Supply Chain Management of Flyover Construction

Hrushikesh S. Londhe[1], Dr. Purushottam S. Dange[2].

[1]*ME Student, Department of Civil Engineering, Dr. D.Y.Patil Institute and Technology Pimpri, Pune, India*

[2]*Professor, Department of Civil Engineering, Dr. D.Y.Patil Institute and Technology Pimpri, Pune, India*

Abstract- Supply Chain Management is a proven concept in the manufacturing industry and has to come along way in the construction industry. In the Indian construction industry, which is still considered sector, Supply chain management can be implemented with considerable improvements in the material flow and overall cost of project. In construction, procurement and procurement related activities occur during all phases of a construction project. Because of inevitable complexity and fragmentations of the construction process, suppliers of resources like equipment, labour, material and other services may not be always available on time, in right amounts and in the desired quality and price. An overall management process like supply chain management is essential to monitor and control all such logistic activities.

The aim of this dissertation is to reduce the cost of project by using SCM model. To study the feasibility of this model, a case study has taken from Pune city to achieve this aim. The case study is construction of flyover at Pune. In this study, a qualitative analysis has done by direct observation on site and interview with the technical staff of both consultant as well as contractor. The case study assesses the supply chain of the project in detailed, finding the problems in supply chain, highlighting the effect of these problems on supply chain. Finally a proposed supply chain is suggested to the contractor, so that he can save the cost of materials as well as lead time giving benefits and limitations of reduction of suppliers.

Keywords- Construction Supply chain management, JIT (Just in time), profitability, cost overrun, time overrun.

I. INTRODUCTION

Supply chain management was born in the manufacturing industry in the 1988 at Shingo with the Just in Time (JIT) delivery system implemented in Toyota (Vrijhoef and Koskela, 1999)[11], with the main aim of reducing inventories and regulating suppliers' interaction with the production lines. The main implementation of SCM was to standardize the supplies to the Toyota car manufacturers. The outcome of this implementation in Toyota car manufacturers was significant in the context of time and money. It enhances the supplier's communication with production line. With the successful implementation of SCM by Toyota, Japanese industry absorbs SCM as a tool in a short duration, with this adoption SCM become important topic for the researcher too and researchers try to find the possibility of SCM as a tool in different industry domains (Chevin and Cook, 2000) in parallel to SCM different new approaches also emerged for example value chain and extended enterprise. These concepts also affect the understanding of SCM in the industry.

II. PURPOSE OF THE CASE STUDY

The construction of Flyover construction requires more time and money. In Pune city, more than ten projects of flyover construction are going on and also some will yet to start. By concerning this fact flyover construction have chosen as an infrastructure for implementing SCM.

In Pune city, most of the flyover projects get in loss due to improper and inefficient management of resources. After observing most of the project, the contractors adopted a traditional supply chain used in most projects. As a result of this traditional supply chain, the project will suffer from delay and increase in the project cost. To deal with the shortcomings of the traditional supply chain and to look into the obstacles for implementation of proper SCM concept, this study is conducted in particular to fast growing city in Pune. . The study focuses on SCM concept concerning flyover project in Pune, its adopted SCM patterns, and providing suggestions for its possible future usage.

III. OBJECTIVES OF THE CASE STUDY

Following on the objective of the study

i. To study the conventional SCM in a flyover construction project.
ii. To identify shortcomings in traditional SCM used in a flyover construction by field survey.
iii. To propose the methods of making the current supply chain more effective and efficient.

IV. SCOPE OF THE STUDY

The scope and extent of this study is a detailed study of the concept of Supply Chain Management and its application in flyover construction . the SCM also highlights the key benefits of Supply Chain Management demonstrating the advantages of Supply Chain Management by illustrating a live case study and to develop a plan which would help companies implement an effective Supply Chain Management in their organization.

Supply chain management is a relatively new concept in construction industry. A few companies have implemented Supply Chain Management in India. Our aim is to develop a template which would help an organization to successfully implement Supply Chain Management.

V. AIM OF THE STUDY

The aim of this study is to improve the effectiveness and efficiency of the traditional supply chain management adopted by the contractors in costruction of flyover to overcome delay & increase in the project cost. The intension of this study is to find out the awareness of the industry in the use of SCM and the obstacles faced by the industry and benefits which can be realized in proper implementation of this concept.

VI. LIMITATIONS OF THE STUDY

In this study, the main focus is on flyover construction in Pune city. For achieving objectives of the study, a one case study has been undertaken and analyzed in detail. Furthermore, for achieving economy to the flyover project, this study mainly concentrates selected material only.
The study focuses only on flyover construction.
The materials like cement, sand, aggregate, steel, admixtures & diesel.

VII. LITERATURE SURVEY

1.1 Introduction

This chapter deals with the review of the research and study carried out by various researchers on the subject of SCM. This literature is taken from online journals, technical websites and conferences. Around 25 technical research papers have been referred to carry out the thesis work.
This chapter covers the concept of SCM, measuring supply chain cost, cost saving from SCM, the roles of SCM in construction industry, SCM in building and construction industry, SCM relationships in construction, JIT production Systems, barriers in implementing SCM, a survey of supply chain collaboration & management in UK construction industry, supply chain modeling using simulation, coordination mechanism for construction SCM in the internet environment, global SCM, improving SCM in construction, the role of supply chain in construction industry, SCM literature review and some issues, Clients and their suppliers, E-commerce technology used in SCM, application of SCM etc. taken from journals and various papers.

1.2 Concept of SCM

Supply Chain Management (SCM) is a concept originating from the supply system by which Toyota was seen to coordinate its supplies and manages its suppliers. The basic concept of the SCM includes tools like Just-In-Time (JIT) and logistics management. The current concept of the SCM is somewhat broader but still largely dominated by logistics (Vrijhoef and Koskela, 1999).
SCM deals with the management of materials and information resources across a network of organizations that are involved in the design and the production process. It recognizes the inter-connection between materials and information resources within and across the organization boundaries and seeks systematic improvement in the way these resources are structured and controlled (Trucker and Mohammed, 2001). The objective of supply chain management is to be able to have the right products in the right quantities at the right place at the right moment at minimal cost.
The focus and attention in this study are given to the materials since it forms a large portion of the total cost of a construction project. In addition, materials are essential for the daily progress of a construction project. The absence of materials when needed is one of the main causes of loss of productivity in a job site. Therefore, contractors have to manage their materials efficiently to lower cost in order to remain in business. They should select reputable suppliers, tracking the materials to identify when materials need to be ordered based on the actual usage of materials on site and progress of the work, dealing on site with materials handling, storage, misplacement and handling of materials surplus.

Joko Sulistio et al. [1] The negative effects of environment climate change caused by industrial activities are inevitable. It forces countries around the world to seek more eco-friendly industrial management system. A great shift of supply chain management already takes place in whole process of purchasing raw material to the end costumer. The objective of this paper firstly is to provide a focused literature review of multi-stage green supply chain management, and secondly to define a future research agenda in this area. The proposed structure follows the systematic literature review approach. It involves four major phases: 1) Selecting a review topic, 2) Searching the literature, 3) Gathering, reading and analyzing the literature, and 4) Writing the literature review. The paper concludes by providing a focused literature review and firmly defines several future research opportunities. A lack of advance mathematical modeling exhibits as well as a complex system approaches because a multidimensional supply chain drivers not only limited from economic, social and economic for green supply chain management implementation that related to corporate and supply chain performance as a whole. Last but not least, operations and tactical level of strategy analysis are rarely applied in Green Supply Chain Management (GSCM) researches.

Amade.B et al. [2] Supply chain management (SCM) is a production based project delivery approach that has come to stay and help streamline all the experiences of extensive delays and abandonment that have bedeviled the Nigerian construction industry. The objectives of this study were to identify and evaluate the constraints to the application of SCM in the delivery of construction projects. The study adopted an exploratory research design method of investigation consisting of both quantitative and qualitative methods. A purposive and convenient sampling technique was deployed in selecting the sample size using the Krejcie and Morgan method. A semistructured interview, multiple case study, personal observation and questionnaire survey was carried out among four (4) construction firms located in Abuja, Lagos and Rivers State respectively. The questionnaires were used as the primary data collection instrument after they were pre-tested using a pilot study for validity and reliability. The data collected were analyzed using Severity Index (SI) and Cronbach's Alpha reliability with the aid of SPSS 17.0 version as well as a Microsoft excels programmed software. The study found that out of the 403 responses gotten on the twenty four (24) factors identified as constraints to the application of SCM in construction project delivery. The followings were identified as the most significant constraints; Lack of the understanding of SCM concept (SI=50.76), unclear strategic benefits (SI=50.52), dearth of trust within and outside an organization (SI=50.31), lack of a common standard for collaboration (SI=49.32) and failure to broaden the SC vision beyond procurement or product distribution (SI=48.12). The study recommends that a forum be created through workshops, conferences, face-to-face interactions to aid in understanding what the concept is all about. The study further recommends that effort should be made by the professionals, contractors, subcontractors and the likes to adopt the SCM techniques in the delivery of their construction projects to schedule, cost and quality objectives.

Priti Mishra et al.[3] Emerging project management methods for construction projects create new kinds of challenges for the delivery process of materials. The main motive behind introducing such methods is to create short-term schedules, based on a constraint analysis of resources. This approach has two requirements for material deliveries: transparency of material availability and short response times in the supply chain. We propose a potential solution for managing the material logistics of construction projects. The empirically validated solution proposes a shipment tracking-based approach to provide inventory transparency, and a pro-active delivery approach for efficient material deliveries.

Se-Hak Chun et al.[4] Recently, enterprises have started considering Green SCM (Supply Chain Management) for the purpose of securing a competitive advantage over other enterprises because of the increase of international conventions related to the recent climate change, the strengthening of global regulations for environment protection, the demand for environmental suitability by stockholders and investors of enterprises, and the consumer's preference for environmentally friendly products. Green SCM is emerging as the strategy to preemptively cope with environmental regulations. However, many small and medium enterprises are less aware of the necessity of its adoption and are not ready to adopt it. This study investigates green business activities of small-medium enterprises and examines differences across SCM processes.

Dhananjay Kumar Pandey et al.[5] Supply chain management (SCM) is the management of the flow of goods and services. It includes the movement and storage of raw materials, work-in- process inventory and finished goods from point of origin to point of consumption.

Supply chain management is an interconnected or interlinked network which deals with design , planning, execution ,control and monitoring of its chain activities. With a massive objective of creating net value, building a competitive infrastructure, leveraging world logistics, synchronizing supply with demand and measuring performance globally. (some reference)**SCM draws heavily from the areas like operation management, logistics, procurement, information technology and strives for an integrated approach. It actually deals with coordination and collaboration with its channel partners which are specifically the suppliers, the intermediaries, the third party service providers in sense their customers. This integrates supply and demand management within and across its channel. Supply chain management is an integrating function with primary responsibilities for linking major business functions and major business processes within and across its chain of companies to form a high performing and business model.

Souresh Bhattacharya et al.[6] The Indian automotive industry, comprising vehicle and component manufacturers, has grown steadily since the economic liberalization of the early 1990's. The arrival of major global auto companies has galvanised the domestic sector into adopting Supply Chain best practices. This has enhanced competitiveness leading to a quantum growth in exports. However, the Indian automotive industry has to operate in an unique environment further posing challenges to the already complex automobile supply chain. Therefore, a need is felt to continually study supply chain practices in this sector from a contemporary, practitioner's viewpoint in order to identify key factors of differentiation which would ultimately provide competitive advantage. This paper seeks to understand the present status, complexities and challenges facing the Indian automobile sector. It examines trends such as visibility and innovation, collaboration and supply networks and evolving leadership roles impacting supply chain effectiveness. Strategies for overcoming challenges are presented as also a framework for further study and analysis.

1.3 Measuring Supply Chain Cost

Gyaneshwar Singh Kushwaha et al.[7] The present work attempts to define the concept of Supply Chain Quality Management (SCQM) and develop a conceptual framework of SCQM after identifying the constructs of Supply Chain Management (SCM) and Quality Management (QM) practices through literature review. The framework proposes that the impacts of both SCM practices and QM practices would be evaluated in terms of competitive advantage and organizational performance. Further the competitive advantage would be measured on the parameters of price/cost, quality, delivery dependability, product innovation and time to market while organizational performance will be measured in terms of marketing, operations and finance. Findings: The framework will help the decision makers in making a comparison among three broad categories of organizations with regard to their competitive advantage and organizational performance which are pursuing only SCM practices, only QM practices and SCM & QM practices both. The main limitation of this research paper is the absence of empirical data.

1.4 Cost Savings from SCM

T.Subramani et al.[8] Supply chain management (SCM) is a concept that has flourished in manufacturing, originating from Just-In-Time (JIT) production and logistics. Today, SCM represents an autonomous managerial concept, although still largely dominated by logistics. SCM endeavors to observe the entire scope of the supply chain. All issues are viewed and resolved in a supply chain perspective; taking into account the interdependency in the supply chain.SCM offers a methodology to relieve the myopic control in the supply chain that has been reinforcing waste and problems. Construction supply chains are still full of waste and problems caused by myopic control. Comparison of case studies with prior research justifies that waste and problems in construction supply chains are extensively present and persistent, and due to interdependency largely interrelated with causes in other stages of the supply chain. The characteristics of the construction supply chain reinforce the problems in the construction supply chain, and may well hinder the application of SCM to construction. Previous initiatives to advance the construction supply chain have been somewhat partial. The construction industry has been slower than other industries to employ the Supply Chain Management (SCM) concept and develop models that support the decision-making and planning.

1.5 The Roles of Supply Chain in Construction Industry

Sudhir Yadav et al.[9] This paper explores the application of supply chain management (SCM) in the Indian construction industry. The authors studied the SCM practices followed in flyover projects and compared them with the seamless SCM model for construction proposed by a previous study. A case study approach was followed for the research work. Structured interviews were conducted to understand the SCM practices in flyover projects in India. The developed model advocates leading roles for client and strategic needs analysis and value management study that are missing in the studied projects. All of the projects studied faced cost and time overruns. The seamless SCM model may be extended to developing countries by incorporating requirements related to the long-term relationship between project agents and, if possible, by suggesting that clients should not select agents using only the minimal cost criteria. The extended model also proposes SCM training for all project agents before the start of the project. Strategic needs analysis and value management study should be an integral part of the construction project to improve project efficiency. Implementing the seamless SCM model calls for the early involvement (i.e., at the project design stage) of all project agents. Project sponsors can apply the findings of this study to manage time and cost overruns.

Sharadchandra V. Patil et al.[10] Construction components managing, usage and layout follow-up perform important role in construction sector which consequently demands thoroughly focus when designing venture plan. Products form a substantial part altogether cost of development project. The lack of resources whenever required is amongst the key reasons behind decrease of productiveness within a worksite. Current resources management routines in the construction sector are carried out on fragmented time frame with numerous complications encountered when controlling materials supply chain, particularly throughout construction stages. These complications are the key origin that leading to performance-related issues such as delay in materials purchasing and acquiring, low productiveness, expense and time period overrun, conflict and conflicts. Thus, this paper examines the analysis of supply chain management during construction phases for Maharashtra Region.

1.6 SCM Market in India

India had a Purchasing Power Parity (PPP) equivalent to US $ 1.5 trillion in 2008 and thus she constitutes one of the fastest growing markets of the world. The Growth Competitiveness Index survey conducted by the Geneva-based '* World Economic Forum(WEF) for 2006-07 puts India at the 43rd position among 125 countries in the Global Competitiveness Report and 27th in the Business Competitive Index. These factors, together with shortening of PLC, proliferation of product variety, low reliability of supply chain networks in India have forced companies to adopt SCM and associated systems and practices. However, lack of proper logistics framework, poor infrastructure support together with poorly designed supply chains with low efficiency leads are the major obstacles to reap full advantages through large scale implementation of SCM. This is also cited in UPS Asia Business Monitor Survey, 2004. Although latest figures are not available, figure estimated by Economic Times Intelligence Group (ET1G) in 2002 indicates the Indian market value for supply chain/ logistics at 13 per cent GDP, i.e., around Rs. 2, 35,000 crore, a large share of which is accounted for transportation, handling, and warehousing.

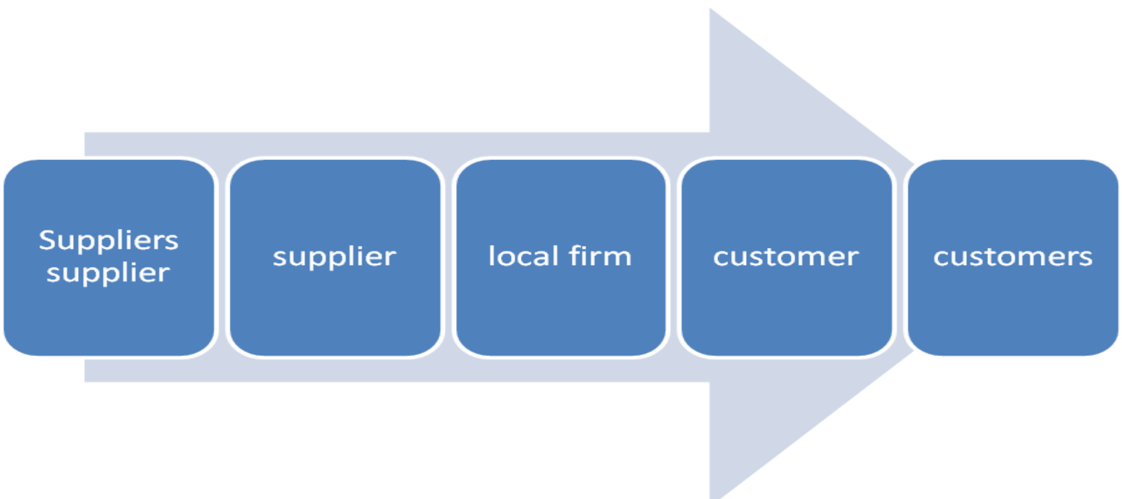
Though supply chain and logistics business in India is still at its infancy, there is tremendous potential ahead. The reason for the late start of supply chain and logistics business in India is that it took sometimes for Indian industry to stream-line and reorganizes their business processes and restructures their supply chain. According to an ETIG study, the state of the Indian industry in various SCM elements as compared with the state in the West and relevant focus.

In most industries, such as automobiles, fast moving consumer goods, consumer durables, foods, pharma, garments, paints, cement, and steel, SCM has been in the process of implementation or already been implemented or supply chains are being restructured and integrated, while in some other industries, the concept of SCM is yet to find takers. So, there is a lot of variability in terms of the extent of implementation of SCM in different industries in India.

2.7 Definition of Supply Chain Management

Let us first analyse the term and concept of a "Supply chain", as put forward by various scholars. Mentzer (2001) categorized and defined a supply chain as follows:

1. A 'basic supply chain' consists of a company, an immediate supplier, and an immediate customer directly linked by one or more of the upstream and downstream flows of products, services, finances, and information.
2. An 'extended supply chain ' includes suppliers of the immediate supplier and customers of the immediate customer, all linked by one or more of the upstream and downstream flows of the products, services, finances, and information.
3. An 'ultimate supply chain' includes all the companies involved in all the upstream and downstream flows of the products, services, finances, and information from the initial supplier to the ultimate customer.



1.8 SCM in Infrastructure Industry

The construction industry in general is highly fragmented with significant negative impacts — perceived low productivity, cost and time overruns, conflicts and disputes and resulting claims and time consuming litigations. These have been acknowledged as the major causes of performance related problems facing the industry

The legacy of this high level of fragmentation is that the project delivery process is considered highly inefficient in comparison with other industry sectors. Some of the consequences of the fragmentation problems include [Tucker et al, 2001][12].

• Inadequate capture, structuring, prioritization and implementation of client needs.
• The fragmentation of design, fabrication and construction data with data generated at one location not being readily reused downstream.
• Development of sub optimal design solutions.
• Lack of integration, coordination and collaboration between the various functional disciplines involved in the life cycle aspects of the project.
• Poor communication of the design intent and rationale, which leads to unwarranted design changes, inadequate design specifications, unnecessary liability claims, and increases in project time and cost.

2.9 Information Flow in Supply Chain Management

The key to Supply Chain Management is the information flows associated with inter organizational communications. As a result, a core issue is the effective management of information, both in the form of information flows that permit rapid inter organization transactions between supply chain partners, and in the form of information accumulated coded, and stored in an organization's database structures.

Construction Supply Chain Management can be regarded as the process or strategic management or information flow, activities, tasks and processes involving various networks of organizations and linkages, throughout a project lifecycle. The relationship between construction project participants is normally complex and invokes many parameters that extend across technical, functional, business, and human dimensions As a result, attention and focus must be given to the intensive collaborative among project participants to synchronize both the input and output of the supply chain. A key enabler to successful collaboration is the ability to communicate, and share and exchange project information in a timely and accurate manner. Project information is usually considered as the processed and presented data in a given situation and is the data that enables effective action. Information produced by many sources, at many levels of abstraction and detail and retained by the creator of that information, contributes to fragmentation of the construction industry.

Traditionally, project information exchange between designers and contractors has been mainly based on paper documents. These documents come in the form of architectural and engineering drawings, specifications and bills of quantities and materials. This practice is far from being satisfactory, with about two-thirds of construction problems being caused by inadequate communication and exchange of information and data. [Tucker et al. 2001][12].

VIII. CASE STUDY

A case study has carried out to check feasibility of SUPPLY CHAIN MANAGEMENT model, the details are as follows:-

2. CASE STUDY ON FLYOVER AT HADAPSAR

2.1 Basic information

Company Name-SGS India Pvt Ltd

Company Profile

Sector: Consumer Discretionary

Industry: Commercial Services

Sub-Industry: Other Commercial Services

S G S India Private Limited was founded in 2001. The company's line of business includes providing various business services.

Corporate Information

Address:

Mumbai, 400083 India

Phone: 0091-22257984

Fax: 0091-22257984

Project Name - Construction of bridge cum flyover connected to saswad at hadpasar pune.

Client- Pune Municipal Corporation, JNNURM -2

Date of Commencement- 03/01/14

Date of completion- 05/09/16

Estimate cost-Rs. 38,20,58,863/-

Percentage Quoted-7.2% above estimate cost

Tender cost-Rs. 28,10,48,863/- (+7.2% above)

2.2 Technical details

Key Features Of The Project :

Alignment over police station building without disturbing existing structure.

Existing bridge is used for both direction.

Multi-stories (two tier) flyover 1st in PMC.

Construction over Existing flyover

Various Types of Super Structures :

Box Girder- Cast in Situ

Precast I Girder + Launching

Fabricated I Girder

Curved Spans

Length of flyover (Viaduct): - Pune to Saswad – 525 M. Saswad to Pune – 192M

Length of Ramp: - Pune to Saswad – 87 M Saswad to Pune – 107 M

Land Acquisition; - Not required.

Type of procurement: - B 1 type tenders (Percentage rate)

Tender No 44/2010

Estimated Cost put to TenderRs 24, 99, 39,211/-

Period of Construction 24 Months Up to 27/07/2013.

Row –

Solapur road 45.00 M

Saswad road 30.00 M

Width of carriageway for proposed flyover :

Pune to Saswad 7.50 M (Two lane carriage way)

Saswad to Pune 7.50 M (Two lane carriage way)

Obligatory Spans

Pune to Saswad 5.50 M height on existing flyover Span 32.70 M on existing flyover

Saswad to Pune 5.50 M height Span 20.0 M

Gradient - 1:30

No of Piers:

Pune Saswad

For Connection to existing flyover

(Portal frame) 04 No

For Viaduct portion 16 No

Saswad Pune

For Viaduct Portion - 07 No

For Connection to existing flyover

(Portal frame) - 01 No

Total - 26 No

Ramp Portion Reinforced embankment with RCC fascia precast panels

Speed Limits 30 Km / hr

Superstructure PSC box girder including deck slab is 2500 mm height

Water Proof Membrane Hydro stop on Deck slab

Wearing course of DBM 50mm (DBM) Mastic - 25 mm

Type of bearing POT - PTFE bearing

Substructure Grade of concrete use M 30

Superstructure Grade of concrete use M 45

Road work: Sub grade thick. – 300 mm

GSB thick. – 250 mm

WMM thick. – 250 mm
DBM thick. – 75 mm
Bituminous concrete - 40 mm

2.3 Process Flow

2.3.1. Store Department

The store department controls and monitors the steel, diesel and hardware materials. The store department is situated 2 km from the working site. All the activities like Loading & unloading of steel, preparing & checking indent of steel, diesel and other hardware materials, data entry of materials on ERP software, checking and comparing the actual rate and market rate of materials.

The department is also maintaining the stock of steel, diesel in register book. There is separate register for different materials. The register includes available stock, date of issue and departure of material, Suppliers purchase order.

Store in charge is responsible for delivery of materials and maintaining the buffer stock of materials. The purchase order of the steel and diesel is drawn from Shivajinagar main office. All the rates and selection of suppliers are decided by main office. H.R manager of the main office decide the rates and select the suitable suppliers. Then they prepared purchase order of materials and send one copy of that to the store office. In store department, this purchase order is checked manually as well as on ERP software.

During steel work on site, the project manager gives the quantity of steel. Then the store in charge checks the buffer stock of steel and as per quantity, he check the quantity of steel and manage the delivery of steel as per drawing on site safely. The store supervisor handles the stock of materials, delivery and undelivered of material on store room.

2.3.2. Supply Chain of the Flyover Project

By observation on site, interview with the project engineer, site engineer and other personnel staff a detailed supply chain of the project is drawn and presented. The case study analyzes the different supply chains involved in the project. The case study applied to the part of supply chain coordinated by the main contractor. The case study assesses the supply chain in three parts i.e. material, labour and equipment.

2.3.3. Supply Chain Assessment

The supply chain of the project is assessed by direct observation, personal interview with the technical staff. While assessing the supply chain of project, mainly concentration is made on material department as material cost of project is about 65 % of total project cost.

Firstly with the help of the supply chain model of construction taken from the journal paper have studied in detailed. On the basis of that model, a supply chain model of the project was made containing the procurement chain and construction chain. After designing the supply chain model of project, a separate supply chain of the different materials are design and study in details. In this project, supply chain of the repetitive materials are take in to consideration i.e. Cement, Aggregate, Sand, Steel, Admixture and Diesel.

2.3.4. Material Chain

This chain is very important because material cost of the project is approximately 65% of total project cost. The proper and efficient management of material chain increases the profit of overall project. The material chain starts from raw materials, material producers, material suppliers/vendors, bidding of suppliers and finally material reach on site.

For the construction of flyover, a different materials are used i.e. repetitive and nonrepititive which are cement, sand, aggregate, admixture, steel, bearing plate, prestressing cables, expansion joint, etc. For assessing the material chain only a repetitive materials have taken into consideration i.e. cement, sand, aggregate, steel, admixture, diesel.

2.3.5. Cement Chain

The company uses ACC, Birla Super & Ultra Tech cements for the project. The company procured this material from supplier. All three cement are procured by same supplier. All these three cements have used as per tender documents. The cement bags (50kg each) are directly loaded by supplier from the factory and it is unloaded on store yard. The monthly procurement of cement of the company is around 500 tons (10 thousand bags). Fig. 5.7 shows the cement chain of the project.

The maximum capacity of the store yard to store the Cement is 300 tons (6000 bags) and minimum stock i.e. safety stock is 100 tons (2000 bags). As soon as the stock goes below 100 tons the order has given to the cement supplier. The maximum capacity of truck is 20 tons (400 bags) at a time. The store incharge keeps the record of quantity of cement in separate register consists of no. of bags available in stock, date of issue of the cement bags to the different project, daily consumption of cement bags etc. For this project, the quantity engineer of the contractor estimates the quantity of concrete for the work, and prepares a material requisition list consist of quantity of concrete required, quantity issued and where used. Prior sending to the RMC plant, it is checked and signed by the site incharge& sent to RMC plant. At the RMC plant, the material requisition list checked and signed by the store inchrge of RMC plant.

The store incharge prepares the indent on ERP, from quantity obtained from the site through material requisition list, and send to the plant incharge. Plant incharge prepares purchase order of that material after checked and signed. The plant manager gives an order to the transporter for procuring the cement as per purchase order. The quantity of cement measured by weighing machine on factory and also it is measured on site by physically counting the no. of cement bags.

2.3.6. Aggregate Chain

The quantity engineer of the contractor estimates the quantity of aggregate for the work and listed in the material requisition list. This material requisition list checked and signed by the site incharge& send to the RMC plant. The store incharge checked and signed the material requisition list and prepared indent on ERP and send to the plant incharge. Plant incharge checked and signed the indent.

After checking the indent, a comparative statement have prepared consists of different suppliers; there phone no., rate of each supplier, and total amount of the aggregate of supplier. After considering the tax, freight, delivery period in days, term of payment, and quality of material, a comparative statement is prepared and a negotiation of the suppliers have been done. Finally the suppliers are decided by the store incharge and plant incharge. As the aggregates are used for both in-house and commercial purpose, the plant incharge prepared purchase order on the basis of the indent from both in-house as well as commercial.

2.3.7. Sand Chain

The sand is purchases from two suppliers. For this project, river sand as well as crushed sand have used. The maximum capacity of storage yard is 60m3. When stock of the sand goes down to 30m3, the plant in charge gives an order to the suppliers for procuring sand.

2.3.8. Steel Chain

The company procured steel from three different suppliers. The company used three types of steel namely, Jindal steel, Tata steel & JSW steel. The company used 10mm, 12mm, 16mm, 20mm, 25mm, 32mm dia. Bars.

The maximum capacity of the store yard for steel is 50 ton. The store in charge prepares an intent on ERP as soon as the stock goes down to 20 ton. Then the required quantity of steel estimated by quantity surveyor for the work is supplied to the working site.

2.3.9. Admixture Chain

In case of admixture, the suppliers are marketing their product on site. In the presence of quality engineer and consultant, the trial and testing of admixture is takes place. The quality engineer check its characteristics like, initial setting time (Normally 2 hrs.), retarding and accelerating agents and then finally consultant decide the supplier for admixture

2.3.10. Diesel Chain

The procurement of diesel takes place as per requirement. The diesel is procured from one supplier for this project. The monthly procurement of diesel is 20,000 liters. The maximum capacity of diesel on site is 20001iters. The 200 liters barrels are available for storing the diesel on site. The storage in charge gives an order of diesel, when the stock of diesel goes down to 4001iters.

2.4 Planning and scheduling the SCM

2.4.1 Data collection from site:

Network techniques serve as an effective tool for management function such as project planning and control .when overlapping activities are involved as in the case of construction project, ladder network with huge number of activities and numerous dummy activities will have to be consider. The precedence network technique will have to be consider. The precedence network technique, which keep the number of activities same as A-O-A networks but eliminated the dummies, will be useful for such construction project

Precedence network are also know as A-O-N network wherein nodes represent the activities and arrow their interdependencies or precedence relationship s. Just like A-O-A network, precedence network represent the logical and sequential inter-relationships between various component jobs or activities to be performed for the final objective of the project completion

Four basic relationships are

1) Finish to start (FS)

Activity B cannot start until activity A has been completed. The time lag between completion of activity A and commencement of activity B can be defined or it can be zero ,in certain circumstances ,it can be a negative time lag that is activity B commences before A finishes.

2) Start to start (SS)

Activity B can start at the same time as activity A but not before .if lag is started, then activity B cannot be started untile that interval after the start of activity A

3) Finish to finish (FF)

Activity B cannot be finished until A has been finished if time lag is started ,then activity B cannot be finished earlier than the finishing of activity earlier than the interval after the finishing of activity A. it can however be finished later

4) Start to finish (SF)

Activity b cannot be started and cannot be finished earlier than started time lag the start and finish of activity A. This sequence is used to defined overlapping independent activities

The durations and relationships of activities scheduled for day time construction of flyover are:

2.4.2 Selection of SCM in construction activities

The selection construction activities for SCM are one of the important tasks of this project. For the selection of activities a questionnaire is distributed to the site engineers who are working on the site. The questionnaires is based on the general survey, quality of construction, safety during construction, , productivity and cost of construction .From the different site engineer the we get the different answers. The questionnaire and its answers are as follows:

TABLE I
Importance of different factors on SCM construction

Factors	**Not important at all**	**Somewhat important**	**Very important**	**Extremely important**
Higher construction costs		Yes		
Inferior work quality			Yes	
Worker problem				yes
Equipment problem				yes

TABLE II
Most delayed activity due to improper planning in SCM

Sr.no.	**Activity**	**Planned days**	**Actual days**	**Delay**
1	Issue of good for construction	521	561	40
2	Construction of viaduct and approaches at junction	590	630	40
3	Foundation	105	125	20
4	Girder and deck casting	590	610	20
			Total=	120

2.4.3 Planning the activity:

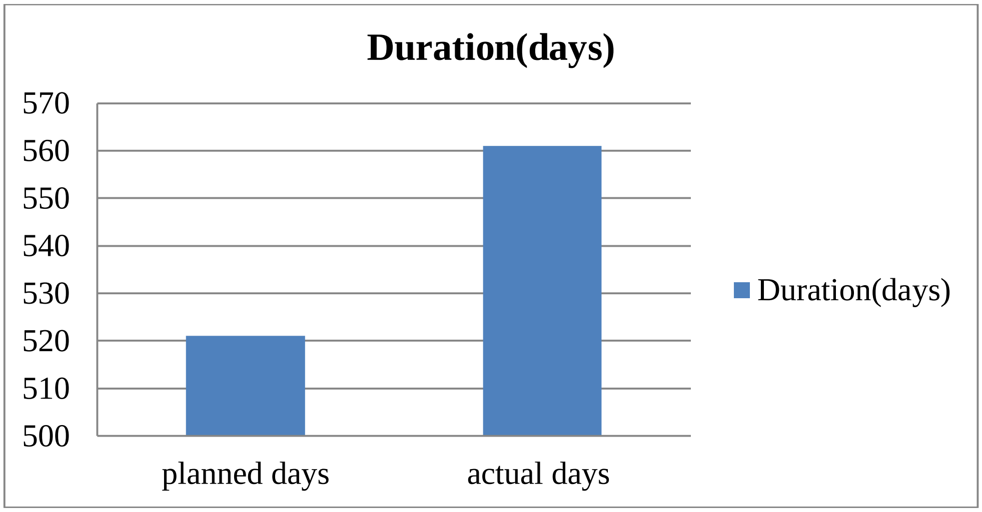
Discussion with the technical staff it was found that the some activity delay due to improper supply chain management of material. In the following tables scheduling the most delayed activity with SCM.

Most delayed activity:

TABLE III
Activity no.1

Sr.no.	**Activity**	**Material required**						
1	**Issue of good for construction**	**cement**				Sand	Aggregate	Steel
		Required	Delay in Duration (days)	Purchase	procurement			
		yes	40	12/01/14	21/02/14	Yes	Yes	Yes

Sr.no	**parameter**	**Duration (days)**
1	planned days	521
2	actual days	561

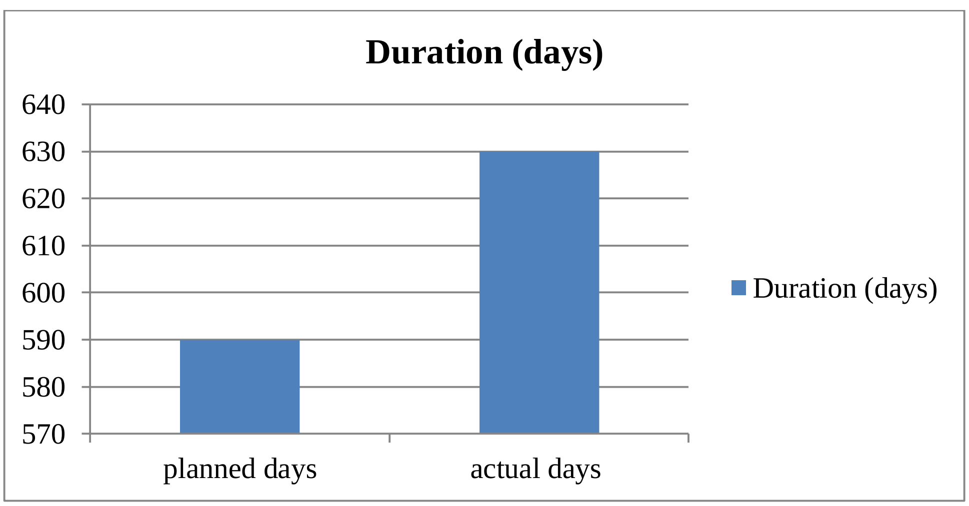


Graph no.1 Most delay activity no.1

TABLE IV
Activity no.2

Sr.no.	**Activity**	**Material required**						
2	**Construction of viaduct and approaches at junction**	**cement**				cement	Aggregate	Steel
		Required	Delay in Duration (days)	Purchase	procurement			
		yes	40	26/01/14	07/03/14	yes	yes	yes

Sr.no	**parameter**	**Duration (days)**
1	planned days	590
2	actual days	630

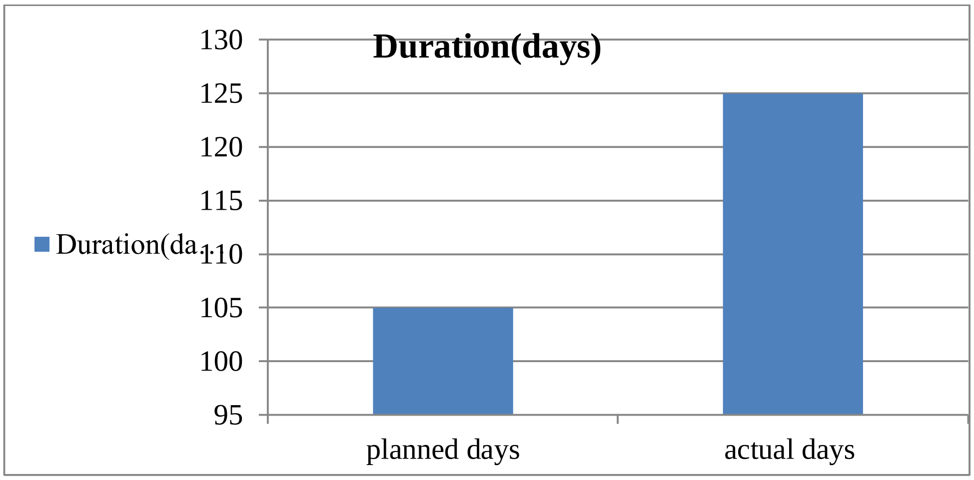


Graph No.2 Most delay activity no.2

TABLE V
Activity no.3

Sr.no.	**Activity**	**Material required**						
3	Foundation	**steel**				Cement	Aggregate	Sand
		Required	Delay in Duration (days)	Purchase	procurement			
		yes	20	24/05/14	13/06/14	yes	yes	yes

Sr.no	**parameter**	**Duration (days)**
1	planned days	105
2	actual days	125

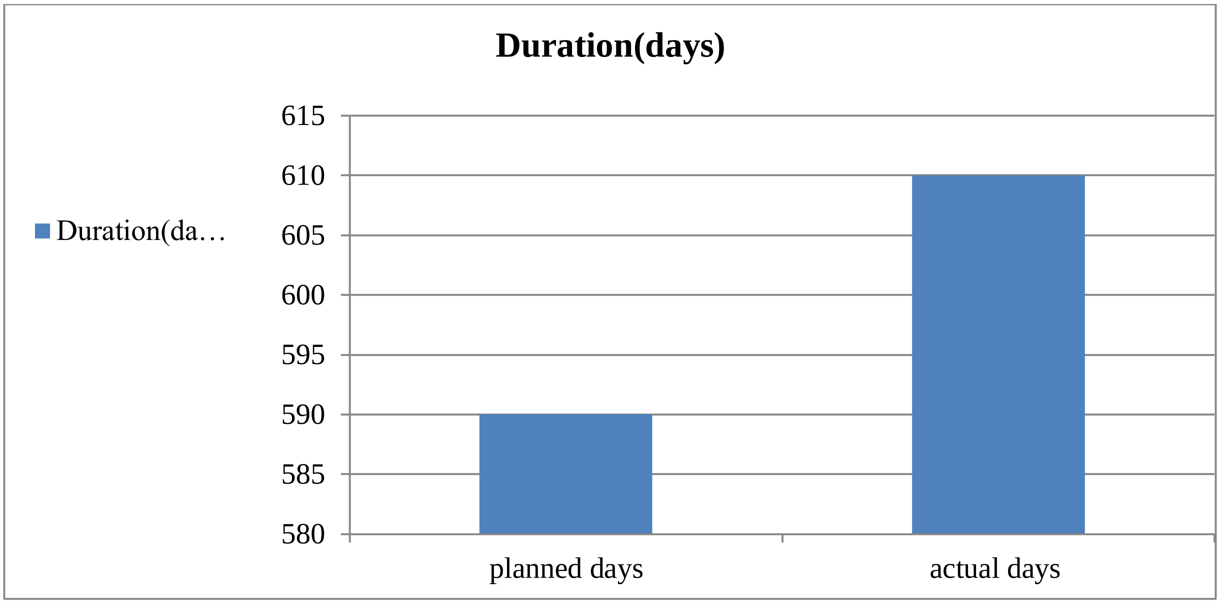


Graph No.3 Most delay activity no.3

Table VI
Activity no.4

Sr.no.	**Activity**	**Material required**						
4	Girder and deck casting	**steel**				cement	Aggregate	Sand
		Required	Delay in Duration (days)	Purchase	procurement			
		yes	20	24/12/14	13/01/15	yes	yes	yes

Sr.no	**parameter**	**Duration (days)**
1	planned days	590
2	actual days	610



Graph no.4 Most delay activity no.4

2.4.4 Due to changes in activity the project cost are:
Total cost of project=38,20,58,863
Per day charges of labour=500
Total labour working on flyover=400
Total charges for 400 labour for 120 days=120*400*500=24000000
Total charges for 400 labour for 365days=365*400*500=73000000

TABLE VII
Increasing cost due to delay

Sr. no	Delay	Duration	Perticulars			Increasing cost=actual+total
			Equipment charges	Overhead Charges	Total	
1	Due to improper SCM	120	500000	5%(24000000+500000)= 1225000	500000+24000000 +1225000=25725000	407783863
2	Due to land substation problem	365	1520000	5%(73000000+1520000) = 3726000	1520000+73000000+3726000=78246000	460304863

Cost benefit ratio:
For 120 days-
% increase in cost of project due to delay= (25725000/38,20,58,863)*100=6.73%
% change in duration due to delay= 100*(870-750)/750= 16.00%

For 365 days-
% increase in cost of project due to delay= (78246000/382058863)*100= 20.48%
% change in duration due to delay= 100*(1115-750)/750= 48.67%

3. CASE STUDY ON FLYOVER AT AKURDI

3.1 Basic Information

Company Name- M/s B.G.shirke contruction technology Pvt.Ltd.
Project Name – Construction of railway over bridge(ROB) 45m.wide road bhakti shakti to mukai chowk near Nisarg darshan society from Ch 2/850 to Ch. 3/740
Client- Pimpri chinchwad Municipal corporation,pimpri.
Name of consultant-STUD consultants Pvt. Limited.
Contract value-Rs. 60,32,88,315/-
Rs.17,15,52,676/-(utility)
Total- Rs.77,48,40,991/-
Date of completion- 13.05.2018
Completion period- 30months

3.2 Technical Details

TABLE VIII
TECHNICAL DETAILS

Sr.no.	particulars	unit	left	right	total
1	Total length of bridge	Rmt	891.147	915.373	1806.520
2	No. of piers	No.	15	16	31
3	Superstructure				
	Psc box girder spans	No.	11	12	23
	Psc i-girder spans	No.	1	1	2
	ROB-steel girder spans	No.	2	2	4
4	Approach ramps				
	Bhakti shakti side	Rmt	293.628		456.358
	Ravet side	Rmt	162.730		
5	Service road	Rmt	795.821	780.489	1576.301
6	Box culvert	No.	3		3
7	Staircase	No.	4		4

3.3 Delayed Activity

TABLE IX
Delayed activity

Sr.no.	Activity	Planned days	Actual days	Delay
1	Construction of box culverts Towards bhakti shakti side	129	132	03
2	Construction of box culverts Toward ravet side	104	106	02
3	Construction of flyover /ROB work	616	620	04
4	Viaduct portion-ravet to ROB(box girder)	607	607	00
5	Foundation work	290	291	01
6	Substructure	305	305	00
7	Superstructure	500	500	00
8	ROB to bhakti shakti chowk (I girder)	616	618	02
9	Approaches with RE Wall	570	580	10
10	Construction of wall Ravet side	502	509	07
11	Completion of project	0	0	0
12	Total			29

4.3 Planning the activity:

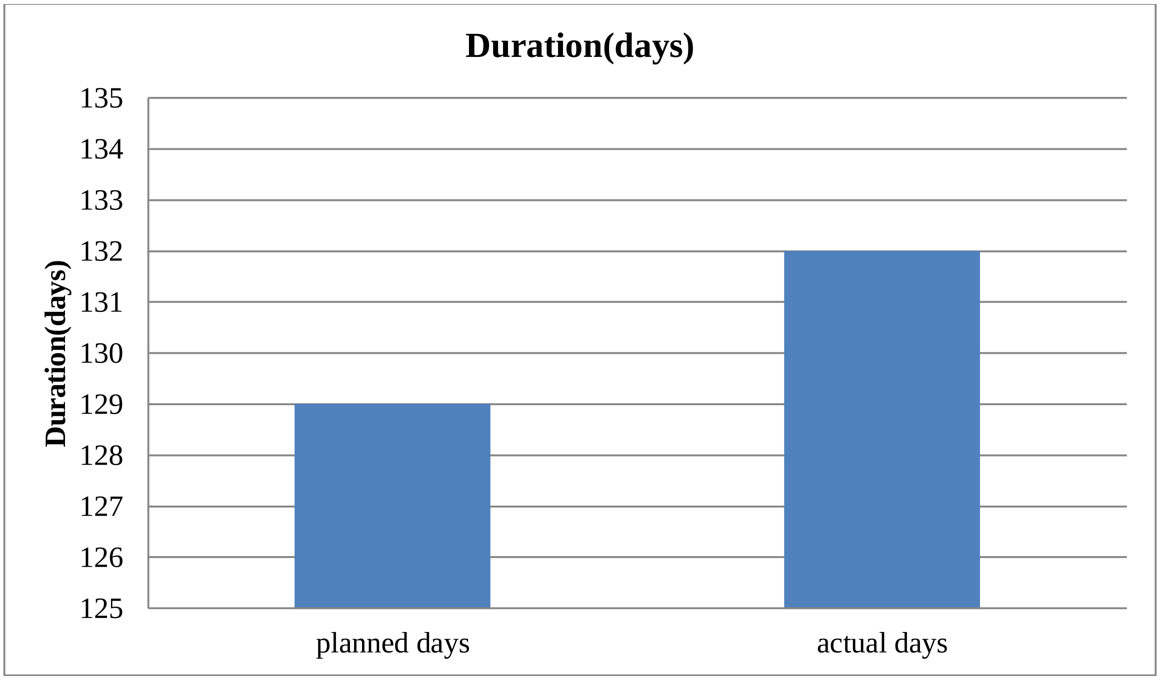
Discussion with the technical staff it was found that the some activity delay due to improper supply chain management of material. In the following tables scheduling the most delayed activity with SCM.

Most delayed activity:

TABLE X
Activity no.1

Sr.no.	**Activity**	**Material required**						
1	Construction of box culverts Towards bhakti shakti side	cement				Sand	Aggregate	Steel
		Required	Delay in Duration (days)	Purchase	procurement			
		yes	00	12/2/2016	28/02/16	yes	yes	yes

Sr.no	**parameter**	**Duration (days)**
1	planned days	129
2	actual days	132



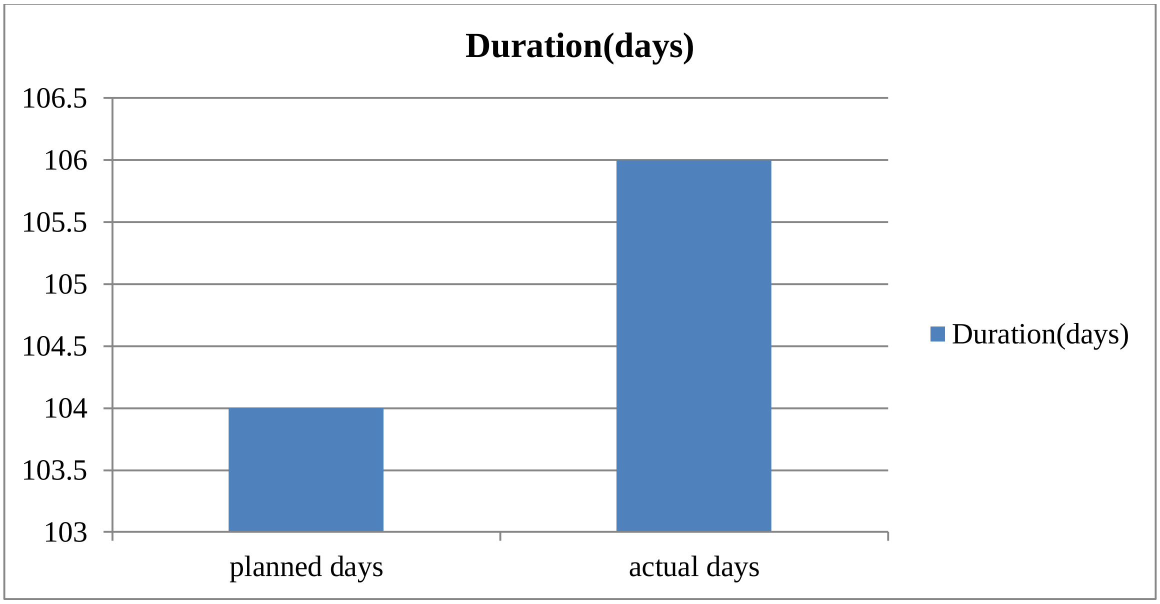
Graph no.5 Most delay activity no.1

TABLE XI
Activity no.2

Sr.no.	**Activity**	**Material required**						
1	Construction of box culverts	cement				Sand	Aggregate	Steel
		Required	Delay in	Purchase	procurement			

	Toward ravet side		Duration (days)					
		yes	00	12/02/2016	28/02/2016	yes	yes	yes

Sr.no	parameter	Duration (days)
1	planned days	104
2	actual days	106

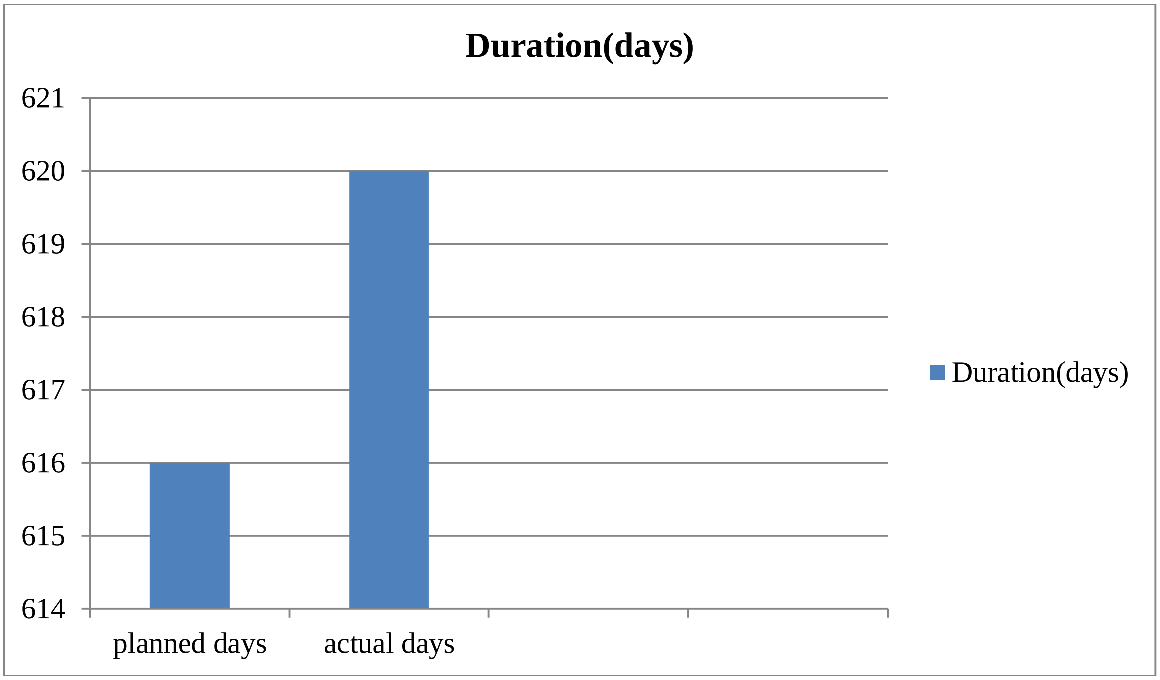


Graph no.6 Most delay activity no.2

TABLE XII
Activity no.3

Sr.no.	Activity	Material required						
1	Construction of flyover /ROB work	cement				Sand	Aggregate	Steel
		Required	Delay in Duration (days)	Purchase	procurement			
		yes	00	02/02/2016	28/02/2016	yes	yes	yes

Sr.no	parameter	Duration (days)
1	planned days	616
2	actual days	620

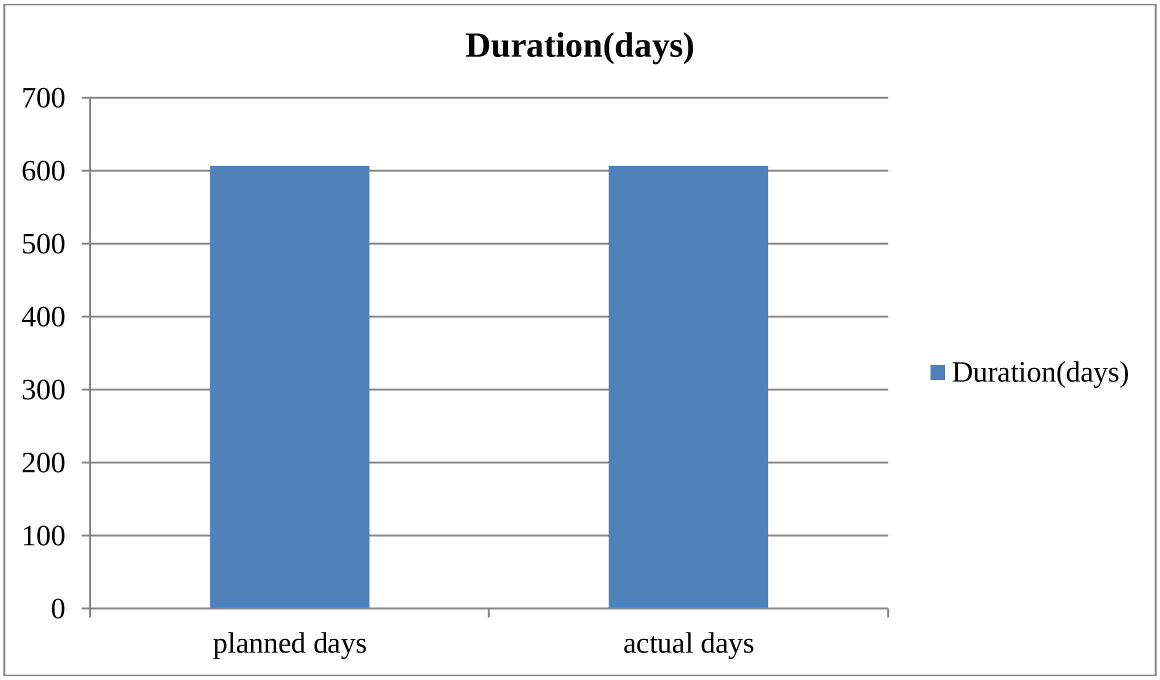


Graph no.7 Most delay activity no.3

TABLE XII
Activity no.4

Sr.no.	**Activity**	**Material required**						
4	Viaduct portion-ravet to ROB(box girder)	cement				Sand	Aggregate	Steel
		Required	Delay in Duration (days)	Purchase	procurement			
		yes	00	02/02/2016	28/02/2016	yes	yes	yes

Sr.no	**parameter**	**Duration (days)**
1	planned days	607
2	actual days	607

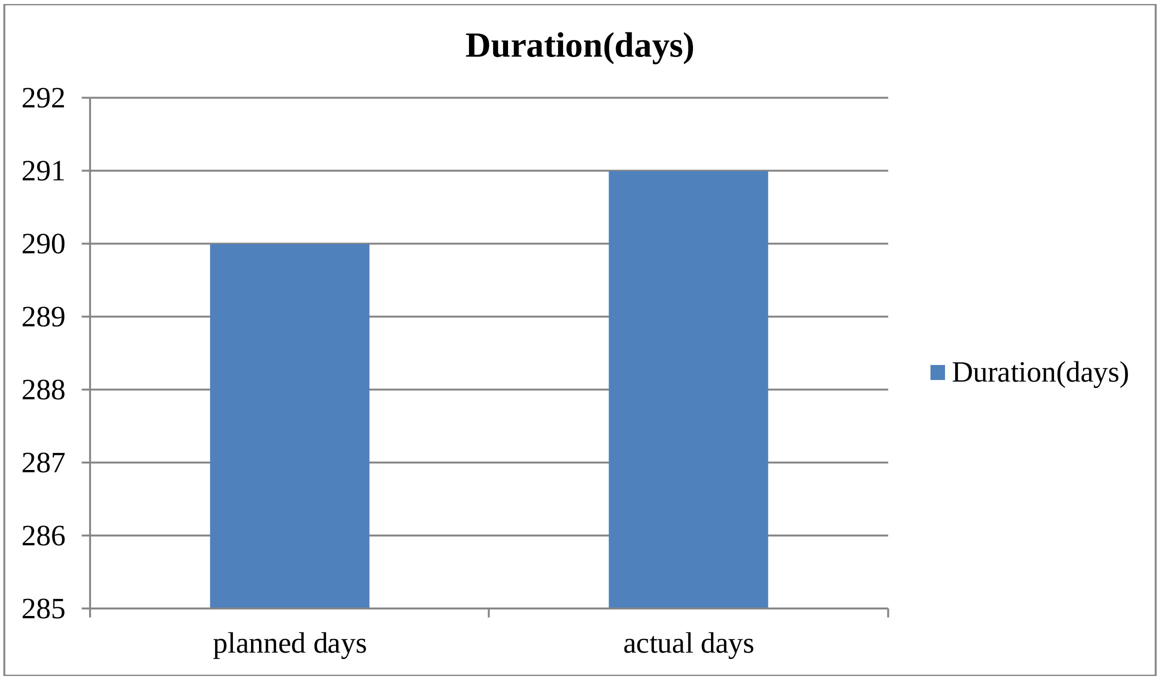


Graph no.8 Most delay activity no.4

TABLE XIV
Activity no.5

Sr.no.	**Activity**	**Material required**						
5	Foundation work	Steel				Sand	Aggregate	cement
		Required	Delay in Duration (days)	Purchase	procurement			
		yes	00	09/03/2016	25/05/2016	yes	yes	yes

Sr.no	**parameter**	**Duration (days)**
1	planned days	290
2	actual days	291

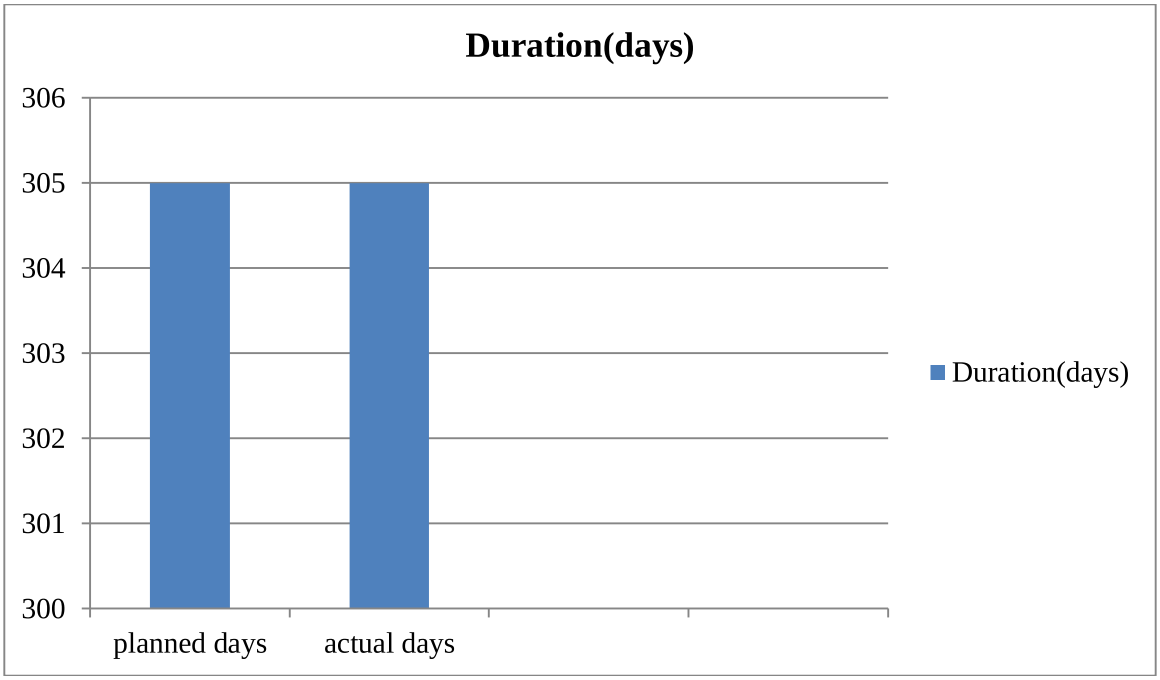


Graph no.9 Most delay activity no.5

TABLE XV
Activity no.6

Sr.no.	Activity	Material required						
6	substructure	steel				Sand	Aggregate	cement
		Required	Delay in Duration (days)	Purchase	procurement			
		yes	00	25/04/2016	30/05/2016	yes	yes	yes

Sr.no	parameter	Duration (days)
1	planned days	305
2	actual days	305

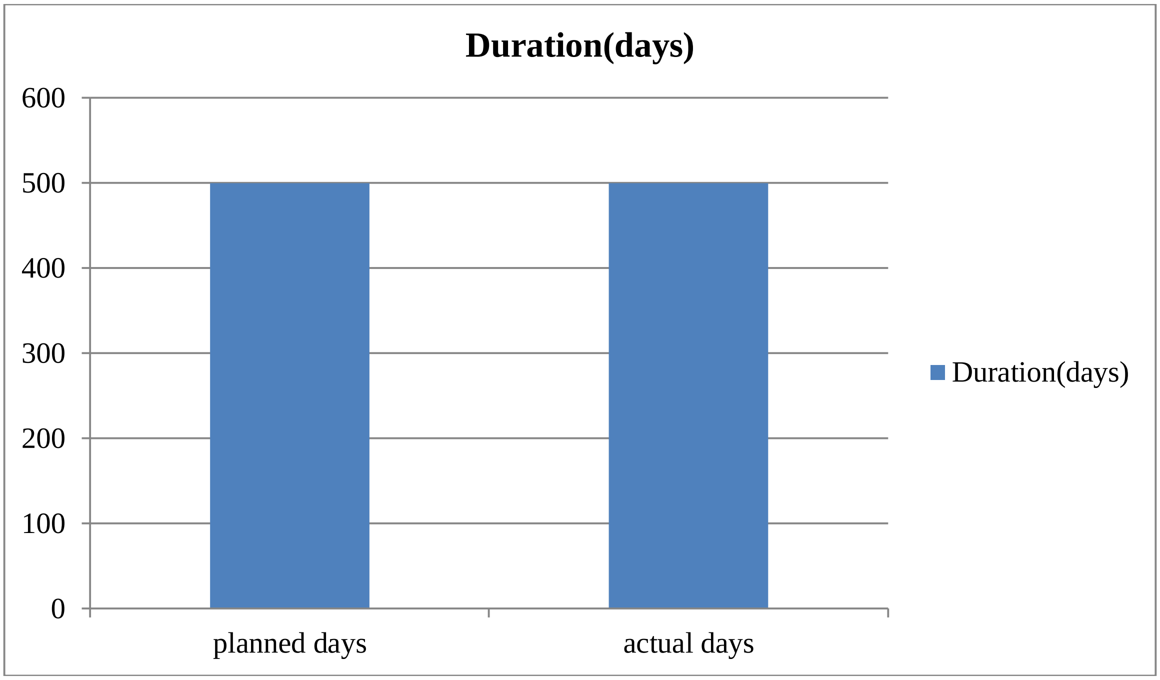


Graph no.10 Most delay activity no.6

TABLE XVI
Activity no.7

Sr.no.	Activity	Material required						
7	superstructure	steel				Sand	Aggregate	cement
		Required	Delay in Duration (days)	Purchase	procurement			
		yes	00	25/05/2016	02/07/2016	yes	yes	yes

Sr.no	parameter	Duration (days)
1	planned days	500
2	actual days	500

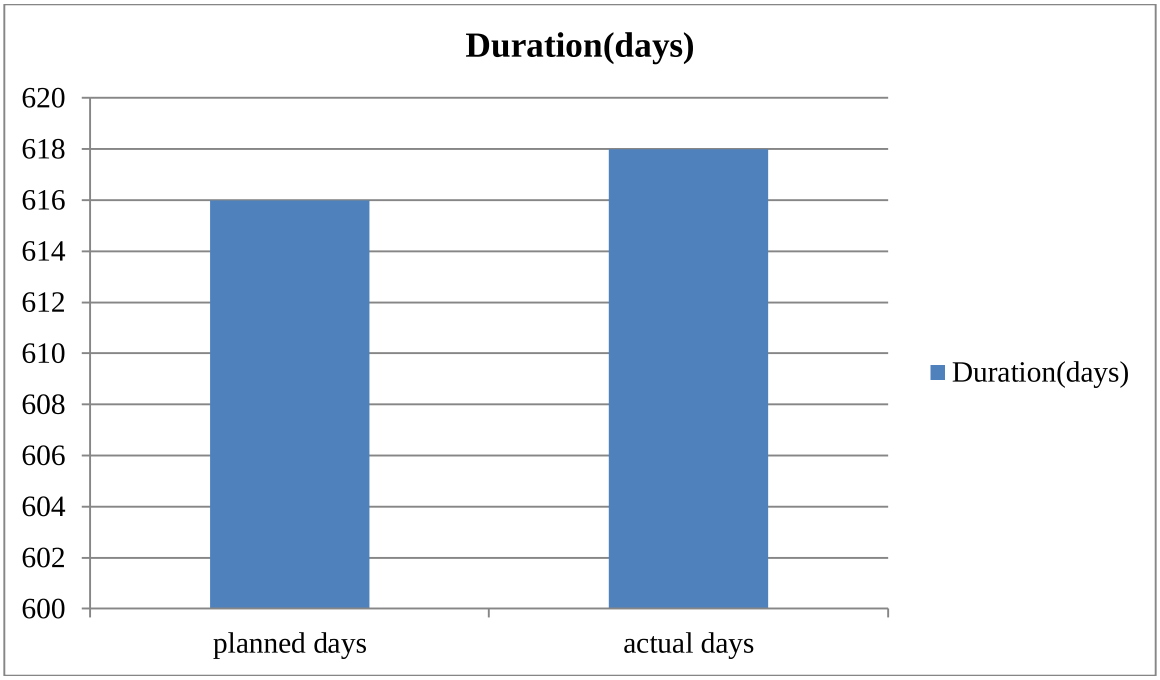


Graph no.11 Most delay activity no.7

TABLE XVII
Activity no.8

Sr.no.	**Activity**	**Material required**						
8	ROB to bhakti shakti chowk (I girder	Aggregate and sand				cement	Aggregate	steel
		Required	Delay in Duration (days)	Purchase	procurement			
		yes	00	12/02/2016	28/02/2016	yes	yes	yes

Sr.no	parameter	Duration (days)
1	planned days	616
2	actual days	618

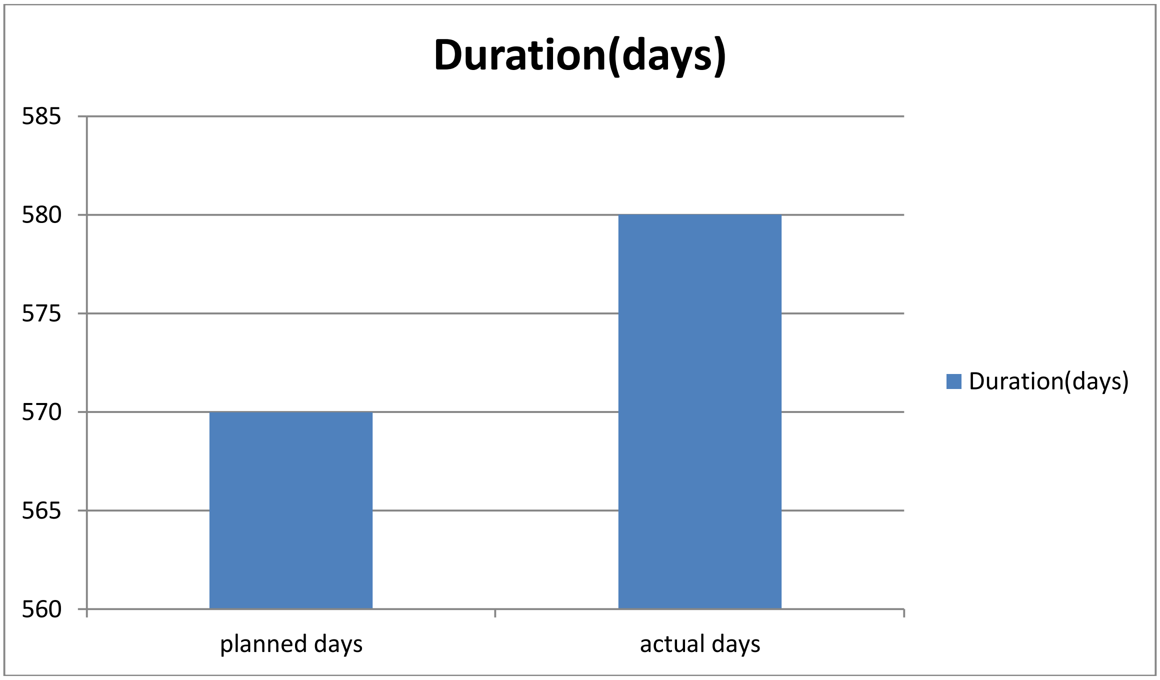


Graph no.12 Most delay activity no.8

TABLE XVIII
Activity no.9

Sr.no.	Activity	Material required						
9	Approaches with RE Wall	steel				Cement	Aggregate	sand
		Required	Delay in Duration (days)	Purchase	procurement			
		yes	00	01/01/2016	28/02/2016	yes	yes	yes

Sr.no	parameter	Duration (days)
1	planned days	570
2	actual days	580

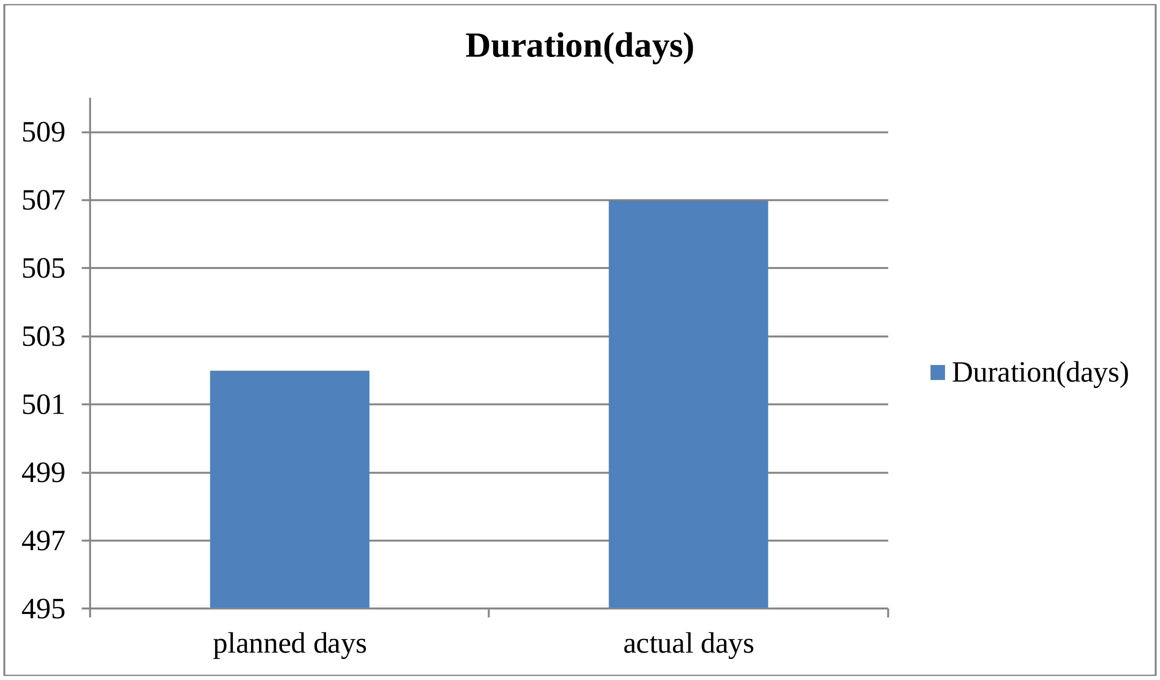


Graph no.13 Most delay activity no.9

TABLE XIX
Activity no.10

Sr.no.	**Activity**	**Material required**						
10	Construction of wall Ravet side	Precast RE wall blocks				steel	Aggregate	sand
		Required	Delay in Duration (days)	Purchase	procurement			
		yes	00	12/02/2016	28/02/2016	-	-	-

Sr.no	**parameter**	**Duration (days)**
1	planned days	502
2	actual days	507



Graph no.14 Most delay activity no.10

IX. CONCLUSION

A typical construction supply chain network has the main contractor at the centre of the hub, with links to the client, main supply agencies (i.e., sub-contractor and suppliers), and design services and any specialist management services. The above agencies all operate independently, which makes the coordination task of the contractor difficult. This study demonstrates how systematic application of Supply Chain Management can improve material chain of project and their by reducing the cost and time of the project. study is applicable to contractor and giving valuable information of saving the cost of materials. Thought the whole work, attempts have been made of reducing the time and cost of project by compressing the unnecessary nodes in the chain. This study is conducted when the project was it in under construction. Since this study is an individualistic academic effort in restricted time, natural shortcomings will creep in. Still this work has been possible with constant, appreciating guidance of experts manufacturing field and construction field with considerable experience. From the detailed case study, it was found that the supplier reduction is the criteria to reduce cost as well as lead time of the materials. The process of awarding work based only on lowest cost and work experience also creates hurdles in the implementation of seamless SCM in the Indian construction industry.

From the detailed case study, it was found that the improper supply chain management is increasing the cost and time of the construction. From the qualitative analysis of the case study, following two results were obtained.

Case study1

For 120 days-

% increase in cost of project due to delay= (25725000/38,20,58,863)*100=6.73%

% change in duration due to delay= 100*(870-750)/750= 16.00%

For 365 days-

% increase in cost of project due to delay= (78246000/382058863)*100= 20.48%

% change in duration due to delay= 100*(1115-750)/750= 48.67%

Case study2

For 29 days-

% increase in cost of project due to delay=(5074125/774840991)*100=0.65%

% change in duration due to delay= 100*(810-781)/781= 3.71%

For 115 days-

% increase in cost of project due to delay= (20125875/774840991)*100= 2.59%

% change in duration due to delay= 100*(896-781)/781= 14.72%

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