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LEAN LABORATORY APPROACHES FOR QUALITY ASSURANCE IN FOOD

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Abstract: *A lean laboratory is one which is focused on testing products and materials to deliver results in the most efficient way in terms of cost or speed or both; primarily focused on improving measurable performance and reducing costs. The goal of a lean laboratory is to use less effort, less resources and less time to test incoming samples. Laboratories have a critical role to play in establishing and improving process capability and key performance indicator (KPI) of the organization. There are inevitably many opinions as to what a lean lab actually is; here is one version from. Quality assurance laboratories are crucial to the success of organization and this effectiveness needs to be measurable and demonstrable. To facilitate this, a method of measuring a laboratory's progress towards complete deployment has been created by lean tools. These tools allow laboratories to conduct gap analysis and identify opportunities for improvement.*

Keywords: *Lean laboratory; Process capability; KPI (Key performance Indicators) and Quality Assurance.*

1. INTRODUCTION

In today's environment; a wide variety of laboratory management strategies have been proposed and emerged to reduce cost while improving quality and efficiency. One of the most successful strategies is that of lean laboratory methodology (Dundas et al., 2011). Lean is not an acronym. It is a methodology used to accelerate the velocity and reduce the cost of any process (e.g. laboratory workflow, analysis, etc.) by removing waste. It is called Lean because it is a descriptive process that uses less of everything: space, time, investment in equipment, inventory, documentation, analysis and other resources. Lean is also known by other names, most notably Operational Excellence, Business Process Redesign, or as the history section describes—the Toyota Production System (TPS).

Lean laboratory programs are generally associated with automobiles, food, beverage, life science and pharmaceutical companies. Lean is a set of principles and techniques that drive organizations to continually add value to the product they deliver by enhancing process steps that are necessary, relevant, and valuable while eliminating those that fail to add value. Lean is basically founded on a mathematical result known as Little's Law; essentially the art of 'doing more with more efficiently by less effort'.

2. MEANING OF LEAN LABORATORY

The term "lean" as defined by Womack et al., (1994) 'It denotes a system that utilizes less, in term of all inputs, to create the same outputs as those created by traditional system, while contributing increased varieties for the end customer' (Panizzolo 1998). Lean definition as developed by the National Institute of Standards and Technology Manufacturing Extension Partnership's Lean Network: "A systematic approach to identifying and eliminating waste through continuous improvement and flow of the product at the pull of the customer in pursuit of perfection." Lean has been used in manufacturing for decades and has been associated with enhanced product quality and overall corporate success (Jerry et al., 2011).

A "Lean Laboratory" is one which is focused on testing products and materials to deliver results in the most efficient way in terms of cost or speed or both (Richard 2009) with an objective of improving measurable performance and reduce costs by less resources, effort and less time to test samples in an laboratory environment. A lean tool is a supplement or component part of a quality program that usually will not stand alone but can enhance the total quality system.

3. LEAN LABORATORY PRINCIPLES

The principles of lean manufacturing have been slow to migrate to laboratories because they are quite different from manufacturing environments. While most of the key principles of traditional lean still apply, there are many unique challenges involved in effectively implementing them in laboratories.

Compared to manufacturing environments most analytical and microbiological laboratories have a relatively low volume of samples but a high degree of variability and complexity. Many standard lean tools are not a good fit; however lean can be applied to labs (Tom Zidel 2006). A generic approach is not suitable for laboratories but careful adaptation of the techniques based on a thorough understanding of lab operations will deliver significant benefits in terms of cost or speed or both. There are five basic fundamental lean laboratory principles, these are:

1. Specify value in the eyes of the customer
2. Identify the value stream and eliminate waste/variation
3. Make value flow at the pull of perfection
4. Involve, align and empower employees, and
5. Continuously improve knowledge in pursuit of perfection

Every activity in the laboratory is identified and categorized as 'value added', 'non value added' (from the customers perspective) and 'incidental'. The incidental work is non value add in itself but essential to enable 'value add' tasks to be carried out. Significant focus of any lean lab initiative will be to eliminate or reduce the non value add activities.

Value stream mapping creates material and information flow of a product family. One of the key steps in lean laboratory is to develop value stream maps of the overall lab process. Ability of a lean laboratory is to deliver timely services right first time (RFT) and it is an integral part of the value stream. Value stream mapping focuses on improvement efforts and pinpoints problem solutions that will give the most value for your money, time, and energy.

Flow of work through the laboratory is so that; once testing begins on a sample, it is kept moving and not allowed to queue between tests. 'Pull' is interpreted as testing according to customer priority and it creates a focus that drives to reduce lead-time of product.

4. LEAN TOOLS

1. 8 Types of Waste
2. 5 Why: Issues analysis
3. Time value map
4. Fishbone diagram: Cause and effect diagram
5. 5 S
6. Lean layouts: Muther's Grid
7. Kaizen
8. Kanban

These key lean laboratory tools can be used in all phases of process, from the beginning of product development up to product marketing and customer support.

At the moment there are a significant number of quality assurance and quality management tools on disposal to quality experts and managers, so the selection of most appropriated one is not always an easy task. (Paliska et al., 2007).

5. MATERIALS AND METHODS

A team charter was made to achieve the optimized laboratory operation, kickoff meeting was held on the present status and then problems were subdivided into fragments then assigned within the team members. Applying above lean tools; worked on quick wins under each problem.

5.1. The 8 types of wastes

Any (economic) activity that adds no value is termed as 'Waste'. Many lean experts reported as eight types of waste(Some case 7 types of waste), represented by the word D-O-W-N-T-I-M-E: as Defects, Overproduction, Waiting, Non Value Added Processing, Transportation, Inventory (excess), Motion (excess), Employee knowledge and skills (not utilized).

In one of our waste reduction activity in an bulk food processing industry; up to 50% reduction on bulk intermediate control sample storage was achieved and $ 2500 US per year saving was achieved along with saving on bottle, capping, transportation cost, storage space and time. This bulk sample was not the finished product; it was just an intermediate food intended for preparation of final product at the main packing station hence; storage of each batch of bulk intermediate was not essential from the point of sample retention policy and this was not falling under risk factor.

5.2 Issues Analysis: The 5 Why

The 5 Whys analysis is a good tool to use when we quickly want to get to the root cause of a problem. The main purpose is to be able to move past symptoms and get to the true root cause of a problem it can be used in conjunction with a fishbone analysis.

5.3 Time value map

It traces a work item through its process where it spends its time. Determines where it spends valuable time and where waste time can be eliminated. A time value map is a graphical representation showing all the value adding steps, necessary non-vaule adding steps and waste. It traces a work item through its process and helps in identifying where it spends valuable time and where waste time can be eliminated.

5.4 Fishbone diagram : cause and effect

Dr. Kaoru Ishikawa, a Japanese quality control statistician invented this fishbone diagram. It may be referred to as a cause-and-effect diagram or "Ishikawa diagram" or a "fishbone diagram" because of the way it looks. The fishbone diagram is an analysis tool that helps identify, sort, and display possible causes of a specific problem or quality characteristic. It graphically illustrates the relationship between a given outcome and all the factors that influence the outcome. Some of the benefits cause and effect diagram are:

1. Helps determine the root causes of a problem or quality characteristic using a structured approach.
2. Encourages group participation and utilizes group knowledge of the process.
3. Uses an orderly, easy-to-read format to diagram cause-and-effect relationships.
4. Indicates possible causes of variation in a process.
5. Increases knowledge of the process by helping everyone to learn more about the factors at work and how they relate and
6. Identifies areas where data should be collected for further study.

This is the one investigation conducted to improve the faster clearance of the tested product. Baseline data for the last one year on batch releases was collected and analysed. This diagram depicting the different cause and effect in the delay in release of finished product, there are 6Ms causes; (Man, Material, Mother-nature, Measurement, Machine and Method) and under each main cause; their possible sub-cause also affecting the outcome as illustrated, all the parameters directly or indirectly resulting on the delay of batch release process. From this lean tool main root cause analysis was done corrective and preventive actions were taken finally it resulted in reduction in batch delays by 82 % and standard deviation for the batch release process has been reduced from 24.2 to 3.23 (7.5 times).

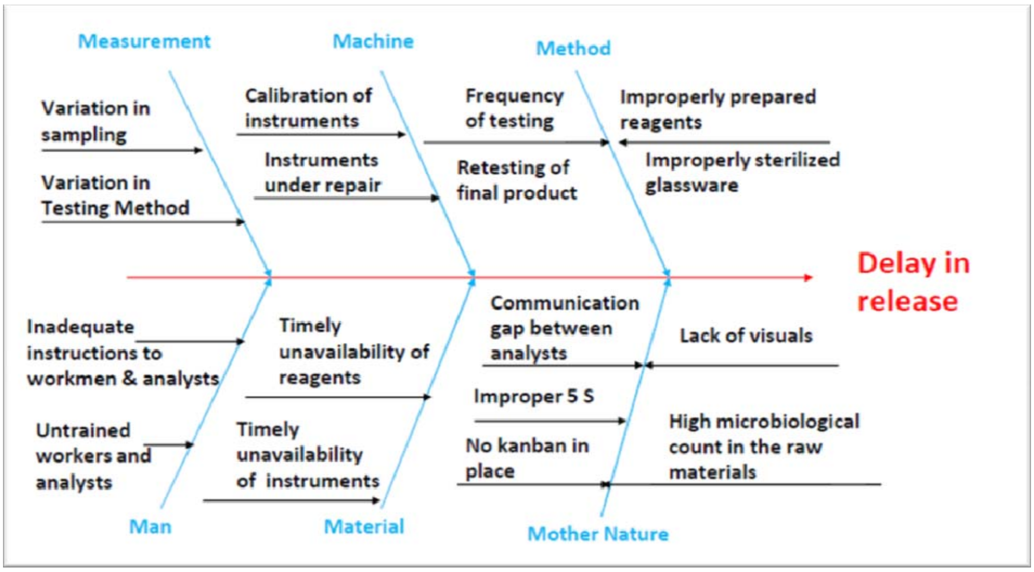

Figure 1 Fishbone diagram: Cause and effect

5.5 The 5 s

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5S" has two main aims in the laboratory: the first is to ensure that a laboratory worker can find anything they need instantly (A place for everything and everything is in its place), the second is to ensure that expensive laboratory environments are used for laboratory work and not mass storage of years of unused consumables and equipment and there by preventing cross- contamination.

5S has the following steps:

- Sort : Sorts through the laboratory and keep only that which is required
- Store : Identify a place for everything (A place for everything)
- Shine : Clean all the surfaces and put them in an orderly manner
- Standardize: Ensure all workers use the space in the same way (e.g. have only one place for a particular type of laboratory consumable that everyone uses)
- Sustain: Have procedures in place to ensure the laboratory remains impeccably organized (e.g. 10 min clear-up session per day, weekly inspection and score).

The visual workplace is an extension of the 5S environment. The aim of the visual workplace is to ensure that laboratory managers know the state of everything in the laboratory by simple displays within the laboratory. For example QC checks of equipment should be clearly displayed on or close to the equipment; Key performance indicators of the laboratory should be prominently displayed and updated daily for the advancement towards visual factory because it has several advantages: It draws the manager into the laboratory, rather than managing from an office or PC, It ensures that any drop off in performance is highlighted rapidly to all and all can help bring the laboratory back to peak performance, and it ensures important information is easily available at the point that it is required.

5.6 Lean layouts: muther's grid

A key aim of lean lab is to ensure that work flows through value-adding steps with little if any delay. When processes are divided between two locations a delay due to transportation (one of the eight wastes) is introduced. The delay caused by the movement alone may be minimal, but whenever movement is required it becomes natural for workers to perform their work in batches and to complete all that is required before the work is moved to the next step. This waiting for other members of the batch to be processed frequently adds up to the large majority of the total cycle-time of the work. Lean; therefore encourages continual reduction in batch sizes accompanied by changes in layouts to allow these smaller batches to be processed and analyzed as efficiently as the larger batches previously were. An important component of this lean flow is reducing delay by putting as many process steps close together as possible, A number of techniques exists to ensure that the layout chosen is the best for the work to be done (any "one size fits all" approach must be avoided).

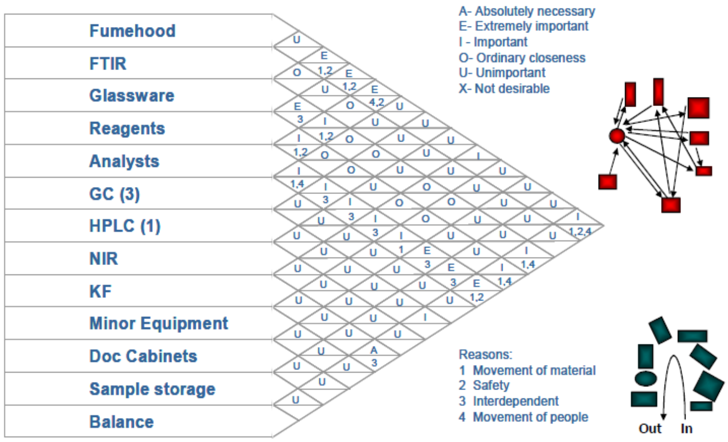

Figure 2

In an another major simplification step on lean layout to ensure that work flows through value-adding steps with little if any delay as depicted on right bottom picture, lab layout was made to improve the flow of testing and reduce the man and material movement in the lab and aiming to establish spaghetti diagrams for all the critical to quality parameters. For this activity collected all the major and minor details about all the food product testing frequencies for all the testing parameters from standard operating procedure (SOP).

Once the sample comes on working cell it moves on without any interruption and less frequent zigzag movements, first in first out (FIFO) concept also considered here. A draft plan for the layout was developed considering what should be located with respect to everything else in the testing process and identified each activity involved. A list of all activities on a relationship chart was recorded. The reason, or reasons for assigning each closeness rating assigned as absolutely necessary, extremely important, important, unimportant or not desired. Then closeness- desired rating determined after that allocation was made as working cell.

5.7 Kaizen

This tool involves setting up a cross-functional waste reduction team to focus on a specific problem area. The team (6 to 10 people) usually includes staff from management, engineering, and sales, as well as hourly production and quality assurance staff. The team sets goals and is guided by an experienced team member. The team follows a proven method to find and then eliminate waste in a certain work area within a given time period (typically five days). The team then creates standard work programs so that the gains can be sustained.

5.8 Kanban

Kanban is a signaling system to indicate when work is required; kanban may be used to control work itself or (more commonly in laboratory environment) replenishment of laboratory materials. Its exact meaning is "signboard" it is a concept related to lean. It is not an inventory control system. To apply kanban on the chemicals and microbiological media used in the laboratory: Presently, there was no proper tracking system for the chemicals, microbiological media and other consumables in our laboratory on date of receipt, opening and expiry .This is a very critical gap on laboratory requirements under Quality Management Systems (QMS). For this a list on the present stock status was made, then calculated approximate quantity of all the chemicals, reagents consumed at our lab on monthly basis. A new sticker was pasted on chemical, reagent or media bottle with additional information like date of receipt, date of open, expiry date, storage condition and handling methods. By implementing this good practice fallowing are the added advantages:

1. Smooth flow by maintaining a constant level of inventory in our lab.
2. Sufficient availability of by tracking on replenishment of laboratory consumables, thus prevent the delay in testing.
3. Complexity reduction.
4. Proper tracking system on shelf life and stability to avoid errors on testing results due to old and expired chemicals.
5. Implementation of safety and avoid any accidents by expired chemical.

6 LEAN LAB APPLICABILITY IN THE FOOD INDUSTRY

Product variation, serious food safety concerns, stringent regulatory issues, skyrocketing raw material and analysis costs are the major focus area in a food industry; hence in order to address some of these issues lean tools gaining the importance. Under the lean tool box, 5S is actually an incredible tool to maintain cleanliness and order; which meshes well with the all food industries regulatory and compliance and focus on preventing contamination. The next main thrust area of lean is to relentlessly reduce waste and quicken the flow of the product to the consumer. The food industry, however, working with perishable products that cannot accumulate, is no stranger to continuously flowing product out the plant door and into the hands of the consumer. “Lean minimizes work-in-progress, retesting and finished goods inventory which are seldom a large form of waste in the food industry. The industry does a good job rapidly flowing through product out to the final customer. By reducing ergonomic problems, lean food plants yield happier and hence more productive employees. Additionally, the elimination of unnecessary equipment, the condensing of work cells or the combining of operations can lead to additional floor space that allows for bringing more production capabilities to a given facility. Many food manufacturers are cutting costs with lean, and this will lead to additional processors grabbing hold of this method. It uses a set of quality management methods, including statistical methods, and creates a special infrastructure of people ("Black Belts", "Green Belts", etc.) within the organization.

7 CONCLUSION

Generally, business goal of every organization is success in doing business. That success is shown through customer recognized quality of company’s products and services. Laboratory plays important role in driving this success and for this; continuous quality improvement process is required. These improvements can be achieved by use of lean concept. Lean is a business philosophy that can be practiced in all disciplines of an organization. Practical use of lean laboratory had shown an improvement up to 80 % quality work, enhanced consumer satisfaction through better service, proper space utilization and faster sample and data flow. Improved communication and delivery of information to all customers and stakeholders, more awareness among analysts and workers, changes in the mindset and culture of the people and improved standard ways of working. On the other side decrease in 73% of cost of production, drastic reduction in defects, rework, re-testing/analysis time and man hours loss, hence lean laboratory plays an important role in the success of any organization and its effective implementation in food industry is a promising opportunity

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