Planning for material deliveries in construction

Construction projects are becoming progressively larger and more complex in terms of physical size and cost, hence the risks and potential for losses require better control. Project management has evolved mainly because of the need to control costs and schedule (Chen and Griffis at el, 2012). In the latest construction world a proper project management should give an overall success to the specific project within the constraints of cost, time, schedule, quality and the safety measurements. Project management plays a major role not only in the architectural and engineering industry but also the development of infrastructure of each and every country. (Edum-Fotwe and McCaffer, 2000).

According to Risku and Karkkainen (2006) material delivery is one of the major parts of project management because materials are consuming huge amount of the construction cost. According to Asad (2005) Poor materials management can result in increased costs during construction. Efficient management of materials can result in substantial savings in project costs. Therefore Rivera (2004) stated Materials are major part of the construction project and the special concern should be provided from the planning stage of the project to end of the project. In the construction projects; amount of required materials cannot be reduced because it will affect the quality of the project. Meanwhile uncertainty is there in material supply due to the price fluctuations and availability of the certain materials. Therefore Sun, Liu and Lan (2011) suggested the material procurement planning (MPP) which is deals with the problem that purchasing the right quantity of material from the right supplier at the right time, a purchaser can reduce the cost for

materials via a reasonable MPP model. Here the purchasing of material at the right time is one of the key elements of MPP.

Risku and Karkkainen (2006) stated that the latest project management systems for construction projects facing new set of challenges in the delivery process of construction material. Mainly two requirements are expected for proper material delivery process. Those are transparency to material availability, and short response time in the material supply chain. Now a days the major challenge in the construction industry is delay in material delivery which is cause to the late completion of the project (Assaf and Al-Hejji 2005). A proper plan in material delivery and inventory management should be scheduled in the initial stage of the project plan and it can be lead to reduce the delay in material delivery in construction projects (Construction best management, 2008). Therefore this study will carry out on a delay in delivery of materials in BOI approved construction project. According to this study examine the delivery of material in projects under planning function and management.

2. 2. Important of purchasing appropriate materials

According to the definition provided by McConville (as cited in Hadikusumo et al., 2005, pp 48), purchasing is “ a fundamental function of material procurement that refers to the acquisition of goods and services and an establishment of mutually acceptable terms and conditions between a seller and a buyer”. As far as the construction industry is concerned, purchasing can occur in all phases of a construction project. The purchasing function of a construction firm is central to materials management and specially includes the commitment of project funds for construction materials.

Construction materials occupy a significant part of the construction’s value contributing nearly 50%. Thus when selecting construction materials, it is very important that painstaking decisions should be made. Even though typically 10 to 15%, but up to 45% (WRAP, 2007) of the total materials ordered for construction projects are either unused or end-up as waste. Therefore purchasing the appropriate material is getting more important.

Purchased materials and services typically represent the largest single element of cost in a company which stresses the importance of purchasing (Ibid and pooler et al, 2004 cited Otterheim, strand, 2007)

The purchasing department may also contribute to a competitive position in more indirect ways. The indirect contributions may be in

- Reduction of quality costs
- Production standardization
- Stock reduction
- Increasing flexibility and fostering purchasing synergy

The indirect contributions have often in practice saved more money than the indirect savings on purchasing prices (Van Weele, 2005 cited Otterheim, strand, 2007)

2. 3. Significance of material procurement process

According to Sun and Liu et al (2009) the process of obtaining raw materials from outside suppliers is considered as material procurement. This process consumes more cost of total operating capital.

Now a day fast track approach is used to reduce the project schedule. The procurement process is very important and should be carried out in a possible manner to achieve the success of the project.

According to Othman and Rahman (2010) five aspects can

According to the analysis of interviews and surveys carried out during the study of the Procurement Process described in this paper (Rivas 1998), five features can expose the relevance of Procurement:

Schedule pressures: Should finish the project within a less possible period, avoid or minimise financial and other indirect costs.

Cooperation and coordination with construction: by following the construction schedule procurement. Improvement of the efficiency for procuring supplies will help to save the resources.

High relative value: Supplies managed by procurement represents 50%, to 70% of the total cost for the project, it is imperious to have a strict and permanent control of the acquisitions, having in mind the financial approach being represented by such situation.

Depends on the operation of the project needed equipments supply by the process of procurement.

Potential critical of the supplies: due to important relationships and interrelation between various part of the project.

Accurate situation diagnostics of the material purchase function in the construction sector, in relation with the proactive purchase implantation in

material purchase functions. Therefore, the significance of this work is in analysing the validation of a purchase area with a new implementation of proactive purchasing.

2. 4. Proactive purchasing

The concept of proactive purchasing management is also addressed by Carr (1996), who defines proactive purchasing as purchasing willingness to take risks and to effectively use current knowledge to make decisions about the future. Purchasing pro action includes purchasing foresight and purchasing willingness to initiate change.

According to Vrijhoef and Koskela (1999) the implementation of proactive purchasing in the construction industry is a challenge. The implementation success is strictly related to the strategies of the activities operation which involve the process of purchasing that guarantees the quality of the process. One tool that can be used to develop a continuous improvement process in the purchasing process is Deming's PDCA cycle (1986).

Deming's PDCA cycle (Source: Wikipedia)

According to Moen and Norman (2011), the steps in each successive PDCA cycle are

Plan

Create the aim and objectives and establish the process to achieve the aim and objectives with the anticipated outcome.

Do

Implement the plan, execute the process, and make the product. Collect needed data and information to check it in the next process.

Check

Compare the actual result got from Do stage with the anticipated results in planning stage. Find variations from this study. Charting the collected data may help to see trends over several PDCA cycles and in order to convert the collected data into information. Information is what you need for the next step Act.

Act

Take severe action on major variations between actual and planned results. Take a good study to identify the reasons for this variation. Find where the changes should be made to improve the process or product.

Proactive purchasing starts in project conception, which is usually executed by the engineering or marketing areas. The responsible team for the project considers the enterprise’s goals and develops solutions for the product, subsystems, and components (Taylor, 2003). The quality assistance area analyses the projects and makes the proper contributions. The purchasing department participates in this process indicating new materials, rating prices quotations, and looking for new suppliers (Lawther and Martin, 2005). The next phase is characterized by the accomplishment of the programming phase of the execution of the project according to the organizational strategy. The purchasing team elaborates the purchase planning, which is based on the enterprise’s projects and specifications, on the production

planning, and the detailed budget that reflects the organizational reality (Donk, 2004). The purchasing process must contain the procedures to put the activities that constitute its routine into practice, to avoid that each collaborator acts in a particular way (Andersson and Bernhardsson, 2011). This doesn’t mean that the process must be set in stone but that policies should exist that orientate the elaboration of activities.

With the application of the structuring of the proactive purchasing process, the team involved with purchasing used most of their time in planning activities, negotiations, and control, what makes the purchasing operational (solicitation, estimating, and purchasing) and faster (Cox et. al., 2005). When the purchase planning is done, it is necessary to effectuate its control and, if necessary, repeat the planning of the activities in order to guarantee that the production area is attended according to the negotiated conditions (Lawther, 2003).

The purchasing process must be continuously analysed, so that the process’ bottlenecks are identified as well as the possibility of aggregating value to the process. As already described by Burt and Pinkerton (1996), the application of proactive purchasing procedures allows the material purchasing process to be focused on strategic actions, which are, the acquisition’s planning realization, and also the relationship with the suppliers. Furthermore, the operational phase will likely be faster than in the traditional model, and it also meshes with the necessities of the final customer, that is, to deliver the material in the right quantities, at the right time, and under the best purchasing conditions.

2. 5. Material requirement planning

According to Acramin and Rahman (2011) the major purpose of material requirement planning is to ensure availability of materials in the future within the certain cost. This procedure includes the monitoring of stocks and, in particular, the automatic creation of procurement proposals for purchasing and production. (Sap, 2001)

Material requirements planning to try to strike the best balance possible between

Optimizing the service level and

Minimizing costs and capital lockup.

Four sorts of information use in material requirement planning to decide what material need to be ordered and when it will ordered (Mahbashi, 2007).

Each and every product is scheduled to be manufactured. It is described in the master production schedule.

Bill of materials, which lists exactly the parts or materials required to make each product.

Production cycle times and material needs at each stage of the production cycle.

Supplier lead times.

The material purchasing process has the responsibility of supplying the customer’s buying necessities, it is also responsible for the planning in a

quantitative and qualitative way. Moreover, it intends to guarantee that the customer will receive the material at the right time, with the right quantities, and within the desired specifications (Burt and, Pinkerton, 1996). In order to execute this important task, the material purchasing function is considered to have a fundamental role in the supply chain. This technical paper uses the proactive purchasing procedure as the purchasing management strategy, and presentation of the concept is very important. Proactive purchasing can be defined as purchasing which is focused on strategic activities. It puts emphasis on long range relationship negotiation activities, expanding the supplier’s and material’s total cost, instead of doing it in repeated demands and stock repositions (Burt and, Pinkerton, 1996).

Making sure of purchasing continuity to keep effective relationships with existing sources, developing other supply alternatives, or attending the emergent or planned necessities, selecting the best suppliers.

Keeping solid and cooperative relationships with the other organizational functions, supplying the necessary information, and advising to make sure of the effective operation of the entire organization.

Developing the training of employees, and the adoption of procedures organization to make sure to reach the previous goals.

Keeping a balance between quality and value, obtaining products and services in the necessary quantity and quality for the lowest cost.

Surveying market tendencies.

Developing methods to negotiate purchasing conditions to deal with suppliers that look for mutual benefit by means of superior economic performance.

Developing and keeping good relationships with the suppliers, besides developing potential suppliers.

Emitting and controlling purchasing solicitation.

2. 6. Material scheduling

Various types of resources are involved in construction projects, including manpower, equipment, materials, money, and space (Taghaddos and Hermann et al, 2010). Here materials are major part of the construction project. Effective scheduling of material is crucial for the success of construction projects (Lasry and Carter et al, 2008). This success implies accomplishing the project on time, in budget and with acceptable quality. Therefore, the concept of material scheduling is introduced to the construction industry as the process of improving the efficiency of the project. Providing such a material schedule is a complicated process, but has a key impact on the total cost and schedule of construction projects (Schwindt, 2005).

According to Pinedo (2008) producing a realistic schedule for material in a construction project is a challenging task. It often happens that the construction process begins before enough detailed information is collected. Ensure the material availability without creating an unnecessary inventory is a major challenge to the delivery of material in the construction industry. But it can be done with the very good communication and good schedule with

suppliers (Bertelsen and Nielsen 1997 cited Risku and Karkkainen et al, 2000).

2. 7. Purchase planning

According to USPS (2012), to obtain a best value in any purchase objectives and tactics to be established. Purchase planning is the process to help in this establishment. Effective purchase planning is essential to a successful construction project. As such, it needs the coordination and cooperation of a number of purchasing related parties often proves the crucial success of the project. Competing objectives of the construction industry, nature of purchase and its impacts on the project will decide the extent of the purchase planning. The success of large scale purchases, which are those with the potential to impact these objectives, need to be planned for by a purchase team that fully reflects the strategic importance of the purchase, and should involve the team’s use of a wide range of supply chain business practices. The success of other purchases will not need the same level of investment, but may require some degree of planning. The good effective purchase plane will lead the project to success.

According to Weele (2010), purchasing and supply function can make an important contribution to construction project’s results. But many organizations handle both large and small purchases through the same standardized purchasing processes. But three purchasing methods are suggested by Ouhimmou and D’Amours et. al, (2007) for different term purchasing.

2. 7. 1. Strategic planning

According to Warszawski (1996), Strategic planning is an essential function in the construction industry and in this level the decisions taken are long ranged. In this, planning is defined as the target and the goals to be reached by the purchase area in the next five years. For Example, to institute " no fail" in activities that involves material purchases (Diabat and Richard et. al, 2011)

2. 7. 2. Tactical planning

Tactical production planning is a midterm planning process and it is concerned with shorter term decisions for purchasing (Aghezzaf and Sitompul et. al, 2009). In this, planning is defined by which and how many resources must be used to reach the goals defined by strategic planning, as well as its acquisition path and the organization of the work structuring. (Edmondson, 1999)

2. 7. 3. Operational Planning

It selects, in a short range time period, the path for necessary operations to reach the goals (Seifert, 2003). These short range plans have a time frame of one year or less. These plans are greatly fallen in the middle and lower levels managers' day to day activities. Petty cash purchasing is one of the operational planning methods. Some organizations permit the use of petty cash for small purchases. But because of frequent misuse and the lack of control in the purchasing process, most organizations discourage this practice (Parikh and Joshi, 2005).

2. 8. Purchasing and delivery process

Weele (2005 cited Otterheim and Strand, 2007) Define purchasing

“ The management of the company’s external resource in such a way that the supply of all capabilities, goods, services and knowledge which are essential for running, managing the company’s primary and secondary activities is secured at the most favourable conditions”

Determining the specification of the goods and services that need to be bought

Selecting the most suitable supplier and developing procedures and routines to select the best supplier from foreign countries or BOI approval supplier from Sri Lanka

Preparing and making negotiations with the supplier to establish an agreement and to write up the contract through the email.

Forward the Performa invoice to BOI and Get approval for that certain material.

Placing the order with the selected supplier and or develop effected purchase order and handling system.

Open the legal contract and delivery dates mentioned in the contract must observe. The supplier and the relevant department must agreed the correct details of the delivery schedule.

Monitoring and control of the order and to secure supply (expediting)

Clearing process in the port

Follow up and evaluation (settling claims, keeping product and supplier files up to date, supplier rating and supplier ranking).

2. 9 Construction material management

2. 9. 1 Material management cycle

Construction materials vary from simple items purchased by direct POs to complex tasks that are purchased by sophisticated contract forms (Halpin and Woodhead, 1998). In all cases, several functions and steps comprise the material management process. Each of these functions can give rise to potential problems that need to be solved by the materials management department. Throughout the various sequential steps of materials management, several materials-oriented costs rise. Generally, those costs could be grouped into four major categories, namely, purchase costs, order cost, holding costs, and unavailability cost:

The purchase cost

The purchase cost of the material means the original unit price of an item added with transportation costs and freight expenses. In the construction industry many discounts are given by suppliers for the bulk orders (Hendrickson, 2000).

The acquisition or order cost.

The acquisition or ordered cost reflects the administrative expense associated with issuing a PO to an outside supplier. Four cost components typically make up the total acquisition cost; they are requisition, purchasing, receiving, and auditing costs (Zenz, 1994).

Figure2. Sequential steps of materials management

(Source: Parikh, M. A. and Joshi, K., 2005)

The holding or carrying cost

The holding or carrying costs are incurred because of the carried volume of inventory. Generally, they are subdivided into three sub-categories, which are capital costs, storage costs, and risk costs (Dobler et al., 1990). Capital costs are those costs or losses due to funds invested (tied-up) in the inventory that can be used for other productive purposes (Dobler et al., 1990). Storage costs are those of warehousing, handling, store workers, and equipment needed for different movements in the warehouse. Risk costs are those that could be incurred due to damage, obsolescence, deterioration, and theft.

The unavailability cost.

If required material unavailable in desire time then the unavailability cost will occur. Unavailability cost well known as stock out or depletion cost in manufacturing industries. Material shortages will lead the project to delay. Also it will cause to the waste of labour force (Hendrickson, 2000).

2. 9. 2 Material delivery and inventory control

After a PO for a construction material is being submitted to the selected supplier, a period of time, usually called “ delivery lead time,” elapses before the actual delivery of materials to the project warehouse takes place. According to Arnold and Chapman (2001) once materials are delivered, they represent an inventory used during the construction process. In this context, inventories can be regarded as materials stocked to cover upcoming future

demand. Since, inventories cost the construction firm whenever the inventory level is more than zero, inventory control is applied to minimize such cost and the various other costs associated with construction materials. Figure 2. 5 shows an inventory control chart, as the ones typically used in industrial and manufacturing practices. As noticed, inventoried materials are depleted to satisfy the existing project demands. Meanwhile, new material deliveries are made at specific points in time to compensate for such depletion. Furthermore, due to the uncertainty of lead times, safety stocks are commonly instated to counterbalance any late materials delivery and keep production non-stopped.

There are several schemes for making material orders, such as, the cyclical or fixed order interval system, just-in-time (JIT) approach, material requirement planning (MRP) systems, fixed order quantity system (Dobler et al., 1990). And additional to that some construction industry using the software. The most popular software models use for Procurement in construction industries are,

- Build smart
- J D Edward
- Great Plan

These software are best to monitor what you ordered and what has been delivered to site and what is the balance to be delivered to the site and when is going to happen. And also trade wise we can summarize the actual cost incurred for every single item in the BOQ by giving specific cost quotes to

each trade and get the summary every month. This will go to the financial report of the moth.

Basically we can monitor the ordered materials from this software but it won’t control any delays. The procurement basically from two parties,

- Local Suppliers.
- Overseas Suppliers.

2. 10. Some delivery methods in the construction industry

2. 10. 1. Material requirement planning

Material Requirements Planning (MRP) is the process that based on a software. The manufacturing process can manage by MRP inventory system. Although it is not common nowadays, MRP can conduct by hand as well. (www1. ximb. ac. in)

According to ERP (2008) the aim of MRP system achieves three objectives simultaneously:

Make sure the availability of the materials to the production and delivery it on time.

Maintain the inventory level as low as possible.

Plan manufacturing activities, delivery schedules and purchasing activities

Logic of MRP

In construction industry MRP mainly using for calculating the required materials and the time period (Slack, 2001). For the effective output there are three inputs are essential. Those are bill of material, inventory data and

master production schedule. Here two main outputs namely planned order releases and reschedule notices (Lunn, 1992). As stated by Starr (1996), the MRP is suitable for products that do not satisfy the order point policy (OPP) models, which demand of the end product is independent or an end product orders may be placed periodically.

Master production schedule

According to Ong (2002) the Master Production Schedule (MPS) is the very essential thing to drive the MRP system. The main function of MPS identifies the required amount of material that should be manufactured.

Bill of material

Also Ong (2002) stated Bill of Material (BOM) is another major part of the MRP, which clarifies the structure of an independent demand item. A bill of material is: “ a listing of all of the sub assemblies, intermediates, parts, and raw materials that go into a parent assembly showing the quantity of each required to make an assembly” (Starr, 1996).

Inventory data

Inventory data are the thing that helps to identify the inventory status to calculate the net requirement in MRP (Slack et al, 2001).

MRP calculation

MPS, BOM, Inventory data will use in MRP to establish the planned order release and reschedule notices (Lunn, 1992). The figure 2. 5 shows generally how the MRP performs the calculations by using the logic (Slack et al, 2001).

2. 10. 2. Just-in-time

In face of the challenges of global competition, business firms are concentrating more on the needs of customers and seeking ways to reduce costs, improve quality and meet the ever-rising expectation of their customers. To these ends, many of them have identified logistics as an area to build cost and service advantages. On the other hand, the Just-in-Time (JIT) management approach, which has long been proven effective in the manufacturing sector in increasing quality, productivity and efficiency, improving communication and decreasing costs and waste, might enhance the chances of firms to achieve cost and service advantages through logistics. (Lai and Cheng)

Just in time (JIT) stimulates new directions of planning and performing activities in manufacturing systems: its effects are significant in improving the overall performance of whole organization. Conceptually, JIT is an approach that combines apparently conflicting objectives of low cost, high quality, manufacturing flexibility and delivery dependability. In short, JIT is a system that produces the required item at the time and in the quantities needed (Chung and Barkar, 2001cited Gunansekaran and Lyu, 1997)

However, the potential of JIT has not been widely recognized in logistics as compared to in manufacturing. Similar to manufacturing, logistics employs processes that add value to the basic inputs used to create the end product. As the focus of JIT is on business processes, not products, the management principles of JIT can be replicated and applied in logistics. This book sets out to explore the possibilities of employing JIT to manage logistics activities, and provide an introduction to the application of JIT in the major areas of

business logistics, which mainly deals with inter-organizational move-store activities (Lai and Cheng)

Just-in-time principle

JIT had many definitions, some of the common definitions are: (Chung and Barkar, 2001)

A system that produces the required item at the time and in the quantities needed.

A manufacturing system where the parts that are required to complete the finished products are produced or arrive at the assembly site as they are needed.

A philosophy that centres on the elimination of waste in the manufacturing process.

An inventory control philosophy whose goal is to maintain just enough materials in just the right place at just the right time to make just the right amount of product.

The exact number of required units is brought to each successive stage of production at the appropriate time.

Capital requirements – reduced rework inventories of purchased parts, raw materials, work-in-progress and finished goods

2. 10. 3. Fixed re order point and fixed order quantity

In this model describes the dependency of average expenses for goods holding, ordering and losses from deficit per time unit on two control

parameters – the order quantity and reorder point. (Kopytov and Greenglaz 2004 cited Muravjovs and Burakov, 2007)

We consider a single-product stochastic inventory control model under the following conditions. The demand for goods is a Poisson process with intensity Î». At the moment of time, when the stock level falls to certain level r, a new order is placed. The quantity R is called as reorder point. The order quantity Q is constant. We suppose that. The lead time L (time between placing an order and receiving it) has a normal distribution with a mean RQ ‰¥LÎ¼ and a standard deviation LÏƒ. There is the possible situation of deficit, when demand during lead time exceeds the value of reorder point R. We suppose that in case of deficit the last cannot be covered by expected order (Muravjovs and Burakov, 2007)

Denote as Z the quantity of goods in stock at the time moment immediately after order receiving. We can determine this quantity of goods Z as a function of demand during lead time L:

Expression (1) is basic. It allows expressing different economical indexes of considered process.

Let T is the duration of a cycle. Length of the cycle consists of two parts: time T1 between receiving the goods and placing a new order and lead time L, i. e.

2. 10. 4. Cyclical or fixed order interval system

In this model the order quantity is determined as the difference between the fixed stock level and quantity of goods at the moment of ordering. The

analytical description of the second model has been considered by the authors in the work (Kopytov et al. 2006 cited Muravjovs and Burakov, 2007).

Let us consider the model 2 with a fixed time T of the cycle, i. e. with fixed time between neighbouring moments of placing the orders (see Fig. 2). It is a single-product stochastic inventory control model under the following conditions. The demand for goods is a Poisson process with intensity Î». The lead time L has a normal distribution with a mean LÎ¼ and a standard deviation LÏƒ. We suppose that lead time essentially less as time of the cycle (Muravjovs and Burakov, 2007)

There is the possible situation of deficit, when the demand during the time between neighbouring moments of orders receiving exceeds the quantity of goods in stock Z at the time moment immediately after order receiving. Analogously model 1 we suppose that in case of deficit the last cannot be covered by expected order.

We denote as S the goods quantity which is needed “ ideally” for one period and it equals to the sum (Muravjovs and Burakov, 2007)

Where TD is the average demand for cycle time; is the some safety stock. In the given sentence we suppose that “ ideally” S gives us in the future the minimum of total ex