internal roads and path	83/sqm	83/sqm	83/sqm	83/sqm
levelling	55/sqm	55/sqm	55/sqm	55/sqm
storm drains	50/sqm	50/sqm	50/sqm	50/sqm
filter water supply	46/sqm	35/sqm	25/sqm	40/sqm
sewer	63/sqm	63/sqm	63/sqm	63/sqm

3.4.2: Creating Detail Sheets:

Detail sheets are pages that contain the actual quantities and unit prices for each of the construction categories. Formulas can easily be entered to perform the calculations that typically take up so much of a builder's time in the estimating process. Once the detail sheets are created, the estimator need only enter the quantities for the different items. Line item totals, and category totals are automatically computed. Changes can easily be made and all calculations are instantly updated. The category totals on the detail sheets can be linked to the summary sheet so that it automatically copies the total from the detail sheet.

TABLE 3.2: Depicting detailed sheets being created and data being entered

log form 2	offices/colleges/hospital	schools	hostel	residential type1,2&3
load bearing construction				
floor hieght 3.35mtr				
single storey	8250	7505	0	0
double strey	7900	6740	0	0
triple storey	8250	7505	0	0
four storey	8715	7555	0	0
floor hieght 2.95mtr				
single storey	0	0	7315	6390
double storey	0	0	6425	6200
triple storey	0	0	7315	6390
four storey	0	0	7665	6740
stronger foundation to take floor load	430	430	430	430
rcc raft foundation	3560	3560	3560	3560
resisting earthquake force zone 4	286	286	286	286
fire fighting system sprinkelr system	450	450	450	450
fire alarm system	300	300	300	300
garages req	0	0	0	5455

3.5 Creating Userforms

Step 1: Rough outline being created
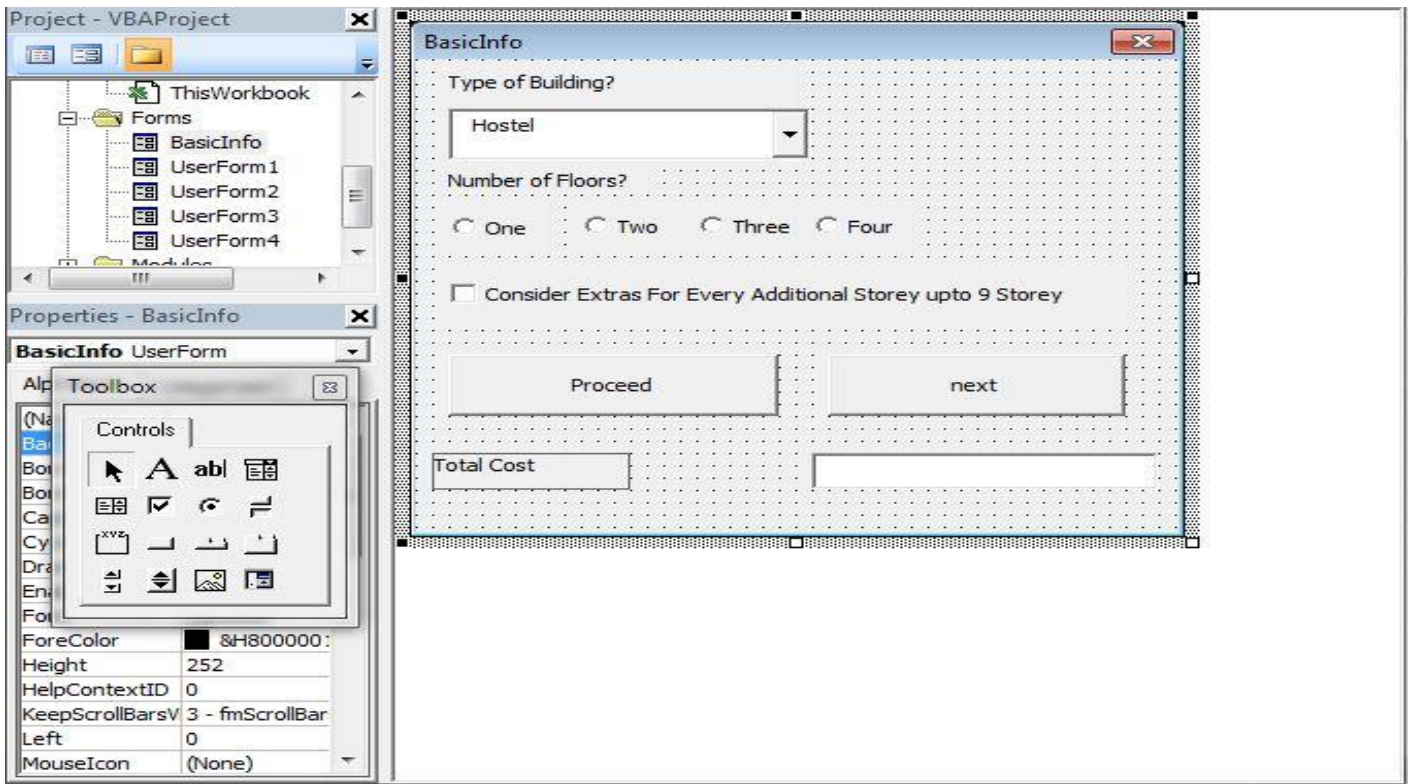
FIG 3.3: Depicting rough outline of basic user form.

Step 2: Inserting userform 1 which depicts type of structure, plinth area and type of building.
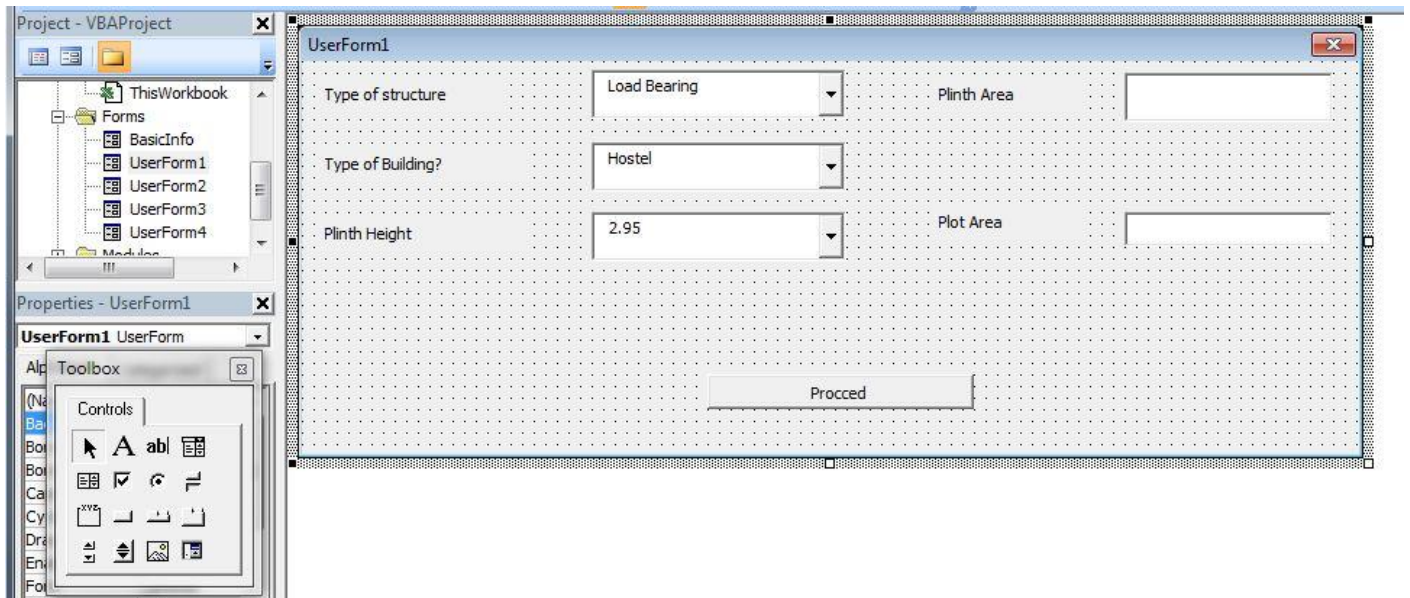
FIG 3.4: Depicting userform 2 having type of building and type of structure.

Step 3: Inserting User form that carries all load bearing structures such as RCC raft foundation and other utilities as fire fighting system and fire alarm system.
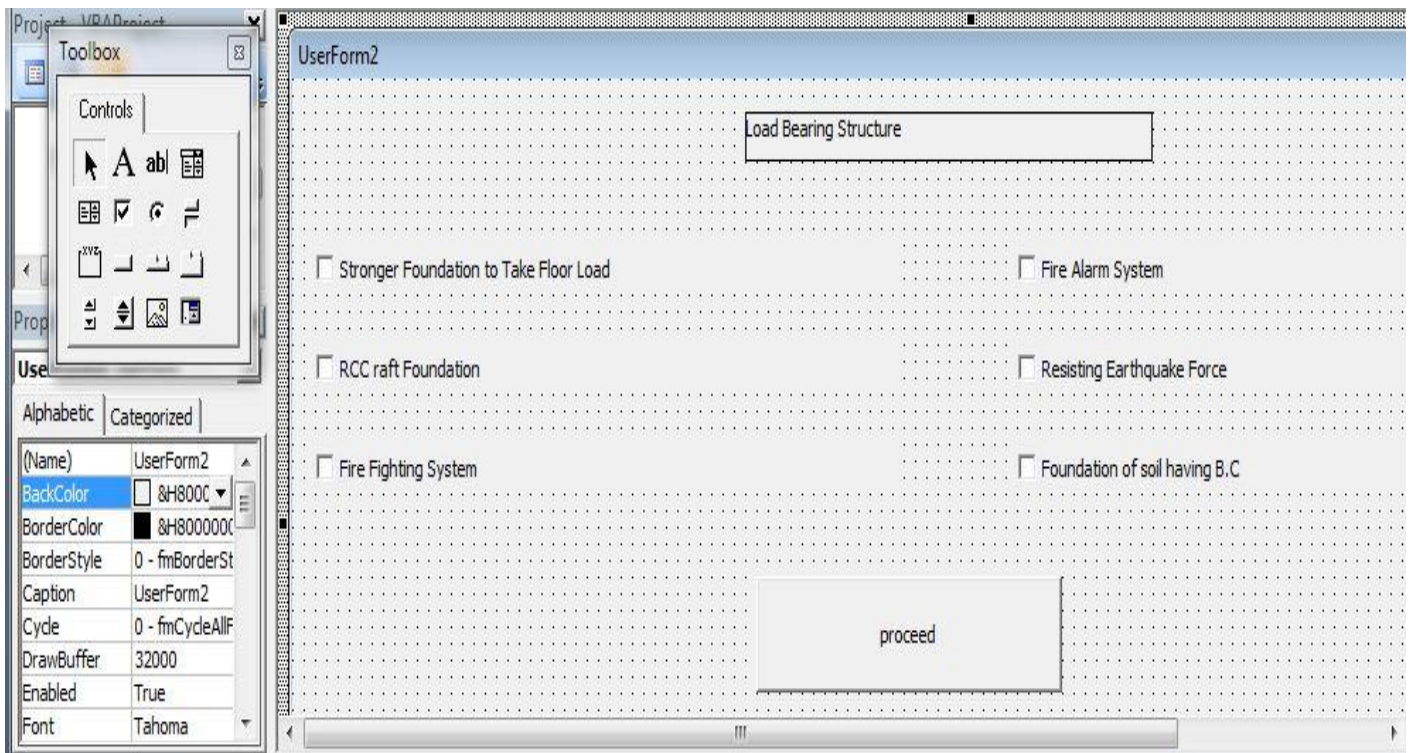
FIG 3.5 : Depicting load bearing structure userfrom.

Step 4: Creating services userform
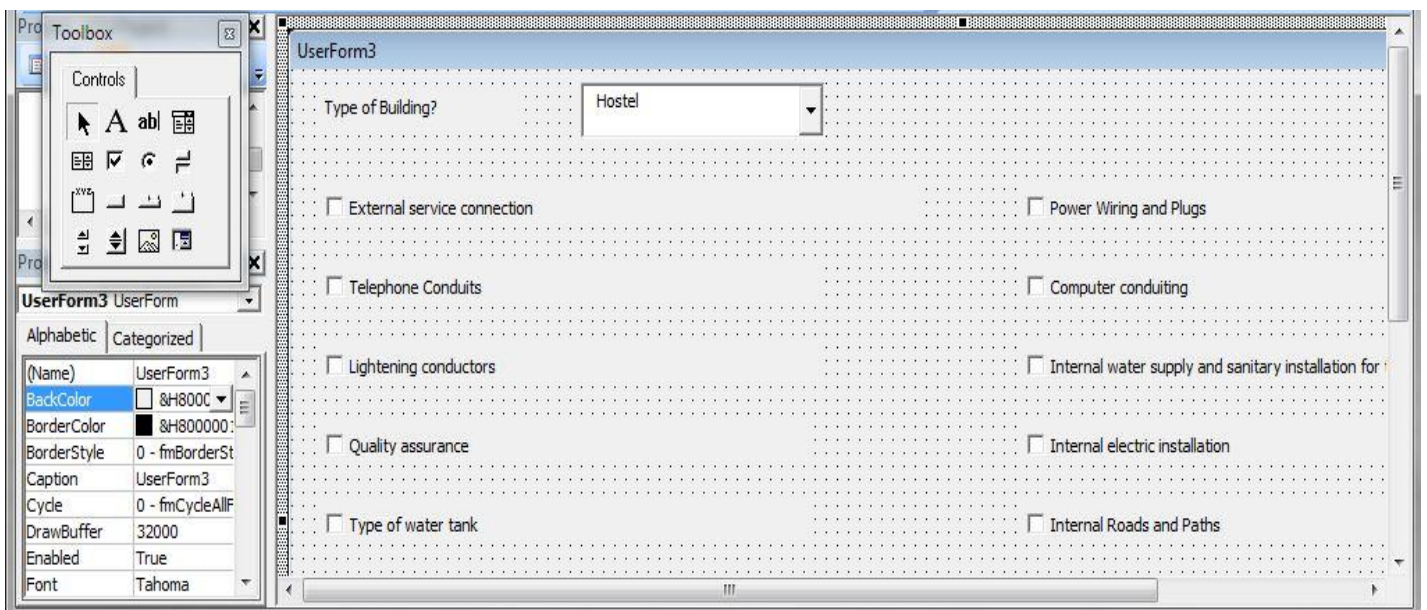
FIG 3.6: Depicting services userform

3.4.4: Coding

Coding means that one spreadsheet cell reflects or mirrors the value of another cell – either on the same sheet, on a different sheet, or in a different file. Linking one spreadsheet cell to another is very simple. Select the cell where you want the new value to be, enter = (the equals sign), and then click on the cell where the old value (the value to be copied) is located and press the enter key. But linking a spreadsheet value to data form requires help of VBA codeing. The basic key is declaring which elements need to be taken and how since that is done then declare the line frm where you want the data to be choosen.for example the following code declaring few members and then linking them.this code is for user form BASIC INFO.

```
Private Sub CommandButton3_Click()

Dim o, s, h, r As Integer

o = 13200

s = 9150

h = 9100

r = 9000

Dim res As Long

Dim ar, ht As Long

  res = Worksheets("Sheet5").Range("A10").Value

  If ComboBox1.Text = "Office" Then

  If ComboBox1.Text = "Load Bearing" Then

  If ComboBox7.Text = "3.35" Then

   res = res + Worksheets("Sheet5").Range("A10").Value

  End If

  If ComboBox7.Text = "2.95" Then
```

```vba
    res = o

 End If

Private Sub CommandButton1_Click()

 Dim res As Long

 res = res + Worksheets("Sheet5").Range("A11").Value

 If CheckBox1.Enabled = True Then

  res = res + 430

 End If

 If CheckBox2.Enabled = True Then

  res = res + 3560

 End If

 If CheckBox3.Enabled = True Then

  res = res + 450

 End If

 If CheckBox5.Enabled = True Then

  res = res + 300

 End If

 If CheckBox6.Enabled = True Then

  res = res + 286

 End If

 If CheckBox7.Enabled = True Then

  res = res + 286  End If  Worksheets("Sheet5").Range("A12").Value = res

.
```

CHAPTER 4

USE OF PRIMAVERA IN SCHEDULING

The objective of this PROJECT is to validate its applicability to the entire life-cycle of construction projects, including planning, design, construction and operation, and maintenance phases. Application of Primavera Project Management –

- Basically project management deals with project cost and resources. So this software enables an organization to deliver project on time and on budgets through reuse of best practices.
- Primavera uses standard windows interfaces, client/server architecture, web-enabled technology, network based (Oracle and Microsoft SQL server) databases. It stores all projects in a single database system, which allows greater flexibility, increased efficiency, consistency and repeatability and hence saves organizations time and money. Application of Enterprise Project Management (E.P.M.)– For big, complex and multi-level projects in any organization, it is necessary to have strong coordination and standardization, centralized resource management, higher-level reporting about projects and resources
- For a company's multi-level Projects, a continual identifying, prioritizing and investing strategies have to be aligned. This can be done by 'Managing projects as a collective portfolio' for better decisions. Human resources are the most valuable and often expensive assets. It is difficult to maximize the productivity and cost-effectiveness, of human resources. So in E.P.M., we have 'Optimizing resources across organization' for proper survival.
- To achieve project success, clear and effective communication should be there with knowledge sharing team members. Project teams can meaningfully get connected and maintain coordination with quality, hence strengthen collaboration across the enterprise for improved productivity.

4.1 Application of Breakdown Structure

- It represents the hierarchy in project for a responsible management. It usually shows the top to bottom level personnel in any business. After defining the hierarchy, one can associate responsible personnel on individual projects i.e. on EPS node and also projects within. So directly/indirectly one is assigning the responsibilities, accountabilities and authorities over the work heads
- A proper and completed work breakdown structure must be defined in a project to assign a committee or person for each task. The OBS will mirror the structure of the WBS. Major category

work will be assigned to senior committee members and lowerlevel tasks to the groups or individuals. By doing this, project manager becomes the responsible person for the project and indirectly gets authority to re assign groups or individuals working in it. The access and privileges to EPS/Project/WBS nodes are assigned through the OBS

.2 Application of Risk parameter of Primavera:

- We are able to identify categories and prioritize potential risks associated with specific WBS elements and resources through integrated risk management feature. One can create risk plans and assign a probability of its occurrence. Also for each risk defined, an OBS can be assigned. This means a particular person or a project manager can be held responsible for defined risk

- The risk type, priority level can be mentioned and also the particular WBS element and resources which will be impacted by that risk

- It uses a risk's probability of occurrence, date of potential impact, and resource unit and expense estimates to calculate a risk's net exposure values. These exposure values are then used to determine the risk's impact on the project's cost, float and finish date
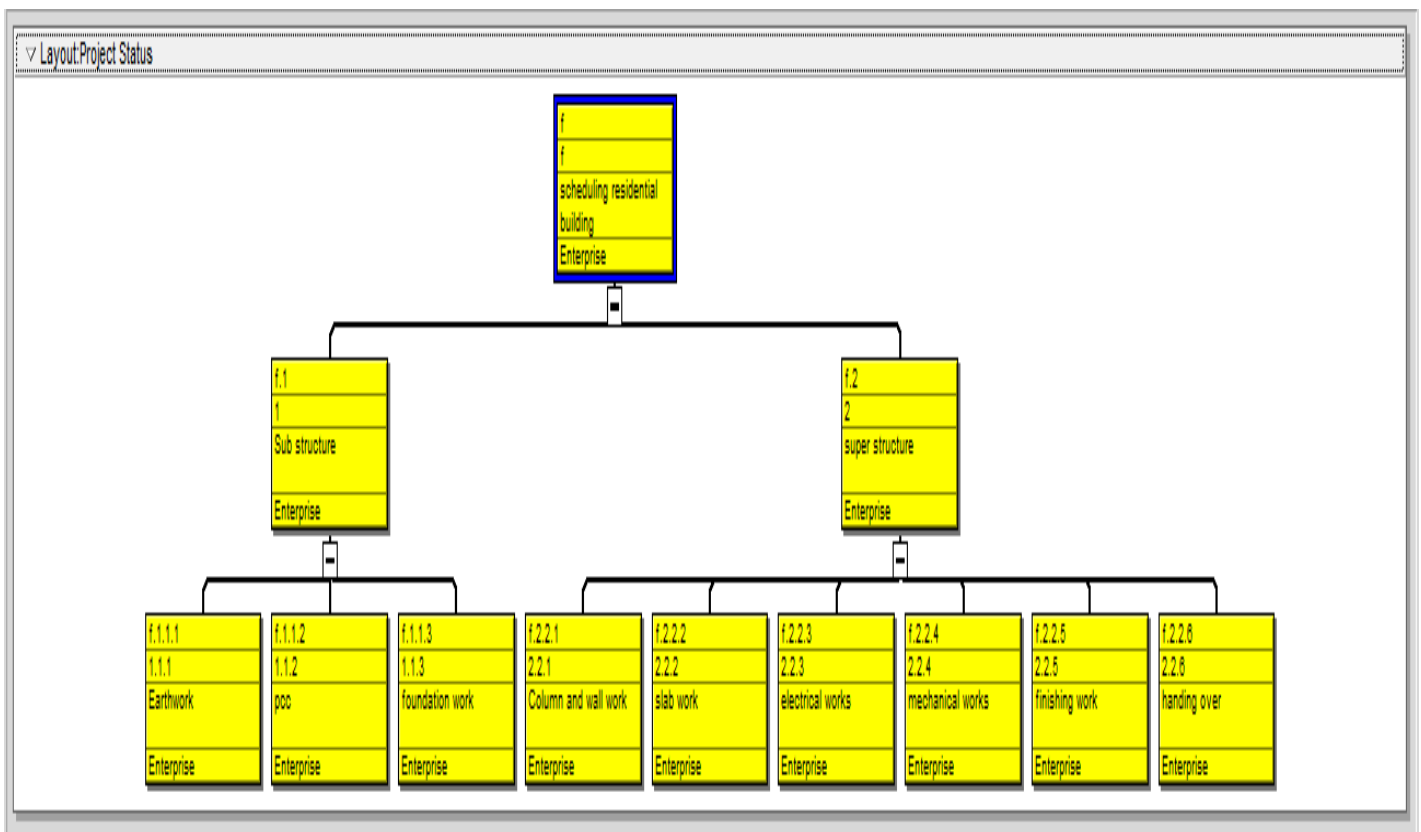
FIG 4.1 (a): Depicting created work break down structure of a residential building

4.3 Methodology

- **Creating an ideal schedule**

  To create a schedule for any project, first step is to collect data available for the project. Subsequently the following steps can be followed in Primavera.

- **Enterprise project structure (EPS)**

  Create the structure of the company with its branches, which is executing the project.   This is known as Enterprise project structure (EPS).
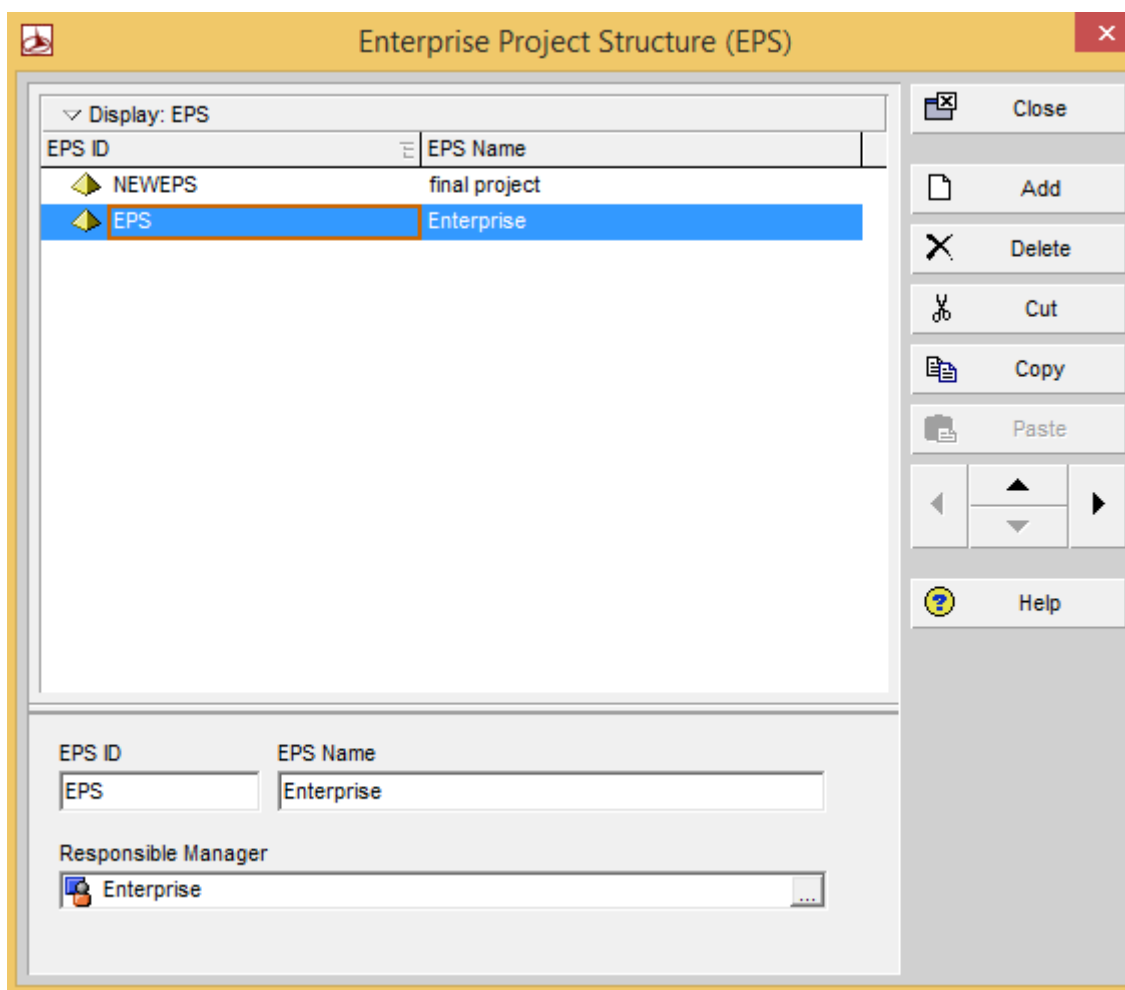
FIG 4.2: Depicting enterprise project structure prompt box

- **Organizational breakdown structure (OBS):**

  After the EPS, OBS is created which is a hierarchy that reflects the persons responsible for the

Project in enterprise.
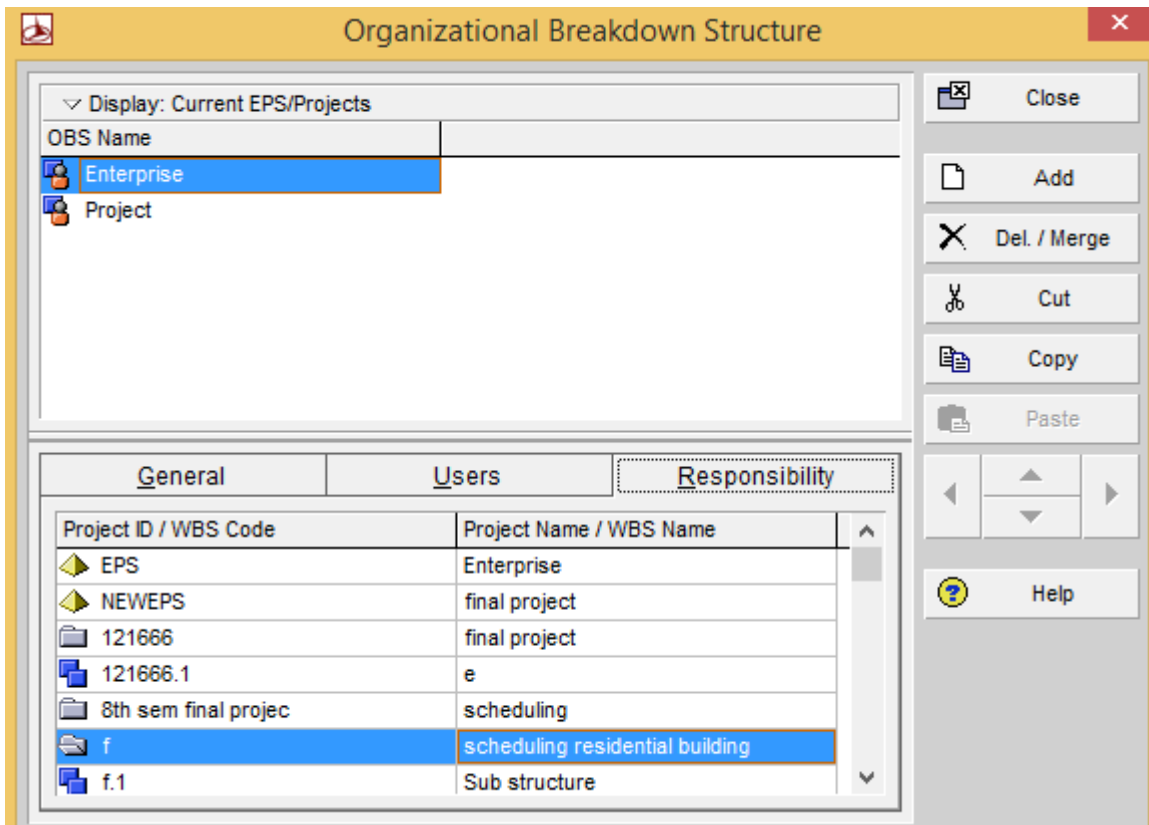
FIG 4.3: Organization break down structure to be chosen for the particular project

- **Creating new projects :**

  A project is a set of activities and associated information that constitutes a plan for creating a product or service. The project is created under the respective divisions in EPS and assigned the person in charge from OBS to it. The project can be given planned start and must finish dates. The project is assigned a calendar which can be global, resource or project calendar.

- **Work breakdown structure (WBS):**

  WBS is a hierarchy of work that must be accomplished to complete a project. Each project has its own WBS hierarchy with top level WBS element being equal to that of each EPS node or project. Each WBS element may contain more detailed WBS levels, activities, or both.
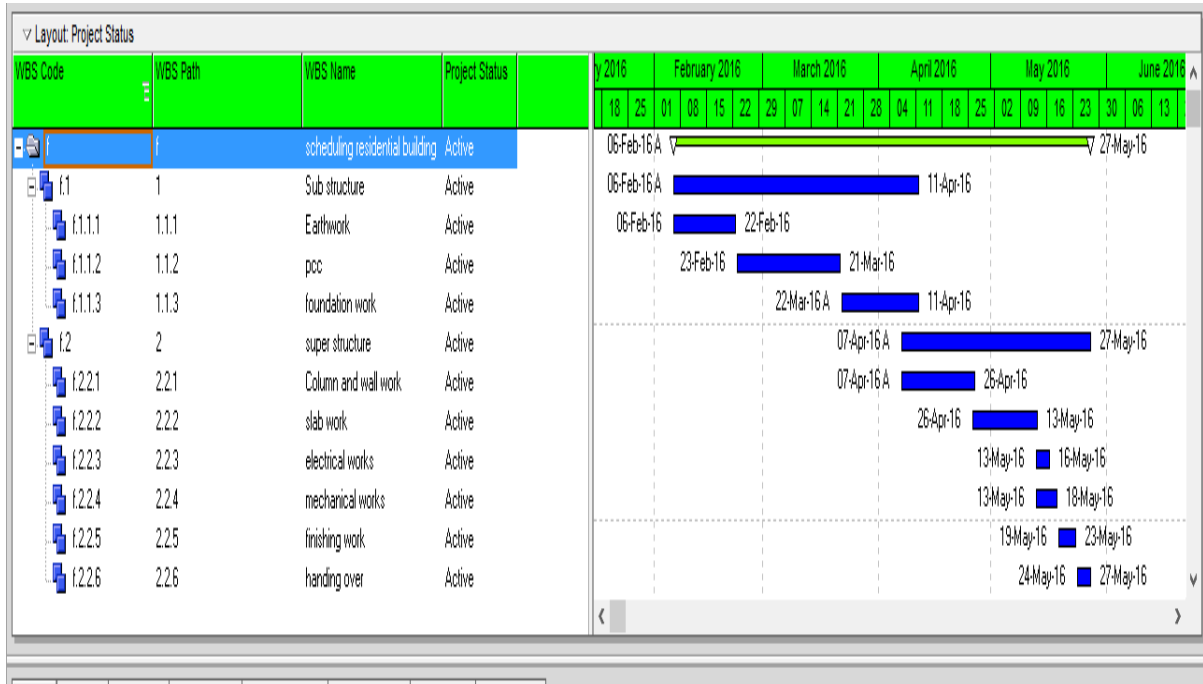
FIG 4.4: Depicting work break down structure with time scale and WBS code
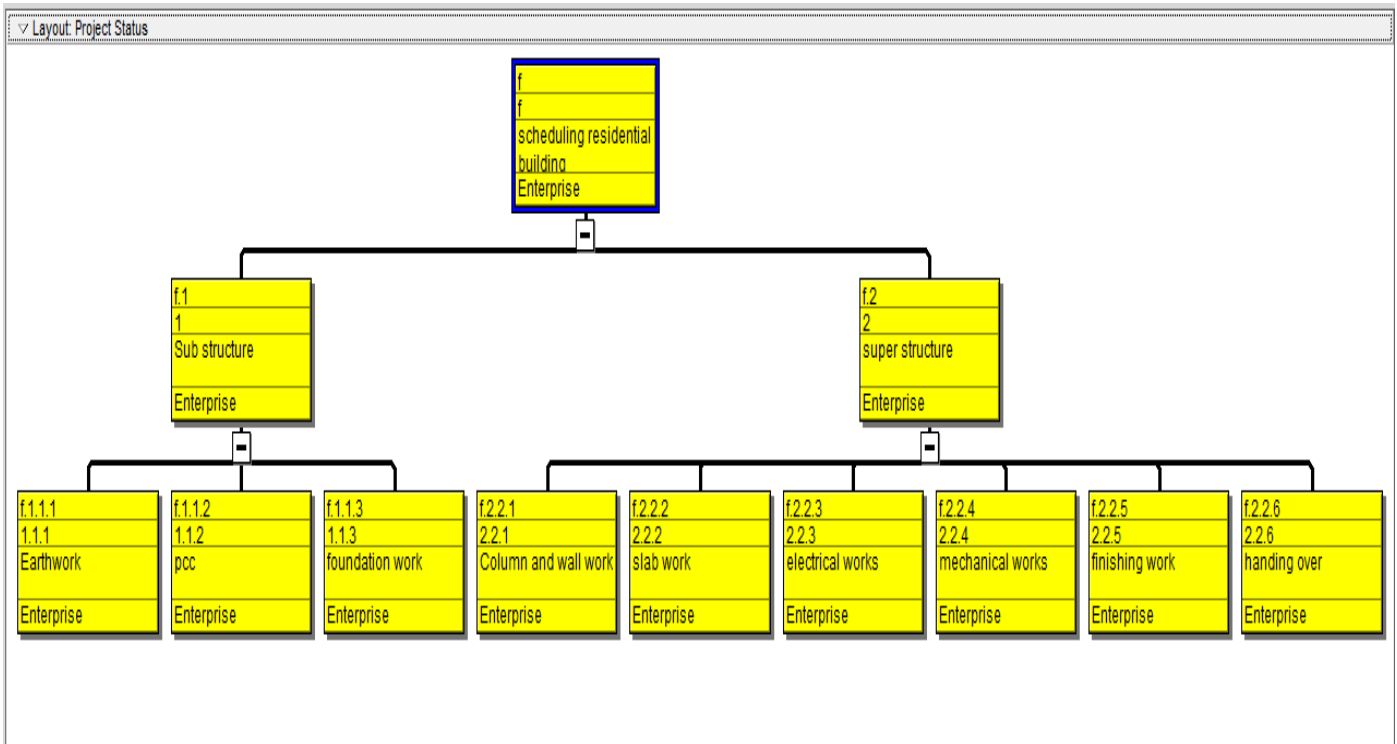
FIG 4.5: Actual WBS of the project showing various milestone activities

- **Defining activities :**

  Activities are the fundamental work elements of a project and form the lowest level of a WBS and, are the smallest subdivision of a project. An activity has the following characteristics like activity ID, name, start and finish dates, activity calendar, activity type, activity codes, constraints, expenses, predecessor and successor relationships.
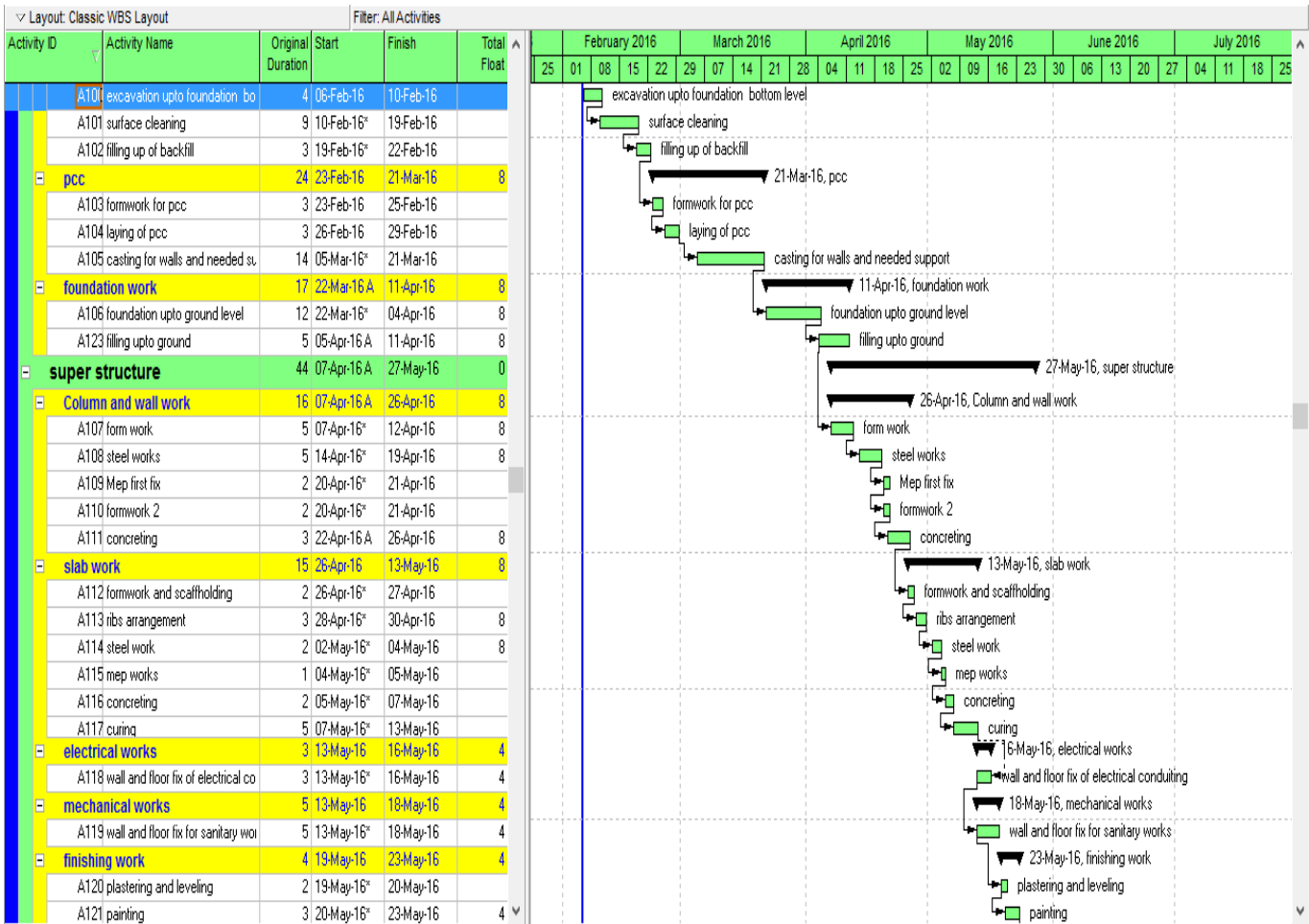
FIG 4.6: Various activities and their expected start and finish time

- **Relationship between activities:**

  To from a network, the activities should be connected to each other, which is done by assigning preceding and succeeding activities with significant relationship to the activities. Finish to start (FS) relationship. Finish to finish (FF) relationship. Start to start (SS) relationship. Start to finish (SF) relationship

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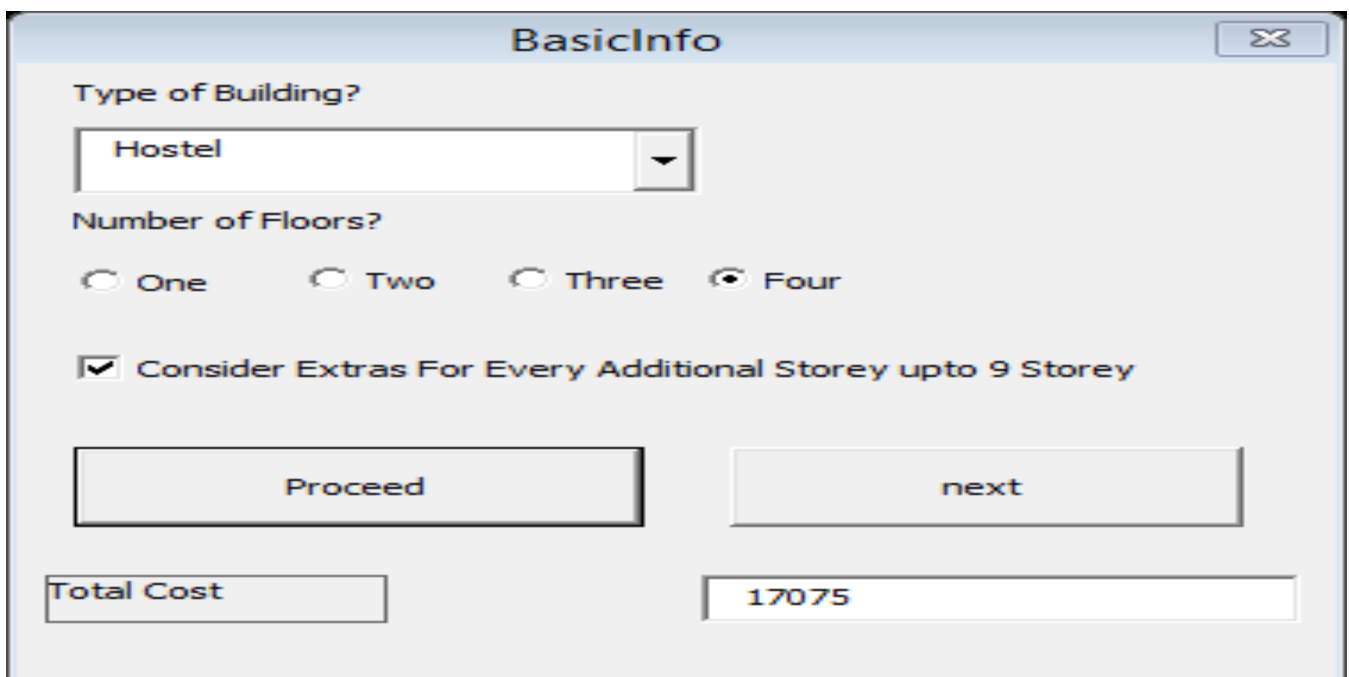
- **Determining activity duration :**

  When planning the work, the duration is entered in the original duration field. The actual duration can only be entered for the activities, which are completed.

CHAPTER 5

RESULT AND DISCUSSION

- We have chosen a type of building from the various type enlisted and done a cost estimation for it, including all services and and cost for all load bearing construction

- **5.1 STEPS**

- **Step5.1**: Choose a type of building, no. of floors, any additional cost for any storey above 9

FIG 5.1: Depicting type of building, number Of floor and associated cost

- **Step5.2:**After basic cost for each floor and no. of floor are being enterd, we need to enter the plinth height,plinth area.

FIG 5.2 : Showing type of structure and plinth height and basic utilities being entered

- **Step5.3:** Now select all the load bearing structure entries u want like raft foundation
  Stronger foundation to take floor load and extras like fire alarm and fire fighting system

FIG 5.3: Considering all load bearing structure and fire fighting system

- **Step 5.4:** The final user form is for services and utilites such as water utilities and and service conduits and sewer system and all the necessary services FIG 5.1.4 :depicting all selected utilities

FIG 5.4: Depicting the services and utilities being chosen by the user.

- **Step 5.5:**Proceeding to final cost calculation based on your selection

Fig 5.5: depicting final result

- Thus the final result based on user's selection is 77754050 INR. For 9 stories

5.2 Data validation

- Thus from the above process we have calculated the cost of the project using VBA coding. Now to validate this we undertake the same cost and same choices in excel.
- We enlist all the changes in a spread sheet such plot area ,plinth ht,and all the respective load bearing cost and services and then calculate the cost and check how much variance from the above result is occurring.
- Through the help of spread sheet screen shot we have compared the result .

TABLE 5.1: Depicting the cost validation and comparison

DATA VALIDATION			
	description	cost per metre	total
type of structure	hostel	0	
no. of storeys	4+additional 5=9	0	
plinth ht	2.95	0	
plinth area	2500 sq.mtr	0	
Rcc framed structure	type of structure	9100/sqr.mtr	
extras fr add storey upto9		310	
extra fr evry add 0.3 mtr rise in ht		150	
resisting earthquake force		630	
extra fr add storey upto 12 storey		320	
pile foundation		6470	
load bearing structure			
for 4 storey high		7665	
stronger foundation to take load		430	
raft foundation		3560	
resisting eath quake zone 4		286	
fire fighting		450	

fire alarm		300	
	total	29,671	
			29671*2500=74117500
services			

|			
internal water supply		rs 25/metre	
external service connection		rs 7/metre	
internal electric installation		rs 45/metre	
telephone conduits		rs 3/metre	
computer conduiting		rs3/metre	
quality assurance		rs 5/metre	
	total	88	
		88*50=4400	4400
Levelling		55sqm	
internal roads and path		83sqm	
storm drains		50sqm	
Sewer		63sqm	
	total	251	251*2500=627500
	grand total		74749400

Thus the result for 9 stories calculation by excel is 74749400.

The result calculated by us thtrough vba coding is 77754050.

% deflection from actual =(77754050-74749400)*100/77545050=3.8747%

5.3 Scheduling:

Step 5.3.1: The duration of work calculated through use of primavera was a systematic and

Sequential process with initial step undertaken as creating of calendar and EPS
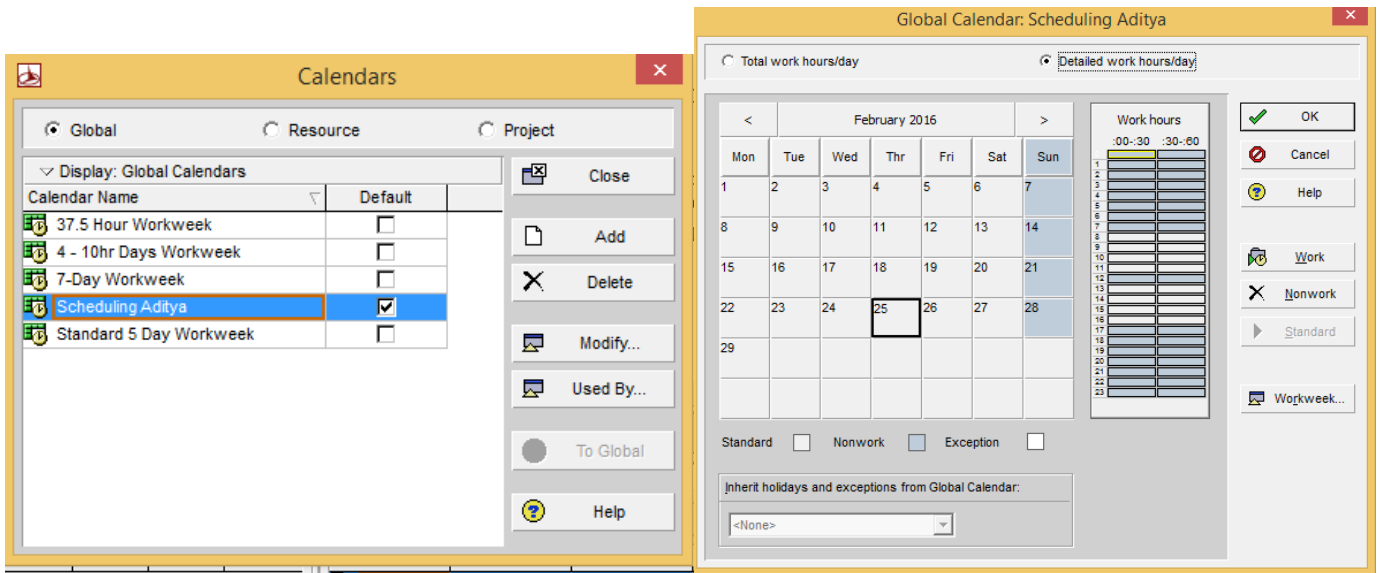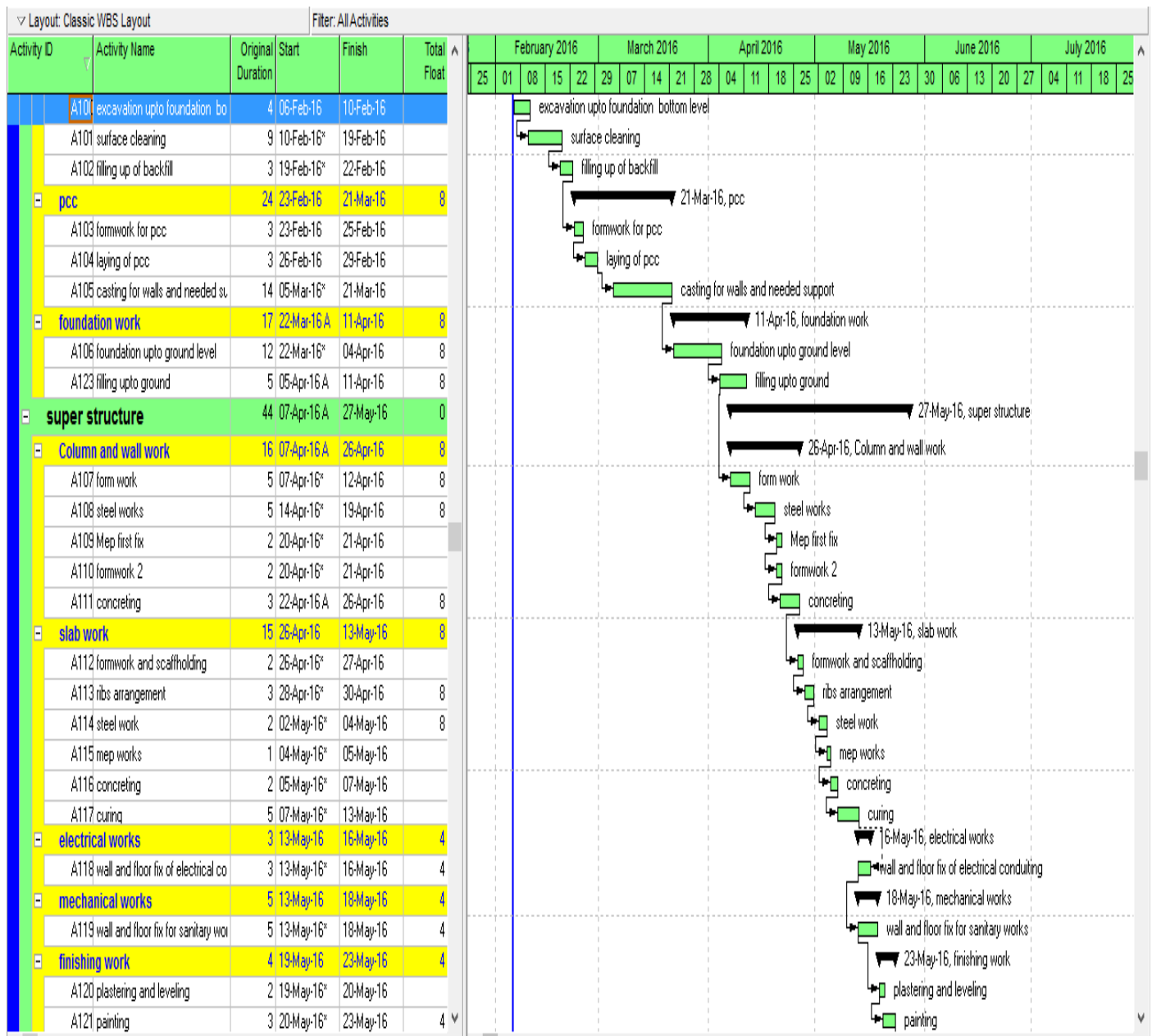
FIG5.6: Depicting the calendar for the project and detailed work hours per day

Step 5.3.2: Creating work break down structure and activities and assigning duration
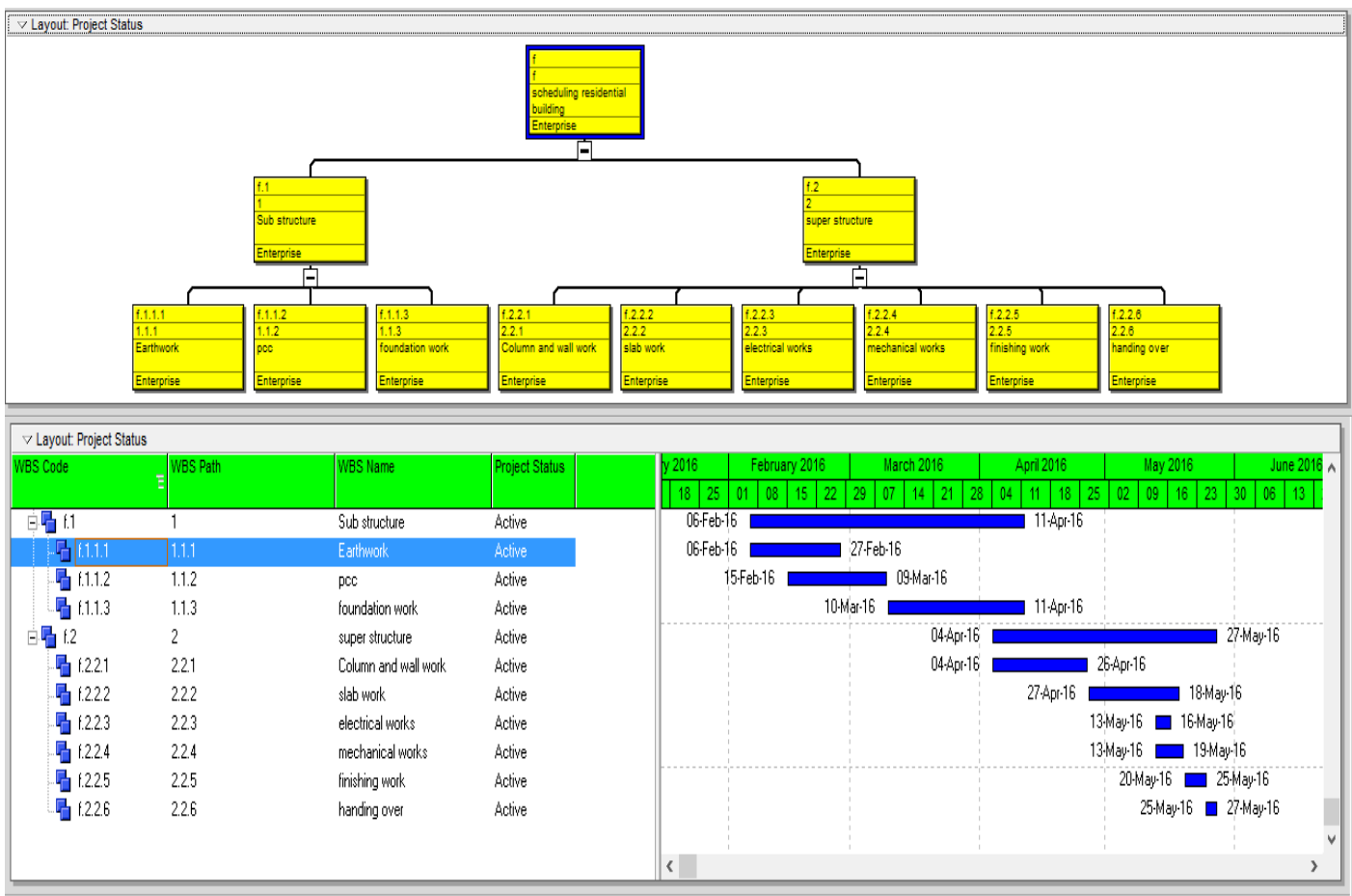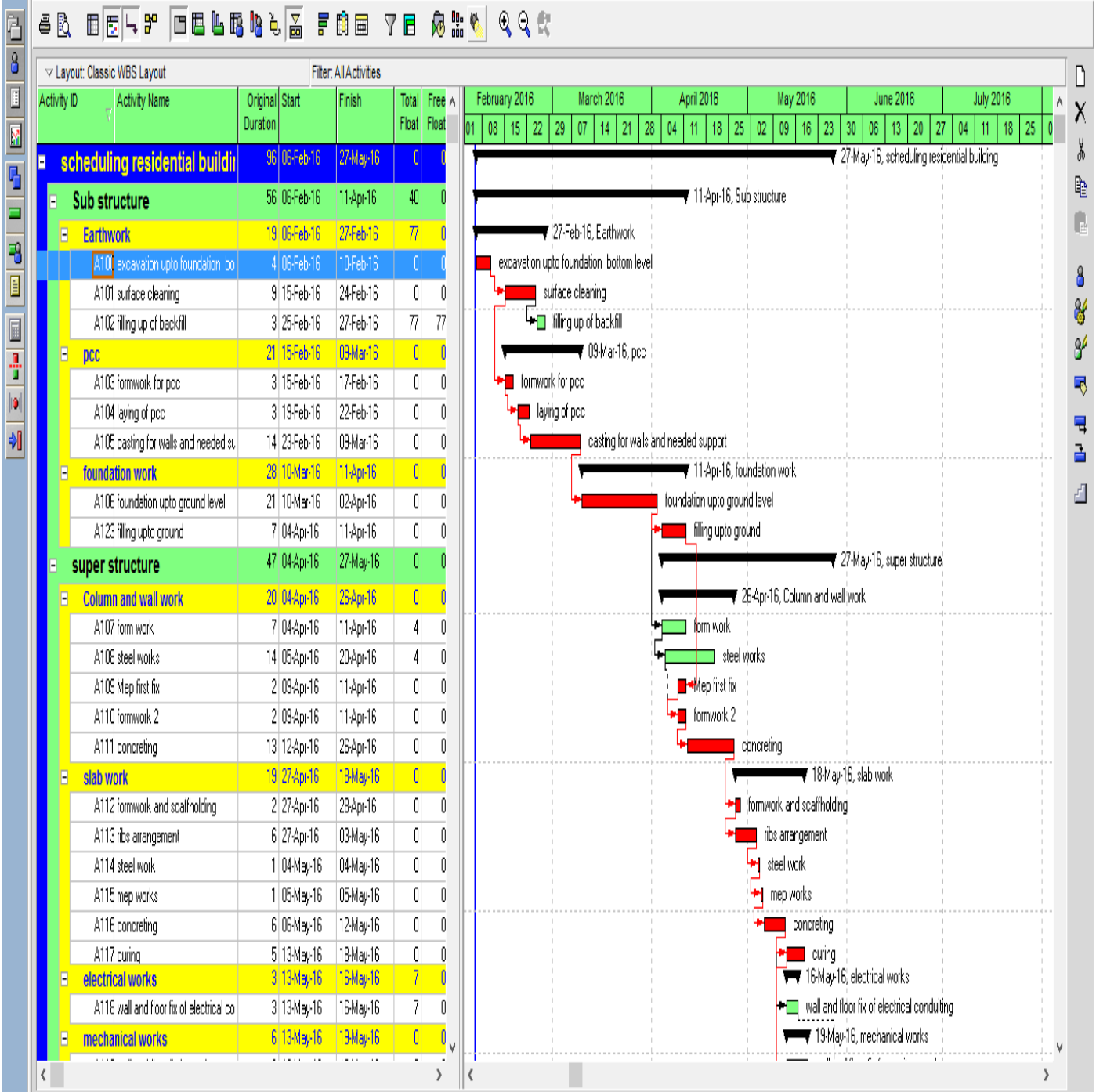

FIG 5.7 a: Depicting work break down structure in both time scale version and normal wbs chart view

STEP 5.3.3: Arranging activities according to work break down structure

FIG 5.8 : Activities being arranged according to work break down structure

Step 5.3.3: Final result being calculated by primavera as 96 days

CHAPTER 6

CONCLUSION & FUTURE SCOPE

6.1 Conclusion:

We have seen from the validation that the result calculated from the visual basic application and excel spredsheet using formulas almost comes out to be same with minor deviation and thus the data base created for building cost calculation is coherent and correct. The selections made by the user in data form are copied in excel and cost is calculated separately there so that we might validate the data. There is only a variation of 3.87% in the actual calculated and manual calculated result

It can also be concluded that this type of estimation model using VBA programming helps in reduction of manual labour, now we can review work done till date with ease and this helps in error reduction, this type of estimation gives us an edge over manual calculation as it is user friendly and helps in saving our time by speedy calculation and accurate calculation

.

Even in the case of knowing only the total construction area and number of storey of the project the user can estimate approximate total building cost. Even if the user has not sufficient project data, the model allows the user to make a project budget. The average quantities of the functional elements groups queried among the similar projects in the database are used for budgeting. If the user has sketches of the project, he can estimate total building cost easily as he measures the quantities of the functional elements in each group on the project.

Furthermore, the user can select and decide which building materials to be used in the project, modify them or create numerous new composite element alternatives. Therefore the model allows the user to make cost planning studies. As the user analyses the total cost per m^2 of each functional element group, he has feedback even if the budgeted cost is exceeded or not.

As the building materials to be used in the project can be modified, the user can see the total building cost difference between the first trial and the latter one accordingly. The model also allows estimating the most suitable total building cost even in the phase of the schematic design phase, as there is a chance of using more than one composite element alternative for each functional element group.

6.2 Future scope:

VBA can be used for any other construction project with its speedy calculation and accurate results it is an asset in the hands of a estimator. Further more successful estimates are the lifeblood of a project. Accurate quantities and costs are needed for strong cost controls. Since this project is still in feasibility stage there are chances of improvement in case of project data entry method and cause of inflation on per unit cost of material coded. These aspects will further more strengthen the capability to estimate as now it will give better and more accurate result with accounting of all variable factors such as inflation which lead to inc in cost and these will all accounted for in our basic design only.

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