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# Application of Value Stream Mapping in Cement Industry's Supply Chain and Analyzing Results by Fuzzy Inference System

Abu Md. Saifuddoha[1], Md. Ahasan Habib[2], Sohana Yasmin Sumi[3]
[1]Student of IEM Department, KUET
[2]Lecturer of IEM Department, KUET
[3]Student of IEM Department, KUET
*E-mail: saifsf08@gmail.com, shiplu04_ipe@yahoo.com*

## 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) approach to improve productivity through reducing non-value added activities in a Bangladeshi context analyzing results by fuzzy inference system. Critical observations and interviewing techniques were used with open-ended questions to understand the processes involved in the value chain of the cement industry. Fuzzy inference system is applied to analyze results by showing rule and surface viewer through different inputs and outputs. Waste or non-value added activities removal from the cement-processing sector is one key to improving the productivity of the sector and showing the resultant output is changed by changing its corresponding inputs for various ranges by fuzzy inference system.*

***Keywords:*** *supply chain, value stream mapping, fuzzy inference system, Waste, cement industry.*

## 1. 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. Among local brands, Shah Cement, Meghna Cement, Crown Cement, Fresh Cement, Premier Cement and Seven Circle Cement are famous across the country. 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 and analyzing the corresponding results by fuzzy inference system.

## 2. 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.
Fuzzy sets can represent imprecise quantities as well as linguistic terms. Fuzzy inference system (FIS) is a method, based on the fuzzy theory, which maps the input values to the output values. The mapping mechanism is based on some set of rules, a list of if-then statements. In this research Mamdani fuzzy inference system is used to derive the overall output results when subjected to eight inputs and one output.

## 3. Waste Identification

Waste refers to all efforts that do not add value to the final product from the point of view of the customer. Reducing the share of non-value-adding activities is a tenet in process improvement. In the field of lean production, it is identified seven sources of waste [1]:

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

Womack and Jones [2] later recognized as an additional source of waste:

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

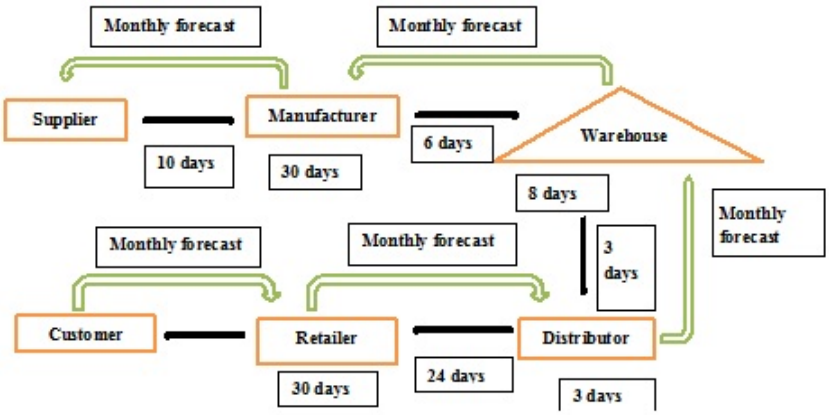
## 4. Case study: Application of value stream mapping in cement industry supply chain

### Step 1: Agents identification

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. 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 Syhlet, a local region of Bangladesh.

### 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



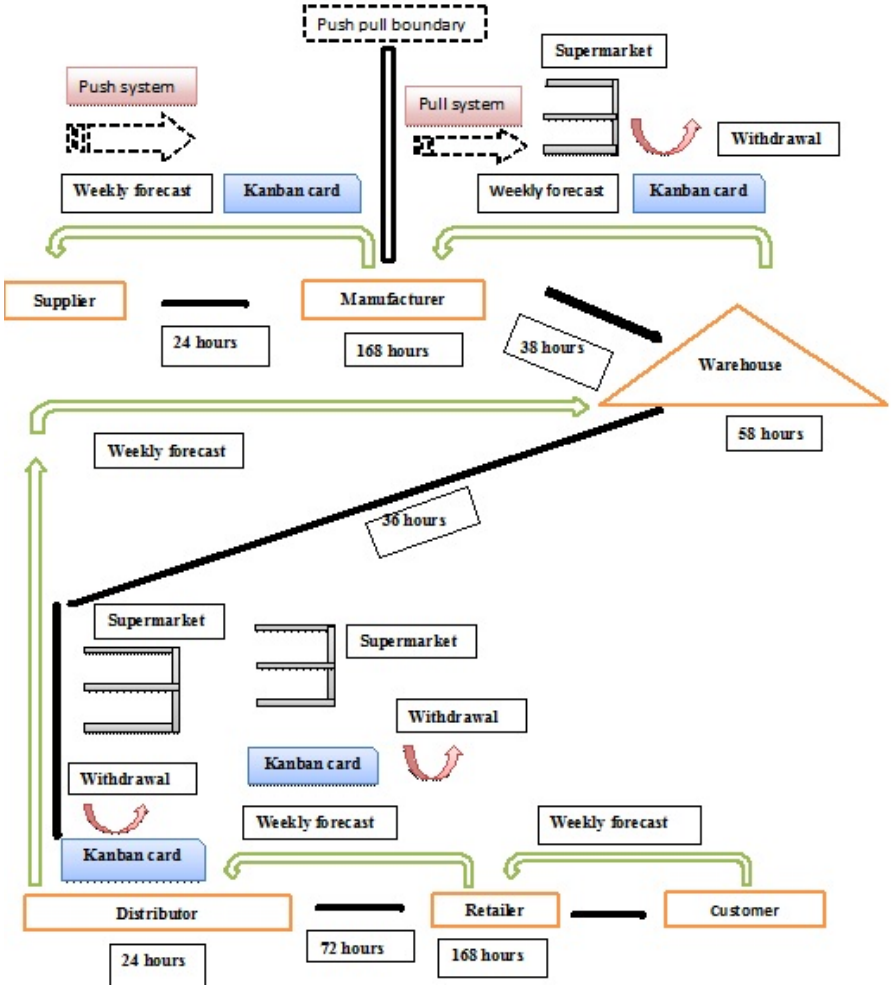

| Time classification | Duration(days) | Percentage of time |
|---|---|---|
| Total value added time | 30 | 26.31% |
| Total non- value added time | 84 | 73.68% |
| Total processing time | 114 | 100% |

**Figure.1** Current state mapping of supply chain network

### 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. It is described some detail about Kanban Card system[3] and [4].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




| 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

### 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.

## 5. Analyzing results through fuzzy inference system

As In this research, the Fuzzy Logic Toolbox built on MATLAB is adapted. It provides tools to create and edit fuzzy inference systems within the framework of MATLAB. This toolbox also provides Graphical User Interface (GUI) tools to facilitate work, besides command line functions. Calculation method goes through the following steps:

- Expert knowledge is gathered and the suitable type of input variables and there range are selected. Mamdani type FIS is used for our research.
- For this work, for both the input and output, sigmoid membership function has been used. This is because it is a normal distribution curve.
- Rules are developed using MATLAB built in fuzzy inference toolbox.
- The surface viewer represents the relationship surface of result and two variables. The surface shows how result is changing with the changing of any two variables.
- By changing the value of the input factors, we can observe the effect on the output at rule viewer.

Some short specific features, which are mandatorily used for the simplification of this research, are following:

### FIS Editor

Displaying general information about a fuzzy inference system is the main concern of FIS editor. The FIS Editor displays general information about a fuzzy inference system. There is a simple diagram at the top that shows the names of each input variable on the left, and those of each output variable on the right. The sample membership functions shown in the boxes are just icons and do not depict the actual shapes of the membership functions.

### Membership Function Editor

Membership function is the mathematical function, which defines the degree of an element's membership in a fuzzy set. The Fuzzy Logic Toolbox includes 11 built-in membership function types. These functions are built from several basic functions:

1.Piecewise linear functions, The sigmoid distribution function,
2.The sigmoid curve and

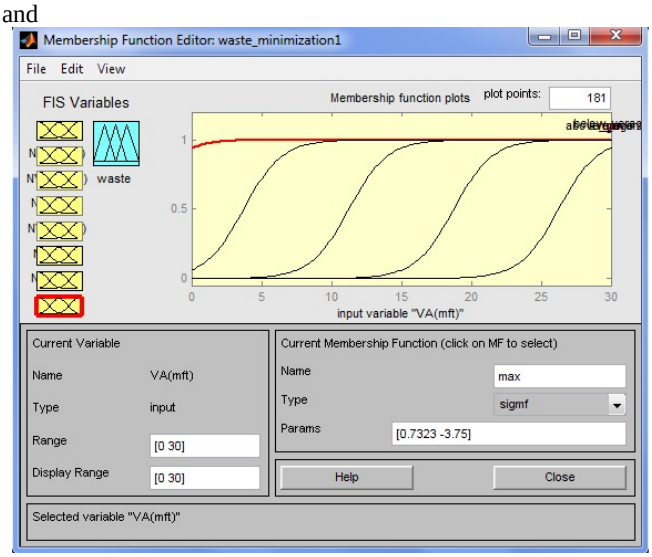



**Fig 1:** Membership Function Editor of FIS

### Rule Editor

Constructing rules using the graphical Rule Editor interface is self-evident. Based on the descriptions of the input and output variables defined with the FIS Editor, the Rule Editor allows you to construct the rule statements automatically, by clicking on and selecting one item in each input variable box, one item in each output box, and one connection item. Choosing none as one of the variable qualities will exclude that variable from a given rule. Choosing not under any variable name will negate the associated quality. Rules may be changed, deleted, or added, by clicking on the appropriate button.

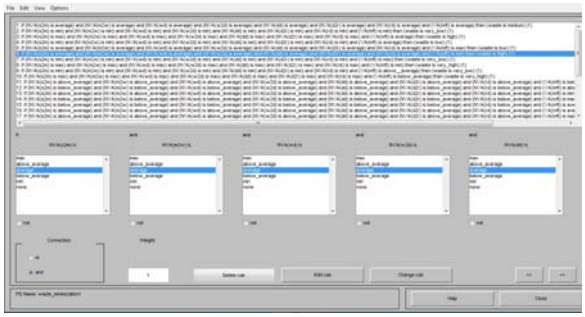


**Fig 2:** Rule Editor

### Rule Viewer

The Rule Viewer displays a roadmap of the whole fuzzy inference process. It is based on the fuzzy inference diagram described in the previous section. You see a single figure window with 10 plots nested in it. The three plots across the top of the figure represent the antecedent and consequent of the first rule. Each rule is a row of plots, and each column is a variable. The rule numbers are displayed on the left of each row. You can click on a rule number to view the rule in the status line.


**Fig 3:** Rule Viewer

**Surface Viewer**

Upon opening the Surface Viewer, we are presented with a three-dimensional curve that represents the mapping from non-value added activity to value added activity and waste. Since this is a one-input one-output case, we can see the entire mapping in one plot. Two-input one-output systems also work well, as they generate three-dimensional plots that MATLAB can adeptly manage. When we move beyond three dimensions overall, we start to encounter trouble displaying the results. Accordingly, the Surface Viewer is equipped with pop-up menus that let you select any two inputs and any one output for plotting. Just below the pop-up menus are two-text inputs fields that let you determine how many x-axis and y-axis grid lines you want to include. This allows you to keep the calculation time reasonable for complex problems. Pushing the Evaluate button initiates the calculation, and the plot comes up soon after the calculation is complete. To change the x-axis or y-axis grid after the surface is in view, simply change the appropriate text field, and click either X- grids or Y-grids, according to which text field you changed, to redraw the plot.

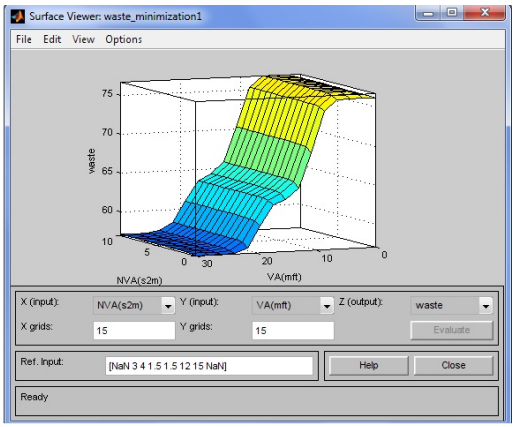



**Fig 4:** Surface Viewer

## 6. Discussion

Rother and Shook [5] rightly argue 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.

The manufacturing companies should use the optimal result which reduce the total waste and increase the overall profit. Fuzzy logic helps to find these optimal results if the company's expert provided data are available. In this research, using data of a cement manufacturing company the final result is obtained by which waste is minimized. Here, eight input variables are considered to find the variations in waste. For each input and output variable Sigmoid membership functions are considered to design the model.

## 7. Acknowledgements

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