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Improvement of Road Marking Paint Manufacturing Process

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ABSTRACT

Road marking paints are produced as a mixture of thermoplastic powder [1]. It is used for painting traffic lines, pedestrian crossings, pavement edges, marking work areas, factory floors, etc. One of the paint manufacturing company in Sri Lanka is limited to production capacity of 2000kg per day due to its manually control mixer and high labour involvement. The production process consists of three stages as mixing, filling and packaging. This company is seeking a method to enhance the productivity of the road marking paint manufacturing process.

Therefore, this project is focused on improving the road marking paint mixing and filling processes. The existing method of road marking paint mixing and filling process, and the raw materials used for manufacturing marking paint were studied. Suitable mixing and filling mechanisms of raw materials were identified through the literature survey. Then necessary modifications to be carried out in order to omit drawbacks in the existing system were identified.

The semi-automated ribbon mixer can function automatically in the mixing and package filling processes. It also has an automatic measuring system and can adjust the mixing time if needed. This automatic process starts with the mixing process. Once raw materials are filled into the ribbon blender completely, the ribbon blender can start. After that, it will run for 2 minutes (clockwise and counterclockwise) and stop the mixing process by giving an alarm as soon as the mixing process has completed. Then the system will check the availability of the bag and if it is available, it will fill 25kg of paint mixture and stop.

Finally, the model was designed and fabricated the mixing and filling processes. Thereby, labour requirement was reduced and daily production can be increased by twice. The aim of this project was to improve production capacity, reduce wastage, and decrease labour involvement. So, with this model, the company will be able to overcome existing problems.

Key words: Road marking paint, Ribbon mixer, automatic, mixing process, filling process

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INTRODUCTION

A Road Marking paint manufacturing company in Sri Lanka, has a production facility to manufacture road marking paint in the form of powder, the basic mixer has the ability to partly homogenize with the aid of human involvement. Since the road marking paints consist of powders, beads, granules, and liquids of various densities has to be mixed thoroughly. In this company, Ribbon blender machine is used with a capacity of 1metric ton to mix seven different raw materials to make the road marking paint powder mixture. The raw materials used are, Calcium Carbonate ($CaCO_3$), Quartz [2], Hydrocarbon resin [3], Titanium Dioxide (TiO_2) [4], Glass beads [5], Polyethylene Wax [6], Dioctyl phthalate [7].

In this process, there are three stages as filling, mixing and packaging. Raw materials are fed to the ribbon blender with the help of screw conveyor feeder. For this process, minimum of two labourers are needed. Total mixing process is 2 minutes and once filling is completed the ribbon blender starts and runs for 1-minute clockwise direction and when it is completed stop the blender and change the direction using button and start the blender and run it for another 1 minute in anticlockwise direction and one person needed for this process. Once mixing is completed, bottom discharge valve is opened, and the mixed materials is filled to the trolley and fill 25kg bags and seal them. For this process, they need a minimum of four labors. Current average day production of this company is 2 metric tons.

RATIONALE FOR STUDY

In the existing process Mixing process is done manually (measuring time, changing direction and stop) and mixed material filling into bags (25kg) is also done manually. Therefore, following drawbacks were identified.

- Material wastage per day is 0.2% to 0.3%.
- Filling process required 4 labors.
- Limited per day production.
- Low production efficiency.

Man-power requirement for 1 metric ton production and Number of Labors and time involvement in the Current Process are given in Table 1 below.

Table -1 Current Man-Power Distribution with minimum requirements

Labor and time involvement in Current Process			
1 metric Ton production system	**Labor**	**Time**	**Man Power**
Filling Process	2	1hr	2
Packaging Process	4	3hr	12
For 1 metric ton production	4	4hr	14

METHODOLOGY

Current Working Process

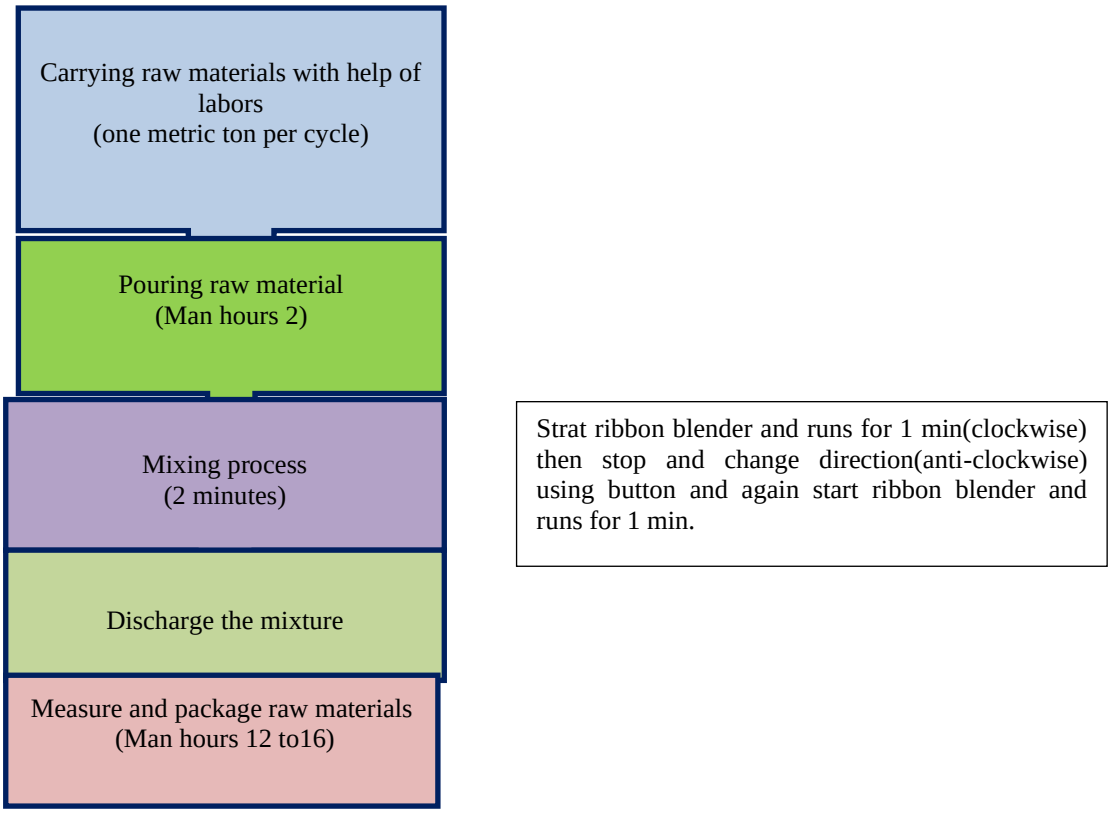

Fig. 1 Current Working Process

Current working process is as shown in Fig. 1.

Possible Necessary Modifications to Overcome Present Problems

According to the literature review, ribbon blender was identified as most appropriate and cost-effective mixer for the mixing process. To overcome current difficulties in discharging and packaging process, conveyor/feeder system was selected to get mixed material out. Screw feeder mechanism is better for that, because it can pull out the packed material gradually and also good for free-flowing materials since it's totally enclosed. Current manual measuring takes more time; therefore, semi-automatic system was proposed as given below.

Proposed Semi-Automatic System

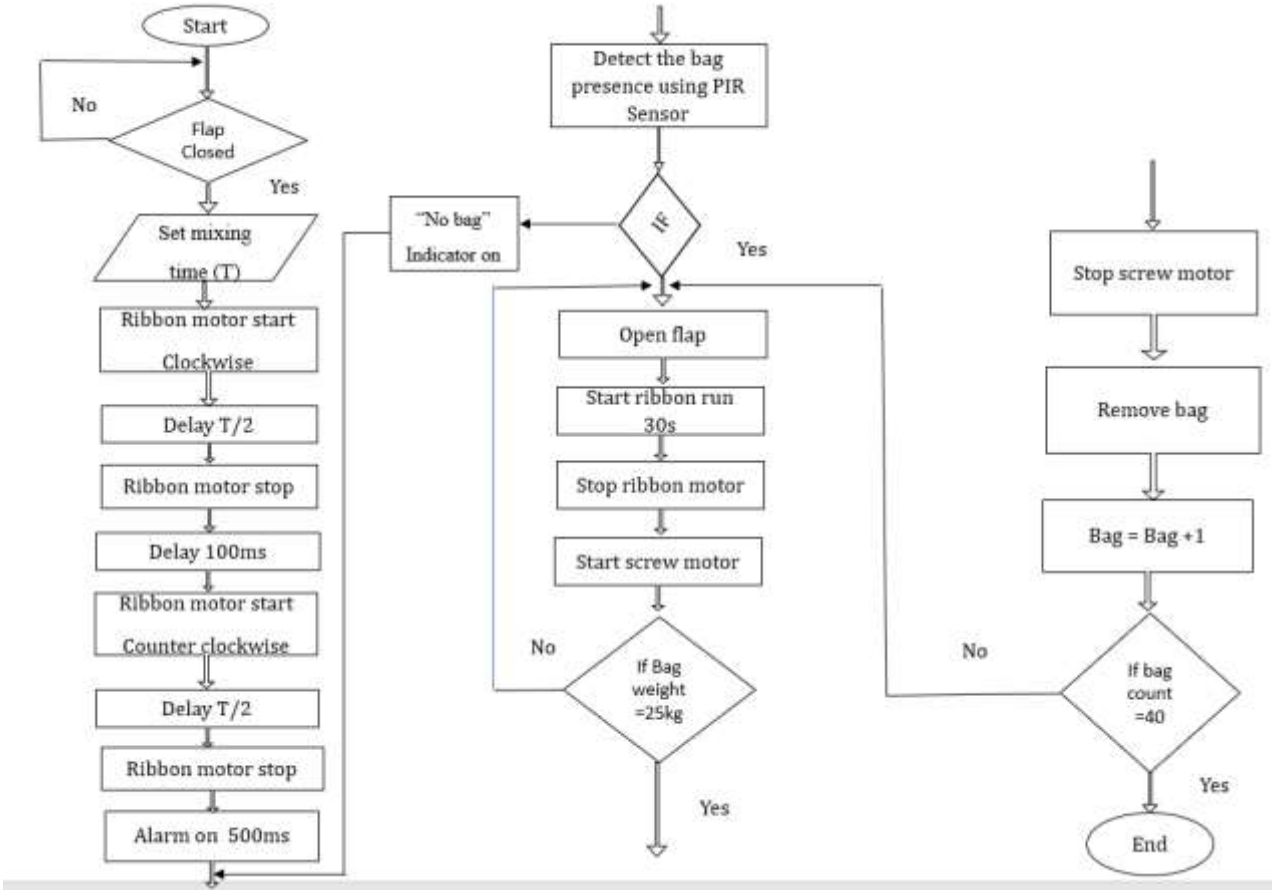

Fig. 2 System Flow Chart of Mixing and Filling Process

As shown in Fig. 2, this automatic process starts with mixing process when the flap is closed (Flap is in between ribbon blender and the screw conveyor) , once raw materials filled to the ribbon blender completely, the ribbon blender can start, after that it will run 2 minutes (clockwise and counterclockwise automatically) and it will stop the mixing process, by giving an alarm as mixing process has completed. Then the system will check whether the bag (object) is available or not, if it's available, then start the screw conveyor and it will fill 25kg and stop, one person is needed to shift the filled bags. The system will count bags quantity and will continue the process accordingly, 2 labors are needed for discharging and pouring process. One for shifting bags and other to seal the bag.

Conceptual Mechanical Design

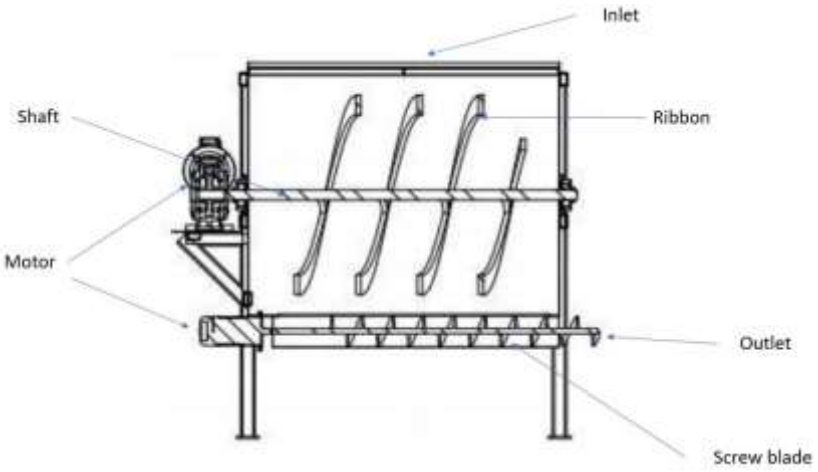

Fig. 3 Sketch of Mechanical Design

Table -2 Dimensions of design sketch

Part name	Dimensions	
Ribbon Details	mm	inches "
Length	2400	94.5
Width	800	31.5
Height	1200	47.3
Screw Details		
Length	2794	110"
Width	177.8	7"
Height	203.7	8"
Screw diameter	152.4	6"
Shaft diameter	38.1	1.5"
Motor rpm	50 rpm	

Conceptual Mechanical Design was designed as shown in Fig. 3. All detail calculations were done as shown in Table 3.

DISCUSSION AND CONCLUSION

Semi –Automated ribbon mixer is developed as a modification for existing ribbon mixer in the factory. The purpose of the project was to improve the production of the company avoiding unnecessary time consumption and material wastage. The design was quite successful and able to meet requirements.

Designing and modeling was the first phase, and the system was designed with theoretical calculations and considering practical assumptions. Then, it was modeled by means of solid works to ensure the appearance and analyze the expected system. After the verification of the modeling, the design was implemented as a prototype one to ensure the proper function of the machine as second phase.

According to the prototype, this machine is powered with two motors as one for mixing process and other for screw conveyor. Moreover, it has designed with two shafts to drive ribbon and screw. The system has been developed by automating from mixing to packaging stage. Automated system is centralized with microcontroller-based system. It was a great experienced and challenge to programing microcontroller without previous knowledge. That system is dedicated to deciding the mixing time, handling the discharging process by controlling the screw conveyor and control the filling time by measuring the weight of the pack in packaging stage.

Numerous challenges were met in implementation phase. Although design phase is finished, the pandemic situation obstructed the implementation process. As a result of prevailing pandemic, materials were rare in the market and its cost is increased. Availability of workshops also limited for machining and fixing the machine. However, it was able to construct the prototype overcoming them.

In contrast with existing system which installed in the company, the developed system has considerable advantages. It reduces the labor requirement for the process by 50% and material wastage by 95% due to automating. It is evidence to prove the project reduces the production cost relatively. Not only that, but the developed system can also produce 4000kg per day instead of 2000kg of existing system by decreasing the production time. The system proves the production capacity also can be increased by 100% per day. It will be a good solution to cover the demand.

Nevertheless, the prototype was able to prove the function of the machine. It is fair to expect any practical issues when it is implementing, installing, and commissioning the actual machine. Capital of the actual machine is considerably high, considering the economic benefits of the proposed system. It will be a good long-term investment for the company. This type of mixer can be deployed not only in this company, but it can also be proposed to the industries with same process with same capacity.

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