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Supply Chain Management in Construction

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Abstract: Supply Chain Management (SCM) is a concept that has flourished in Manufacturing, originating from Just-In-Time (JIT) Production and Logistics. SCM endeavors to observe the entire scope of the supply chain. SCM offers a Methodology to relieve the myopic control in the supply chain that has reinforcing waste and problems. The generic methodology offered by SCM contributes to better understanding and resolution of basic problems in construction supply chains, and gives directions for construction supply chain development. In this paper application of Lean principles are carried out to optimize the concreting operation. The application and Fundamentals of VSM are applied into the case study for improvisation of concreting operation.

Key Words: *Construction Supply Chain Management, JIT, SCM, Myopic Control, VSM.*

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I. Introduction

Concurrent with the development of lean approaches in construction, there has been Increasing interest and research in Supply Chain Management as a field of study and application. Supply chain management focuses on understanding and improving the coordination of multiple firms that compose a supply chain. Supply chain management (SCM) is a concept originating from the supply system by which Toyota was seen to coordinate its supplies, and manage its suppliers. In terms of lean production, SCM is closely related to lean supply. The basic concept of SCM includes tools like Just-In-Time delivery (JIT) and logistics management. The current concept of SCM is somewhat broader but still largely dominated by logistics.

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Until now, in construction, initiatives belonging to the domain of SCM have been rather partial covering a subset of issues (e.g., transportation costs) in a limited part of the construction supply chain (e.g., the construction site).

Construction supply chain management (CSCM) is an emerging area of practice. It is inspired by but differs substantially from manufacturing supply chain management, where the emphasis is on modeling volume production. CSCM is more concerned with the coordination of discrete quantities of materials (and associated specialty engineering services) delivered to specific construction projects. Therefore, to be competitive in global economy, there is a need for industry -government co-operation to increase the focus on research and development to promote the new culture like lean construction techniques (Supply Chain Management, JIT systems, etc).

II. Methodology Of Supply Chain Management

In the Literature on SCM, many Supply Chain methods have been proposed. The Methods of Pipeline mapping, Supply Chain Modeling and Logistics Performance measurement is to analyze stock levels across the supply chain. The LOGI method is used to studies time buffers and controllability problems of the delivery process. Supply Chain Costing focuses on cost buildup along the supply chain and the methods like Value Stream mapping and process Performance Measurement is to analyze various issues including lead time and Quality Defects.

In this paper the VSM Methodology of Lean SCM is used to analyze the Process of Concreting operation in the case study. Application of VSM consists of three stages. The first stage is to identify current state of the operation followed by identifying barriers to flow of value in the process. The next stage is to design the targeted future state and in the third stage implementation strategy is to be established.

III. Value Stream Mapping

Value stream mapping is a high level perspective of the process. Mapping is to be done by following the process from beginning to end and drawing a visual representation of primary information steps, information flows, process flows / delays and key time metric.

Value Stream Mapping is three step Processes. It consists of

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1. Documenting- Current state and barriers to flow to understand how existing process operates and to identify leverages points for the improvement.

2. Designing- future state of how process should flow. It is a design of targeted state to optimize the operation. Future state should be designed considering the smooth flow of the operation through elimination of unnecessary non- value adding activities (NVA).

3. Creation of Implementation Strategy and plan. It is a plan to realize the targeted future state.

IV. Methodology of VSM in Case Study

In this paper the study being carried out at Textile Industrial building which consists of Humidification Plant, Return Air Ducts and Yarn Godown. There is a central batching plant i.e. Two batching plant of 30cum/hr capacity which caters to the requirement of three sites in the vicinity where M/s Desai Construction Pvt. Ltd is working as a contractor. When there is a major concrete work to one of the sites one batching plant is fully devoted and the other batching plant caters to the requirement of other two sites. There are three transit mixer allotted to each of the site. Based on the observations by the site personals average time of a transit mixer from batching plant to site is 30 min when fully loaded, whereas return time is 25 min. there are 9 transit mixer to support the transportation operation, 3 transit mixer to each site and it is the duty of project manager of respective site for its efficient utilization and to cater to the need of different structure of the site. Generally for major concreting works it is observed that all the 3 transit mixers are allocated to that work completely.

Assuming efficiency of batching plant as 80% capacity which is considered as 24cum/hr. The time required to load one transit mixer is 15 min, and the time required to unload a transit mixer is 10 min. The concrete is to be pumped through placer boom having capacity of 45cum/hr, assuming 80% change over time capacity as 36cum/hr.

Cycle time=Loading time+ travel time+ unloading time+ Return Time.

Therefore Cycle time = (15+30+10+25) min

=80min

To analyze the process certain observations were taken as presented in the Table no-1 which suggest that actual rate of concreting achieved is 10cum/hr which results in a huge difference in capacity of the batching plant and rate of concreting achieved.

Table no-1 Actual Rate of Concreting

Sr. no	Observation	Qty (cum)	Duration (Hr)
1.	Yarn Godown	580	54
2.	Humidification Plant(1^{st} Floor)	535	54
3.	Humidification Plant(2^{nd} Floor)	175	19
4.	Total	1290	127

It is observed that project is delayed by 2 months of its scheduled time after the completion of 10months of construction activity. Project is to be handed over within 20months as per agreement. Project manager has made every attempt to speed up construction activity considering the prevailing constraints and he established the fact that there is unnecessary delay in concreting activity which is a root cause of delay. Hence attempt is made to improve the process by applying Value stream Mapping.

4.1 Current State and Barriers to Flow

Current state is a walk through the process. Systematic analysis is to be done for each step and barriers to flow are to be identified. It enables to identify and quantify the waste and delays between the processes. The current state of the project is illustrated in the Present State of SCM of Concreting Process. As derived earlier the loading time of a transit mixer is 15 min and transportation time is 30 min. Their are two batching plant of 30cum/hr which caters to the requirement of the three sites (i.e. B.P-1 & B.P-2).

As the Transit Mixer 1 starts loading and is loaded in 15^{th} min from B.P-1 and the Transit Mixer reaches at site by 45^{th} min. The T.M. 1 gets unloaded at 55^{th} min and meanwhile the T.M. 2 starts loading at B.P II at 10^{th} min & is loaded at 25^{th} min. The T.M II as gets loaded at B.P. II it transported to the site at 55^{th} min as the T.M. 1 which was unloaded at 55^{th} min. The Transit Mixer II reaches at site to 55^{th} min and starts unloading which completes at 65^{th} min. As T.M. II unloading completed at 65^{th} min to continue the process of concreting operation. The Transit Mixer III starts loading the concrete from B.P-1 at 20^{th} min such that 5 min change over time between T.M-I (Loading Finish Time) & T.M- III (Loading Start Time). Transit Mixer-I was loaded at 15^{th} min such that 5min is kept as buffer time & Transit Mixer

III loaded at 35th min and it gets transported to the site by 65th min. as the T.M. II was completely unloaded at 65th min, T.M-III loaded at 35th min and it transported to site by 65th min. As the T.M-II was completely unloaded at 65th min, T.M-III unloading starts at 65th min and thus complete by 75th min. As the unloading of T.M-III is completed in 75th min from time (zero) , at that time T.M-I has still not reaches to B.P-1 and it will reaches to the site back at 125th min after which it will reaches again to B.P.-1 for Loading the concrete. So there is a huge ideal waiting concreting operation till 125th min as the last unloading was completed at 75th min, and hence the waiting period of 50th min.

1. T.M-1 Loading time starts at

   0+15= 15th min

2. T.M-I starts transportation to site at 15+30= 45th min

3. T.M-I unloading time Finish at 55th min

4. T.M-II loading finishes at

   10th+15 = 25th min

5. T.M-II transportation completes at 25th + 15= 55th min

6. T.M-III Loading at B.P-I at

   25th +15= 35th min

7. T.M- III Transportation completes at 35th+30= 65th min

8. T.M- III Unloading completes at 65th+10= 75th min

9. T.M-I (IInd Round) at loaded at B.P-I & reaches at site by= 125th min

As there are 3 Transit Mixer are available at site the waiting time at site is 50min where no concreting operation has been done, which can be reduced by increasing the no. of transit mixer during the waiting period so as to carry out smooth continuous concreting operation.

Barriers to Flow

The primary cause for the deviation actual concreting rate from the rate analyzed from current state is frequent breakdown. Breakdown of batching plant, one of the transit mixer or placer boom frequently results into unnecessary delay in the concreting operation and hence, attempt should be made to minimize such delays. Furthermore, there is no proper channel for the flow of information to monitor travel time of transit mixers in the both direction. There is a human tendency to escape from the job which results into increased travel time that leads to increase in the waiting time for the operation and hampers the smooth flow. As only three transit mixers are available the waiting time is 50 minutes in each cycle which can be reduced if more no. transit mixer can be arranged.

4.2 Future State

To optimize the operations the next step is to design future state. Future state enables to set the TARGET to improve the process. The targeted future state of the operation is shown in Future State of SCM Process in Concreting.

As Represented in future State SCM of concreting in the last stage is to balance the waiting time till the T.M-I travels to the site. Therefore 3 no. of Transit Mixer is to be arranged in such a manner that the waiting time of the concreting operation should be reduced so as to balance the smooth flow of concreting operation.

As shown in Future state by arranging T.M- 4 has started loading at (B.P-II) at 45th min which it gets loaded at 55th min. Thereafter the T.M- 4 travels to the site by 85th min but the last unloading of concrete was achieved at 75th min for which the Buffer time is to be given after 75th min as their may be delay or breakdown may occur at the site and thus the T.M- 4 gets unloaded at 95th min. In the same manner during the loading & unloading of T.M-5 takes place the buffer time of 15min & 10min is to be taken in to account as their may be delay at site & Batching Plant respectively. In the same manner T.M- 6 was also arranged so that it gets unloaded at 120th min after which the T.M-I reaches again at site by 125th min. In this stage the buffering time was 10 min at batching plant & 5 min at site is to be given so as their may be delay at both the location due to breakdown and the continues labour work done cannot be achieved at site. Hence the 50min waiting time can be reduced by arranging more 3 no of Transit Mixer by proper channel is to be established for effective co-ordination between all the remaining two sites so that the additional Transit Mixer can be arranged.

1. Loading of TM-4 completes at (B.P.-II)=40th min+15=55th min

2. TM-4 Travels to site at=55th min+30min=85th min

3. Unloading of TM-4 completes at 95th min

4. Loading of TM-5 completes at (B.P.-I)=50th min+15= 65th min

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5. TM-5 travels to site at=65th min+30min=95th min
6. Unloading of TM-5 completes at 105th min
7. Loading of TM-6 completes at (B.P.-II)=65th min+15min=80min
8. TM-6 travels to site at=80th min+30min= 110th min
9. Unloading of TM-6 Completes at 120th min.

4.3 Implementation Strategy

It is a plan that enables to implement targeted future state for the project. It consists of certain guidelines to be followed to achieve the target. Barriers to the flow are to be avoided or reduce as far as possible to achieve smooth flow of value that will optimize the operation. The first target is to reduce the breakdown by implementing systematic periodic maintenance scheme. Periodic maintenance reduces frequency of the breakdown so that actual rate of concreting can be improved.

As mentioned earlier that there are nine transit mixers which are distributed to three sites such that each site is having three transit mixers. Proper channel is to be established for effective coordination between project managers of these sites so that the transit mixers can be arranged in such cases. If this is not possible it is advisable to allocate more no of transit mixer which will cater to pick demand of all three sites. Hence, this transit mixer can be utilized during period of major concreting works by any of the three sites. Hence, cost and overheads of this additional transit mixer is distributed amongst the three sites.

To decrease the travel time of the transit mixer, effective monitoring system is to be established. A system is generated wherein a card is provided to each operator of the transit mixer which records time of departure from the batching plant and the time at which it reaches to site is maintained which is to be countersigned by respective site in charge. It is recommended to provide a coordinator to who will check the adequacy of the system and is responsible to take measures. In addition to that coordinator is responsible to communicate with respective site in charge to avoid any delays due to miscommunication.

V. Conclusion

VSM is a systematic approach lean SCM to evaluate the flow of value through the operation. It is a handy tool to identify delays and wastages in the operation and to achieve optimization of the process. As illustrated in the case study by implementing targeted future state the rate of concreting achieved is high as well as the waiting ideal time until another Transit Mixer to the site is reduced by arranging three no. of Transit Mixer and concreting rate achieved is also high.

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