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Research Article

Reduction of Dropping Tiles in RKSL Department through Re-Design of Suction Cup at MSM Incorporated, Philippines

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Abstract: In this view, the researcher came up to the idea of conducting a study on the production of ceramic tiles which focused on eliminating defects due to dropping of tiles. The study was conducted at MSM Incorporated. Series of observations were done and one of the major defects encountered by the company is the dropping of tiles. More defects means profit loss in the company. Since the company allowed the researcher to get necessary data, they conducted thorough observations in the production line. The researcher then focused on the RKSL Department and found out that the design of the suction cup is not applicable with sculptured tiles. Furthermore, the researcher came up with the idea of re-designing the suction cup used in MSM Incorporated, where it can suck both smooth and sculptured tiles. To know if the new design of suction cup is workable or not, the researcher gather a three weeks data of usual dropping tiles without the proposed suction cup and a three weeks data with the proposed suction cup. It reveals that 7573.04sqm of dropping tiles occur having a cost of Php. 848,180.48 (7573.04X112.00), while on the proposed suction cup the results is 205.04sqm of dropping tiles occur with a cost of Php. 24,04.48 (215.04X112). It only shows that there is a big discrepancy of dropping tiles after the implementation of the proposed suction cup which declined from 14.10% of existing down to 0.46% of proposed.
Keywords: Dropping Tiles, Suction Cup, Defects, Material Handling.

Introduction

Every manufacturer aims to be more competitive than others in order to survive in the inconsistent state of market. More and more customers are demanding for quick response of the manufacturers of their wants, needs and deliver perfect quality product. However, companies who conduct mass production or continuous production can't preclude the occurrence of defective products. One of the most easily recognizable wastes in lean manufacturing is the production of Defects. Examples of Defects in manufacturing include waste such as scrap parts, products that require rework, or assemblies that are missing details. Defects are often considered to be one of the most significant manufacturing wastes because they can actually lead to the generation of additional wastes such as Overproduction, Transportation, and Excess Processing (Gay, 2016). One major contributor of defective products is material handling.

Materials handling is the movement and storage of materials at the lowest possible cost through the use of proper methods and equipment. It is used in moving of materials or product by any means, including storage, and all movements except processing operations and inspection. Materials handling is the art and science of conveying, elevating, positioning, transporting, packaging and storing of materials (Ray, 2017).

MSM Incorporation is a manufacturing company that uses mass production or continuous production as their production method, since they have standard products. One of their major problems is defects with different types such as, conveyor broken tile (after firing chipping, dropping tiles and before firing chipping), breakage, bloat, surface crack, and stock up. One major contributor of these defective products is the broken tiles which exist in different area of the production. From the conveyors of the body preparation department to the sorting area, broken tiles exist. It can be reduced through improvement of process, equipment, materials and machines.

Conveyor broken tiles specifically dropping tile is one of the main factor that contribute to defects. Dropping tiles usually occurs in the suction area in which suction cap can't suck the sculptured tiles. This study aims to diminish the dropping tiles by improving material handling specifically in the suction area that can help to reduce cost and reworking and enhance productivity for continuous improvement.

Statement of the Problem

This study was focused on the analysis and documentation of the RKSL Department in the suction area of MSM Incorporated. The researcher intended to minimize the defects through the design and development of suction cap.

In line with this, the study sought to find solutions to the following questions:

1. What is the current situation in MSM Incorporated at RKSL Department in line with:
a) Defect rate; and
b) Material Handling equipment
2. What are the problems encountered in material handling that causes dropping tiles in MSM Incorporated?
3. What proposed solution must be done to improve material handling to reduce dropping tiles?
4. What is the impact of the proposed suction cup in MSM Incorporated?

Related Literature

It was stated study of Mantriota and Messina (2011) entitled "Theoretical and Experimental Study of the Performance of Fat Suction Cups in the Presence of Tangential Loads" the minimum value of the vacuum force and the adhesion coefficient able to guarantee the grasp and movement of the object with suction cups have been studied by means of theoretical and experimental approach. The result of their study shows how the ability to bear the tangential loads in the gripping of objects with flat suction cups is greatly conditioned by the presence of misalignment of the external forces: a misalignment as large as the radius of the suction cup leads to a reduction of 42% of the sustainable tangential pressure. According to Mathan *et al.,* (2014) in their study entitled "Root Cause Analysis of Tong Mark Defect during Material Handling of IF Steel Coils" the mechanical tongs used as a material handling equipment caused the line marks or surface defects in transferring the cold rolled IF coils into Batch Annealing Furnace (BAF). This line mark appeared perpendicular to rolling direction on both inner and outer wraps of IF steel coils after discharge from BAF. These defects are causing significant appearance problems after painting. The morphology of the defect was examined in detail through characterization by visual inspection and optical microscopy.

In the study of Yang (2013) entitled "Positive Pressure induced channel suction cups", leaking in water pipes is critical to Middle Eastern countries such as Kuwait where water is scarce. In-pipe robots can be dispatched to discover the network and inspect the inner surface

of the pipe. This thesis describes the design and characterization of suction pads for in-pipe. The suction cups are made of hyper elastic materials that contain air channel inside instead of using conventional suction technique that is prone to leaking and loosing adhesion force, the suction cup is actuated by compressed air or liquid, which deforms the geometry of the cups to achieve suction. Results show that a positive pressure actuated suction cup (PPAS) of diameter forty millimeters can achieve suction force up to 68N. As more air is inserted into PPAS the suction force also increases. The concept has proved to be a feasible solution for pipe inspection robot.

The study of Forbes *et al.,* (2014) entitled "Root Causes Analysis of the Occurrences of Missing Inventory Parts of Material Handling Section of B/E Aerospace B.V. (Phils. Branch)" was similar to the present study in considering the loss acquired in material handling and differs in way of solving the problem. They differ in such a way that the previous standardized and well planned process flow of material handling while the present study redesigned the existing material handling equipment.

The study of Gonzales *et al.,* (2017) entitled "Design and Development of Hamonado Slicer for Productivity and Efficiency Improvements at C and M Food Enterprises" was similar to the present study because both studies used prototype to improve the productivity. However, they differ because the previous study modified the tools and equipment used in slicing, sorting and weighing to meet the customer demand, while the present study redesigned/modified the suction cup use in transferring the tiles to reduce dropping tiles.

The study of Caluyo *et al.,* (2017) entitled "Design and Development of Patty Molder for Work Efficiency at Limcoma Batangas Prime Inc, Philippines" was similar because both studies proposed a tool used to focused on how to improve efficiency in the production. They differ because the previous study designed a of patty molder to increase production with efficiency while the present study designed material handling equipment to reduce defects.

The study of Villaflor (2016) entitled "A Study of Defect Prevention for a Fabric Manufacturing Company", and the present study were similar because both studies identified the different kind of defects and the major sources of defects. On the other hand they differ on how they deal with these defects. The previous study had used Predictive Preventive Maintenance while the present study provide a prototype to reduce defects due to dropping of tiles.

Meanwhile, the study of Craig *et al.,* (2014) entitled "A Prototype for Detecting Defective Pills during Manufacturing" was also similar to the present study because both developed a prototype to detect defects during the manufacturing processes. They differ because the previous research created an integrated sensing and processing (ISP) to reduce errors in pill dispensation and usage, identify defective pills in the manufacturing process in real-time, and identify pills in the wrong packaging at end of manufacturing. However, the present research proposed a tool which helps reduce defects by means of improving material handling.

Materials and Methods

Figure 1 shows the conceptual paradigm, these factors include the inputs, process, and the output. These provide as a basis on how the study will be conducted and what are the processes of the study to attain the aim of the study. For this study, the input involves the knowledge requirements which are the theories of material handling, different types of defects and knowledge about the existing suction cup. It also contains design requirements, it

includes material selection and specification, and design of the suction cup. Current set up of MSM Inc. is also included such as the occurrence of dropping tiles in RKSL due to material handling failure.

The process is a methodology of the study, analysis of existing design, which includes Business Process Re- Engineering that focus in the design and development with regards to material specification and fabrication, also it focus in analysis and evaluation of existing design. Process also includes Lean Manufacturing that focus on minimizing dropping tiles through installation of proposed suction cup.

Under the process material handling are also included which focus on evaluating the performance of tekpile. After the input and process analysis, Reduction of Dropping Tiles was the output of the study together with the reduction reworking and Development of Suction Cup.

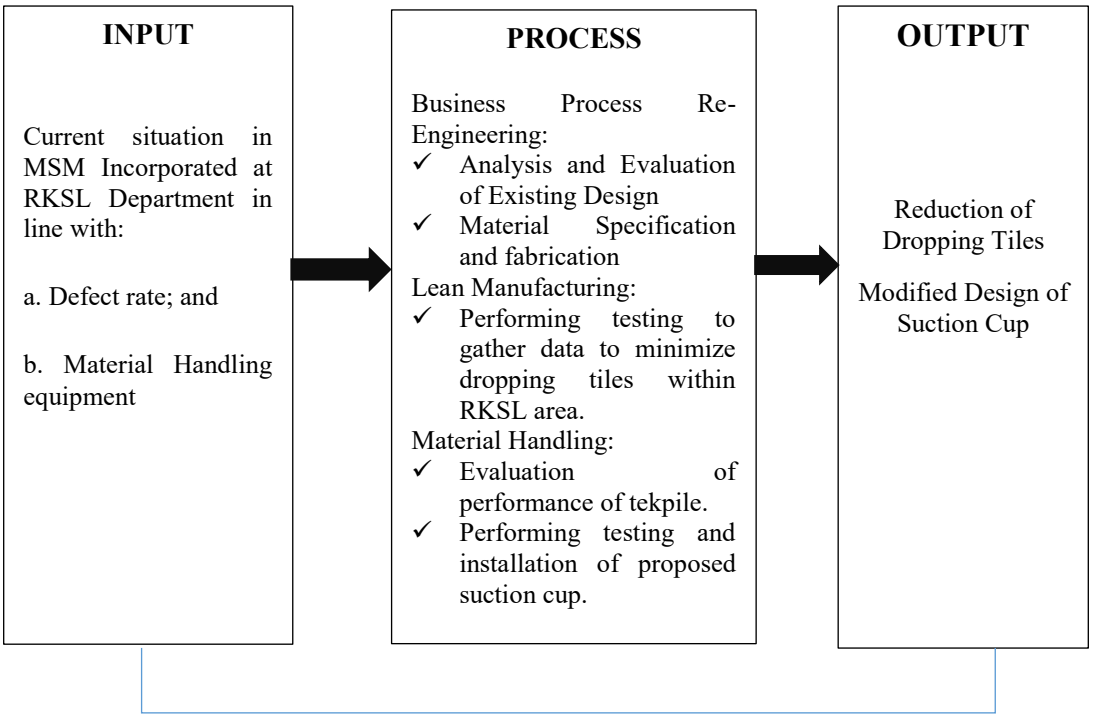

Figure 1. Conceptual Paradigm

Results and Discussion

1. Present Set-up

a. Defects

MSM Incorporated as a large manufacturing industry of tiles can't preclude the occurrence of different kind of defects. Figure 2 show that bloat, off size and dropping tiles contributes the largest amount of defects. On the first week (7 working days) of gathering data, Figure 2 shows that 2236.75 square meter are classified as dropping tiles out of 17060.6 square meter of the total defects. This implies that dropping tiles is one of the largest amount of defects within the production, that's why the researcher focused on minimizing the number of dropping tiles.

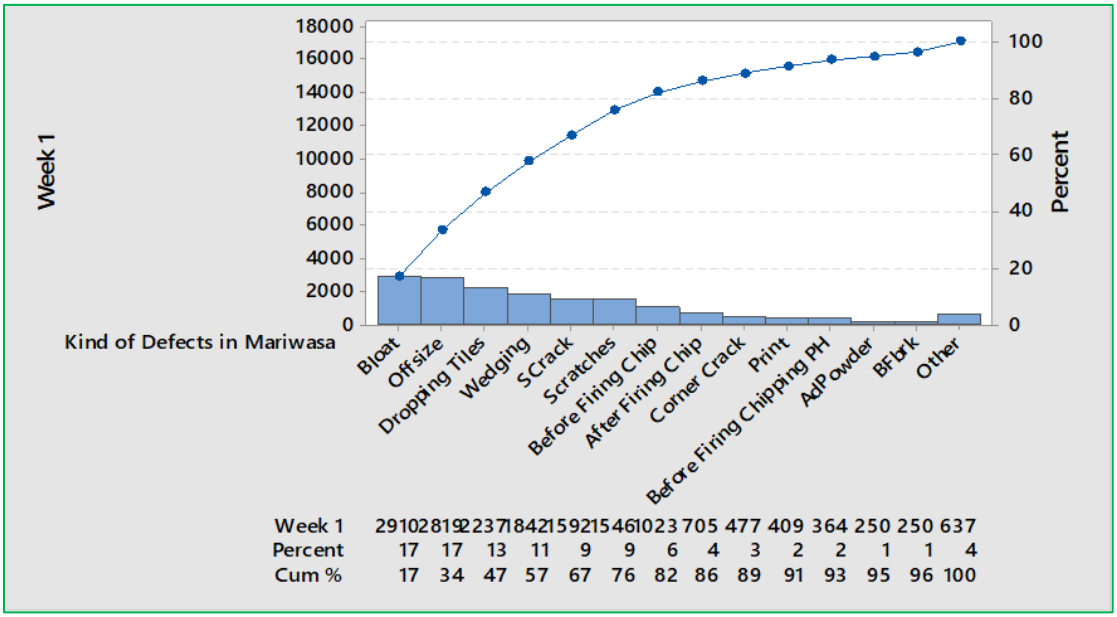

Figure 2. Week 1 Record of Defects in MSM Incorporated

As shows in Figure 3, in the second week (7 working days of gathering data), out of 17499.91 square meter of rejects 2737.23 are dropping tiles. This reveals that dropping tiles contributes a larger amount of cost compared to the other defects. In accordance with the price of Fired tiles, it costs PHP 112.00 per square meter.

The researcher determine the lost in profit of MSM Inc. when it comes to dropping tiles which results to PHP 306569.76 (PHP 112.00X2737.23). This defects usually occurs in the RKSL where researcher focused their study on.

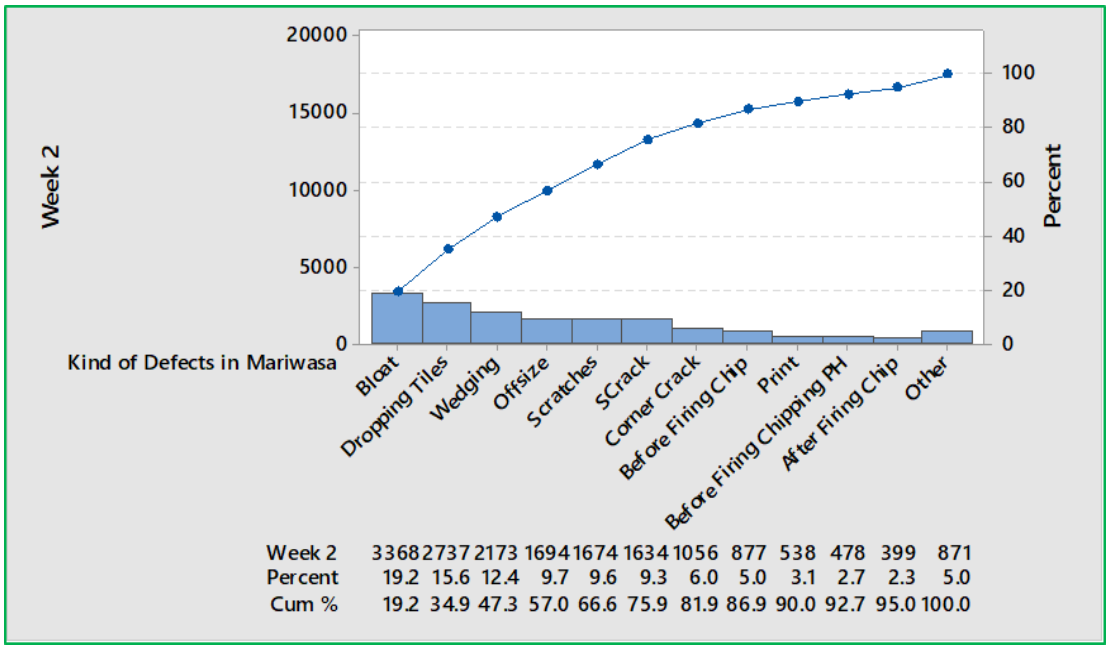

Figure 3. Week 2 Record of Defects in MSM Incorporated

Figure 4 below shows that, in the third week of observation (7 working days), out of 19134.86 square meter of the unconstructive outcome 2599.06 are dropping tiles. It occurs in RKSL due to inappropriate design of suction cup used in tekpile machine. Bloat, off size and

wedging needs a broader and long range study since it occurs due to different factors in different area in the production such as the temperature in the kiln and pressure exerted in the body preparation department (BPD). SCrack, scratches, and corner crack is cause by clogging of tiles in the conveyor. Before firing chip and after firing chip defects occurs because of overlapping. This reveals that dropping tiles is one of the main problem of the company. This is the reason why the researcher focus on this study.

The researcher gather data through observation and interviews to the operator and team leaders on where and when the problem occurs. They analyzed the gathered data and the entire production to determine the causes of dropping tiles and to minimize the said defects.

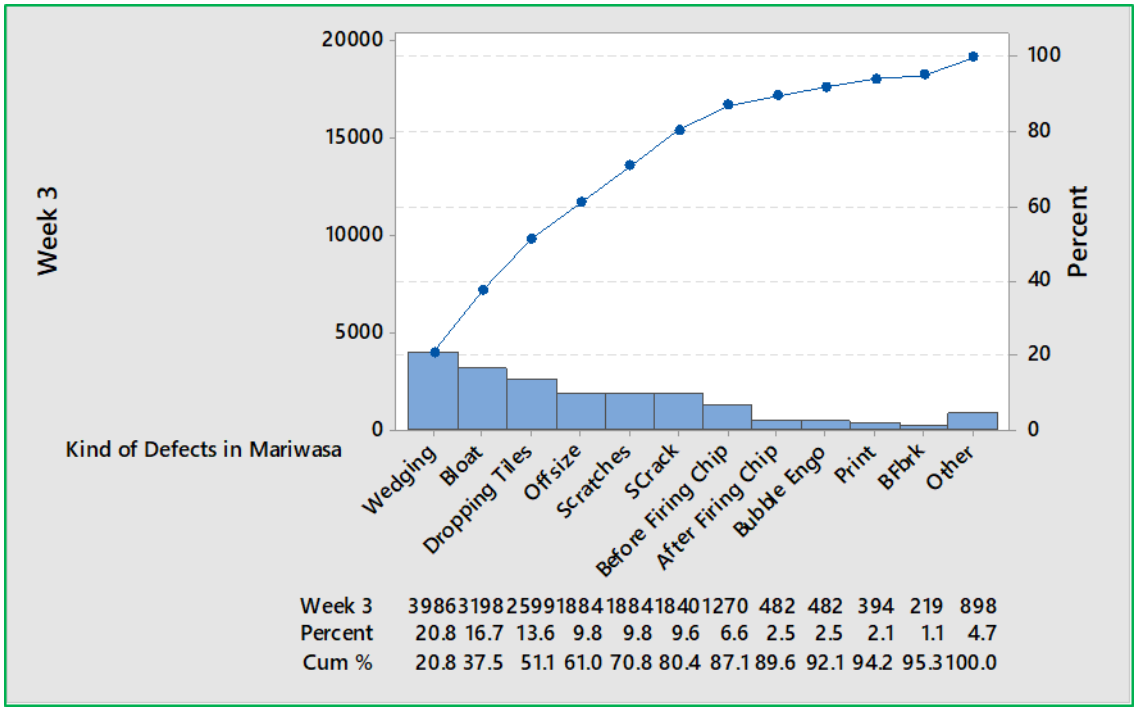

Figure 4. Week 3 Record of Defects in MSM Incorporated

b. Material Handling Equipment used in RKSL

MSM Incorporated is a large tile manufacturer who used different types of material handling in order to fulfill the needs of different process. One of the material handling used by MSM is the tekpile. Tekpile is a large vacuum with suction cap that suck the fired tile to the metal cart. The air that comes from the machine flows to the two tube, each tube distribute air to their respective suction cap which suck the tiles to the metal cart.

Tekpile is composed of seventy two suction cup and the pressure of this machine is adjustable. If they manufacture smooth tiles the set-up pressure of the machine is eight psi and if sculptured the set-up pressure is ten psi.

Tekpile is used to accommodate all the tiles that is produced in the kiln if the direct sorting line is fully loaded. It is also used not only in the kiln exit but also in the beginning of sorting line.

2. The Problems

Figure 5 shows the root cause of dropping tiles in RKSL Department, it is the reason why the researcher focus on studying the design of the existing suction cup of MSM.

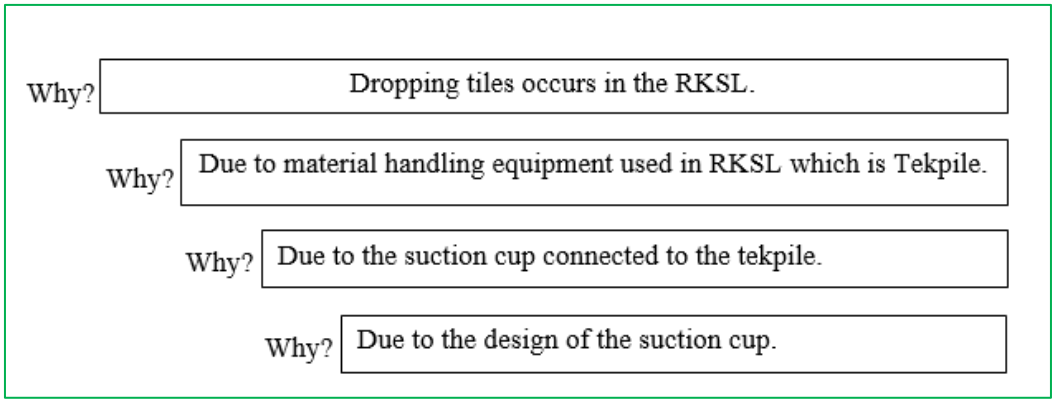

Figure 5. Why-Why Analysis for Dropping Tiles

3. Proposed Set-up

The researcher used the concept of Business Process Re-Engineering in developing the proposed suction cup to resolve the issue of reworking, reduce cost and support organization mission which is to provide uncompromising quality. Figure 6 shows the proposed suction cup. The suction cup proposed by the researcher is the deep concave suction cup which is good in gripping the curved and irregular surfaces. The proposed suction cup is composed of stainless for the body with a diameter of 10cm and four suction cup with a diameter of 3.5cm. The researcher used a stainless nut thread which serve as the connector between the suction cup and the rod connected to the machine. The stainless body serve as the pathway of the vacuum to the four suction cup. The suction cup is made up of rubber silicone which can resist heat that came from the fired tile. It is harder than the existing suction cup and also smaller. The suction cup use by the researcher is not that soft so that the stability of actual handling is stronger than the existing cup. The reason why researcher used smaller suction cup is because it made the probability of the suction cup will fall on the edge of the tiles lesser. The theory used by the researcher is the tentacles of the octopus. If one of the suction cup didn't suck there's still three suction cup that will hold the tiles. The existing suction cup used six cup to hold the tiles, while the proposed suction cup can hold a tile by only two or three cups.

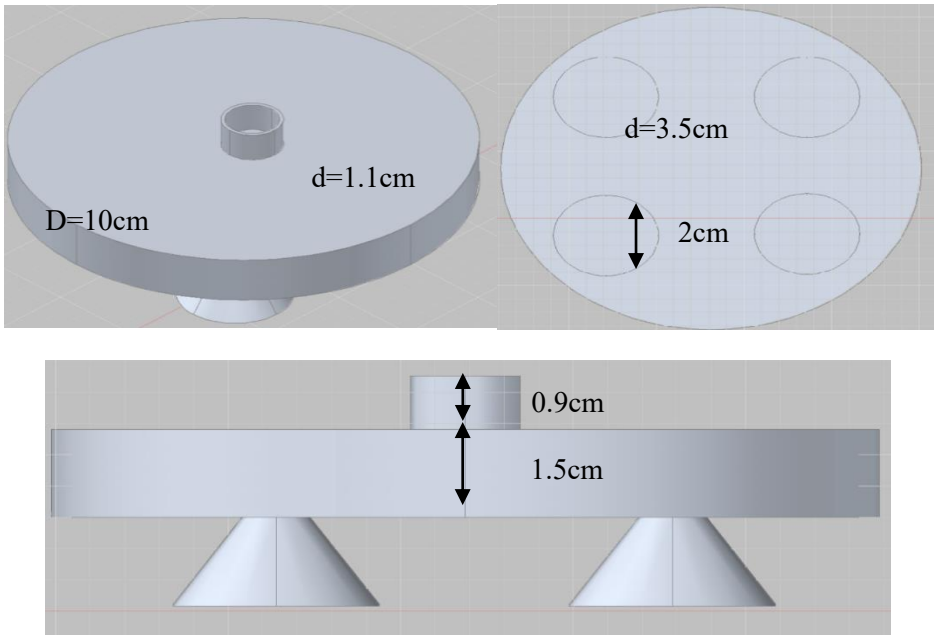

Figure 6. Schematic Design of Proposed Suction Cup

Table 1 shows the records of dropping tiles during the implementation of re-design suction cup. On the first week of observation, MSM produced three batch of sculptured and three batch of smooth tiles. On the second day of observation, dropping tiles occur, but the reason why it happens is because the existing suction cup release the tiles that results to domino effect. Dropping tiles also occurs in the second and third week of observation, but it only occurs because of the influence of other factor like the pressure of the tekpile due to the other existing suction cup used while implementing the prototype.

Table 1. Summary of Dropping Tiles in Tekpile Area after the Implementation of Re-design Suction Cup

Records of Dropping Tiles in Tekpile Area after the Implementation of Re-design Suction Cup			
Days	**1st Week**	**2nd Week**	**3rd Week**
1	0	0	92.16sqm
2	30.72sqm	61.44sqm	0
3	0	30.72sqm	0
4	0	0	0
5	0	0	0
6	0	0	0
Total	**30.72**	**92.16**	**92.16**

By using the concept of lean manufacturing which is to reduce "mudas" or waste such as the defects, waiting and extra processing. Waiting time occur when the tekpile stops due to the occurrence of dropping tiles, also it will result to undergo extra processing.

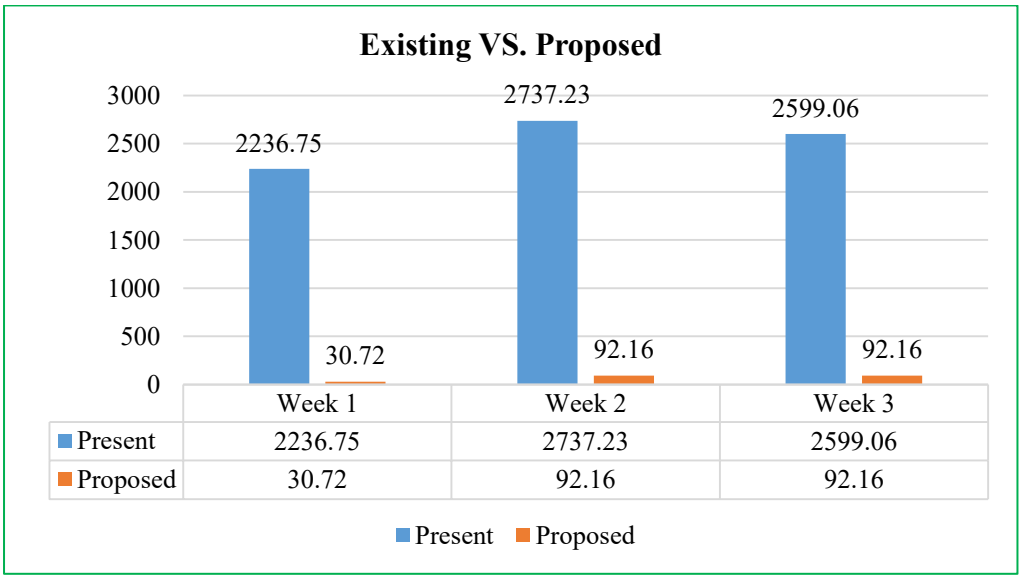

Figure 7. Dropping Tiles Comparison of Existing and Proposed

Figure 7 shows the reduction of defects which is known as common contributor of waste in the company, also it shows the comparison of existing and proposed unit of dropping tiles. It shows that dropping tiles greatly decreased through the use of proposed suction cup.

The units of dropping tiles in week 1, 2, 3 are 2236.75sqm, 2737.23sqm and 2599.06sqm respectively, while after the implementation of proposed suction cup the units of dropping tiles greatly decreased given as 30.72sqm, 92.16sqm and 92.16sqm.

Conclusions

Based on the findings mentioned above, the proponent were able to arrive at the following conclusions.

1) Dropping of tiles are one of the defects with the highest percentage of rejects during the production of tiles in MSM Incorporated. MSM uses different kind of material handling and one of these is the tekpile, which is used to transfer the fired tile to the metal cart.
2) The major contributor of dropping tiles is the tekpile, which the problem is the design of their suction cup. The suction cup that MSM used cannot hold the sculptured tiles and it results to dropping tiles.
3) The redesign suction cup is used to grip the irregular surfaces, in the researcher design if the one of the suction release the rest will still hold the tiles. It is really great help in achieving continuous improvement by reducing dropping tiles.
4) The suction cup tends to continuously eliminate the occurrence of dropping tiles in the RKSL.

Conflicts of interest: The author declares no conflicts of interest.

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