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Minimization of waste by applying value stream mapping in the supply chain of cement industry

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Abstract : *The purpose of this paper is to identify and address various wastes or non-value added activities in the supply chain of a cement industry using a value stream mapping (VSM). Critical observations and interviewing techniques were used with open-ended questions to understand the processes involved in the value chain of the cement industry. There is an overproduction, excess inventory and information delays in the whole supply chain. Waste or non-value added activities removal from the cement-processing sector is one key to improving the productivity of the sector. The paper addresses the various wastes or non-value added activities in the processing side of the supply chain of a cement industry, using VSM as an approach which was hardly ever attempted before.*

Keywords - *Waste removal, value stream mapping, Current state mapping, Future state mapping, supply chain.*

I. INTRODUCTION

The cement industry of Bangladesh is a rapidly developing sector of the economy Many countries cannot produce enough cement to meet their internal demand, and they depend on imports. However, Bangladesh is self-sufficient in fulfilling local demand for cement. Even so, the installed production capacity is higher than local demand. In Bangladesh, there are around 55 cement-manufacturing companies, most of which are in operations either on a large or small scale. A total of 34, including multinational cement manufacturers, are in commercial production.

Among local brands, Shah Cement, Meghna Cement, Crown Cement, Fresh Cement, Premier Cement and Seven Circle Cement are famous across the country.The five multinational cement companies in operation are: Holcim, Heidelberg, Lafarge Surma, Cemex and Emirates.

Despite the huge demand supply gap that persists for Bangladeshi cement industry, very little has been done for improvement in the productivity by reducing the processing waste of the industry. In this paper, an attempt is being made to apply value stream mapping (VSM) approach to address various wastes in the processing side supply chain of cement industry sector in Bangladeshi context.

This paper therefore has three goals. The first is to characterize today's traditional practices for the delivery of the product. The second is to describe means for improving systems-level performance. The third is to introduce value stream mapping (VSM) as a methodology for modeling and analyzing supply chains. To achieve these goals, details and an analysis are presented of the supply chain configuration of the cement industry.

II. METHODOLOGY

The data presented in this paper were obtained from a cement industry. Data about industry practices at large were collected over 1 month by conducting in-depth interviews with more than 25 practitioners working in various departments of cement industry (including supply chain engineers, warehouse operators, structural engineers, materials managers and expediters), raw material support suppliers (upper management as well a project managers and shop production managers). Interviews included an initial workshop and other face-to-face meetings, numerous telephone interviews with follow-up calls and e-mail exchanges. Discussions were structured around specific project data when available, but invariably also included anecdotal, historical evidence. To augment the data collected through interviews, the researchers also reviewed the technical and trade literature for information available on the World Wide Web.

Cross-functional maps, value stream maps and computer simulations were used to capture and analyze project data, and to develop understanding of the causality of more complex supply chain behaviors (i.e.,[1] and [2]).

III. LEAN CONSTRUCTION: TRANSFORMATION, FLOW AND VALUE (TFV) VIEW OF PRODUCTION

In the field of lean production, (i.e., [3]) identified seven sources of waste:

1. Defects in products
2. Overproduction of goods
3. Excess inventories
4. Unnecessary processing
5. Unnecessary movement of people
6. Unnecessary transport of goods
7. Waiting time

([3]) it is later recognized as an additional source of waste:

- Design of goods and services that fail to meet the user's needs

After tracing the history of various schools of thought in production management and while searching for a theory of construction, (i.e., [4] and [5]) forwarded an integrated view of production, the so-called transformation, flow and value (TFV) theory.

The crucial contribution of the TFV theory of production lies in calling attention to modeling, structuring, controlling, and improving production from these three points of view combined. This TFV theory includes the goal of eliminating waste in the six flow principles (i.e., [5]):

- Reduce the share of non-value-adding activities (waste)
- Reduce lead time
- Reduce variability
- Simplify by minimizing the number of steps, parts and linkages
- Increase flexibility
- Increase transparency

Simply put, waste refers to all efforts that do not add value to the final product from the point of view of the customer. It is possible to attack directly the most visible waste just by flowcharting the process, then pinpointing and measuring non value-added activities (i.e., [4]). Reducing the share of non-value-adding activities is a tenet in process improvement.

IV. LEAD TIME: ONE METRIC TO GAUGE SYSTEM PERFORMANCE

Supply chain lead times are determined by several factors such as:

- Processing time
- Set-up time
- Move time
- Queue or wait time (i.e., [6])

A reduction in lead time of a single supply chain, in and by itself, also is important. A short lead time has the following advantages over a long lead time for that supply chain (i.e., [5]):

- Faster delivery of the product or service to the customer
- Reduced need to forecast future demand accurately
- Less opportunity for disruption in the supply chain due to (design) changes
- Greater possibility that participants will interact in a timely fashion with other supply chain participants
- Easier synchronization of one supply chain with others (e.g. merging supply chains at the site)
- Less opportunity for products to become obsolete.

V. CASE STUDY: APPLICATION OF VALUE STREAM MAPPING IN CEMENT INDUSTRY SUPPLY CHAIN

5.1 Step 1: Agents identification

The supply flow chosen for the case study was the chain of cement form raw material supplier to customer. The cement was chosen because of its significant participation in total building cost for residential and commercial building, around 40%-60%, depending on each project specification.

The manufacturer is Shah Cement industries limited, a local medium size company that acts in development and construction of residential and commercial buildings in all over the country. The job site chosen for the study is a residential eight floor building located in the city of companies.

Cement is made by inter grinding or blending clinker (80%) and Gypsum (13%) with one or more of the mineral components which are given below:

- Fly Ash (Class F). It is up to maximum 7%.
- An inert components: e.g. Limestone (2%-3%) and sand which usually do not have any real participation in the chemical hydration process and is produced by grinding or blending of the constituents.

Now days, many cement industries are facing problems in terms of fixing up their incoming raw material sources. Shah Cement has however fixed two sources of clinker: Thailand and Malaysia. Clinker is brought to Bangladesh by using the company's own transportation. The company imports most of natural gypsum from India & rest of gypsum is imported locally (Bangladesh) as it provides it with more consistence of raw material. The fly ash is imported from India whereas the limestone is brought from Sylhet, a local region of Bangladesh.

5.2 Step 2: Current state mapping

In the current state of Shah Cement industry's supply chain network is followed by two different methods, at first raw materials are supplied to manufacturer, then after manufacturing and packaging the cement, then it is sent to different warehouses through different barges or ships and from the warehouse the fully packaged cements are sent to different distributors and then from distributors it is carried to retailers and from retailers it reaches to the hand of customers.50 percent of the total product follow the above network. Especially we are focusing on this above network which is shown in Fig.1

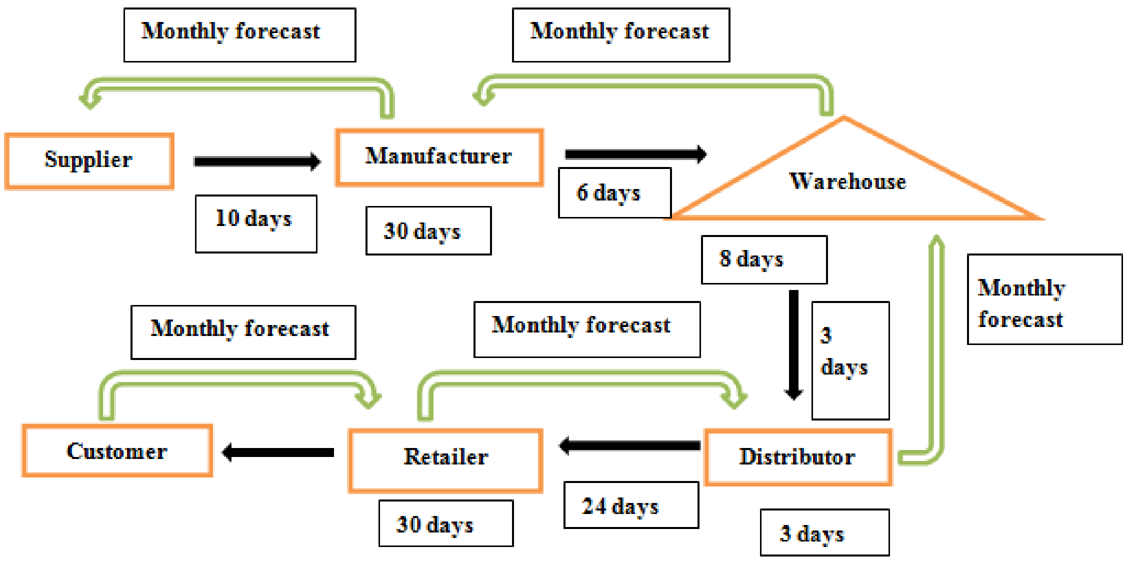
At second, raw materials are supplied to manufacturer, then after manufacturing and packaging the cement, then it is sent to different distributors through trucks and then from distributors it is carried to retailers and from retailers it reaches to the hand of customers.

The current plant capacity of the manufacturing firm is 9000 tons per day. At present, the cement industry produces 6500 tons per day that means almost 195000 tons per month. But according to the monthly demand forecast, market demand of cement is almost 165000 tons per month. That means 30000 tons of extra cement is produces in every month.

Production cost of cement is 395 taka per bag (1 bag = 50kg) and raw material cost is 220taka/beg. So the current total production cost is 51.35 million taka and total raw material cost is 28.6 million taka. The current takt time of the manufacturing firm is 4.5tons/min. For the current production basic raw materials such as clinker is needed 156000 tons per month, gypsum is needed 23400 tons per month, fly ash is needed 11700 tons per month and limestone is needed 3900 tons per month.

In this cement industry, there are 11 distribution centers and 18 warehouses. The total warehouse space for inventory is 70000 bags that it is almost 3500 tons. But only 50 percent cement that means 65000 bag or 3250 tons of cement goes through different warehouses. The present warehouse space for 70000 bags is almost 28000square feet.

Here, in the current state of this cement factory the production is pushed which is based on the forecasts, the system has considerable lead times, information delays and inventories. In the current state of this cement factory the production is pushed which is based on the forecasts, the system has considerable lead times, information delays and inventories.



Time classification	Duration(days)	Percentage of time
Total value added time	30	26.31%
Total non- value added time	84	73.68%
Total processing time	114	100%

Figure-1: Current state mapping of supply chain network

5.3 Step-3: Future state mapping

Some proposed steps for future state mapping is suggested below. The first step is to waste elimination which can be the application of lean principles. With this improvement quality, productivity and lead time reduction can be achieved. The second step can be the development of pull system between supply chain agents. One potential suggestion is to implement Kanban Card system among supply chain agents. The Kanban Card system implementation implies significant changes in the supply chain network by adopting JIT (just –in-time) production, where each agent needs to produce what the customer demands actually. The Kanban Card system is used to inform each company, the production necessity, changing the too each forecasts made with enormous forecasts antecedence for each agent. (i.e., [7]) and [8]) described some detail about Kanban Card system.

By the implementation of pull production system through Kanban card system, supermarket and withdrawal, we have reduced non-value added activities or wastes from the supply chain network which is shown in the Fig.2

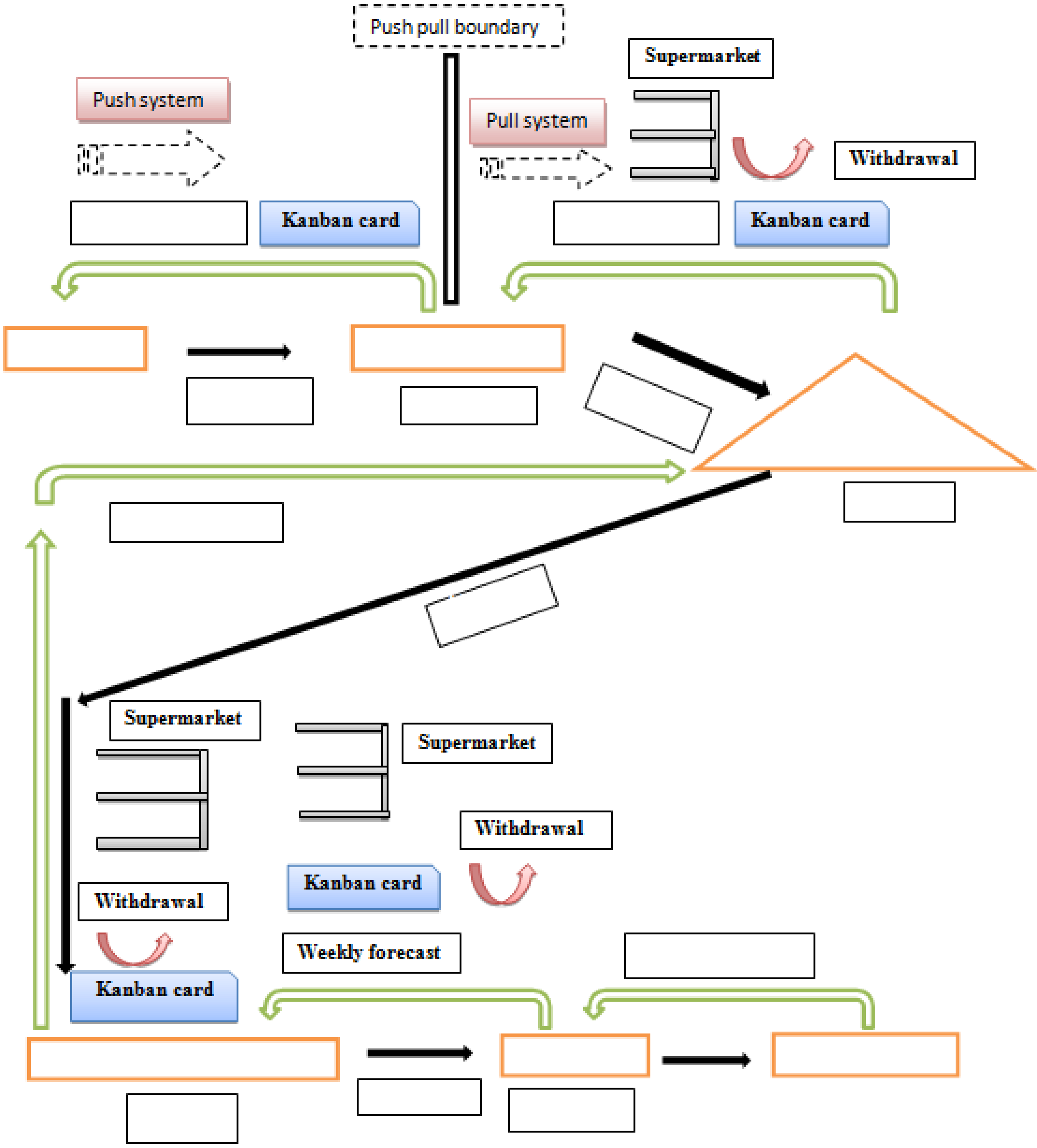
According to the weekly demand forecast, the market demand can be almost 38500 tons per week. The plant at present produces 45500 tons of cement every week. That means there is an excess production about 7000 tons per week. Because of implementing pull system we can reduce the extra production which is about 4000 tons per week. That means the weekly production will be almost 41500 tons. Thus if we consider this production reduction monthly then almost 17000 tons of cement will be need not to be produced. Then our total production cost is reduced which can be almost 67.15 million taka. The reduction of ware house space will be almost 6800square feet.

For the production of future state basic raw materials such as clinker will be needed almost 33200 tons per week, gypsum will be needed almost 4980 tons per week, fly ash will be needed almost 2490 tons per week and limestone will be needed almost 830 tons per week. That means reduction of raw material such as clinker is almost 13000 tons per month, gypsum is almost 1400 tons per month, fly ash is almost 700 tons per month and limestone is 300 tons per month.

5.4 Step 4: creating action plans

Following suggestions or recommendations can be applied to improve the current state supply chain network of cement industry:

1. Adoption of pulled production through using supermarket and Kanban Card system in the supply chain network.
2. Stocks or inventory reduction inside the supply chain network by implementing JIT (just-in-time) methodology like warehouse, and distributor.
3. Minimizing the batch sizes or adaptation of small lots, it improves the communication between participants in the supply chain.
4. Fostering communication and co-ordination between supply chain participants. It helps to increase flexibility and transparency that are needed to balance and synchronize flows in the supply chain network.
5. Creation of an integrated information system among all the supply chain agents.
6. Additionally, supply chain agents integration can be improved by means of period meetings, to discuss goals and strategies to reduce cost in the supply chain, to standardize the information flow, to warranty self-learning and to elaborate the action plans.
7. Resources must be dictated to particular tasks and have some excess capacity to buffer the anticipated variability in workload.



Time classification	Duration(hours)	Percentage of time
Total value added time	168	28.57%
Total non- value added time	420	71.42%
Total processing time	588	100%

Figure-2: Future state mapping of supply chain network

VI. Conclusion

(i.e., [9]) it is rightly argued that whenever there is a product for a customer, there is a value stream. The challenge lies in seeing and working on it. VSM can be done in the same way for practically any business activity and expanded upstream or downstream. Cement Industry has a huge potential due to fast rising commercial and residential in Bangladesh. Use of inappropriate methods of processing, unorganized supply chain network and excess inventory is making the overall supply chain inefficient and is causing losses and wastes.

Thus, the wastes of the industry in terms of overproduction, unnecessary inventory, motion and transport, etc. need to be addressed to improve efficiency and effectiveness of supply chain. Seven major recommendations or suggestions come out of this paper for the industry.

With the above recommendations being in practice, the cement industry might look into future with positive outlook. The future scope of work lies in exploiting other powerful tools of value stream to attack wastes in the supply chain of cement industry. Similarly, the concepts can be replicated for other cement industries to capture various scenarios and attack wastes in processing and distribution chains. Similarly, studies can be used to compare value streams in context to country specific situation.

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