

**INTEGRATION AND DEVELOPMENT OF CONSTRUCTION ERP
SOFTWARE**Sagar R Hasabe¹. Dr. G.A. Hinge²¹ ME Civil (Construction Management) Second year Student, Civil Engg. Dept.,
TSSM's Bhivarabai Sawant College of Engineering & Research, Narhe, Pune.² Dr.G.A.Hinge, Civil Engg. Dept., TSSM's Bhivarabai Sawant College of Engineering & Research, Narhe, Pune.

Abstract— Enterprise resource planning (ERP) integrates internal and external management information across an entire organization, embracing finance/accounting, manufacturing, sales and service, customer relationship management, etc. ERP systems automate this activity with an integrated software application. Its purpose is to facilitate the flow of information between all business functions inside the boundaries of the organization and manage the connections to outside stakeholders. ERP systems can run on a variety of hardware and network configurations. It is necessary for the construction enterprises to efficiently manage their functioning and address the customer requirements by balancing the functioning of individual departments in the construction enterprise. Construction ERP is an ultimate solution to manage entire enterprise under a single roof. This will only automate the functioning of Construction Company. This paper aims to study various ERP softwares for manufacturing and construction industry with in depth study of ERP software which is exclusively developed for Indian Construction industry. Implementing an ERP for Construction Enterprise is the current need of construction market. Since the functioning of the construction enterprise is different from other domain industries. There is a need to develop a specific construction enterprise oriented ERP.

Keywords — ERP, construction, resource planning;

I. INTRODUCTION

Enterprise resource planning (ERP) is a category of business-management software-typically a suite of integrated applications—that an organization can use to collect, store, manage and interpret data from many business activities. ERP provides an integrated view of core business processes, often in real-time, using common databases maintained by a database management system. ERP systems track business resources—cash, raw materials, production capacity—and the status of business commitments: orders, purchase orders, and payroll. The applications that make up the system share data across various departments.

(Manufacturing, purchasing, sales, accounting, etc.) that provide the data. ERP facilitates information flow between all business functions, and manages connections to outside stakeholders. [7] The ERP system is considered a vital organizational tool because it integrates varied organizational systems and facilitates error-free transactions and production. [8]

II. OBJECTIVE AND SCOPE

The scope of this paper is to study and implement construction ERP software for an organization. The objective of this paper is mentioned point wise as follows:

- a) To study scope of ERP softwares in Construction Industry.
- b) To analyze process flow of ERP softwares in construction.
- c) To implement the ERP system and study the success factor for ERP software.

III. LITERATURE REVIEW**3.1 Characteristics of ERP**

ERP (Enterprise Resource Planning) systems typically include the following characteristics:

- An integrated system that operates in (or near) real time without relying on periodic updates. [5]
- A common database that supports all applications.
- A consistent look and feel across modules.
- Installation of the system with elaborate application/data integration by the Information Technology (IT) department provided the implementation is not done in small steps. [2]

3.2 Functional areas of ERP

An ERP system covers the following common functional areas. In many ERP systems these are called and grouped together as ERP modules:

1. Financial accounting: General ledger, fixed asset, payables including vouchering, matching and payment, receivables cash application and collections, cash management, financial consolidation. [5]
2. Management accounting: Budgeting, costing, cost management, activity based costing
3. Human resources: Recruiting, training, rostering, payroll, benefits, 401K, diversity management, retirement, separation.
4. Manufacturing: Engineering, bill of materials, work orders, scheduling, capacity, workflow management, quality control, manufacturing process, manufacturing projects, manufacturing flow, product life cycle management. [9]
5. Order Processing: Order to cash, order entry, credit checking, pricing, available to promise, inventory, shipping, sales analysis and reporting, sales commissioning.
6. Supply chain management: Supply chain planning, supplier scheduling, product configurator, order to cash, purchasing, inventory, claim processing, warehousing (receiving, put away, picking and packing). [5]
7. Project management: Project planning, resource planning, project costing, work breakdown structure, billing, time and expense, performance units, activity management. [6]
8. Customer relationship management: Sales and marketing, commissions, service, customer contact, call center support — CRM systems are not always considered part of ERP systems but rather Business Support systems (BSS). [3]
9. Data services: Various "self-service" interfaces for customers, suppliers and/or employee.

Enterprise Resource Planning System (ERP), just by considering name we can simply define ERP as System or software that used to manage all the resources of whole enterprise. Right from employee payments to single screw coming into the enterprise, everything can be managed & tracked by using ERP Systems. ERP is a cross functional software that supports all the business processes within the organization. [11] In organization, ERP helps to manage business processes of various departments & functions through centralized application. We can make all the major decisions by screening the information provided by ERP. There are many vendors in market which are providing traditional ERP solutions or Cloud based ERP solutions. [11] Though implementation platforms or technologies are different, there are common & basic modules of ERP which can be found in any ERP System. Depending on organizations need required components are integrated & customized ERP system is formed. All the below mentioned modules can be found in any ERP system:

- Human Resource
- Sales & Marketing
- Purchase
- Finance & Accounting
- Customer Relationship Management(CRM)
- Engineering/ Production

3.3 Overview and Development

SAP ERP was built based on the former SAP R/3 software. SAP R/3 through version 4.6C consisted of various applications on top of SAP Basis, SAP's set of middleware programs and tools. When SAP R/3 Enterprise was launched in 2002, all applications were built on top of the SAP Web Application Server. Extension sets were used to deliver new features and keep the core as stable as possible. The Web Application Server contained all the capabilities of SAP Basis. [11]

As a result of marketing changes and changes in the industry, new versions of SAP have been released. The first edition of my SAP ERP was launched in 2003 and bundled previously separate products, including SAP R/3 Enterprise, SAP Strategic Enterprise Management (SEM) and extension sets. The SAP Web Application Server was wrapped into NetWeaver, which was also introduced in 2003. [3]

A complete architecture change took place with the introduction of my SAP ERP edition in 2004. R/3 Enterprise was replaced with the introduction of ERP Central Component (SAP ECC). The SAP Business Warehouse, SAP Strategic Enterprise Management and Internet Transaction Server were also merged into SAP ECC, allowing users to run them under one instance. Architectural changes were also made to support enterprise service architecture to transition customers to a services-oriented architecture.

Enterprise resource planning ~ERP! was originated in the manufacturing industry. It provides a general working environment for an enterprise to integrate its major business management functions with one single common database so that information can be shared and efficient communications can be achieved between management functions. [6] Based on the needs of running a construction enterprise, ERP shows its potential for the construction industry. [6]

However, the unique nature of the industry prevents a direct implementation of existing ERP systems, which are primarily developed for the manufacturing industry. This paper underlines the importance of the establishment of the basic theory for developing construction enterprise resource planning systems A CERP must address the nature of the general industry practice. [6] Fundamental features are identified and discussed in the paper. Three- tiered client/server architecture is proposed, with discussions on the functions and major components of each tier. Needed research issues are discussed, including CERP architectures, project management functions, advanced planning techniques, standardization of management functions, and modeling human intelligence. [6]

Several areas for future research seem promising looking after literature review. One area is the education of ERP. After several years of active ERP education due to some vendor sponsored university programs, a significant amount of experience must have been accumulated. It might be a time for teacher-scholar to reflect on their experiences and begin

publishing for common good. Another interesting area is to assess the current status of ERP with international collaboration. Most articles that attempted to capture differences between different cultures or nations are limited to one or two of those. A large scale, simultaneous survey studies might generate useful insights on this subject. The concept of ERP seems to be growing and expanding. It will be useful to investigate topics such as how the companies using the ERP system perceive this trends, how they will cope with the changes, what tools, methodologies, models are useful in their expansion efforts, etc.

More literature review articles are expected as the field becomes more mature. Even though this article reports all the articles on ERP without any screening process, more selection criteria can be applied to reduce the number of articles for a different kind of review.

The ERP research community is diverse and comprehensive. The field is truly multi-disciplinary and inter-disciplinary. In a relatively short period of time, the researchers have contributed so much to the field that newer topics are now covered from various points of view.

3.4 CASE STUDY-SAP ERP SYSTEM

The primary functions of Enterprise Resource Planning (ERP) are to integrate the inter-departmental operation procedures and Management Information System (MIS) modules, and to reallocate the resources of a company. [10] How to successfully implement an ERP system in an organization is always a hot research topic for researchers as well as a pending problem for an organization that wants to implement it. This research is a case study on the selection of system suppliers and contract negotiation during the ERP implementation of a local construction company in Taiwan. After reviewing the common key success factors discussed in the literature, this study discussed seven issues: coding system, working process reengineering, priority of ERP functionality implementation, customization, participant roles, consultant role and performance level of subcontractor, which also affected the implementation. [2]



Figure 1- Construction ERP System

3.5 SAP ERP Software

SAP is India's first Construction ERP; a specialized Internet Ready software solution popularly known as ERP for Construction, Contracting & Real Estate industries. In simple words an ERP is the integrated software solution encompassing all the functional departments of the enterprise. SAP consists of integrated functions of Accounts & Finance management, Sales, Marketing & CRM Management, Project Estimation, Planning, & Project Management, Purchase, Store & Inventory Control, Labour Contract Management, Human Resource Management, Quality Control, Lease & Mall Management, Tender & Billing Management and Fixed Asset Management. All the above functions share common data thus makes the organization homogenous. [3]

SAP is a specialized Enterprise Resource Planning (ERP) system catering the Construction industry. Being modular, the ERP caters to all the departments running on a centralized database. The built in business processes following standard practices, enhances the products capability in efficiently managing the company's operations, thus improving their bottom line. The user friendliness of this package facilitates the users to efficiently use the ERP system, thus generating the right kind of MIS reports for the management. Its feature rich integrated functions of Accounts & Finance Management, Sales & Marketing Management, Project Estimation & Planning, Purchase & Inventory Control, Contracting Management, Human Resource Management, Quality Control, Lease & Mall Management, and Tender Management formulates the ERP to be the most preferred system. The product has been developed considering security, scalability and customizability aspects in accordance to the technological compliance for today and tomorrow's needs. The system can be hosted centrally with provision to access through internet from any location, thus offering a real time view on the data transaction. The multi-level configurable security facilitates to link the Head office, Branch offices and the sites seamlessly either through Internet or company's Intranet. [10]

The Business Intelligence derives the right kind of MIS statements and the graphical dashboards provides the management the tool to take timely decisions real time. 'SAP' is very useful for Townships, SEZ's, Residential, Commercial, Infrastructure & Turnkey Projects. Being modular, its various versions meet the requirements of Large, Mid-size and Small businesses.

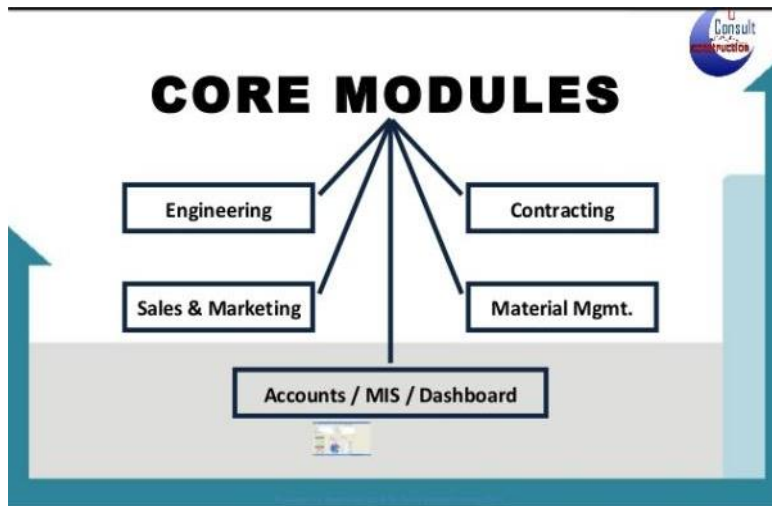


Figure 2- SAP ERP Core Modules

3.5.1 Engineering Module

SAP is a generalized Accounts & Finance Management Software useful for any Industry. It can work in integral fashion with departments of the enterprise like Sales & Marketing, Projects & Planning, Purchase, Contracts, Human Resource, Quality Control, etc. This software is capable to handle large number of concurrent users and huge volume of data.

The processes involved are:

- Define project, WBS
- Defining Rate analysis
- Estimation (directly converting CAD drawings)
- Re-estimate & maintain versions
- Project scheduling (using PERT / CPM) & planning
- Project costing & budgeting
- Computation of activity-wise and material-wise variance for quantity & Cost
- Incorporation of quality checks using quality check lists at task level

Business Benefits:

- Centralized document management & monitoring
- Accurate estimates
- Better change management & control management
- Accurate project planning, execution & monitoring
- Better & timely management directions; Real time available of data
- Timely alerts & escalations for any abnormal behavior; avoid postmortem
- Timely project completions with quality control

3.5.2 Material Management Module

With regards to the operations & execution of projects, the focus of any construction industry is on the material movement. Being a very large capital intensive industry, it is the requirement of every management to control and monitor the movement of materials at any given point of time.

The modules involved here are the Site Management and the Purchase Management, where there is complete transparency between these two entities.

The processes involved at the site are:

- Generation of requisition / indent based on the project plan defined
- Generation of Goods Receipt Notes (GRN's) from site (via internet); either against a Purchase Order, Work Order, Cash based purchases, and / or from other sites
- Generation of issue slips from site (via internet); as per the requirements
- Stores management – tracking all GRN's & issues
- Stock reconciliation

The processes involved at the Centralized Purchasing Dept. are:

- Verifying the requisition against estimation, project plan & accordingly process it
- Supplier registration & grading
- Handling material requisition / indents from site (via internet)
- Cross comparison against estimates before approval
- Floating enquiry & receiving quotations; Generate comparative statements
- Generate purchase & transport orders along with all the taxation

- Generation of import orders
- Checking & passing of material & transport bills
- Inventory control – using FIFO, LIFO, FEFO Recorder levels etc.
- Receiving goods either against a Purchase Order, Work Order, Cash based purchases, and / or from other sites

Business Benefits:

- Define strategic purchase controls
- No manual intervention; avoid unnecessary delays in material procurement
- Up to date & better pricing
- Timely escalation of issues
- Centralized document management & monitoring
- Complete and real time Material Management; from Estimation to Indent to Purchase to Delivery to Issue with checks & controls

There are more than 100 major construction suppliers available in Thane city region. This paper has limited its research on 122 major suppliers and is restricted to only sand and cement owing to its importance and availability. Data collection included personal information of suppliers like name and address, details of materials like cost, brand, quarry source, available stock, lead time, discount, and transportation, guarantee, for safety, test certificates etc.

IV. ADVANTAGES OF SAP ERP

The fundamental advantage of ERP is that integrated myriad business processes saves time and expense. Management can make decisions faster and with fewer errors. Data becomes visible across the organization. Tasks that benefit from this integration include:

- Chronological history of every transaction through relevant data compilation in every area of operation. [5]
- Revenue tracking, from invoice through cash receipt
- Matching purchase orders (what was ordered), inventory receipts (what arrived), and costing (what the vendor invoiced)
- ERP systems centralize business data, which:
- Eliminates the need to synchronize changes between multiple systems—consolidation of finance, marketing, sales, human resource, and manufacturing applications
- Brings legitimacy and transparency to each bit of statistical data
- Provides a comprehensive enterprise view (no “islands of information”), making real-time information available to management anywhere, any time to make proper decisions. [7]
- Protects sensitive data by consolidating multiple security systems into a single structure.

V. RESULT

A large scale, simultaneous survey studies might generate useful insights on this subject. The concept of ERP seems to be growing and expanding. It will be useful to investigate topics such as how the companies using the ERP system perceive this trends, how they will cope with the changes, what tools, methodologies, models are useful in their expansion efforts, etc.

VI. CONCLUSION

- Integration and Development of Construction ERP can solve coordination and Project management issues arising due to fluid nature of Construction projects.
- Various projects within company can be brought at one platform, enhancing speedy & efficient decision making. Mathematical modelling creates basic framework which can be used in any similar organization.
- It enriched the project profitability by 7.95% at Pre-start estimate level against Tender costing due to current market scenario report generated through SAP.
- Periodical tracking of budget is narrowed to real time tracking, creating chances for identifying project loopholes at root cause level.
- Project timeline duration is reduced by 9.5% against Tender schedule by real time monitoring & mitigation planning.

VII. FUTURE SCOPE

Integration of all construction process & activities into SAP ERP software will eliminate chances of errors and increase in profitability of organization. Development of ERP software for small and medium size organization can yield good results in the field of project cost and progress monitoring.

REFERENCES

- [1] Amy A. Kim, Hessam Sadatsafavi, M. Kim Soucek Y. (2016). "Effective Communication Practices for Implementing ERP for a Large Transportation Agency" ASCE Journal of Management in Engineering, 32(3).
- [2] Mirosław J. Skibniewski, Saumyendu Ghosh (2009) "Determination of Key Performance Indicators with Enterprise Resource Planning Systems in Engineering Construction Firms" ASCE Journal of Construction Engineering and Management, 965-978.
- [3] BooYoung Chung, Mirosław J. Skibniewski, Young Hoon Kwak, (2009). "Analyzing Enterprise Resource Planning System Implementation Success Factors in the Engineering–Construction Industry" ASCE Journal of Construction Engineering and Management, 202-216.
- [4] Boo Young Chung, Mirosław J. Skibniewski, Henry C. Lucas Jr., Young Hoon Kwak, (2008). "Analyzing Enterprise Resource Planning System Implementation Success Factors in the Engineering–Construction Industry" ASCE Journal of Computing in Civil Engineering, 373-382.
- [5] Omer Tatari¹; Daniel Castro-Lacouture, Mirosław J. Skibniewski (2008) "Performance Evaluation of Construction Enterprise Resource Planning Systems, ASCE Journal of Management in Engineering. 4-198-206.
- [6] Jonathan Jingsheng Shi, Daniel W. Halpin, (2003). "Enterprise Resource Planning for Construction Business Management" ASCE Journal of Construction Engineering and Management, 2-214-221.
- [7] Jyh-Bin Yang, Chih-Tes Wu, Chiang-Huai Tsai, (2007). "Selection of an ERP system for a construction firm in Taiwan: A case study" AC Journal of Automation in Construction, 926.
- [8] Andrejs Tambovcevs (2010) "ERP SYSTEM IMPLEMENTATION : A CASE STUDY OF THE CONSTRUCTION ENTERPRISE, EM Journal of Economics & Management.
- [9] HANS VOORDIJK, ARJEN VAN LEUVEN and ALBERTUS LAAN, (2003). "Enterprise Resource Planning in a large construction firm: implementation analysis" Journal of Construction Management and Economics, 21-511-521.
- [10] SANDESH GUPTA, (2010). "High-rise ERP Software Analysis", Journal of Construction Management and Economics.
- [11] VIJAY NAIR, (2012), "Implementation of SAP ERP in construction organization' SPARK Journal, SPCPL, Oct 2012