Reduction in packaging wastes through identification of lean wastes to deliver efficient waste controlling techniques for a Pharmaceutical Industry

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Abstract: - The purpose of this paper is to propose a method of reducing material and time waste during packaging in the pharmaceutical industry. This is done by means of identifying the four major lean wastes i.e., motion, inadequate processing, waiting, and defects. These wastes are identified and reduced by means of using lean tools and proposing other cost-effective solutions that would increase process efficiency. Material waste is dealt with through selecting optimal requirements under the constraint limits of ergonomics, engineering, and machine space availability. Along with reduction in change over time, a strategy ensuring improvement in the primary packaging area was developed. The validity of this research has been brought about by means of a case study of a multinational pharmaceutical company. The proposed system proves to be highly beneficial in ensuring wastage and time reduction in changeovers. This strategy provides improved results without any new costs introduced and the production targets were met faster. There is also a special consideration given to the ergonomic aspect of the production processes.

Keywords: - Productivity Improvement, Lean tools, Changeover time, Primary packaging, Packaging machine, SMED, Ergonomics

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1 Introduction

As markets grow aggressive in competition, it's important for companies to improve their production processes and be extremely efficient along with product quality sustained while cost effective measures are taken. The Pharmaceutical industry is one of the most competitive and developed industries that has gone through intense diversification and globalization to reduce the costs associated in manufacturing [1]. Even though there are strict regulations and standard operating procedures (SOPs) defined, there is still a lot of waste generated that can be avoided. One major source of the waste is the packaging unit identified by recent literature. Packaging machines stopping for even a minute can cause productivity loss.

Machines are neither not optimized properly, nor material being fed to them is calculated with the right precision. Furthermore, the changeover time is also a concern for a type of industry where precision and productivity are required all the time. For maximum efficiency, not only the employees have to perform, but a reliable workflow also has to be established [2].

In this aspect, the research question which arises are as follows:

1. Identifying whether packaging machines are being utilized to their full potential.
2. Identifying the lean categories of wastes.
3. How to introduce measures that would help in less foil material being wasted while packaging?
4. Application of lean tools and their influence on the process.
5. Providing additional measures for better usage of machines while keeping the process cost effective.
6. Exploring the non-investment measures to help improve production.
7. Reducing changeover time through SMED (single minute exchange of dies).

To address these concerns, this paper suggests a mathematical model that provides the dimensions and calculations necessary for minimizing wastage of material. Based on calculations, the optimal weight of the foil that should be utilized in the packaging machine is identified. A design of machine is also suggested that if developed and used, would greatly reduce the burden on the labor and give consistent and reliable results. The entire procedure involves usage of several lean tools that helped in the identification of the problems. The efficiency of this proposed model is validated by means of applying it to a pharmaceutical industry as a case study. The three major issues addressed in this paper are:

1.Due to Goods Manufacturing Practices (GMPs), pharmaceutical industries are being very reluctant in adopting lean manufacturing techniques leading to much wastage: ABC pharmaceutical company had numerous wastages in changeover times leading to inefficient use of time and resources. There are unnecessary stoppages in the packaging department on the blister packing machines.

2.Since there are large batches of tablets packed on a single production line, a significant amount of material is required: This material cannot be fed to the machine in one attempt therefore there are changeovers used here. These changeovers result in a waste of time.

3.The wastage of material on setting up the machine for a new batch: This waste is quite frequent and results in the issuance of more packing material than planned. Therefore, the types of wastage occurring need to be identified and reduced. The wastage in packaging does not end here. As the Roll changeovers occur, there is much wastage that happens during those changeovers. These may be associated with batch setup or product setup and results in making large number of wastages and rejections.

2 Literature Review

The term pharmaceutical packaging means enclosing or covering the product in a protective coating, to provide protection, ease of storage/transportation [3]. Pharmaceutical packaging also stands for an affordable way of providing the product with safety, exhibition, presentation, identification, information etc. The major role of pharmaceutical packaging is to provide products with these traits.

- Product Identification
- Product Protection
- Product Promotion
- Facilitating the use of the product

There are three phases of packaging in a pharmaceutical industry categorized as below [3],

- Primary Packaging
- Secondary Packaging
- Tertiary Packaging

Primary packaging is the very first and basic enclosing of the product, for example a blister pack or a bottle. It is the type of packaging that will remain with the product until it reaches the end user. Utility and presentation of the primary packaging is also very important as broken or damaged packaging is discouraged by the end user and if it is a pharmaceutical product, it its entirely scraped. This is the phase of packaging that we are going to target in our project. Secondary Packaging comes after the primary packaging. It is the phase which is concerned with keeping the goods and multiple units together in an arrangement which is feasible for economical storage. The third phase of packaging is concerned with packaging which will allow the goods to be transported easily, safely, and economically. These packaging are made with such design considerations to protect the good from the adversities that can occur during transportation that are damages due to shock, vibrations, air pressure orientation etc. The wastes in the packaging procedure are identified by their categorization among lean wastes. Seven lean wastages being described by [4],[5] and [6] are as follows:

1. Overproduction: It is something that was produced before it was demanded. In other words, a product manufactured before it is required is said to be overproduced. It is a key waste of lean because a product made before its time will degrade in quality by the time it is required to be delivered. One of the most efficient production systems in the world is the Toyota Production system, which starts production as soon as demand comes. This system is known as JIT or Just-in-time system. The concept is to schedule and produce only what can be immediately sold/shipped and improve machine changeover/set-up capability [7]
2. Inventory: Inventory is an outcome of overproduction and waiting. When excess goods are produced, they need to be stored somewhere. This results in high setup costs of inventory. To maintain the quality of the stored goods the running cost of inventory also increases. Another form of inventory is the WIP or Work-in-process inventory. When there are products that are waiting to be processed or are in queue, these products take up space and they are counted as WIP. This is the inventory that results from poor workspace management and inefficient plant layout.
3. Waiting: Waiting is the waste the occur when the product is not moving or not being processed. In batch production systems, the product's life will be mostly spent waiting in queue to be processed. They will be waiting in line for the next operation as other products are being processed. The reason

why this type of waste occurs is because either the production run is excessively long or the flow of material throughout the line is poor.

4. Motion: As all 7 wastes are related to different aspects in a manufacturing firm, this is related to ergonomics. While fulfilling their duty, if a worker does any excessive motion or work which does not help or add value to the process it will be regarded as a waste. This is also an important factor to consider in setting up the health and safety policy of the organization. Excessive working and over-burdening a worker can result in excessive fatigue for a worker. This results in safety issues and can deteriorate the health of the worker.
5. Transportation: Another waste related to material handling is called Transportation. Moving the goods from one place to another incurs a huge amount of costs that the company must bear. Another problem with transportation is that during transportation the product is exposed to the danger of quality deterioration and might get damaged. Therefore, it can be concluded that transportation does not add value to the product. By setting up a good layout and utilization of space, transportation wastes can be reduced.
6. Rework: One of the major wastes in any organization is the occurring in defects in the final product. Any defective product incurs huge amounts of costs for the company to bear. These can be categorized as quarantining inventory, re-inspecting, rescheduling, and capacity lost costs [7]. There are effective ways to reduce these defects which include lean tools such as TQM and TPM.
7. Inadequate Processing: Using the inappropriate tool, method, or material to complete a specific process is called waste in processing. This waste occurs when there is a lack of understanding of the process to be carried out by the people in charge. Organizations often acquire high precision tools or instruments to work with something that could be accomplished without such high-cost equipment.

In order to reduce changeover time, this paper utilizes SMED methodology. SMED was introduced by Shigeo Shingo (a Japanese engineer) to reduce times for setup to a greater extant. It works to convert the current production setup for a product to next product as quickly and effectively as possible.

Basic model of SMED consists of following three stages [8]

- Finding internal external activities
- Differentiating internal and external activities
- Changing mostly internal activities into external activities
- Rationalize the internal and external activities.

Generally, SMED aims to standardize and simplify the operations; in addition, the production can be more planned. By this means, the need for special skilled workers is also minimized [9]. Before this method, changeover / setup time was termed as a necessary nonvalue adding that must be done. By reducing time for change-over and anticipated costs, applying SMED successfully improvements of significance in quality and production efficiency are achieved.

The first SMED implementation requires a precise analysis of changeover process to know the details of every setup operation [10]. The steps are as follows:

- Gemba Observation,
- Analyze the time for changeovers,
- changeover time to be divided into internal and external activities,
- Internal Activities: Activities done while the match is not working,
- External Activities: Activities done while machine is still running,
- Convert internal activities into external activities,
- Internal phase to tool change should be optimized (using parallelization),
- External phase to tool change should be optimized (using parallelization),
- Action plans are built up,
- Finalize and quickly implement.

These comprehensively steps represent all the wastages that occur in an Industry. This research paper only targets four of these wastes, their causes and elaborates how reducing number of changeovers will result in reduced adverse effects of wastages thus escalating productivity. These four wastages are waiting, defects, inadequate processing, and motion.

3 Problem Solution

Approach used in this study for wastages related to primary packaging involves the following steps as in Figure 1:

3.1 Gemba walk and process information

Production lines in this scope are used in packaging the solid medicines. These are mainly packed in blisters and then further packed in unit boxes which are packed in cartons at the end. Therefore, the line is divided into 2 areas, blister filling and cartooning the process of blister packing starts with a finishing

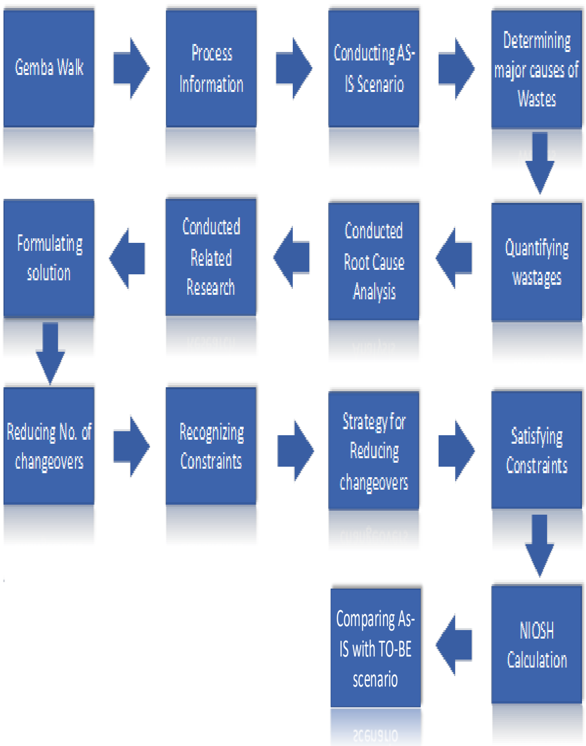

Figure (1): Methodology/ Process flow chart

order being generated; a document that includes specifics of the batch scheduled is generated. After the arrival of bulk tablets, Aluminium and PVC foils from the staging area; a small room of inventory for the packaging area in which tablet bulks and packaging material is stored, is where the production starts. The machine is pneumatic and works in strokes. 5 key stations are present in the machine:

1. Forming station: this is where the PVC sheet is heated and formed into the shape of the blister, which varies from product to product
2. Filling station: tablets are fed into a hopper and are filled in the slots of the blister with the help of brushes
3. Inspection: a camera is placed which monitors and verifies that every slot in the blister is filled
4. Sealing station: a heating press takes the filled blister and seals it close by joining it with the Aluminum foil
5. Cutting station: the blisters are then punched out into their shapes leaving behind a long roll of net cutout

As is scenario:

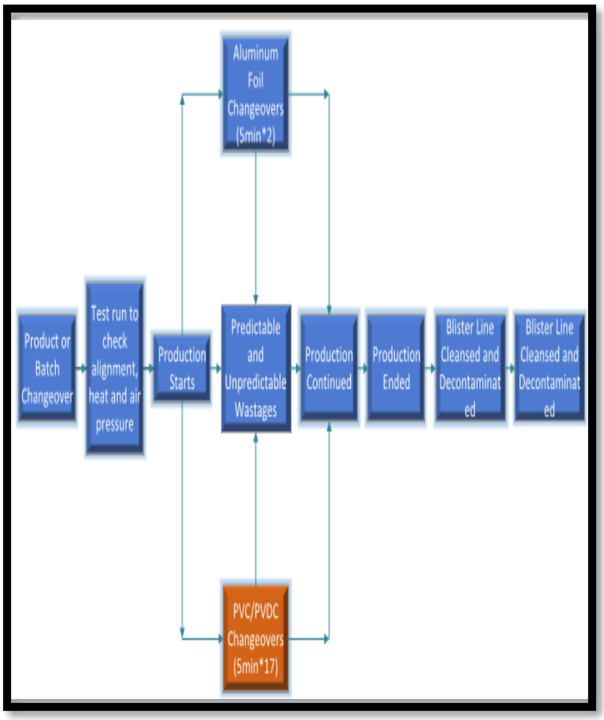

Figure (2): AS IS Scenario

AS-IS SCENARIO OF THE ROLL CHANGOVER

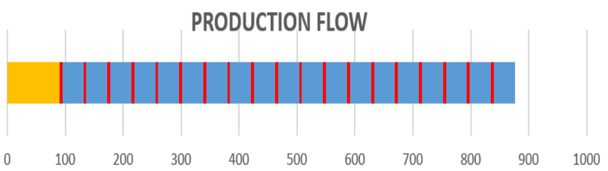

Figure (2a): Time Distribution of Packaging

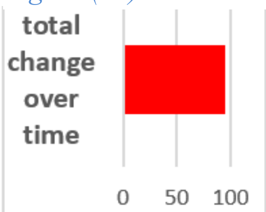

Figure (2b): Accumulated Time of Changeover

Figure (2a) graphically represents the time distribution of entire packaging process for a batch of a p00harmaceutical blister product (876.03 minutes or 14 hours and 36 minutes). Yellow colored region shows the initial product/batch changeover activities and its time which is about 90 minutes or 1.5 hours. Blue region shows the time in which production is taking place which took 691minutes or 11.5 hours, while the region displayed as red strips represents the time taken by foil/Roll changeovers which took 95minutes or 1.5 hours. Figure (2b) on the other hand represents the accumulated time of changeovers. So, this red region is basically the necessary non value adding time which is 95 minutes or 1.5 hours and that's the phase which causes most of equipment inefficiency. This non-value adding time can be reduced by either of the following two major ways,

- Reducing no. of changeovers itself
- Reducing changeover time by effectively applying SMED.

3.2 Causes of wastes:

- Excessive wastages of PVC and Aluminum foil in packaging
- Loss of production time during changeovers
- Loss of packaging material during changeovers
- Random wastages associated with anomalies in the system

3.3 Quantifying wastes:

Large number of wastes were occurring in production including fixed and variable wastages. The variable wastages were random and occurred due to uncontrollable circumstances. The fixed wastages were quantifiable and recurring. To quantify and measure the waste, data had to be collected on every type of material waste that occurred during production. This was achieved by means of data collection for various batches and using a mean value in the calculations. The following template was used in collecting data related to wastages (table 1).

Since rolls of uniform material were used for production, the entire weight of the roll could be divided in the entire length of the roll being used. Hence, a relation of length and weight is used to identify the weight of a particular length. This is done because identifying the length that is wasted is easier and more error free than directly finding out the weight that is wasted. Furthermore, the length and weight of each roll is rated by the vendors, so its data was easily collected.

$$Weight = weight\ of\ a\ roll(PVC\ /Alluminium)of\ a\ Product$$

$$Length = weight\ of\ a\ roll(PVC\ /Alluminium)of\ a\ Product$$

$$Weight\ to\ Length\ \ Ratio = \frac{Weight}{length}$$

Description	Length(cm)	Weight (kg)
Length of Foil/PVC wasted (beginning)	2993	1.475
Alignment Wastage	1610	0.793
Taped blister	469.2	0.231
Wastage for every PVC/Foil changeover	1913.6	0.943
	Total Wastage	3.443kg

Table (1): Ideal Wastages calculation

Considering the variable/Random/unpredictable wastages, these kinds of wastes occurred on regular basis and mostly depend on the number of interruptions in the entire production process. These random unpredictable wastages occurred due to:

1) Power breakdown for a few seconds wasted 3 strokes,
2) Wastage due to alignment,
3) Unfilled blisters/Partially Filled,
4) Centre Out [causes failure in leak test],
5) Unprinted Blisters,
6) Low Pressure [causes defected blow molding in blisters resulting in damaged tablets in blisters],
7) Over lapping of tablets [causes hiccup in machine pulling system, lead to stretching of blister resulting in multiple disorders],
8) Belt broke due to jerk of overlapping tablets [causing wastage of multiple blisters],
9) Ignorance/Non-Serious attitude towards process and machine increases all types of wastages,
10) Tablets without outer layer of polished coating do not fill the blister properly,
11) Insufficient temperature also causes defected blow molding in blisters resulting in damaged tablets in blisters],
12) Long distance between roll and the blister punching die increases the time and error of alignment resulting in waste,
13) Machines depending on both alignment and temperature need to run longer in start to achieve continuity as compared to the machines that only need alignment,

14) Tablets exposed to dirty environment (fall on ground) are disposed as wastages,
15) Average Quality Foil/Aluminum do not roll and slide smoothly causing misalignment,
16) Medicines which are produced with 4 blisters per stroke have higher tendency to cause alignment issues,
17) Excess requirements of PVC cause its waste as excess PVC is Disposed,

The higher the number of stoppages or interruptions due to unpredictable breakdowns, the greater the losses (both of time and material). There were around seventeen random interruptions occurring during production described above; some of them caused time wastage while some produced both time as well as material wastes. The uncertainty in the nature of their occurrence made their tracking a difficult task. Therefore, based on past experiences as well as intelligent guess, 1% of the entire production material is taken as random wastages as the predictability of their occurrence is higher when the no. of predictable (Roll changeovers) and unpredictable interruptions are higher.

3.4 Proposed solution:

The major causes of wastages were identified i.e., the number of changeovers and then time and material wastages that occur during and after the Roll changeovers. The proposed way of reducing the number of Roll changeovers with this amount of information was by increasing weight of single roll of aluminum and PVC foil, keeping the total weight required for a batch intact and thus reducing the number of changeovers.

Reducing number of roll changeovers: To reduce waste, the method devised was to increase the weight(W) of roll i.e., the PVC and Foil. This in turn resulted in increase in many parameters. First one was Length of the Foil/PVC, as it has direct proportion with weight, mathematically

$$Length \propto Weight$$

The expressions of proportionality used to describe these mathematical relations were first proposed and derived by Aristotle

The second one was the radius of the roll, as length has a direct relation with weight, mathematically

$$Radius \propto Weight$$

The third parameter is the number of roll change overs of PVC (N), its relationship with weight is unlike the two mentioned above, mathematically

$$N \propto \frac{1}{Weight}$$

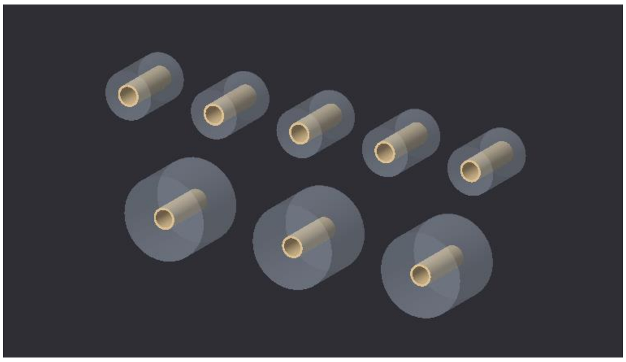

Figure (3): Roll Size modification

To increase the weight of the roll, certain constraints needed to be satisfied i.e., Ergonomics, Engineering, and available space in machine.

3.5 Constraints:

Ergonomic aspect:

It is the sector which deals with the suitable working conditions and workloads for humans. Here, the suitable Weight of roll (Al/PVC) is set to be 15kg unextendible. Internationally the allowable weight that the workers should lift is 25 Kgs. The highest weight that is being used is 12.7 Kgs in the observed industry.

Engineering Aspect:

This sector deals with the Maintenance, installations and up gradation of the machinery installed in the facility. The constraint which is related to this sector is to find out the maximum loading capacity of machine, which turns out to be 25 Kgs.

Space availability in machine:

Weight, when increased as mentioned earlier results in an increase of the overall volume of the roll. To accommodate the increased volume of roll, limiting factors were to be found out, which were the components of machine near the roll. This was done in parallel with data collection for other calculations

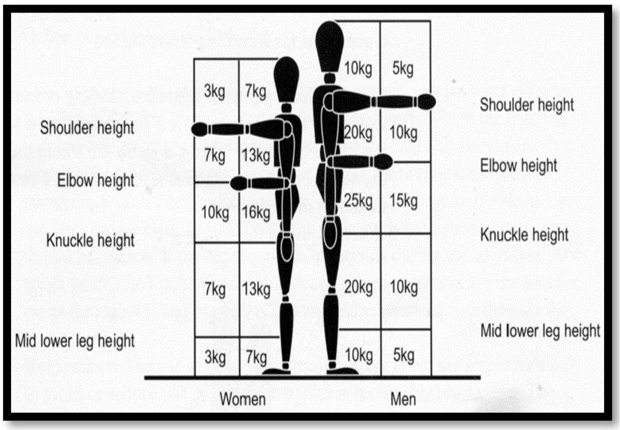

Figure (4): Ergonomic weightlifting standards (Ergonomics in the workplace) (hsa.ie) of waste reduction. This constraint was different for all machines.

3.6 Strategy Application:

After identifying and addressing/discussing these constraints with relevant departments, the issues were resolved and a solution in accordance with maximum limits was devised through which desired optimal amount of weight or diameter of the roll could be calculated. This was done by means of formulating an excel sheet (MICROSOFT EXCEL 2016) containing formulas and variables.

VARIABLES

Radius of current roll = r
Width = w
Length = L
Radius of Core = r(c)
Weight of Previous Roll = W

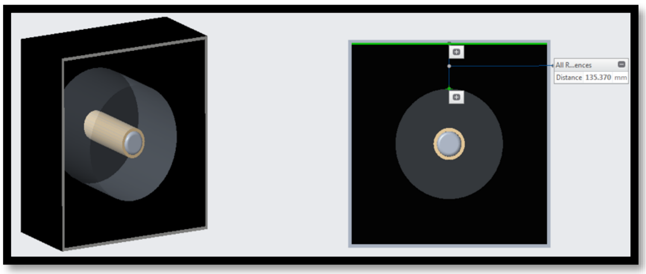

Figure (5): Allowable Space in machine

Total Weight used for batch production = W (T)
Iterative Radius of New Roll = R

FORMULAE:

$$\textbf{Volume of material on roll} = Volume\ of\ roll - Volume\ of\ core$$

$$\textbf{Volume of material on existing roll} = \pi(r)^2(w) - \pi(r_c)^2(w)$$

The expressions of Volume used to describe these mathematical relations were first proposed and derived by Archimedes

$$\textbf{Density} = \frac{weight\ of\ current\ roll}{length\ of\ current\ roll}$$

The expressions of Density used to describe these mathematical relations were first proposed and derived by Archimedes

$$\textbf{Length to weight ratio} = W/L$$

$$\textbf{Volume of material new roll} = \pi(R)^2(w) - \pi(r_c)^2(w)$$

$$\textbf{Weight of new roll} = Density * Volume\ of\ material\ on\ new\ roll$$

The expressions of Weight of an object used to describe these mathematical relations were first proposed and derived by Newton

$$\textbf{Length of new roll} = Lenth\ to\ weight\ ratio * weight$$

$$\textbf{No. of rolls for batch production} = \frac{Total\ weight\ for\ batch\ Production}{Weight\ of\ new\ roll}$$

A template (table 2) for calculation of ideal foil size was generated using Excel, using above-described Formulas and Variables. The upper portion contains both the dependent (i.e., density, volume and weight) and independent (i.e., diameter) variables which were given as an input to the system and these ranges from

"Current radius of roll" to "Weight of foil used in batch". The lower portion of the template provides the results. This portion is unique as it provides with multiple answers based on different diameter values, each of which serves as an iteration and also shows the relation and impact of altering the diameter on the results i.e. new radius, new volume, new Weight, and new Length.

This work was done for rolls of aluminum foil. The same calculations were also required for PVC roll; hence we generated another template for PVC rolls. Both templates were almost identical, the difference just lies in the data of independent and Dependent variables and in the formulae used. The template for PVC is shown below (table 3).
The work done for reducing number of changeovers

PRODUCT "A" FOIL					
Current radius of roll(mm)	107				
Width(mm)	126				
Current Volume of roll(mm³)	4533804				
Radius of core(mm)	43				
Volume of core(mm³)	732204				
Volume of Roll used currently(mm³)	3801600				
Weight of Roll Used Currently(kg)	7.5				
Density(kg/mm³)	1.97E-06				
Length(m)	1000				
Length-to-Weight ratio	133.3333				
Weight of foil used in batch(kg)	16.308				
	Current	R1	R2	R3	Limit
Radius of proposed roll size(mm)	108	120	130	140	150
Volume of proposed roll size	3801600	5702400	6692400	7761600	8910000
Weight of proposed roll size	7.5	11.25	13.20	15.31	17.58
Length of proposed roll size	1000	1500	1760.4	2041.7	2343.8
Number of changeovers	2.17	1.45	1.24	1.07	0.93

Table (2): Template for Ideal Foil Size

is very comprehensive and detailed therefore it is applicable on all the medicinal products which are packed in form of blisters.

This template uses the relation of radius with other physical attributes of rolls and is designed to show the impact of altering the radius of roll on these physical qualities i.e., volume, weight, length, and number of changeovers. Multiple potential readings of new desired radius are to be entered and the template would provide new specifications of the roll. The rolls would be selected based on weights. NIOSH calculations have been done to satisfy that the 15 kgs weight rolls are favorable for lifting.

NIOSH Weightlifting Equation:

National institute for Occupational Health and safety is an international organization which caters to and deals with the occupational health and safety of the on-field industrial workers. It is a small part of a huge institution i.e., Centre of Disease Control and Prevention in United States department of health and human Safety.

PRODUCT A PVC					
Current radius of roll(mm)	135				
Width(mm)	126				
Current Volume of roll(mm³)	7217100				
Radius of core(mm)	48				
Volume of core(mm³)	912384				
Volume of Roll used currently(mm³)	6304716				
Weight of Roll Used Currently(kg)	6.9				
Density(kg/mm³)	1.09442E-06				
Length(m)	140				
Length-to-Weight ratio	20.29				
Weight of foil used in batch(kg)	116.37				
	Current	R1	R2	R3	Limit
Radius of proposed roll size(mm)	135	165	185	215	235
Volume of proposed roll size	6304716	10781100	13553100	18305100	21869100
Weight of proposed roll size	6.9	11.80	14.83	20.03	23.93
Length of proposed roll size	140	239.40	300.95	406.48	485.62
Number of changeovers	16.87	9.86	7.85	5.81	4.86

Table (2): Template for Ideal PVC Size Calculation

This Institution also emphasizes on safe working conditions for the workers. As lifting heavy weights manually has a serious impact on workers' health, NIOSH has devised an equation which when provided with proper and relevant data tells that the current load that is being used is ergonomically feasible or not. If it tells that the current load in inappropriate, then it also provides a recommended load which perfectly fits the working criteria.

The Recommended Weight Limit (RWL) and Load Index (LI) is defined by the following equation:

1) $RWL = (LC)X\,(HM)X\,(VM)X\,(DM)X\,(AM)X\,(FM)X\,(CM)$

2) $LI = (Load\ Weight) \div (Recommended\ Weight\ Limit)$

The Variables used in NIOSH equations are as follows:

- Load Constant (LC)
- Horizontal Multiplier (HM)
- Vertical Multiplier (VM)
- Distance Multiplier (DM)
- Asymmetric Multiplier (AM)
- Frequency Multiplier (FM)
- Coupling Multiplier (CM)

The Above provided equations belong to NIOSH The above equations are used while manually performing the calculations but instead of doing it manually, an application provided by NIOSH was utilized.

The recommended weights that can be used according to the under consideration company were 12.5 kg and 15 kg as the Load Index for these weights lie under 1 i.e. 0.8 and 0.9 respectively, to be exact (figure 2).

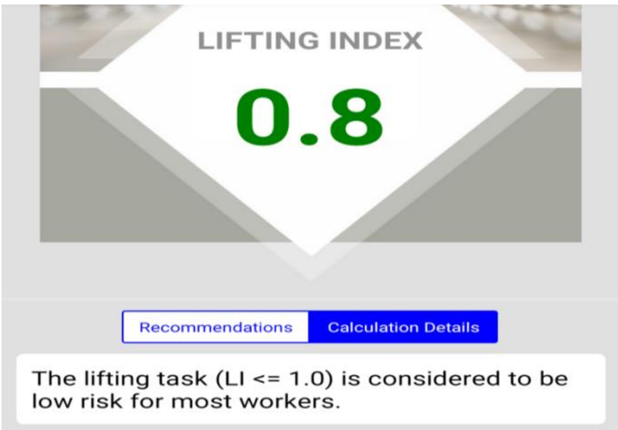

Figure (6): NLE CDC application.

According to NIOSH weight lifting equation, increasing weight to 15Kg is admissible as its lifting index lied under 1. This established that the provided calculation and weight increase is completely justified and satisfies all constraints including ergonomics.

3.7 Compression of AS-IS and TO-BE Scenario

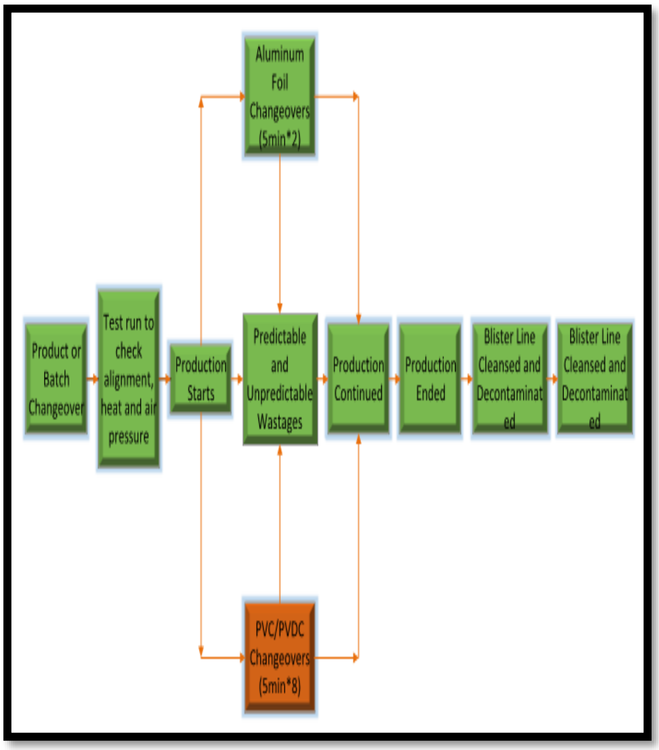

Figure (7): Compression of AS-IS and TO-BE Scenario

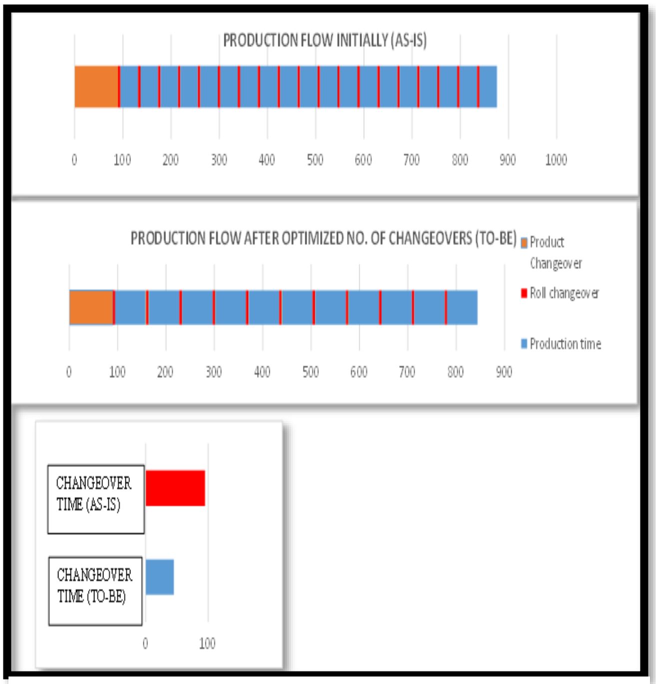

Figure (8): TO-BE Scenario

4 Result and Discussion

The application of suggested strategy results in the following benefits:

There are two fundamental types of wastages as described in methodology above. One is known as Fixed or Repetitive wastages which are described and calculated as under,

a. Savings in material and time:

Savings in terms of material and time after opting roll of 15kgs would be:

i. Fixed/repetitive wastages:

Losses in terms of weight which are directly related to no. of changeovers also reduces with the reduction in no. of changeovers as the wastages in a batch of Product A are given below

Wastages on current no. of changeovers = 3.44300kg

Wastages after reducing no. of changeovers by adopting optimal PVC rolls.

Wastages on Reduced no. of changeovers = 2.87kg

Savings in terms of weight for Products A would be,

Savings in terms of weight = 0.573 kg

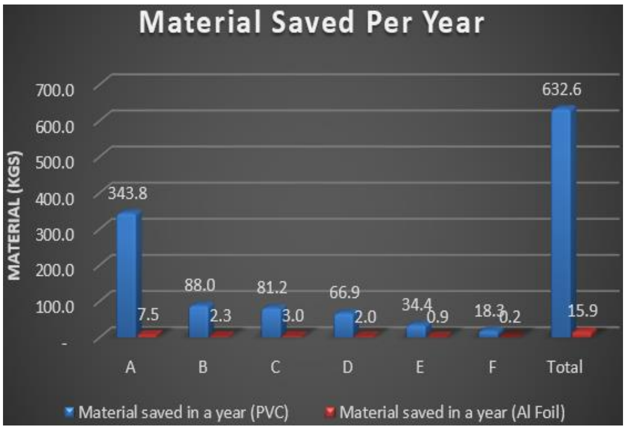

Figure (9): Savings from Fixed Wastages

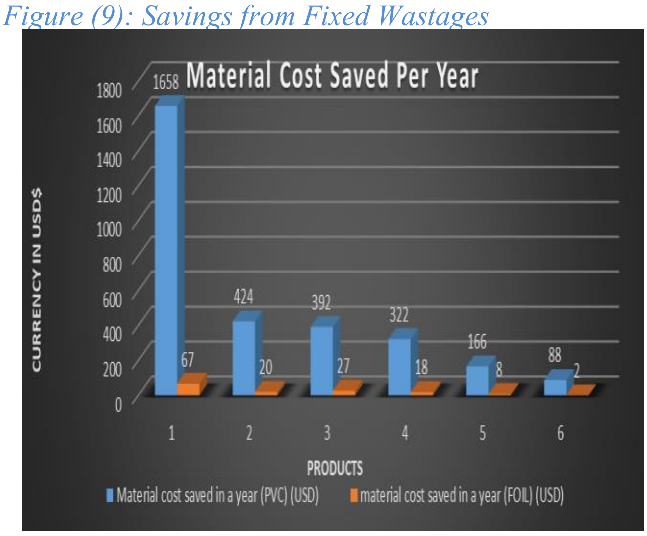

Figure (10): Cost saved from fixed savings

ii. Random/unpredictable wastages:

This type of wastage occurs with no certain repetition, so tracking them is a difficult task but keeping them in account is also important as they had a great impact on material wastages. Their importance can be understood by the fact that they are almost equal or sometimes even greater than the fixed wastages. Their weightage is 1% of the total packaging material which would be, Unpredictable /Random wastages for Product A would be = 0.01*(total weight)
= 0.01*116
= 1.16 kg
But as the number of changeovers is reduced to half, the probability of occurrence of these wastages would also reduce to half, so the wastages would also reduce as,
Wastages would be reduced to = 1.16*0.5 => 0.58 kg

Figure (11): Savings of Random Wastages

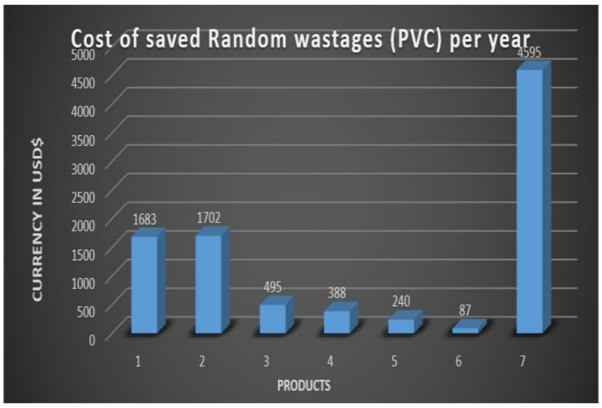

Figure (12): Cost Saved from Random Wastages

Total materialistic savings = savings from fixed wastages + savings from random wastages
Total materialistic savings (USD) = 3053 + 142 + 4595 = 7790 USD

b. Reduction in non-value adding time:

If a batch of product A is considered, which needs 17 PVC changeovers for a batch and each change overtook 5mins to take place and it's all necessary nonvalue adding activity. The overall time it takes for changeovers in a batch of Product A is,

Changeovers in a batch = 17*5 = 85minutes.

By using an optimized weight under the permissible limit, the number of changeovers can be reduced. By using PVC roll of 15kg, the no. of change overs would be reduced to 8 as calculated earlier. So, the no. of changeovers would be,

Changeovers in a batch = 8*5 = 40minutes

Therefore, by using a standard permissible foil size batch production time can be reduced. This in turn saves material as well because most of the material wastages occur during, between or after the Changeover. Time that is saved would be

Time saved for a batch production = 85 – 40 = 45 minutes

Time saved for a batch production of product A was described earlier. Now for other product, the savings are:

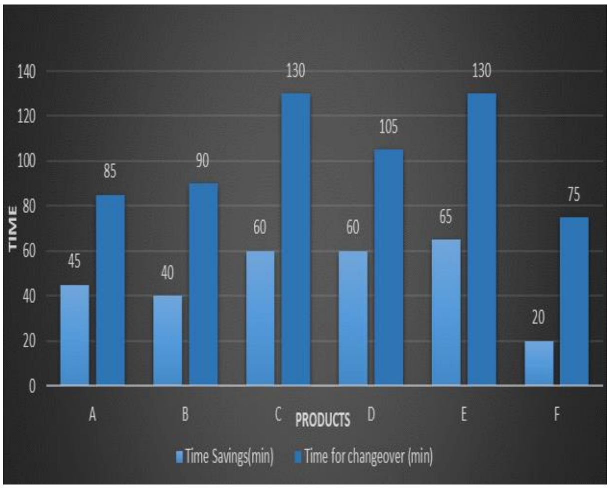

Figure (13): Non-Value Adding Time Reduction

c. Effective utilization of time saved:

The time saved in a batch by reducing the number of changeovers can be effectively used in many of the processes that act as bottle neck activities, so they can be relieved or used in some other activities which when positively altered will improve the production capacity and utilization of resources.

The three major areas of impact as a result of increasing weight of the PVC foil to 15 kgs are:

1) To produce potentially a greater number of Units

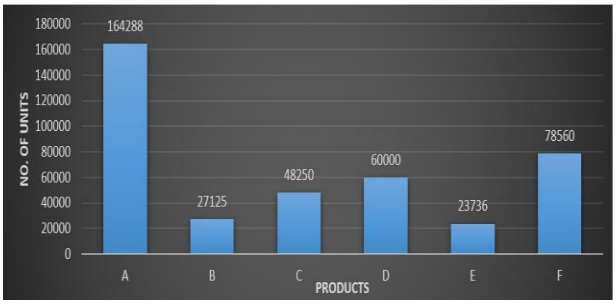

Figure (14): Potential units increase for 15kg roll

2) To reduce the overtime required to produce same batches by utilizing extra man-days.

Figure (15): Production time saving in terms of Man Days by 15kg PVC roll

3) To increase the capacity of current production.

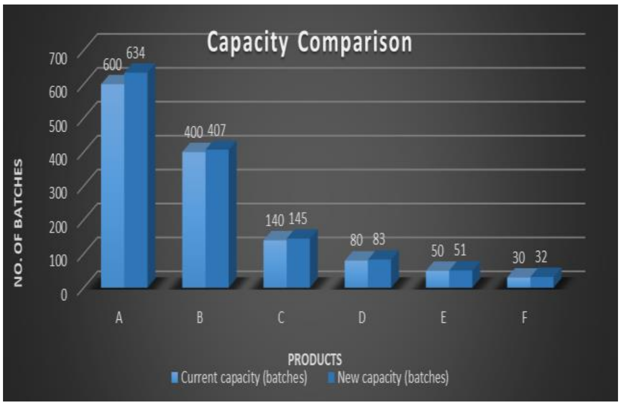

Figure (16): Increase in capacity by 15kg PVC

5 Conclusion

This paper is related to the implementation of a technique for reducing the wastages during finishing or packaging phase of the medicines. Specifically, the objective was to reduce the wastage of resources associated with packaging materials, primary packaging materials, and reducing the wastage of time also. Lean tools were used to understand the existing system and the problem itself, such as Gemba Walk, AS-IS Scenario, and Root Cause Analysis. This provided major reasons of wastages which were the number of change overs itself and the material wastages that occur during the changeover. The suggested solution was to reduce number of changeovers and to reduce the time of roll changeovers along with the controlling material wastages that occur during the roll changeover and the process itself.

In order to reduce the number of roll changeovers, the proposed approach was to increase the weight of an individual roll of either Aluminum or PVC. This approach reduced the number of changeovers as now each roll had more material on at and would last longer. The total weight required for a production batch was kept intact, only the numbers of rolls in a batch were decreased and thus reducing the number of changeovers as well. The increment in weight of rolls of PVC to 15 KGs will cause time savings that could be utilized to make 34 more batches of Product A (if this medicine is considered) resulting in surge in annual profits of up to 95000 USD. This recommendation of increasing the weight up to 15 kg or 33 lb is very cost effective as it does not require any investment and adheres to the restrictions of ergonomics and is approved by NIOSH standards.

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Conflict of Interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.