Proceedings of the 2016 International Conference on Industrial Engineering and Operations Management
Detroit, Michigan, USA, September 23-25, 2016

Applications of Lean Methodologies and Quality Improvement in Textile Industry

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Abstract

Industries in general have a lot of waste. Wool Textile Company in Baniwalid, Libya has many complex problems that led to enormous waste generated due to the lack of lean strategies, expertise, technical support and commitment. To successfully address waste at Wool textile company, this study will attempt to develop a methodical approach that integrates lean manufacturing tools to optimize performance characteristics such as lead time and delivery.
This methodology will utilize VSM techniques to identify the process variables that affect production. Once these variables are identified, Design of Experiments methodology will be used to determine the significantly influential process variables; these variables are then controlled and set at their optimal to achieve optimal levels of productivity, quality, agility, efficiency and delivery to analyze the outputs of the simulation model for different lean configurations. The goal of this research is to investigate how the tools of lean manufacturing can be adapted from the discrete to the continuous manufacturing environment and to evaluate their benefits at a specific industrial.

Keywords
Lean manufacturing, DOE, Value Stream Mapping, Textiles

1. Introduction
There has been a small portion of research over the past years in unindustrialized textile industries. "Hokoma" published research focused on areas of modeling and simulation of manufacturing operations, whereas strategies and implementation within textile industries were less studied. Over several decades, profitability and competition from the textile companies, has resulted in fewer low cost foreign manufactures in the marketplace.
"Rudrajeet et al." and his team concluded that many companies have utilized lean manufacturing techniques because they help their organization with shorter delivery times, improvement in quality, and reduced cost. However, even though this helps with upstream customers, it has been noticed that it may not be so helpful to downstream customers and competitors who operate with lean principles.
The goal of lean manufacturing is to help companies aspiring to enter the competitive market to find ways to recover their operations and be more competitive to accomplish this, companies can implement use of diverse lean manufacturing tools and techniques to eliminate waste and non-value- added activities at every production or service process in order to improve product quality, enhance productivity and reduce costs.
"Womack and Jones" describe the word "lean" as a system that adapts to operating with a smaller amount, in conditions of all inputs, to produce indistinguishable outputs indistinguishable from to those produced by a usual mass production systems, all while increasing quality for the end buyer. The use of a lean system mean to manufacture what the customer wants in a product, when it is required and in the quantities arranged.

1.1 Expected Research Contribution

This paper will focus on the work involved in enabling companies to use objective lean manufacturing tools in companies. However, the study will focus specifically on identifying the current waste in textile company, as well as identifying ways to develop and enhance textile company's' manufacturing process design methods in order to determine which lean principles are appropriate for implementation in the textile industries. Baniwalid textile in Libya has many complex problems that led to enormous waste generated due to the lack of lean strategies, expertise, technical support and commitment.

1.2 The Increasing Importance of Lean Tools in Industries

Twenty million dollars are wasted annually on non-value added activities at the Baniwalid textile plant in Libya. Eighty percent of the plant shipments were delivered late to customers during the period from November 2010 through February 2011. This is creates customer dissatisfaction and has resulted in cancellation of orders. More than forty percent of Baniwalid textile respondents in 2013 mid-year survey stated that they were very or somewhat dissatisfied with communication within the departments. The objective of this study is to develop a lean manufacturing strategy with a clear road map for Baniwalid textile Plant Baniwalid textile using Value Stream Mapping (VSM), along with recommendations for future improvements by using design of experiments for both states the current state and the future state. The objective of this research is to reduce waste to at least twenty percent leading to cost savings of four million dollars.

2. Complete Design (VSM) Value Stream Mapping

Once the initial strategy requirements are recognized, we may create to calculate how well value stream mapping can be expected to be implemented. A rigorous design waste modes and effects analysis will be completed to identify the most significant waste in the current VSM value stream mapping. The VSM will be led through enablement by a group of engineers from both the equipment supplier and the assembly plant. Beginning with the defined waste, future VSM value steam mapping will be constructed based on the information provided by current VSM. Each waste will be expressed in terms of equipment waste.

"Abdullah" did his doctoral on Lean and he described VSM as an assortment of all actions added, including non-value added that are essential to transport a product or group of products that make use of the same resources through the main flows, from raw materials straight to the customers. The nucleus of profitable lean operation are the information and operation flows in the overall supply chain. The use of VSM is an improvement method to assist in the visualization of the complete production process, on the behalf of material and information flows.

It is important when using the value stream technique to try to identify any types of waste in the stream and develop steps for finding a way to eliminate the waste. Using the value stream tool to improve the whole flow and not just optimization means to look at the whole picture of the process and not just individual processes. Value stream mapping is created by hand with paper and pencil. There are several benefits in using this tool. Manual mapping allows what is actually happening in the shop floor value stream to be seen, rather than controlled by a computer. Another benefit is that this process acts as a plan-do-check-act cycle that expands our understanding of the overall flow of value, or lack thereof. See icons used in value stream mapping shows in Figure.1

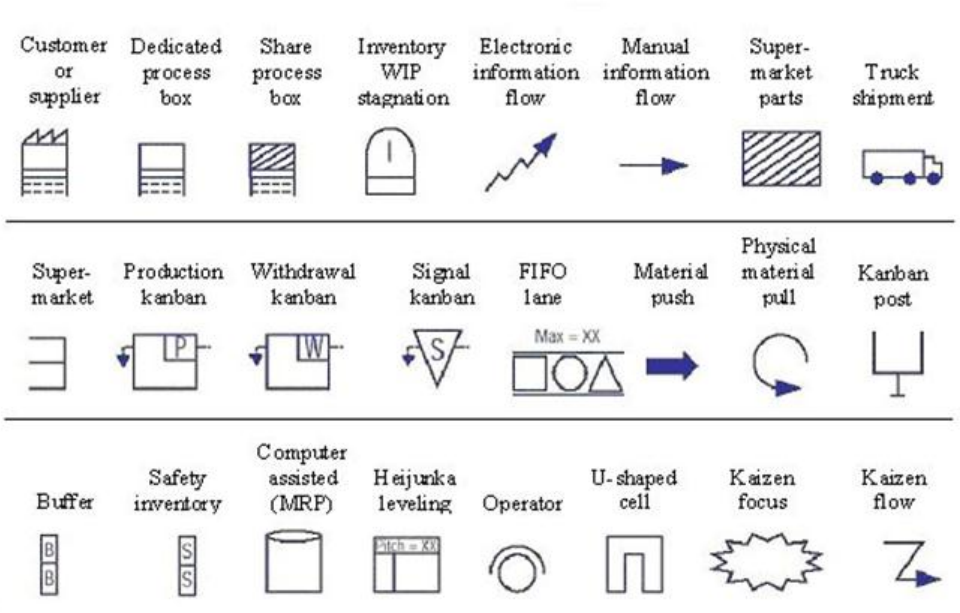

Figure 1. Icon Used In Value Stream Mapping.

2.1 Create Current State Value Stream Mapping (CSM)

Wool textile company, baniwalid ,libya To create current state Value Stream Mapping first of all we have to define the scope of the value stream map then set agreement on the symbols, icons, data to use, this data collection allow to appropriately target Lean improvement efforts on the highest priority problems, and there by achieve the greatest benefits. Second, draw materials are often a large source of a product's costs, so looking explicitly at the material flows in a value stream is another way to leverage greater gains. And finally, Sketch a map then gather and create as much information about causes of waste (include customer, suppliers, the material moves between processes and the inventory levels etc.) uncover wastes in value stream mapping is to select one or two performance metrics to measure for each process in the value stream. Weigh the amounts of scrap and wastes generated by each process during a shift. Build a Current State Value Stream Mapping and make a list of remarks for further improvements. Figure. 2

2.2 Create Future State Value Stream Mapping (FSM)

Create Future State Value Stream Mapping (FSM) Figure. 3

Cycle Time = Actual time required for a worker to complete one cycle of his job process
Lead Time = The period of time between the initiation of any process of production and the completion of that process

Takt Time = Available time/Number of unit

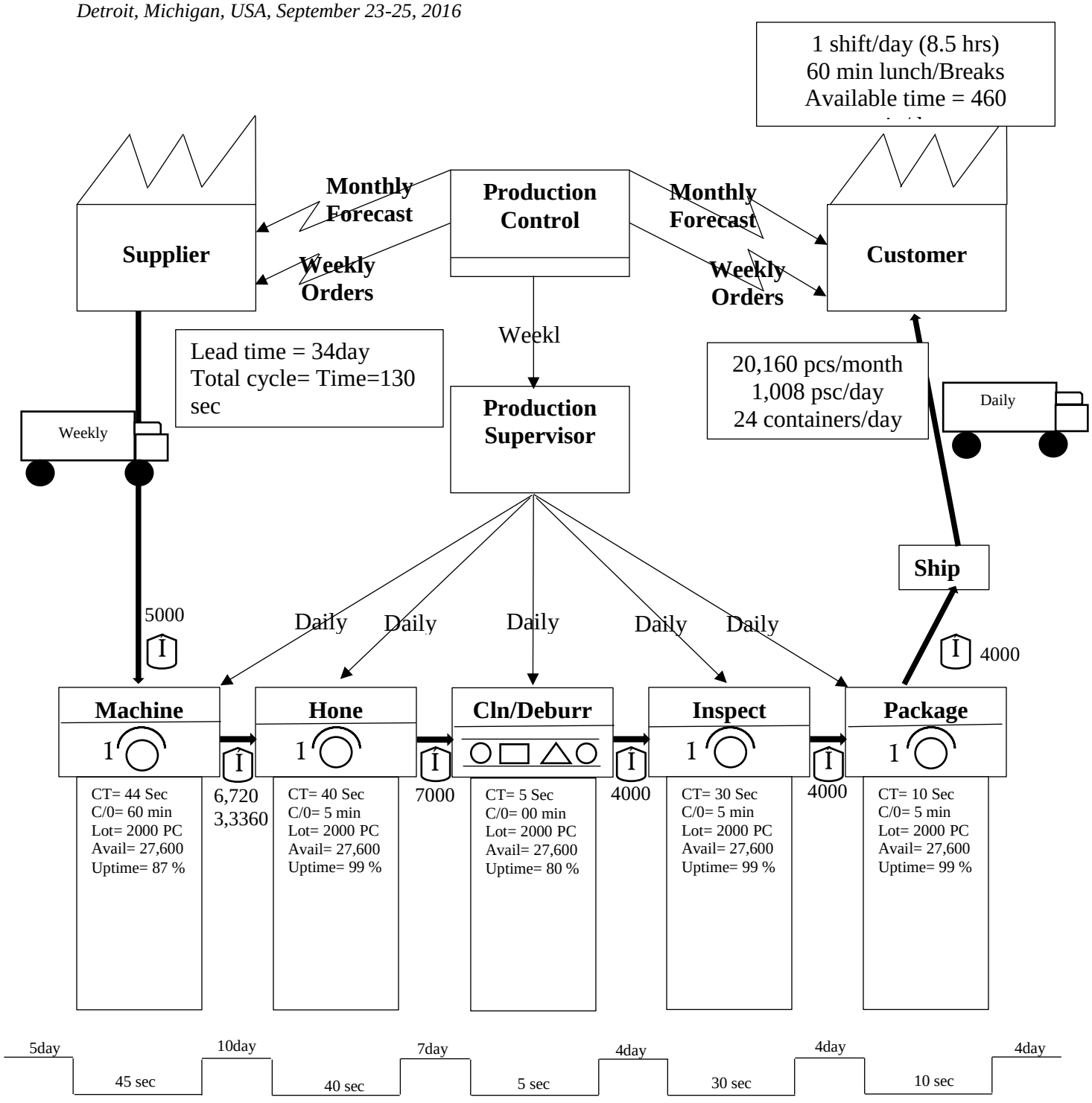

Figure. 2 Current State Value Stream Mapping (CSM).

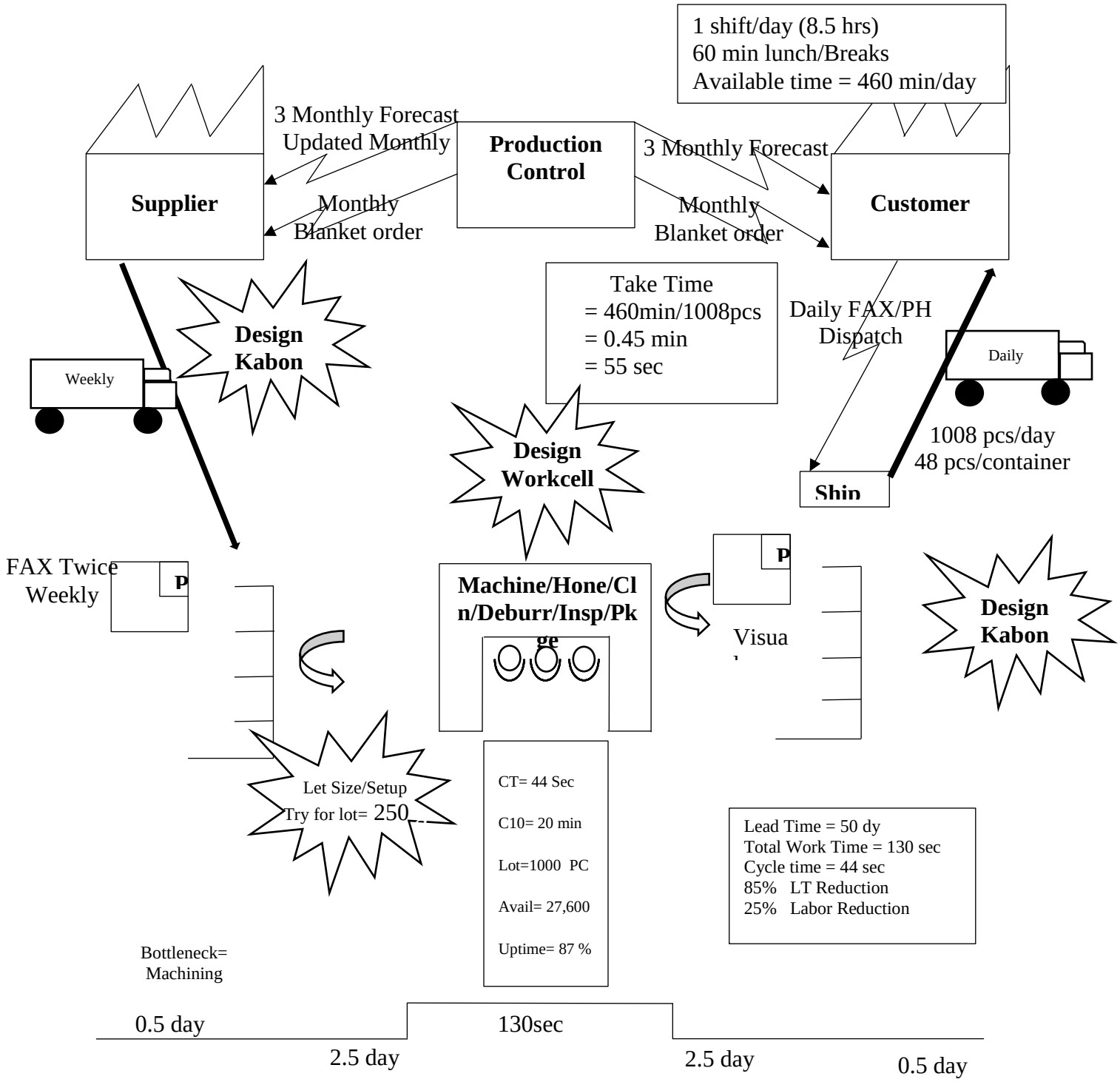

Figure. 3 Future State Value Stream Mapping

3. Design of Experiments

The purpose of using DOE is to classify the future VSM. These factors will be derived from the VSM for operational waste and are expected to include: process and design factors such as Just-In-Time, standardization of work, production smoothing, and Other Waste Reduction Techniques. A fractional factorial experimental design will be used to screen for the most significant factors affecting the system operational performance. A fractional factorial design will allow assessment of the greatest number of potential factors with the fewest experimental runs by analyzing the aliasing effects in the data. Also we are going to use the design of experiments for our final outcome of this research which is optimize system throughput. Using the results of the design of experiments, initial feasibility of the prototype system is established and process constraints may be identified. At this point, further improvement to the inspection system may be warranted.

4. Using Value Stream Mapping (VSM) by Design of Experiments (DOE)

Design of experiment techniques enable designers to determine simultaneously the individual and interactive effects of many factors that could affect the output results in any design. DOE will be used for both states, the current state and the future state which lean tools use to eliminate waste and non-value-added activities at every production or service process in order to bring the most satisfaction to the customer and determine the best design variables from among all possibilities without explicitly evaluating each possibility. The levels or factors are production system (X1), TPM (X2), and Setup reduction (X3). By using a full factorial design 2^k all possible combinations of these levels are investigated and replicated. Where 2 is the number of levels for each factor ^{k} is the number of factors, $^k = 3$ and factor will examined at two levels. Machine and operation due date System will be the two levels used for the production system factor Table 1, 2. The Machine system represents the current state map and the operation due date system represents the future state map

Table 1. The Number in Each Level-Factor Combination Represent the Average Lead-Time in Days for the Factorial Designs.

Total Productive Maintenance (TPM)				
	Without Setup Reduction		With Setup Reduction	
Production System	Without	With	Without	With
Machine	34.36	34.22	27.28	27.01
	34.35	34.03	27.39	27.30
	34.36	33.87	27.13	27.77
	34.19	34.23	27.33	27.36
	34.12	34.49	27.39	27.56
Operation due date	19.17	12.13	12.13	12.12
	19.28	12.11	12.11	12.11
	19.03	12.14	12.14	12.13
	19.18	12.11	12.11	12.10
	19.23	12.13	12.13	12.12

Table 2. Proposed Setup Reduction Time

Process	Setup time for main stages (min)	Setup time for stage process flow (min)
Kinit	20	10
Preparation	-	5
Dye	20	5

Finish	20	5
Despatch	(4,8,5,6)	-

DOE provides a full insight of interaction between design elements, therefore helping to turn any standard design into a robust one. Simply put, DOE helps to pin point the sensitive parts and sensitive areas in your designs that cause problems in Yield as shown in Figure 4. Designers then are able to fix the problems and produce robust and higher yield designs prior going into production.

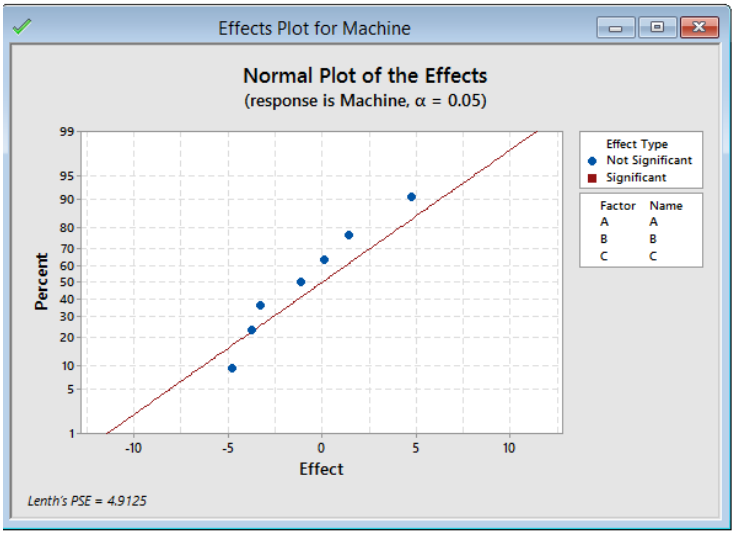

Figure 4. Line Plot Indicates Effect Plot for Machine

VSM was developed and popularized in the automotive industry. Automotive plants are highly focused factories with a narrow family of products for a few customers. VSM works well in these situations.

5. Summary

This research is expected to help in understanding how to solve real problems in textile industries, as well as how to improve existing manufacturing practices in the factory. Implementing lean techniques to evaluate the existing manufacturing system of the company and/or industry is valuable tool. By using these methods, development of the current and future state value stream map will be completed. At the end of the process, the company will be able to propose an implementation process for the lean manufacturing system for further future improvements.

- Lead Time reduction of 85%
- Productivity increase of 25%
- Inventory will decrease about 85%

Acknowledgements
I cannot express enough thanks to my committee for their continued support and encouragement: Dr. Badih Jawad, my committee chair; Dr. Ahad Ali; Dr. Sabah Abro, and Dr. Mohamed Nasser. I offer my sincere appreciation for the learning opportunities provided my committee.

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Biography
Ahmad Ali Yame earned his BSc in Engineering Technology 2010, and two MSc in Industrial Engineering 2015, and Engineering Management 2011 from the Lawrence Technological University and his first MSc in Mechanical Engineering 2007 from the National University of Malaysia. He earned his Associate's degree, Mechanical Engineering 2004 from the Libyan Higher Professional Center for Comprehensive Professions. He primarily develops engineer, but also has experience with software, and testing. Mr. Yame has tested many enterprise applications for automotive MAHLE Laboratories in 2013, he worked with Wipro and Panasonic automotive in North America 2016 to test a vehicles application and AHU for diagnostic functionalities of engine control systems. He has organized several simulations, in order to test the engine control software and the diagnostic functionality on a CAN logs, respectively, through non-regression and diagnostic tests. He is member of SME and IEEE.

Daw Al-Werfalli is Professor, and Director of Director of Master of Engineering Management and Manufacturing Systems Degree Programs in the A. Leon Linton Department of Mechanical Engineering at the Lawrence Technological University, Michigan, USA. Highly experienced and dedicated community leader with great ability to work with an array of constituencies and coalitions in developing shared organizational vision to create and implement strategies aimed at advancing common causes to accomplish goals in fulfilment of the organization's mission. Possess good analytical and decision-making skills, and the ability to conceptualize new initiatives and solutions to problems while possessing an outcomes orientation Highly perceived expert and technical consultant driven to acquire and apply industry proven standards, practices, and methodologies to offer the best possible solutions that improve, productivity, quality, performance and reliability while reducing costs.