

## Design of rolled conveyor using rational product development method

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AMDK PDAM Bandung City Company is a startup company that produce mineral water size 220ml and 19liters. The production process, transferring process of 19liters gallon from sealing machine to loading bay is using manual material handling method without material handling equipment. The company has a policy to increase the number of production per day than 300 per day into products 2000 products per day. The transferring process of gallons of capacity manually is 1440 gallons per day so it needs changing methods transfer of gallons into the loading bay with using the tools so that products can be moved in accordance with company target. Method Tools used in the relocation process was designed using rational product design process by Nigel Cross. The stages of product design process rational is clarification purpose, set needs and characteristics, the function and sub function, eliciting an alternative concept, and selection of the concept of elected. Results and discussion: The result of research is concept material handling equipment gallons from sealing machine to loading bay that can send gallon accordance with the company's production target.

### Introduction

AMDK PDAM Bandung City Company is a company that produce mineral water size 220ml and 19l. Production process, transferring process of 19liters gallon from sealing machine to loading bay is using manual material handling method without material handling equipment. The company has a policy to increase the number of production per day than 300 per day into products 2000 products per day. The manually transferring process of gallons of capacity is 1440 gallons per day so it needs changing methods transfer of gallons into the loading bay with using the tools so that products can be moved in accordance with company target. In the production process of the gallon, the process of transferring the gallon to loading bay is the process that has the largest number of gallons. According to the results of the observation, the factors that cause the product stack or bottleneck are human factors, namely operator factors because operators must often delay the transfer process The process of transferring the gallon to the loading bay is done manually, namely by rolling the gallon without using material handling equipment. According to observations, the transfer of gallons from the gallon sealing machine to loading bay requires an average gallon removal time of 9.03 seconds with a transfer capacity per day obtained from the division of work time which is equal to four hours per day with the transfer time of 9.03 seconds / gallon so that it is obtained gallon transfer capacity to loading bay from PDAM Kota Bandung bottled water company is 1594 gallons / day where operators work for 4 hours / day during the gallon production process. Due to the existence of a business strategy carried out by the company regarding the addition of production volume from 300 gallons / day to 2000 gallons / day while the transfer capacity in the gallon transfer process from the sealing machine to loading bay is only 1594 gallons / day causing products that are not moved to loading bay. From the above problems there must be additional product transfer capacity from the process. Improvements that can be made are changes to the transfer method which was initially manually changed to use material handling equipment

### **Fundamental Principle**

The design of the product type of the method that is rational and creative methods (Cross, 2008). A method of designing creative products have the goal to stimulate creative thinking in a way to increase production of the idea, setting aside the mental barriers against creativity or expand search area solution. Whereas the rational design methods is a more systematic method in the process of designing and further limit the design with the goal of designing what it actually wants to achieve by that product. Comparative research on the rational Method with creative Tools to design a pair of Lights (Prakosa & Tantowi, 2010) obtained that rational methods to more accurately answer the needs as compared to the creative method so that the method of design of rational products selected as research methods. Rational methods compared with exiting layout, previous process, and the additional needs of the stakeholders. Product development steps (Cross, 2008).

1. The first stage of product design rational is clarify the purpose of determining the purpose of design.
2. The next step is setting the needs and characteristic of products will be made.
3. The next step is the determination of function and sub-function necessary to bring up alternatives used to achieve a solution from trouble design. In this step use morphological chart as method for generating the concept. Morphological charts are useful for finding out potential new solutions in developing alternatives that have not been previously identified
4. The last step is evaluating the alternatives using concept screening and concept scoring which developed by (Pugh, 1990). In this stage, we will selecting the best alternative between several alternatives from the greatest score of objective weighting method.

Material handling is a method of transferring and storing products. Material handling equipment is a tool to move materials or machines to different places with the right cost, right time, right position and right place. (Keyur, Mayur, Mrugesh, Jay, & Solanki, 2018). Material handling itself does not add value to the product but still affects the production process. Some things to consider in material handling are:

- a. Products, both shapes, sizes, quantities that must be removed and product durability.
- b. Layout
- c. Production process, sequence of production processes, direction of material transfer, and production equipment
- d. Material handling equipment, equipment related to the transfer, storage, protection, distribution, consumption and disposal of a material. Equipment material handling is important in the production process so that the production process can run as expected by the company.

Material handling equipment generally consists of 3 types (Apple, 1990), namely:

- a. Conveyor is a mechanical system that has the function of moving goods from one place to another. Conveyors are widely used in industries for the transportation of goods that are very large and sustainable. Conveyor has several type, there are : belt conveyor, roller conveyor, skatewheel conveyor, chute, etc. Conveyor can huge load carrying capacity and easy to repair. (Ashwini & Ismail, 2019)
- b. Crane is one of the heavy equipment that is used as a lifting tool in a construction project. Crane works by lifting the material to be moved, moving horizontally, lowering the material in the desired place.
- c. Industrial truck is a tool used to move material with a flexible transfer path. Industrial trucks require operators to operate.

But, for transferred the material we can use conventional method material. Material transferred by trolley, tray, pallets, lift, trucks, and portable hand hoist. In this type requires extra power from human and need more time to transfer it. Conventional method has several risk; risk of damage of material and risk of health the human. . (Patil et al., 2017)

The resultant calculation of force on an inclined plane:

$$\Sigma F = m \times a$$

Where        F = Force (N)  
                  m = Massa (kg)  
                  a = Accerelation(  $\frac{m}{s^2}$  )

Uniformly accelerated motion equations:

$$s = v_0 \times t + \frac{1}{2} \times a \times t^2$$

Where        s = displacement (m)  
                  v = Velocity ( $\frac{m}{s}$ )  
                  t = time (s)

The formula of transfer capacity:

$$\text{Transfer Capacity} = \frac{\text{Working time}}{\text{Processing Time}}$$

### **Conceptual Model**

The conceptual model is a construction that describes the relationship or relationship between each variable in the research concept. This model is used to better structure the research process so that the objectives of the research can be achieved. In designing the gallon transfer device in the process of transferring the gallon to the loading bay, variables are needed to assist in the process of designing the gallon transfer tool. Variable needs are collected through direct field observations and the data provided by the company will be used to reference the technical specifications of the gallon transfer device. From the technical specifications obtained, an alternative concept of a gallon transfer device will be made. From the alternative concept of the gallon transfer tool that is made, one alternative concept that is considered best based on considerations will be chosen. The results of the selection of the concept are the final results expected from this study.

### **Product Planning Process**

The initial stage of the product design process aims to determine the purpose of the product design process to be made. At this stage the destination tree method is used. The first step taken in making the destination tree is to list the design goals. Based on field observations, the tools designed must be in accordance with the needs of the process before and after. From the needs of the previous process the tool must match the height of the conveyor of the sealing machine and after that the tool must be able to move to the next process, namely to loading bay. In addition, the tools made must be able to be stored when not in use because the production floor will be used for the production of other products. From these needs, the product design goals are explained in the destination tree diagram in Figure 1

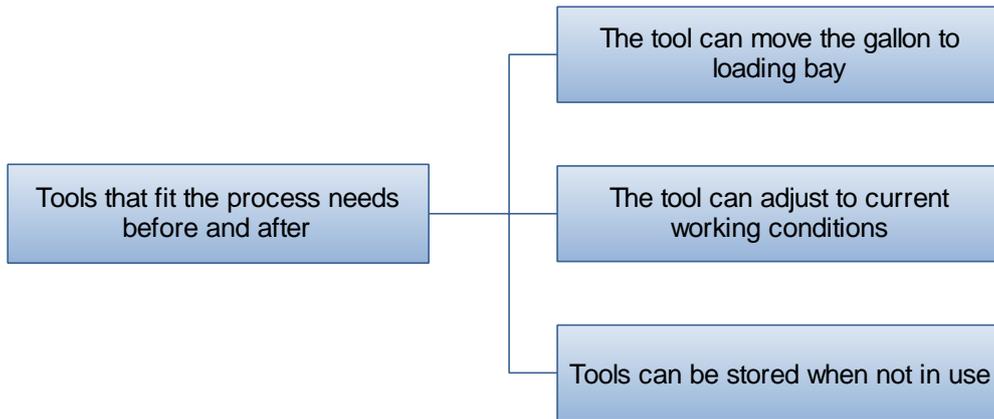


Fig. 1 Product design goals

From the objectives obtained, then it will be continued by finding out what criteria are needed in achieving the objectives of the tool to be designed. At this stage alternatives will appear that can answer the problems that exist in PDAM Bandung City. At this stage morphological charts are used to help bring out combinations that might occur. From an alternative combination of concepts that can be implemented, an evaluation of all existing alternative combinations of concepts using concept screening and concept scoring is often called Pugh concept selection (Pugh, 1990).

#### Concept 1

This concept has a combination of Roller Conveyor using gravity drive, height control with pin, and modular storage mechanism and connected with bolts, has wheels as a transfer mechanism and has elastic retaining. Following is the design of concept 1 illustrated in Figure 1

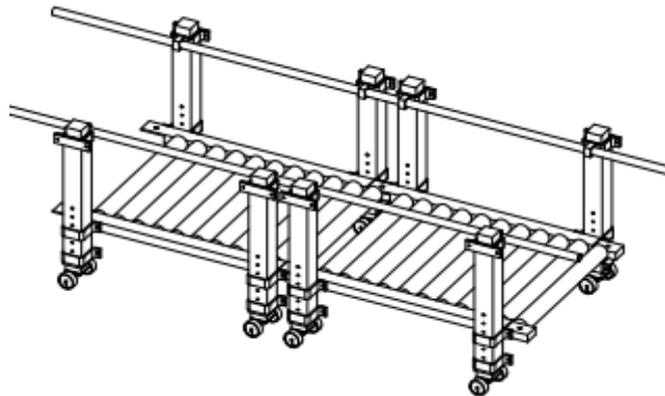


Fig. 2 Design concep 1

#### Concept 3

In this concept it has a combination of Roller Conveyor using gravity drive, height control with pins, and a modular storage mechanism and connected with bolts, the transfer mechanism is carried out by the operator and has an elastic barrier. Following is the design of concept 1 illustrated in Figure IV.5.

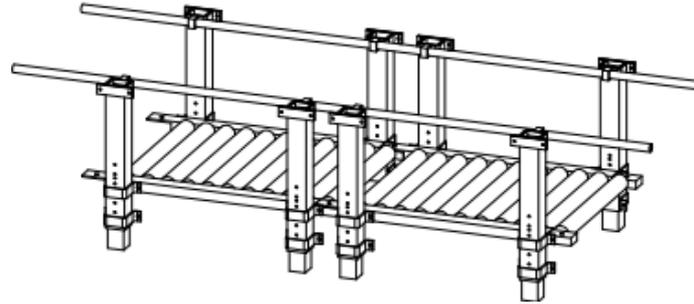


Fig. 3 Design Concept 3

### Concept 5

In this concept it has a combination of Roller Conveyor using gravity drive, height control with pins, and expandable storage mechanism, has wheels as its transfer mechanism and has elastic retaining. The following is the design of concept 1 illustrated in Figure IV.6.

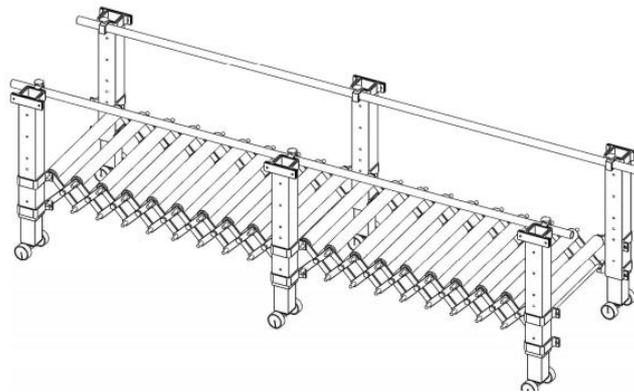


Fig. 4 Design Concept 5

### Concept 7

This concept has a combination of Roller Conveyor using gravity drive, height control with pins, and expandable storage mechanism, the transfer mechanism is carried out by the operator and has an elastic barrier. Following is the design of concept 1 illustrated in Figure IV.7.

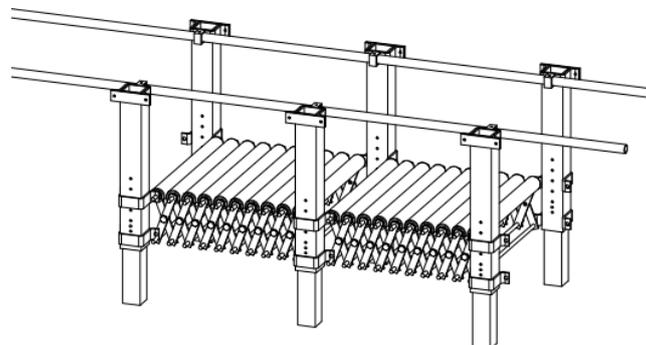


Fig.5 Design Concept 7

From the results of the concept scoring, the selected concept was obtained, namely the concept 5. The concept has a combination of Roller Conveyor using gravity drive, height control with pins, and expandable storage mechanism, has wheels as its transfer mechanism and has elastic retaining. This new tool design is named safety flexible gravity roller conveyor.

### Result & Analysis

At this stage an analysis of the gallon capacity that can be transferred by the Safety Flexible Gravity Roller Conveyor with several assumptions, including the track is considered to be perfectly smooth and from the end of the conveyor the operator is ready to lower the gallon from the conveyor. The following is an analysis of the transfer capacity using the Safety Flexible Gravity Roller Conveyor

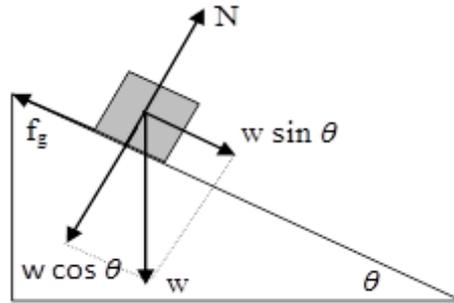


Fig. 6 Style in the Oblique Field

The transferred gallon mass = 19 kg  
 Gravity acceleration =  $[9.8 \text{ m / s}]^2$   
 The slope of conveyor =  $[1.87]^\circ$   
 So that it gets  $W \sin\theta$  to go down the track:  
 $W \sin\theta = w \times \sin\theta$   
 $W \sin\theta = 19 \times \sin [1.87]^\circ$   
 $W \sin\theta = 186.2 \text{ N}$

From the travel time above it is assumed to be the processing time from transferring the gallon to loading bay and working time / day for 4 hours so that the displacement capacity of the proposed gallons is:

Transfer capacity = (working time) / (processing time)  
 Transfer capacity =  $14400 / 5.35$   
 Transfer capacity =  $2691.58 \sim 2691$  gallons / day

### Conclusion

Based on the results of product design and analysis of the results obtained conclusions that refer to the objectives to solve the problems raised in this study. The following is the conclusion of this study:

- Based on the results of the product design, a design with a combination of the Roller Conveyor concept is used using gravity drive, height control with pins, and expandable (stretchable and shortened) storage mechanism, has wheels as its transfer mechanism and has elastic retaining. The design was named the safety flexible gravity roller conveyor.
- The problems that exist in PDAM Kota Bandung's bottled water company are the capacity problems that cannot be met by the current transfer process which is only 1594 gallons / day while the transfer requirement is 2000 gallons / day so that with the safety flexible gravity roller conveyor it can meet these needs with transfer capacity amounting to 2691 gallons / day.

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