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Design of Mixer Machine for Powder with Triz Method (Case Study: Mixing Powder Process in PT. X)

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Abstract

The age carries a lot of impact and change in social life increasingly modern and complex. The same holds true in the business world. Along with the times, the business has developed very rapidly. In order to defend the existence and increase its business, company must to meet the safety standard that will affect to quality of its products.

PT. X is an engaged company of milk powder production that prioritizes high safety standard, including the management of their waste. Problem faced by this company is the process of waste production that unmeet the company safety standards.

The substitution of a mixer machine that used by PT. X with mixer machine that available in the market has a few drawbacks to be the solution because it does not meet the company needs. Therefore the researchers designed a mixer machine using TRIZ method that can be a solution of the existing problems. Issues that will be discussed in the research is how to determine the best concept of the various alternative concepts of mixer machine resulting from the needs of PT. X in order to create a new mixer machine that answers the problems that exist.

Keyword : TRIZ, Pugh,Concept Selection

INTRODUCTION

PT. X having 2 trained labors for operating mixer machine in waste process. Waste process need to be review because ways of working from current mixer machine condition.

Started from pick up the waste product until processed, PT. X need at least 2 labors because weight of waste product adjust to mixer machine capacity which the weight cannot covered by 1 labor only.

Picture 1. Current Mixer Machine for Waste Product

Pictures describe that the waste product should lifted out of height limit factor for operator body.

As one of the other alternatives that may used by company is changing the mixer machine into other mixer machine that available in the market that meet the safety standard company.

Picture 2. Mixer Machine in Market

https://chemix.en.made-in-china.com

Current machine has the advantages of a mixer on the operations that do not require operator assistance while working but still need operator to lift the product. However, the change of the mixer machine also has some disadvantages.

The disadvantage, among others:

- There is no lifting tools set in mixer machine. Need to buy separately.
- Electricity consumption is bigger than current mixer machines.
- Other mixer machine in market still need modifcation as company needs.

Based on the explanations that described in the background section, the problems experienced by company is the waste powder process is not safety enough. That is because the ways of work and current mixer machine. The turnover from current mixer machine to mixer machine on the market has a few drawbacks to be solution because it does not meet the company needs. Investigators therefore designed a machine mixer that can be the solution of existing problems. Issues that will be discussed in the research is how to determine the best concept of the various alternative mixer machine concept generated

from PT. X needs in order to create a new mixer machine that answers the problems that exist.

LITERATURE REVIEW

TRIZ METHOD

TRIZ or in the stands for the Russian language is teoriya Resheniya izobretatelskikh zadacth is a theory to solve the cause of the problem (Dieter, 2009). TRIZ is a methodology, to develop innovative ideas and solutions to a problem solving. TRIZ generating methods that can used in problem formulation, system analysis, failure analysis, and changes in the pattern of a system.

ISQ (*Innovation Situation Questionnaire*)

ISQ is a device in the TRIZ method to define a situation. The situation can be goods or activities. ISQ, made by discussing the information about the system to be developed and all things that are in the neighborhood of a system.

The discussion begins with identifying information such as a description of a system of systems, the name of the system, the functions of existing systems, and the workings of the system. The most significant of the ISQ is information about problem situations that occur in the system. Problems can occur at or outside the system. ISQ serves to record it.

PFD (*Problem Formulation Diagram*)

As a first step to formulate the problem that exists, we can use the chain of cause and effect, which can be preceded by Harmful Function (HFN) or Useful Function (UFn), which indicates weakness Harmful and Useful Function Function indicates the primary function of a system. If the depiction of the causal chain begins with Harmful Function, then try to identify the functions that can be associated with a Useful Function. A chain will be considered complete until at least one chain of Useful Function to Harmful Function.

To be able to solve the problem (eliminate Harmful Function), formulated all causal relationship is problematic, because as has been said before that in this chain we can describe the small problems, and also problems that require innovation process. After all the problems identified, then start finish of issues that have the most significant effect on the overall system.

After connecting the existing statements of HFN and UFn, then the next step is to connect these statements are interconnected with each other into a diagram called PFD (problem formulation diagram). After making a PFD, made of various kinds of relationships that allow for the problem statement further developed especially contradictory statements that happen.

CONTRADICTION

This contradiction analysis is a method that is capable of generating multiple solution concepts by using a table contradiction. If the problem with the fit parameters are the parameters of the TRIZ method, then we will be able to find a variety of creative problem solving and effective. 39 kinds of parameters used in the TRIZ methods can be seen in Table 1.

Table 1. 39 Parameters in TRIZ Method

1. Weight of moving object	*21. Power*
2. Weight of non-moving object	*22. Waste of energy*
3. Length of moving object	*23. Waste of substance*
4. Length of non-moving object	*24. Loss of information*
5. Area of moving object	*25. Waste of time*
6. Area of non-moving object	*26. Amount of substance*
7. Volume of moving object	*27. Reliability*
8. Volume of non-moving object	*28. Accuracy of measurement*
9. Speed	*29. Accuracy of manufacturing*
10. Force	*30. Harmful factors acting on object*
11. Tension, pressure	*31. Harmful side effects*
12. Shape	*32. Manufacturability*
13. Stability of object	*33. Convenience of use*
14. Strength	*34. Repairability*
15. Durability of moving object	*35. Adaptability*
16. Durability of non-moving object	*36. Complexity of device*
17. Temperature	*37. Complexity of control*
18. Brightness	*38. Level of automation*
19. Energy spent by moving object	*39. Productivity*
20. Energy spent by non-moving objects	

By using a table of contradiction, TRIZ method will open new vistas of which already exist for this to be able to identify the principles that can offer solutions that enable. By using this table, the researcher will be able to concentrate on adapting the principles of this standard, so as to produce an innovative. Here are the 40 principles of TRIZ methods in Table 2.

Table 2. 40 Principles in TRIZ Method

1. Segmentation
2. Extraction
3. Local quality
4. Asymmetry
5. Combining
6. Universality
7. Nesting
8. Counterweight
9. Prior counter-action
10. Prior action
11. Cushion in advance
12. Equipotentiality
13. Inversion
14. Spheroidality
15. Dynamicity
16. Partial or overdone action
17. Moving to a new dimension
18. Mechanical vibration
19. Periodic action
20. Continuity of useful action
21. Rushing through
22. Convert harm into benefit
23. Feedback
24. Mediator
25. Self-service
26. Copying
27. An inexpensive short-lived object instead of an expensive durable one
28. Replacement of a mechanical system
29. Use a pneumatic or hydraulic construction
30. Flexible film or thin membranes
31. Use of porous material
32. Changing the color
33. Homogeneity
34. Rejecting and regenerating parts
35. Tranformation of physical and chemical states of an object
36. Phase transition
37. Thermal expansion
38. Use strong oxidizers
39. Inert environment
40. Composite materials

Morphological Chart

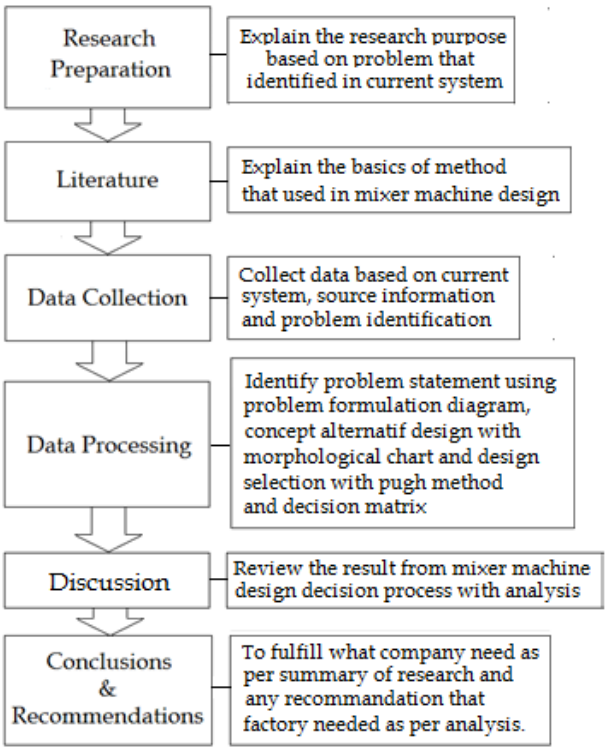
Morphological Chart regulate the functions and sub-functions and logic sequence for each sub-function that records all possible concepts (hows). Morphology alone means learning from the shape or form, so the morphological analysis is a way to find a form (forms) new, new design concepts. The purpose of this method is to find a combination of ideas that shape the design concepts that may not be found.

Pugh's Concept Selection Methods

The selection of concept has done to get the best concept in accordance with the criteria specified. In addition, the selection is done to narrow the number of concepts, when the number of concepts in significant amounts. The selection of concepts divided into 2 stages: concept screening and assessment concepts.

METHODOLOGY

Flowchart about research methodology description showed in picture 2.

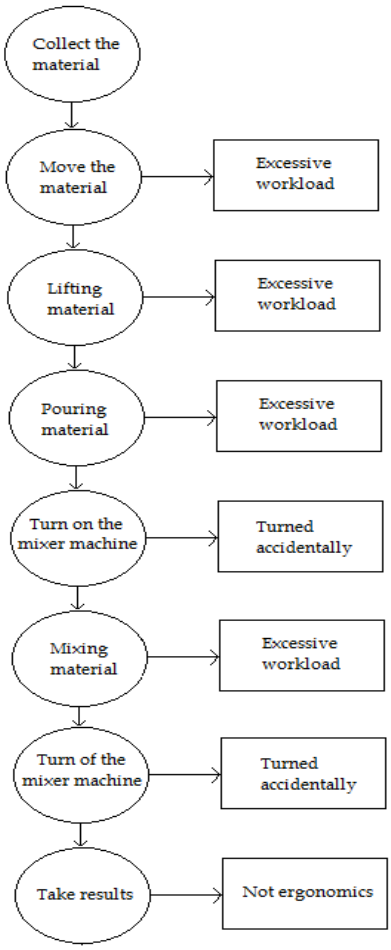


Picture 3. Flowchart of Research Methodology Description

RESULT AND ANALYZE

Based on work systems in use today, the problem that occurs generally found on cable, reservoir and engine during the mixing process takes place. Statements identifying existing problems done using the Problem Formulation Diagram (PFD). PFD classified into 3 groups consisting of several parts of the process according to the current working system function.

The group is as follows:



Picture 4. PFD of Mixing Process

Based on the problems that have been identified previously using problem formulation diagram, it will further develop problem statements that there be a contradiction. Statement of the problem statement will used as input in the development of contradictions, where the parameters identified on each problem statement.

Development of the contradiction done for each problem statement. The first thing to do is to identify any statement of the problem, then look for relevant principles based on the relationship between each parameter. After obtaining the ideas derived from the principles that have done previously, the next step is to pour these ideas into a morphological chart based on its function.

Morphological chart used as a means of comparison of each concept are formed and recorded all possible concepts and to develop functions and sub-functions in a logical order.

Some alternative concepts have been developed previously will be selected using the Pugh method. Before selecting Pugh method, criteria determined in advance what will be the material for the assessment of alternative concepts. Criteria that used, among others, user needs, technical requirements and operational needs of the tools specified by the researcher based

on the interview. Concept selection results by using the Pugh method can seen in Table 3.

Table 3. Table of Concept Selection With *Pugh* Method

No	Criteria	Concept		
		Current	1	2
	User needs			
1	Easy to use		+	+
2	Mixing results		+	+
3	Capacity results		+	+
4	Electrical consumption		-	+
5	Mixing speed		+	+
6	Safety		+	+
	Technical needs			
7	Volume	**Datum**	+	+
8	Machine Power		+	+
9	Lock system		+	+
10	Machine speed		+	+
11	Stirrer power		+	+
	Operational needs			
12	Mixing process		+	+
13	Output process		0	+
14	Cleaning process		0	-
Total		+	11	13
		0	2	0
		-	1	1
Last Score			10	12
Rank			II	I
Continue			Yes	Yes

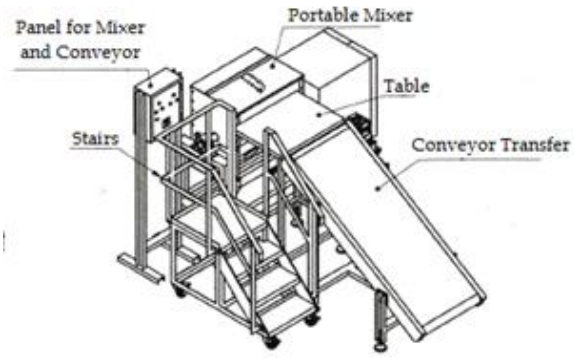
Based on the concept of selection results by using the Pugh method, there are three alternative engine concepts selected for further development. At this stage, each screened alternative concept in more detail by using the selection matrix, where there is a weight given to each of the selection criteria and a scoring machine on each alternative concept for each criteria.

The scoring of the concept of selection will be determined by the investigator using ordinal scale, where the ordinal scale used manifold higher the better with a scale ranging from 1 to 5. Decision matrix can seen in Table 4.

Table 4. Decision Matrix

No	Criteria	Concept				
		Point Selection (%)	1		2	
			Scores	Points	Scores	Points
	User needs					
1	Easy to use	**9**	5	0.45	4	0.36
2	Mixing results	**8**	5	0.4	4	0.32
3	Capacity results	**8**	4	0.32	4	0.32
4	Electrical consumption	**7**	1	0.07	4	0.28
5	Mixing speed	**7**	4	0.28	4	0.28
6	Safety	**6**	4	0.24	4	0.24
	Technical needs					
7	Volume	**8**	4	0.32	4	0.32
8	Machine power	**6**	4	0.24	4	0.24
9	Lock system	**6**	5	0.3	5	0.3
10	Machine speed	**7**	4	0.28	4	0.28
11	Stirrer power	**7**	4	0.28	4	0.28
	Operational needs					
12	Mixing process	**8**	4	0.32	4	0.32
13	Output process	**7**	3	0.21	5	0.35
14	Cleaning process	**6**	3	0.18	1	0.06
Total Score			3.89		**3.95**	

Based on the results of the total value, an alternative concept which has the highest value is machine concept 2 with the highest total score of 3.95. Based on these results it can be seen that the machine concept 2 is better than the machine concept 1 so that the machine concept 2 as the owner of the highest value is a concept that was selected for further development. The machine concept image 2 is as follows:



Picture 5. Machine Concept 2

Concept machine 2 are the result of development of a mixer machine used on PT. X by using ideas derived from principles of TRIZ method.

Considering shop condition and technical needs to user needs, so restrictions specifications obtained as reach the target of technical achievement by machinery.

Technical needs target:

1. Capacity : max. 100 kg
2. Speed : 100 rpm
4. Max. Power : 950 watt / 220V

To realize the concept of selected machines required some technical considerations about the specifics of the concept. This done to obtain the technical specifications of the selected machine concept that can help facilitate the detailed design phase.

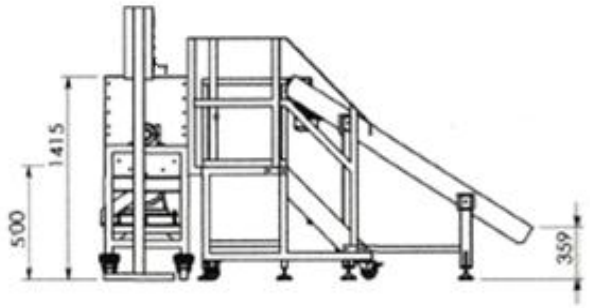
With new mixer machine, capacity has increase to be max 100 kg compared capacity before that have max 90 kg. Although capacity increase, capacity of mixing process recommended is still 90 kg (as previous) to avoid any uneven results. With new mixer machine, mixing proceed can be finished in 10 minutes only with good results. This affect to increase the output 50% for 1 shift.

To determine the overall dimensions of the machine used anthropometric measure for the average Indonesian woman.

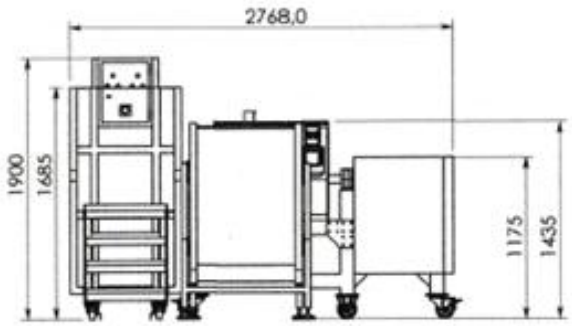
The dimensions needed to obtain the ideal high lifting hand position making it easier for the user objects laying to taken to the next process. Overall engine height (with stand) adjusted for anthropometric measure not to exceed shoulder height is 127.2 cm. Adjusted for not passing because of a shoulder height in order to allow a user to pour the material. Height from mixer machine is 141.5 cm, so with the height of top stairs 50 cm is

still safe because the minimum floor of top stairs is 14.3 cm (141.5 cm - 127.2 cm).

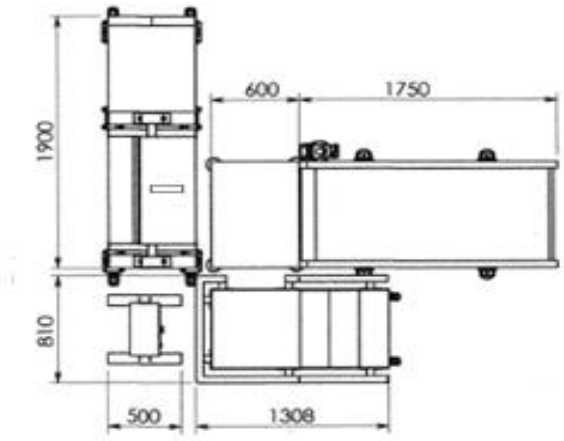
By looking at each component related to the high altitude of the machine as a whole is 35.9 cm. Where 35.9 cm is the distance from the floor to the conveyor. The top of stairs should be more from 35.9 cm.



Picture 6. Side Dimension of Choosen Machine Concept



Picture 7. Front Side Dimension of Choosen Machine Concept



Picture 8. Top Dimension of Choosen Mixer Machine Concept

For the length of the machine are:

175 cm + 60 cm + 50 cm = 285 cm

where:

A 175 cm is a long of conveyor that will help labor to lift the material near to mixer machine. 60 cm is the table to support the pouring process. 50 cm is a measure of the machine wide. Differences were found in the concept of 2 machines with mixer machine used today can be seen in Table 5 below.

Table 5. Difference between Choosen Machine Design With Current Used Mixer Machine

Current Mixer Machine	Mixer Machine Chosen
Manual power button system	Using timer for auto off
Using chain	Using *gear box*
There is no cell in container	Using cell in container so hand cannot reach the stirrer to avoid any accident
Need 15 minutes per mixing process	Only 10 minutes for one time mixing process
Manual Lifting	Using Conveyor for lifting the material
Doesn't have stairs	Have stairs
Capacity container is 90 kg per process	Capacity container is max 100 kg per process

The concept selected of mixer machine designed base on deficiencies and weaknesses in the current mixer machine used. To answer the problem that there is the necessary requirement for the user as a comparison of mixer machine concept has selected because the user needs to have an important role in the problem.

PT. X problems is uneven mix results and safety in production unmeet the company standard. User needs are not fulfilled is the trigger of the problems occurred. With meet the user needs, so the choosen machine concept can be the answer to solve the problem in PT. X. There are user needs in PT. X:

User needs:

1. Doesn't need to hire more labor
2. Capacity increased
3. Mix powder more thoroughly mixed
4. Mixing process more faster
5. Low electrical power consumed
6. Safety to use

The meet of user needs in PT. X by mixer machine concept chosen reviewed in table 6.

Table 6. Chosen Machine Concept Design against User Needs

User Needs	Chosen Machine Concept
No additional Manpower	With selected mixer machine, company doesn't need additional labor to handle the waste process from beginning until end of process
Capacity increased	With new mixer machine, capacity has increase to be max 100 kg compared capacity before that have max 90 kg. Although capacity increase, capacity of mixing process recommended is still 90 kg (as previous) to avoid any uneven results. With new mixer machine, mixing proceed can be finished in 10 minutes only with good results. This affect to increase the output 50% for 1 shift.
Mix powder more thoroughly mixed	Stirrer design more efficient, product more mixed with new mixer machine
Mixing process more faster	Based on report, the process improve around 33% faster with new mixer machine. Mixing process improve from 15 minutes to 10 minutes with new mixer machine.
Low watt needed	Using motor from *photocopy machine* to improve power with low watt
Safety from beginning until end of process	- Using conveyor to lifting material to reduce labor load when lifting the material. - Using cell in container, so hand cannot reach the stirrer.

Based on Table 6 above, it can be seen that the selected mixer machine concept meets the user needs so that it can be concluded that the choosen machine concept meet the criteria as a solution to solve the problems that exist in PT. X and deserves to be developed further.

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