

Integrated Cost Management System for Delivering Construction Project

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Abstract - Cost management forms a major discipline in delivering construction projects of different sizes and complexity. Traditional cost management systems are mostly based on principles enacted several decades ago. A notable feature of these traditional cost management systems is that key information required for critical decisions is usually produced too late, and is often too aggregated and configured in a form that is not amenable to the requirements for current project management practice. Other problems associated with traditional cost systems relate to inadequacies in estimating and cost control processes and particularly the lack of integration of cost management across the whole project. The lack of integration means measurements provided by traditional cost systems do not sufficiently align with the goals and objectives set for the project. To address these inherent weaknesses in the current practice of cost management, a number of studies have argued for an integrated alternative that better responds to the information demand and decision making need to be developed. The thesis presents the development of a solution to such an integrated cost management system. The developed solution addresses the gaps of the traditional option by integrating the stages making up the whole life cycle of the project to enable professionals gain an appreciation of the ramifications of any early decisions made. The investigation conducted to support the development of the integrated cost management system and the applied model addresses user requirements and determination of the system boundary conditions for efficacious use by key decision makers. The new cost management system developed achieves a linkage of the planning and control stages into one, with a continuous stream of cost management information in both stages. The integration ensures that cost information is more relevant to the circumstances of the modern project manager

Index Terms - Construction project, Integrated cost management system, Primavera, Resources

I. INTRODUCTION

Cost management forms a major discipline in delivering construction projects of different sizes and complexity. A cost control of a construction project is a crucial management task which is a key to success of the business. Traditional cost management systems are mostly based on principles enacted several decades ago. Traditional cost management systems is that key information required for critical decisions is usually produced too late. Problems associated with traditional cost systems relate to inadequacies in estimating and cost control processes and particularly the lack of integration of cost management across the whole project. The lack of integration means measurements provided by traditional cost systems do not sufficiently align with the goals and objectives set for the project. This project presents the development of a solution to such an integrated cost management system. The investigation conducted to support the development of the integrated cost management system and the applied model addresses user requirements and determination of the system boundary conditions for effective use by key decision makers.

II. OBJECTIVE

1. To investigate and establish the essential features of a cost management system
2. To provide a prototype development and trialing of a cost management system which integrates the planning and control stages for the delivery of projects in the construction sector.
3. To identification and find solution for the problems of poor connectivity that predominates in the use of traditional cost management methods.

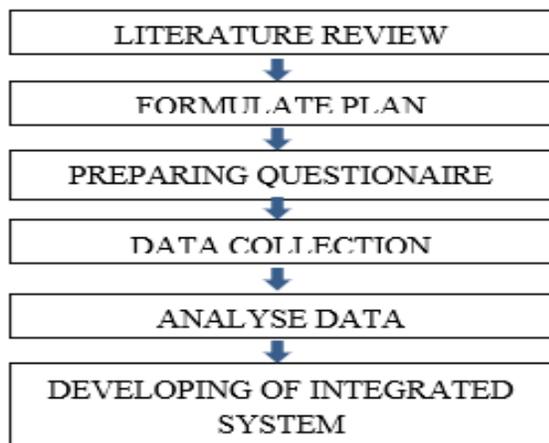
2.1 TO ACHIEVE THE AIM OF THIS PROJECT, THE FOLLOWING OBJECTIVES WERE PURSUED:

1. Establishment of current knowledge base that supports the study to include cost management, integrated systems development, and project information planning.
2. System requirements analysis and data collection work to obtain the data configuration for the integrated system development.
3. Development of a prototypical version of the Integrated Cost Management System.
4. Coding and developing the application for the Integrated Cost Management System.
5. Providing a set of recommendations for the use of the new system.
6. Testing and validating the Integrated System.

III. LITERATURE REVIEWS

The main aim of the journals is to determine the production cost in companies and in construction and their managing the costs. To reduce the cost of production majority of the companies tend to follow their own cost management system. Results from the system development and verification with construction project cases find that cost management system can help to reduce time effort and input errors compared to the manual methods. By using the cost management system complete information regarding the cost status of the project can be accessed at any time. So, it can reduce the total project cost and increase the efficiency and profitability of the construction.

IV. METHODOLOGY



Data analysis is done by Relative Importance Index (RII). 30 questionnaires were distributed to various construction companies to the targeted respondent.

The RII was calculated by using the formula as below

$$RII = \frac{\sum w}{AN}$$

Where,

w – Weighting given to each factor by respondents

A - Highest weight ('4' in this case)

N - Total number of respondents.

Based on the relative important Index method analysis, the ranking is provided to data. The most significant factors are identified.

TABLE I - SIGNIFICANT LIMITATIONS

SL NO:	FACTORS	RII	RANK
1	Lack of software integration	.8433	1
2	Lack of Automation	.8253	2
3	Lack of adequate communication	.8222	3
4	Lack of standard for information exchange	.8063	4
5	Lack of proper decision making tools for project planning	.8053	5

Above mentioned are the 5 topmost significant limitations that are identified. Developing an integrated system can be useful to overcome the problems. Primavera P6 software was used. Here I considered a bridge construction project and analysed using Primavera and given the solution.

VI. PRIMAVERA

Primavera is enterprise project portfolio management system. It includes project management, product management, collaboration and control capabilities and integrates with other enterprise software such as Oracle and SAP's ERP systems. Primavera was launched in 1983 by Primavera system Inc. and was acquired by Oracle cooperation in 2008. Oracle Cooperation's Primavera Global Business Unit (PGBU) focuses as of 2016 on providing web-based enterprise project-portfolio management software that encompasses resource allocation, cost reduction, supply-chain efficiency, and decision-making – using real-time data – for the enterprise market

6.1 ANALYSIS OF BRIDGE CONSTRUCTION PROJECT USING PRIMAVERA

The study area selected for this project is “Construction of bridge at Pattambi in Pattambi constituency – Palakkad district”. Its length is 23m and width is 3.6m and its height is 22.86m

6.1.1 CREATING EPS

The Enterprise Project Structure (EPS) is also a hierarchical based structure that represents how your projects are organized. The OBS and EPS are combined together through the responsible manager field on the EPS structure, project folder and Work Break Structure (WBS) level.

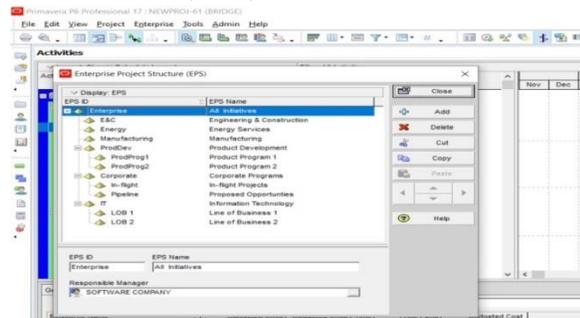


Fig.1 EPS OF THE PROJECT

6.1.2 WORK BREAKDOWN STRUCTURE (WBS)

The various activities that make up the project have to be clearly identified. The process of breaking the project into easily identifiable major systems, their sub-systems and discrete activities is known as WBS.

Activity ID	Activity Name	Start	Original Duration	Finish	Budgeted Total Cost
NEWPROJ-61 BRIDGE		29-Feb-20	150	05-Jun-20	Ru6,771,512.00
NEWPROJ-61.1 PREPARATION OF SITE		29-Feb-20	38	13-Apr-20	Ru1,311,268.00
NEWPROJ-61.2 SUB STRUCTURE		14-Apr-20	40	24-May-20	Ru2,500,000.00
NEWPROJ-61.3 SUPER STRUCTURE		29-Feb-20	25	27-Jun-20	Ru1,950,144.00
NEWPROJ-61.4 ROAD		29-Jun-20	7	06-Jul-20	Ru2,850,480.00

Fig.2 WBS OF THE PROJECT

6.1.3 CREATING ACTIVITIES

A project can be broken down into various jobs in the form of operations and processes necessary for its completion

Activity ID	Activity Name	Start	Original Duration	Finish	Budgeted Total Cost
NEWPROJ-61 BRIDGE		29-Feb-20	150	05-Jun-20	Ru6,771,512.00
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NEWPROJ-61.3 SUPER STRUCTURE		29-Feb-20	25	27-Jun-20	Ru1,950,144.00
NEWPROJ-61.4 ROAD		29-Jun-20	7	06-Jul-20	Ru2,850,480.00

Fig.3 ACTIVITIES OF THE PROJECT

6.1.4 GANTT CHART

A Gantt chart, commonly used in project management, is one of the most popular and useful ways of showing activities (tasks or events) displayed against time. Each activity is represented by a bar; the position and length of the bar reflects the start date, duration, and end date of the activity

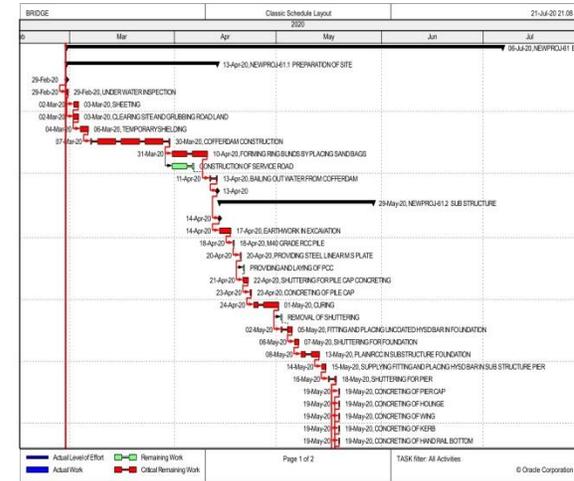


Fig.4 GANTT CHART OF THE PROJECT ACTIVITIES

A specific resource ID is taken, (eg: jcb). Activity usage profile, Resource usage profile, Activity usage spreadsheet, Resource usage spreadsheet are shown below

6.1.5 ACTIVITY USAGE PROFILE

Use the Activity Usage Profile to view cost or unit values for activities in the open project over time according to a timescale you specify. The Activity Usage Profile displays resource allocations for all activities

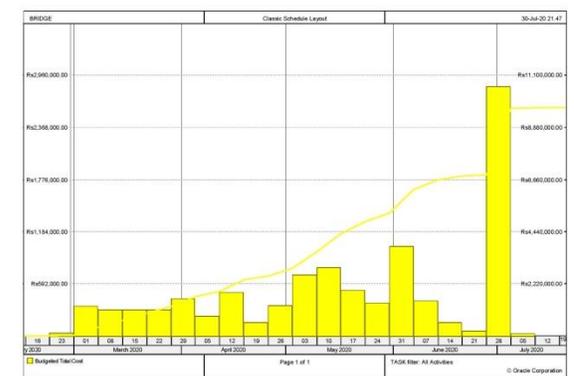


Fig.5 ACTIVITY USAGE PROFILE

6.1.6 RESOURCE USAGE PROFILE

Use the Resource Usage Profile to analyze quantity or cost usage for resources or roles. We can view a resource's or role's cost and quantity data for a specific project.

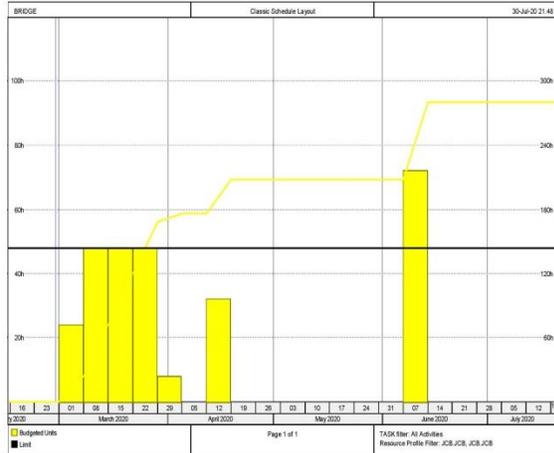


Fig.6 RESOURCE USAGE PROFILE

6.1.7 ACTIVITY USAGE SPREADSHEET

The Activity Usage Spreadsheet displays activity data in a spreadsheet format. View baseline budgeted or planned, actual, remaining, and at completion values or review information such as earned value cost, actual labor and non-labor units, and remaining total cost for the activities in your project.

BRIDGE	Activity Name	Original Duration	2020	2020	2020	2020	2020	2020
A1460	PINNING TWO COATS AFTER FILLING THE SURFACE WITH SPOKES TO CHANNEL FIBRE	2d					01-Jun-20	03-Jun-20
A1470	PROTECTING AND APPLYING TRUCK COAT WITH BITUMEN EMULSION	1d					03-Jun-20	03-Jun-20
A1480	PROTECTING AND LAYING BOLLERS AROUND CONCRETE	1d					04-Jul-20	04-Jul-20
A1490	CONCRETE	1d					04-Jul-20	04-Jul-20
A1500	FINISH	0d					05-Jun-20	05-Jun-20

BRIDGE	Budgeted Labor	Actual Labor	Remaining Labor	Planned Total Cost	Actual Total Cost	Remaining Total Cost
NEWPROJ-61 BRIDGE	204	2704	1800	1100	1600	720
NEWPROJ-61.1 PREPARATION OF SITE	204	2704	1800	1100	1600	720
A100 START						
A1000 UNDERWATER INSPECTION	240	240		862,000.00	862,000.00	
A1010 SHEETING	1000	320		363,280.00	231,280.00	132,000.00
A1020 CLEARING SITE AND GRUBBING ROADLAND	900			748,720.00	748,720.00	
A1030 TEMPORARY SHEETING	204			868,400.00	868,400.00	
A1040 COFFER DAM CONSTRUCTION	2240			1,172,160.00	1,172,160.00	

Fig.7 ACTIVITY USAGE SPREADSHEET

6.1.8 RESOURCE USAGE SPREADSHEET

Use the Resource Usage Spreadsheet to analyze quantity or cost usage for resources or roles. For every role and resource in the project, you can review cost or

quantity information for a specific project or for all projects across the enterprise (total allocation).

BRIDGE	Activity Name	Original Duration	2020	2020	2020	2020	2020
NEWPROJ-61 BRIDGE	NEWPROJ-61.1 PREPARATION OF SITE	2d					
A1500	CLEARING SITE AND GRUBBING ROADLAND	2d					03-Mar-20
A1510	COFFER DAM CONSTRUCTION	2d					03-Mar-20
A1520	EARTHWORK RECALCULATION	4d					14-Apr-20
NEWPROJ-61.3 SUPER STRUCTURE	NEWPROJ-61.3.1 SUPER STRUCTURE	5d					
A1550	PROTECTING AND LAYING BOLLERS AROUND CONCRETE	4d					08-Jun-20
A1560	INSTALLING FIBRE REINFORCING WALL AND CURB WALL	5d					08-Jun-20

B&C Resources	Start	Finish	Remaining Units	2020	2020	2020	2020
A1500	03-Mar-20	03-Mar-20	20h				
A1510	03-Mar-20	03-Mar-20	16h				
A1520	07-Mar-20	30-Mar-20	100h				
A1550	08-Jun-20	11-Jun-20	32h				
A1560	08-Jun-20	13-Jun-20	40h				

Fig.8 RESOURCE USAGE SPREADSHEET

VII. DEVELOPMENT OF INTEGRATED SYSTEM (PRONTO)

Resources are required to carry out the project tasks. Resources can be labour, non-labour, and materials required for the completion of a project activity. In the primavera software, before assigning the resources, we have to define the resources and assign to each activity. While defining the resources, we have to add resource name, resource type and resource units. Then assign the activities. In the primavera software, if we want to manage the cost of the project by replace or adding resources, we have to define the resources and assign the activities. And have to repeat the procedure from stage one and it will consume more time. In my project a solution for it has been found by developing an integrated system (PRONTO). If it is added to the primavera software, replacing and adding resources to the activities will become easier and can be done at any stage of the project.

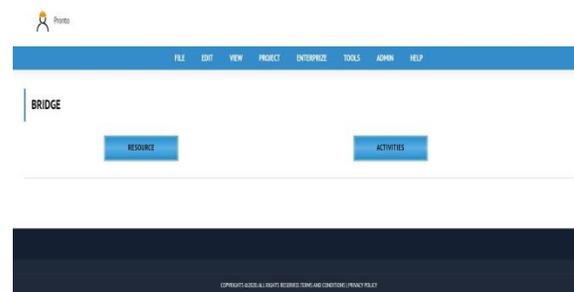


Fig.9 PRONTO home page

Fig.9 shows the PRONTO home page. This page consists of two options such as Resources and

Activities. Using these two options, we can add or replace the resources at any stage of project process.

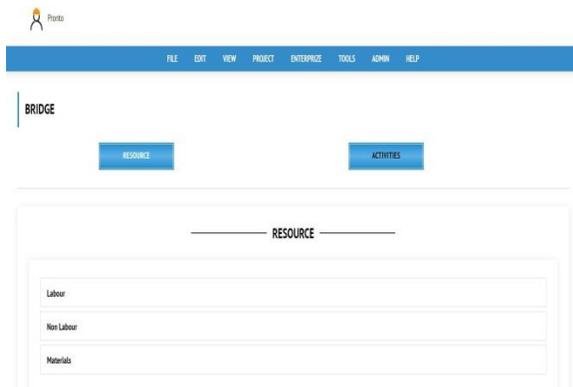


Fig.10 Resources

Fig.10 shows the list comes under Resource options. Resources like Labour, non-labour and materials can be changed at this stage.



Fig.11 Subtopics under each resource Fig.11 shows the subtopics under each resource

RESOURCE	Activity Name	Start	Original Duration	Finish
NEWPROJ-61 BRIDGE		29-Feb-20	110d	09-Jun-20
NEWPROJ-61.1 PREPARATION OF SITE		29-Feb-20	34d	04-Jun-20
A1001	ESTABLISH	29-Feb-20	6d	
A1002	UNDERWATER INSPECTION	29-Feb-20	14d	23-Feb-20
A1010	SHEETPIILING	02-Mar-20	20d	03-Mar-20
A1003	CLEARING SITE AND GRUBBING ROADLAND	02-Mar-20	20d	03-Mar-20
A1030	TEMPORARY SHIELDING	04-Mar-20	3d	06-Mar-20
A1004	CONCRETEWORK CONSTRUCTION	07-Mar-20	20d	26-Mar-20
A1005	FORMING AND BRACING BY PLACING SAND BAGS	31-Mar-20	10d	10-Apr-20
A1006	CONSTRUCTION OF SERVICE ROAD	31-Mar-20	6d	06-Apr-20
A1070	BALING OUT WATER FROM COFFERDAM	11-Apr-20	2d	13-Apr-20
A1071	FINISH	06	13-Apr-20	
NEWPROJ-61.2 SUB STRUCTURE		14-Apr-20	40d	23-May-20
A1075	START	14-Apr-20	0d	
A1080	EXCAVATION IN EXCAVATION	14-Apr-20	4d	18-Apr-20
A1090	M40 GRADE RECEIPIBLE	18-Apr-20	14d	18-Apr-20
A1100	PROVIDING STEEL LINER AND SLATE	20-Apr-20	14d	20-Apr-20
A1110	PROVIDING LAYING OF PCC	21-Apr-20	14d	21-Apr-20
A1120	SHUTTLING FOR PILE CAP CONCRETING	21-Apr-20	2d	23-Apr-20
A1130	CONCRETING OF PILE CAP	23-Apr-20	14d	23-Apr-20
A1140	CURING	24-Apr-20	7d	01-May-20
A1150	REMOVAL OF SHUTTLING	02-May-20	14d	02-May-20
A1160	FITTING AND PLACING UNGRADED HYSD BARR IN FOUNDAT	02-May-20	3d	05-May-20
A1170	SHUTTLING FOR FOUNDATION	05-May-20	2d	07-May-20
A1175	PLAIN PCC IN SUB STRUCTURE FOUNDATION	08-May-20	5d	13-May-20
A1180	SUPPLYING FITTING AND PLACING HYSD BAR IN SUB STR	14-May-20	2d	15-May-20
A1190	SHUTTLING FOR PIER	15-May-20	2d	17-May-20
A1200	CONCRETING OF PIER CAP	19-May-20	1d	19-May-20
A1210	CONCRETING OF PIER	19-May-20	1d	19-May-20
A1220	CONCRETING OF WING	19-May-20	1d	19-May-20
A1230	CONCRETING OF HANDRAIL BOTTOM	19-May-20	1d	19-May-20
A1240	CONCRETING OF HANDRAIL TOP	19-May-20	1d	19-May-20
A1250	CONCRETING OF HANDRAIL VERTICAL	19-May-20	1d	19-May-20
A1270	FURISHING AND PLACING PSC GRADE M40	20-May-20	14d	20-May-20
A1280	CURING	21-May-20	7d	28-May-20
A1290	REMOVAL OF SHUTTLING	28-May-20	14d	28-May-20
A1295	FINISH	01	28-May-20	
NEWPROJ-61.3 SUPER STRUCTURE		30-May-20	25d	27-Jun-20
A1297	START	30-May-20	0d	

Fig.12 Activity table

Fig.12 shows the Activity table of non-labour resource. Select any activity to add or replace. Here, an activity — Earthwork in Excavation is selected from the table.

A1320	HIGH TENSILE STEEL WRESTRANDS	02-Jun-20	2d	03-Jun-20
A1330	SUPPLYING AND FIXING ELASTOMER PAD	02-Jun-20	1d	02-Jun-20
A1340	DRAINAGE SPOUTS	04-Jun-20	3d	06-Jun-20
A1350	PROVIDING AND LAYING BOULDERS APRON ON RIVER BE	08-Jun-20	4d	11-Jun-20
A1360	BACK FILLING BEHIND ABUTMENT WING WALL AND RETU	08-Jun-20	5d	12-Jun-20
A1370	SHUTTLING FOR PCC BELOW APPROACH SLAB	08-Jun-20	2d	09-Jun-20
A1380	CONCRETING FOR PCC BELOW APPROACH SLAB	13-Jun-20	1d	13-Jun-20
A1390	SHUTTLING FOR SLAB	15-Jun-20	2d	16-Jun-20



Fig.13 Add or Replace

Below activity table, we have two options such as 'ADD' and 'REPLACE'. Click on the desired option to meet our requirement.

Item	Rate
Power Shovel	- 350
Back Hoe/JCB	- 900
Drag Line	- 600
Clam Shell	- 800
Trenching machine	- 650
Hoist	- 1500

Fig.14 List of Replaceable items

Fig.14 shows the list of replaceable items comes under Replace option. Select the item that has to be replaced with.

By using integrated system PRONTO, we can skilfully manage the cost of the project any stage of construction process.

A. BENEFITS

- To eliminate differences between the cost estimation and cost control processes.
- To reduce the cost uncertainties in construction projects.
- To integrate cost estimation and cost control processes.
- To provide a new way of managing cost in a project delivery.
- To solve poor communication of information linkages that traditional cost management methodology produces.
- To satisfy better client's needs.
- Seeks to make cost a driver for design, thereby reducing waste and increasing value.
- To improve manager's and project team's performance.

VIII. CONCLUSION

This work examined and developed an integrated cost management system for project delivery. Essential feature has been concluded and an integrated cost management system has been developed through the methodology adopted to meet the research objectives. The integrated cost management system enables the identification and solution of the problems of poor linkages that predominate in the use of traditional cost management methods. The main conclusions are strongly connected with the objectives of the research, providing valuable information for future researchers and professionals. It is a valid guide for all the project managers and upper management within companies, as it supports the decision making in any stages of the project. The contribution of the cost management system is immense in the completion of delivering construction projects. Integrated cost management system is a decision-making tool for all project managers and upper management offering continuous support in all the stages of a project's life cycle.

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