Feasibility Study and Planning New Factory Layout Using Systematic Layout Planning (SLP) Method For Smart Trolley

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Abstract

Some facilities had not become the main focus in the supermarket, that is a trolley. Therefore, Smart Hygiene Trolley C - 19 are designed. The smart trolley is an innovation that prevents the transmission of COVID - 19. This product allows people to use shopping trolleys without touching the trolley's handle. Also, some facilities like sterilizers will clean the trolley when the shoppers use it to keep the trolley clean. This product was created by doing market surveys at supermarkets during the pandemic era to find customer concerns and needs when shopping at supermarkets. After getting the customer's concerns and needs from the survey, three product concepts are created using Autodesk Fusion 360 and then narrowed to the final concept by concept screening and concept assessment. After getting the final product concept from concept screening and assessment, the final product concept is measured using anthropometry to make the product comfortable and safe. After that, the layout for the company was made using the SLP method. After that, cash flow was made to determine the payback period for selling the product based on the forecasting that has been done using software QM for Windows V5.

Keywords
COVID - 19, Smart Trolley, Forecasting, Payback Periods, Layout

1. Introduction.
When shopping, people very often use trolleys to carry goods. The trolley itself is a medium for transmitting the virus because many people use it and do not know whether people re-exposed to the COVID - 19 virus. Therefore, to prevent the transmission of COVID -19, we designed the Smart Hygiene Trolley C-19. Smart Hygiene Trolley C-19 is an innovation that allows people who shop using shopping trolleys not to hold or touch the trolley handle. Also equipped with gloves and hand sanitizer facilities that make it easier for shoppers to pick up items that have been touched by many people hygienically. The trolley will also clean the whole time when the shopper changes with a disinfectant so that it is always hygienic and clean. In making this Smart Hygiene Trolley C-19 product, we created a company that will focus on the production of Smart Hygiene Trolley C-19 product. The production process also requires a place called a factory. The factory's layout that has not been adequately structured also impacts the waste of human resources and production time. So, to create a factory that can produce with an efficient and effective flow, we use the Systematic Layout Planning (SLP) method in making factory layouts. With this method, the layout of machines, equipment, material flow, production flow, and people directly related to production activities toward the optimal point of the existing layout. After determining the production process, cash flow and payback period calculations are also carried out to make the company's financial report more structured and organized.

1.1 Objectives
Based on the results of interviews conducted with supermarket visitors during the PSBB period, the following are the objectives in designing the Smart Hygiene Trolley C-19, which are as follows:

a) Creating a trolley that has a disinfectant feature to sterilize groceries on the trolley.
b) Creating a trolley that can be controlled with a smartphone application to minimize contact with the trolley.
c) Creating a trolley equipped with a glove or hand sanitizer feature reduces the risk of touching the trolley or items directly.
d) Creating the layout for Gethan Gailly company using the SLP method.
e) Creating cash flow to find the payback period for Gethan Gailly Company.

2. Literature Review

2.1 Market Research

According to Maholtra in the American Marketing Association (AMA), marketing research is the identification, collection, analysis, and dissemination (sharing) of systematic and objective information to improve decision making related to the identification and solution of problems and opportunities in marketing.

2.2 Validity

Validity comes from the word validity which means the extent to which the accuracy and accuracy of a measuring instrument in carrying out its measure function (Azwar, 1988). Meanwhile, according to Sugiharto and Sitinjak (2006), validity is related to a variable measuring what should be measured. The validity of the research states the degree of accuracy of the research measuring instrument to the actual content being measured.

2.3 Ergonomic

Ergonomics comes from the Greek words ergon (work) and nomos (rule). The definition of ergonomics is science, technology and art to harmonize tools, work methods, and the environment with human abilities, abilities, and limitations to obtain healthy, safe, comfortable and efficient working conditions and environments to achieve the highest productivity. (Manuaba, 1996).

2.4 Anthropometry

Anthropometry comes from "anthro", which means human, and "metri", which means size. The application of this data is for handling design and workspace problems. Things related to the dimensions of the human body such as conditions, frequency and difficulty, posture, conditions to make it easier to move. Humans, in general, have different body shapes and sizes (Wignjosoebroto, 2000).

2.5 Product Design and Development

Product design is the process designers use to blend user needs with business goals to help brands make consistently successful products. Product designers optimize the user experience in the solutions people make for their users and help their brands make products sustainable for long term business needs. Designing or planning is an attempt to arrange, obtain, and create new things beneficial to human life. In this case, designing can be wholly new or developing an existing product to increase the product's performance. Manufacturers widely use this concept to produce various product variants, which are accepted as new products in the eyes of consumers. Product development can also be defined as the process of finding ideas for new goods and services and converting them into additional commercially successful product lines. The purpose of the product development process is to provide maximum value to consumers, win the competition by choosing innovative products, and modify products with high value in design, colour, size, packaging, brand, and other characteristics

2.6 VDI 2221 Method

VDI 2221 method is a systematic approach to design for engineering systems and engineering products. Creating a design for a product means developing an idea for the product that will serve as a design object. Ho ver, in designing a product, several things need to be considered, for example, the method to be used. The goal of paying attention to this is that the product from the design results can have a use-value.

2.7 Systematic Layout Planning (SLP)

Systematic Layout Planning (SLP) is used to produce a more efficient flow-through layout design. This method pays attention to the sequence of a process and the relationship between each activity that occurs by designing the layout and facilities. Thus, SLP organises layout workplaces in factories by locating areas with high frequency and logical connections close to each other.

2.8 Cashflow and Payback Periods

cashflow is a financial report that contains information about the effect of cash from operating activities, investment transactions and financing or funding transactions, and the net increase or decrease in cash of a company during a certain period. The payback period is defined as the time required to recover the initial investment from operations. The payback period method of financial appraisal is used to evaluate capital projects and to calculate the return per year. From the project's starting until the accumulated returns value is equal to the investment cost.

3. Methods

In designing Smart Hygiene Trolley C-19, the steps to apply the trolley design concept are generally used to help bring groceries into products. This step needs to use the trolley at the supermarkets, especially facing the current situation and conditions during this pandemic era at the supermarket. The following are the stages methods to design Smart Hygiene Trolley C-19:

a) Conduct market research at supermarkets to know customers' concerns and needs when shopping at supermarkets during the pandemic era.
b) Do some validity tests from the data of customers' concerns and needs gathered at supermarkets.
c) Using the Benchmarking method in developing the Smart Hygiene Trolley C-19 design so that it is better than the previous design. Benchmarks are used, such as metal shopping carts, plastic baskets, and smart shopping carts.
d) Designing smart trolley with VDI 2221 method using Autodesk Fusion 360, where the functional requirements of the trolley are analyzed to form a complete Smart Trolley C-19 product and according to functional requirements.
e) Do some concept screening and assessment to get the final concept to fulfil customers' needs.
f) Analyze final product design from an ergonomic point of view using anthropometry to get the size of the product design, so the final product design is safe and comfortable to use.
g) Creating the final design of the product using the size from anthropometry and analyzing the size of the product's final design.
h) Creating the layout for the company using the Systematic Layout Planning (SLP) method.
i) Using QM Windows V5 to forecast the product that will be sold from 2021 until year 2030 based on the trolley product from 2011 until the year 2020.
j) Creating the cash flow to find the payback period for the company from selling the product based on the data product that will be sold from the year 2021 until the year 2030.

The methods of designing Smart Hygiene Trolley C-19 steps are formed into a flowchart. The flowchart for the methods in designing Smart Hygiene Trolley C-19 can be seen in Figure 1.

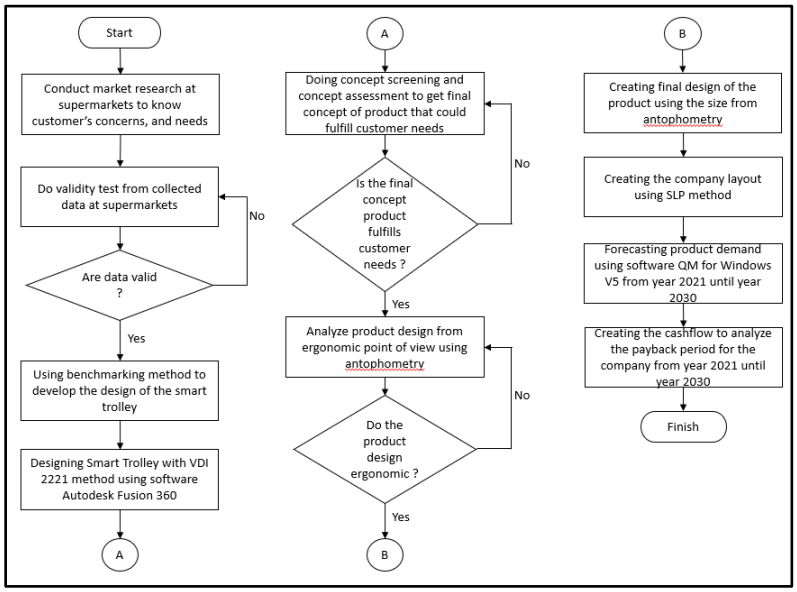


Figure 1. Flowchart Designing Smart Trolley

4. Data Collection

4.1 Customer's Concerns

The questionnaire given to supermarkets could let us know some customers' concerns when people shop at supermarkets during this pandemic era. We take the number of respondents as many as 100 people. The number of respondents used is 100 people because this number is the minimum number to conduct descriptive research. Based on the questionnaire, the customers' concerns when shopping at supermarkets during this pandemic era can be seen in Table 1.

Table 1. Customer's Concerns (Geraldo et al.,2021)

Customer Concerns	Number of Respondents	Percentage of Respondents (%)
Products are not hygiene because many people touch it	93	93
Trolley handle not hygiene because used by many people	88	88
The trolley to put goods are not hygiene	97	97
Unavailability of tools to protect hands when touching products at supermarkets	51	51

4.2 Customer's Needs

The customer was concerned that getting from our research could know what customers need when shopping during this pandemic. Using the Likert Scale to calculate the customer needs from the questionnaire. We take the number of respondents as many as 100 people. The number of respondents used is 100 people because this number is the minimum number to conduct descriptive research. Based on the result from 100 respondents, the customer's needs for "Smart Hygiene Trolley C-19" can be seen in Table 2.

Table 2. Customer's Needs (Geraldo et al.,2021)

Variable	Score	Categories
Trolley and Goods Sterility	93	Very Important
Application Easy to Use	88.4	Very Important
Protect Users from Risk of Covid	88	Very Important
Safety	90.8	Very Important
Aesthetics	77.6	Important
Material Type	79.2	Important
Comfortable to Use	93.4	Very Important
Durability	88.2	Very Important
The capacity of The Trolley	80.8	Very Important
Space of Trolley	79.4	Important
Price	79.4	Important

4.3 Morphology Concept

Based on the survey result, obtain several alternatives for the material, location, and form for designing "Smart Hygiene Trolley C-19". These results put those aspects in a morphology concept to design three different concepts for our product, "Smart Hygiene Trolley C-19." The morphology concepts table can be seen in Table 3.

Table 3. Morphology Concepts (Geraldo et al.,2021)

No.	Aspect	Components	Alternative 1	Alternative 2	Alternative 3
A	Material	Trolley's Body	Copper	Plastic	Stainless Steel
B	Material	Trolley's Handle	Copper	Plastic	Stainless Steel
C	Location	Sterilizer	Left / Right	Back	Trolley's Corner Side
D	Location	Hand Sanitizer & Glove	Left / Right	Left and right	Trolley's Handle
E	Form	Trolley's Motion Application	Website	Application	-
F	Material	Trolley's Source Energy	Battery	Magnet + Dinamo	-
G	Form	Linked Machine and Wheels	Gear	Gear + Chain	Gear + V-Belt
H	Form	Trolley's Wheels Motion	FWD	RWD	AWD
I	Material	Wheels	Iron + Rubber	Plastic + Rubber	Stainless Steel + Rubber
			Concept 1	Concept 2	Concept 3

The concept design for each concept can be seen in Figure 2.

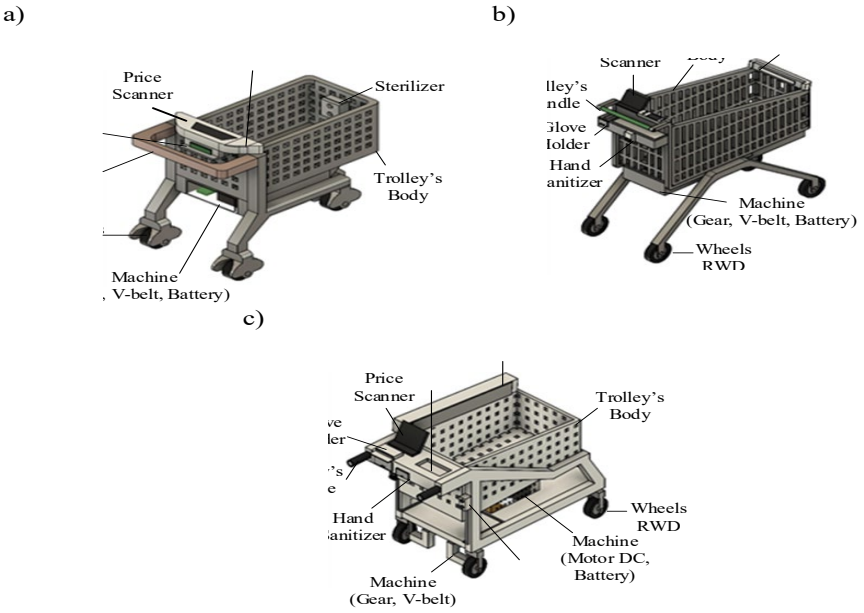


Figure 2. a) Concept 1, b) Concept 2, c) Concept 3 (Geraldo et al.,2021)

4.4 Concepts Screening

Based on the concepts that have been made, a concept screening to get the best concept that can proceed to the final stage. The concepts screening for "Smart Hygiene Trolley C-19" can be seen in Table 4.

Table 4. Concepts Screening (Geraldo et al.,2021)

Selection Criteria	**Concept**		
	1	2	3
Trolleys and Goods Hygiene	0	+	+
Easy to Use Application	+	+	+
Protect Users from Risk of COVID-19 Infection	+	0	+
Safety	+	+	+
Aesthetics	0	+	+
Material Type	+	+	+
Comfortable to Use	0	+	+
Durability	+	+	+
Trolley's Capacity	+	+	+
Trolley's Space	+	0	0
Price	+	+	+
Amount of +	8	9	10
Amount of 0	3	2	1
Amount of -	0	0	0
Final Score	8	9	10
Ranking	3	2	1
Continue?	Need to be repaired	Need to be repaired	Yes

4.5 Concepts Assessment

After the concept's screening, three concepts with the best final score (concept 1, concept 2, and concept 3) will be given a score for each existing concept with the expected needs. The concept with the biggest total score is the concept that will be continued or selected. The concepts assessment table can be seen in Table 5.

Table 5. Concepts Assessment (Geraldo et al.,2021)

		Concept					
		1		2		3	
Selection Criteria	**Value (%)**	Rating	Score Value	Rating	Score Value	Rating	Score Value
Trolley and Goods Sterlity	12.66	3	0.3798	5	0.633	5	0.633
Application Easy to Use	12.66	5	0.633	5	0.633	5	0.633
Protect Users from Risk of of Covid	11.39	5	0.5695	3	0.3417	5	0.5695
Safety	11.39	5	0.5695	5	0.5695	5	0.5695
Aesthetics	3.79	4	0.1516	4	0.1516	4	0.1516
Material Type	8.86	5	0.3544	5	0.3544	5	0.3544
Comfortable to Use	11.39	4	0.4556	4	0.4456	5	0.5695
Durability	7.6	5	0.38	5	0.38	5	0.38
Capacity of The Trolley	6.33	5	0.1899	5	0.1899	5	0.1899
Space of Trolley	7.6	4	0.304	4	0.304	3	0.228
Price	6.33	5	0.1899	5	0.1899	5	0.1899
Total Score		4.1772		4.1926		4.4683	
Ranking		3		2		1	
Continue?		No		No		Yes	

Based on the concepts screening and assessment conducted, the final concept for "Smart Trolley" is concept number three. Concept 3 is the most suitable concept for "Smart Hygiene Trolley C-19" because it fulfils all customer needs.

4.6 Validation

Using SPSS to test the validity of the data collected from research. Researchers often use the testing technique to test the validity of the Bivariate Pearson correlation (Pearson Moment Product). This analysis is done by correlating the score of each item with the total score. The total score is the sum of all items. If r count ≥ r table, the instrument or question items significantly correlate to the total score (declared valid). The following is an explanation for the table of interests that will be tested for validity:

1: Very Not Important
2: Not Important
3: Simply Important
4: Important
5: Very Important

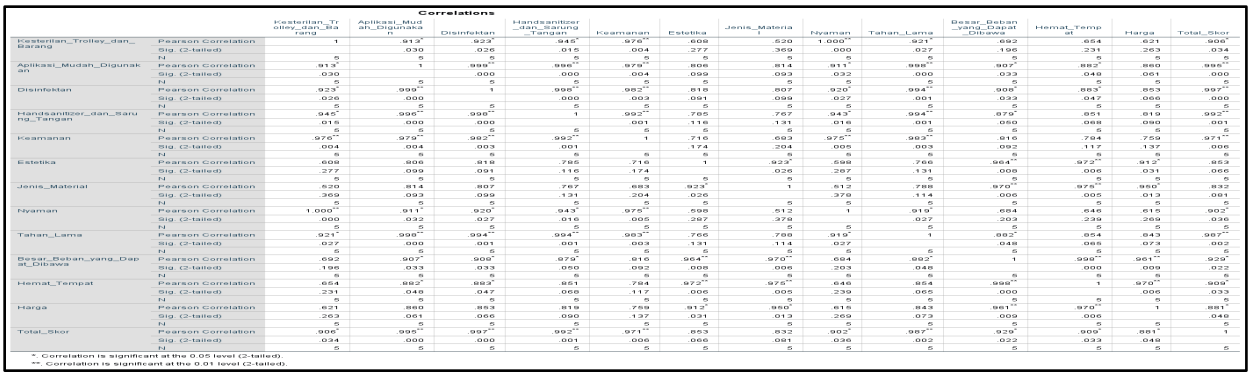
We take the number of respondents as many as 100 people. The number of respondents used is 100 people because this number is the minimum number to conduct descriptive research. The process to ensure the validity of the result taken from 100 respondents using a questionnaire from Google Form is as follows.

1. Find R Table Value using level significance 5%. R table value can be seen in Table 6.

Table 6. R table value (Geraldo et al.,2021)

N	Taraf Signifikan		N	Taraf Signifikan		N	Taraf Signifikan	
	5%	1%		5%	1%		5%	1%
3	0,997	0,999	27	0,381	0,487	55	0,266	0,345
4	0,950	0,990	28	0,374	0,478	60	0,254	0,330
5	0,878	0,959	29	0,367	0,470	65	0,244	0,317
6	0,811	0,917	30	0,361	0,463	70	0,235	0,306
7	0,754	0,874	31	0,355	0,456	75	0,227	0,296
8	0,707	0,834	32	0,349	0,449	80	0,220	0,286
9	0,666	0,798	33	0,344	0,442	85	0,213	0,278
10	0,632	0,765	34	0,339	0,436	90	0,207	0,270
11	0,602	0,735	35	0,334	0,430	95	0,202	0,263
12	0,576	0,708	36	0,329	0,424	100	0,195	0,256

2. Find the R count using SPSS software. R count value using SPSS software can be seen in Figure 3.



Correlations

		Kesterilan_Trolley_dan_Barang	Aplikasi_Mudah_Digunakan	Disinfektan	Handsanitizer_dan_Sarung_Tangan	Keamanan	Estetika	Jenis_Material	Nyaman	Tahan_Lama	Besar_Beban_yang_Dapat_Dibawa	Hemat_Tempat	Harga	Total_Skor
Kesterilan_Trolley_dan_Barang	Pearson Correlation	1	.913*	.923*	.945*	.976**	.609	.520	1.000**	.921*	.692	.654	.621	.906*
	Sig. (2-tailed)		.030	.026	.015	.004	.277	.369	.000	.027	.196	.231	.263	.034
	N	5	5	5	5	5	5	5	5	5	5	5	5	5
Aplikasi_Mudah_Digunakan	Pearson Correlation	.913*	1	.999**	.998**	.979**	.806	.814	.911*	.998**	.907*	.882*	.860	.995**
	Sig. (2-tailed)	.030		.000	.000	.004	.099	.093	.032	.000	.033	.048	.061	.000
	N	5	5	5	5	5	5	5	5	5	5	5	5	5
Disinfektan	Pearson Correlation	.923*	.999**	1	.998**	.982**	.818	.807	.920*	.994**	.908*	.883*	.853	.997**
	Sig. (2-tailed)	.026	.000		.000	.003	.091	.099	.027	.001	.033	.047	.066	.000
	N	5	5	5	5	5	5	5	5	5	5	5	5	5
Handsanitizer_dan_Sarung_Tangan	Pearson Correlation	.945*	.998**	.998**	1	.992**	.785	.767	.943*	.994**	.879*	.851	.819	.992**
	Sig. (2-tailed)	.015	.000	.000		.001	.116	.131	.015	.001	.050	.068	.090	.001
	N	5	5	5	5	5	5	5	5	5	5	5	5	5
Keamanan	Pearson Correlation	.976**	.979**	.982**	.992**	1	.716	.693	.975**	.982**	.816	.794	.759	.971**
	Sig. (2-tailed)	.004	.004	.003	.001		.174	.204	.005	.003	.092	.117	.137	.006
	N	5	5	5	5	5	5	5	5	5	5	5	5	5
Estetika	Pearson Correlation	.609	.806	.818	.785	.716	1	.923*	.598	.766	.964**	.972**	.912*	.853
	Sig. (2-tailed)	.277	.099	.091	.116	.174		.026	.287	.131	.008	.006	.031	.066
	N	5	5	5	5	5	5	5	5	5	5	5	5	5
Jenis_Material	Pearson Correlation	.520	.814	.807	.767	.693	.923*	1	.512	.788	.970**	.975**	.950*	.832
	Sig. (2-tailed)	.369	.093	.099	.131	.204	.026		.378	.114	.006	.005	.013	.081
	N	5	5	5	5	5	5	5	5	5	5	5	5	5
Nyaman	Pearson Correlation	1.000**	.911*	.920*	.943*	.975**	.598	.512	1	.919*	.684	.646	.615	.902*
	Sig. (2-tailed)	.000	.032	.027	.015	.005	.287	.378		.027	.203	.239	.269	.036
	N	5	5	5	5	5	5	5	5	5	5	5	5	5
Tahan_Lama	Pearson Correlation	.921*	.998**	.994**	.994**	.982**	.766	.788	.919*	1	.882*	.854	.843	.987**
	Sig. (2-tailed)	.027	.000	.001	.001	.003	.131	.114	.027		.048	.065	.073	.002
	N	5	5	5	5	5	5	5	5	5	5	5	5	5
Besar_Beban_yang_Dapat_Dibawa	Pearson Correlation	.692	.907*	.908*	.879*	.816	.964**	.970**	.684	.882*	1	.999**	.961**	.929*
	Sig. (2-tailed)	.196	.033	.033	.050	.092	.008	.006	.203	.048		.000	.009	.022
	N	5	5	5	5	5	5	5	5	5	5	5	5	5
Hemat_Tempat	Pearson Correlation	.654	.882*	.883*	.851	.794	.972**	.975**	.646	.854	.999**	1	.970**	.909*
	Sig. (2-tailed)	.231	.048	.047	.068	.117	.006	.005	.239	.065	.000		.006	.033
	N	5	5	5	5	5	5	5	5	5	5	5	5	5
Harga	Pearson Correlation	.621	.860	.853	.819	.759	.912*	.950*	.615	.843	.961**	.970**	1	.881*
	Sig. (2-tailed)	.263	.061	.066	.090	.137	.031	.013	.269	.073	.009	.006		.048
	N	5	5	5	5	5	5	5	5	5	5	5	5	5
Total_Skor	Pearson Correlation	.906*	.995**	.997**	.992**	.971**	.853	.832	.902*	.987**	.929*	.909*	.881*	1
	Sig. (2-tailed)	.034	.000	.000	.001	.006	.066	.081	.036	.002	.022	.033	.048	
	N	5	5	5	5	5	5	5	5	5	5	5	5	5

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Figure 3. R count value using SPSS software (Geraldo et al.,2021)

3. After the R count value and R table value is found, compare the R table and R count score to get the final result of the validity test. The final result of the validity test can be seen in Table 7.

Table 7. Final Result of Validity Test (Geraldo et al.,2021)

Variable	R count	R Table	Result
Trolley and Goods Sterility	0.906	0.197	Valid
Application Easy to Use	0.995	0.197	Valid
Protect Users from Risk of of Covid	0.997	0.197	Valid
Safety	0.971	0.197	Valid
Aesthetics	0.853	0.197	Valid
Material Type	0.832	0.197	Valid
Comfortable to Use	0.902	0.197	Valid
Durability	0.987	0.197	Valid
Capacity of The Trolley	0.929	0.197	Valid
Space of Trolley	0.909	0.197	Valid
Price	0.881	0.197	Valid

The validity test's final results are that all customer needs to be used for designing "Smart Hygiene Trolley" are valid. These results show that features and functions of the " Smart Hygiene Trolley " correspond to the customer's needs.

5. Results and Discussion

5.1 Numerical Results

"Smart Trolley" is an innovation from the original trolley into an automatic trolley. This machine is designed with the ergonomic aspect of "Trolley" using tolerance 10%. This machine will move automatically without touching the trolley handle by using software from a handphone. The size of the "Smart Trolley" dimension can be seen in Table

8.

Table 8. Smart Trolley Dimension (Geraldo et al.,2021)

Component	Dimension (mm)	Tolerance (mm)
Trolley Length x Width x Height	990 x 605 x 460	Length = ±99, Width = ±60.5, Height = ±46
Outer Diameter of Trolley Wheel	125	±13
Inner Diameter of Trolley Wheel	95	±95
Trolley Handle Length x Width x Height	80 x 466 x 980	Length = ±8, Width = ±46.6, Height = ±98
Trolley Handle Diameter	50	±5
Sensor Height from Ground	598	±59.8
Machine Length x Width x Height	500 x 300 x 225	Length = ±950, Width = ±30, Height = ±22.5
Sterilizer Length x Width x Height	930 x 50 x 150	Length = ±93, Width = ±5, Height = ±15
Hand Sanitizer Machine Length x Width x Height	120 x 150 x 30	Length = ±12, Width = ±15, Height = ±3
Gloves Place Length x Width x Height	150 x 75 x 45	Length = ±15, Width = ±7.5, Height = ±4.5
Bag Hanger Length x Width	35 x 30	Length = ±3.5, Width = ±3
Price Scanner Length x Width x Height	200 x 140 x 135	Length = ±920, Width = ±14, Height = ±13.5

5.2 Graphical Results

The layout for the company was made using the SLP method. The layout was made by making ARC, ARD, and AAD. TheThe activity Relationship Chart for the company can be seen in Figure 4.

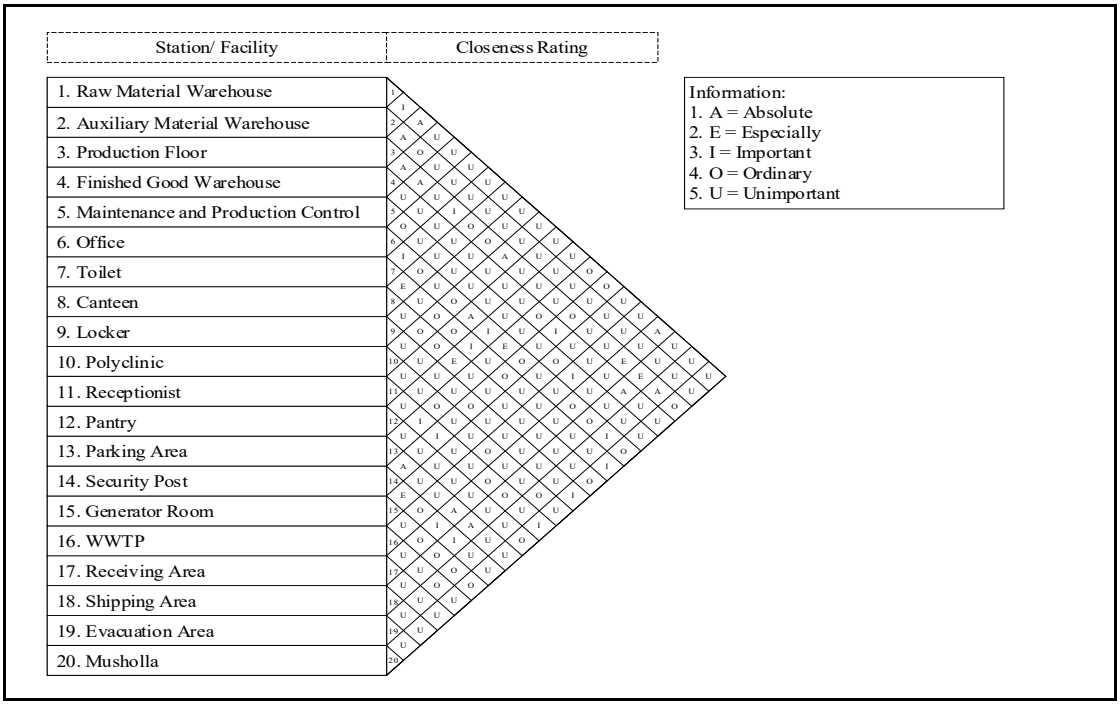


Figure 4. Activity Relationship Chart

After making ARC, the SLP method continues by making Activity Relationship Diagram that can be seen in Figure 5.

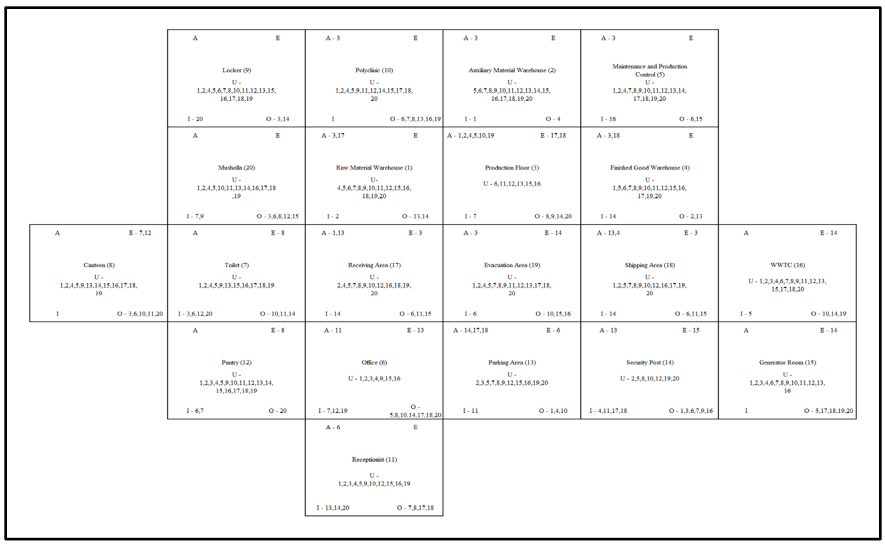


Figure 5. Activity Relationship Diagram

After making ARD, the SLP method continues by making Area Allocation Diagram that can be seen in Figure 6.

Figure 6. Area Allocation Diagram

After making the AAD then the layout could be made. The layout for the company can be seen in Figure 7.

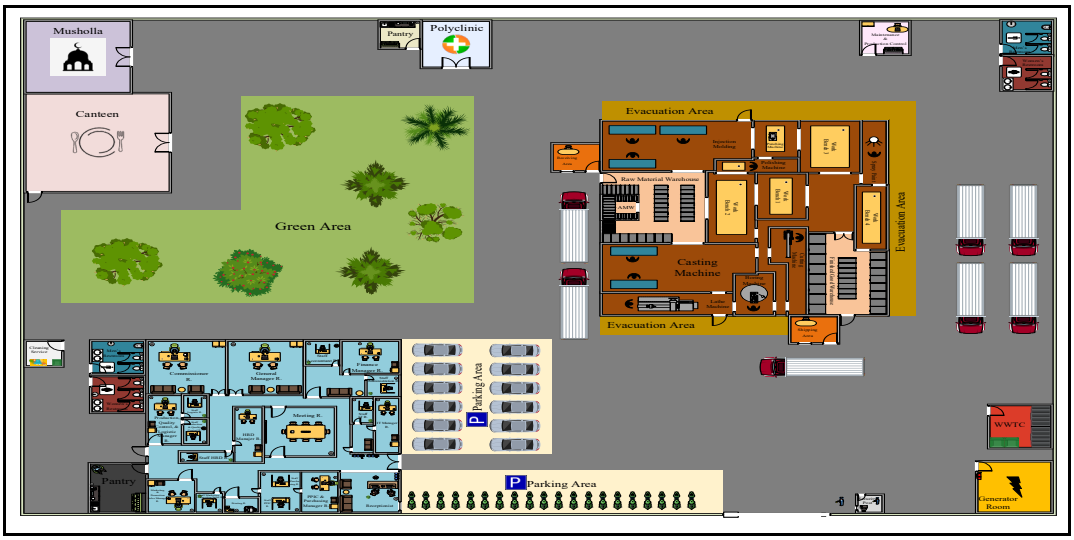


Figure 7. Company Layout

5.3 Company Cashflow and Payback Periods

The forecasting for product demand from 2021 until 2030 uses the quadratic method because this method has the lowest error from any other method. The demand for this product using the assumption of 10% for the market share can be seen in Table 9.

Table 9. Product Demand and Marketshare

Year	Demand Forecasting (Unit)	Market Share 10% (Unit)
2021	6550	655
2022	6771	677
2023	6965	697
2024	7131	713
2025	7269	727
2026	7463	746
2027	7517	752
2028	7545	755
2029	7544	754
2030	7515	752

The cash flow was made to determine this company's payback periods from the data demand. The company cash flow from selling the product from 2021 until the year 2030 can be seen in Table 10.

Table 10. Company Cashflow

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gross Profit											
Product Sales Income		Rp 5.076.250.000	Rp 5.246.750.000	Rp 5.401.750.000	Rp 5.525.750.000	Rp 5.634.250.000	Rp 5.781.500.000	Rp 5.828.000.000	Rp 5.851.250.000	Rp 5.843.500.000	Rp 5.828.000.000
Other Income		Rp 2.334.250	Rp 2.408.750	Rp 2.479.750	Rp 2.615.750	Rp 2.712.250	Rp 2.889.500	Rp 2.972.000	Rp 3.049.250	Rp 3.011.500	Rp 2.972.000
Total Income		Rp 5.078.584.250	Rp 5.249.158.750	Rp 5.404.229.750	Rp 5.528.365.750	Rp 5.636.962.250	Rp 5.784.389.500	Rp 5.830.972.000	Rp 5.854.299.250	Rp 5.846.511.500	Rp 5.830.972.000
Fixed Cost		Rp 3.825.374.828	Rp 3.899.159.621	Rp 3.974.521.878	Rp 4.051.498.234	Rp 4.130.126.316	Rp 4.210.444.768	Rp 4.292.493.287	Rp 4.376.312.660	Rp 4.461.944.798	Rp 4.549.432.775
Variabel Cost		Rp 1.012.533.570	Rp 1.098.358.874	Rp 1.130.462.624	Rp 1.156.560.374	Rp 1.179.182.624	Rp 1.210.086.749	Rp 1.219.888.499	Rp 1.224.920.624	Rp 1.223.237.999	Rp 1.219.888.499
Total Cost		Rp 4.837.908.398	Rp 4.997.518.495	Rp 5.104.984.501	Rp 5.208.058.608	Rp 5.309.308.940	Rp 5.420.531.517	Rp 5.512.381.786	Rp 5.601.233.284	Rp 5.685.182.796	Rp 5.769.321.273
Gross Profit		Rp 240.675.852	Rp 251.640.255	Rp 299.245.249	Rp 320.307.142	Rp 327.653.310	Rp 363.857.983	Rp 318.590.214	Rp 253.065.966	Rp 161.328.704	Rp 61.650.727
General Cost											
Promotion Cost		Rp 50.775.943	Rp 52.481.388	Rp 54.042.298	Rp 55.283.658	Rp 56.369.623	Rp 57.843.895	Rp 58.309.720	Rp 58.542.993	Rp 58.465.115	Rp 58.309.720
CSR Cost		Rp 50.775.943	Rp 52.481.388	Rp 54.042.298	Rp 55.283.658	Rp 56.369.623	Rp 57.843.895	Rp 58.309.720	Rp 58.542.993	Rp 58.465.115	Rp 58.309.720
Total General Cost		Rp 101.551.885	Rp 104.962.775	Rp 108.084.595	Rp 110.567.315	Rp 112.739.245	Rp 115.687.790	Rp 116.619.440	Rp 117.085.985	Rp 116.930.230	Rp 116.619.440
Total Profit		Rp 139.123.967	Rp 146.677.480	Rp 191.160.654	Rp 209.739.827	Rp 214.914.065	Rp 248.170.193	Rp 201.970.774	Rp 135.979.981	Rp 44.398.474	-Rp 54.968.713
Tax											
Earning Before Tax		Rp 139.123.967	Rp 146.677.480	Rp 191.160.654	Rp 209.739.827	Rp 214.914.065	Rp 248.170.193	Rp 201.970.774	Rp 135.979.981	Rp 44.398.474	-Rp 54.968.713
Tax		Rp 17.390.496	Rp 18.334.685	Rp 23.895.082	Rp 26.217.478	Rp 26.864.258	Rp 31.021.274	Rp 25.246.347	Rp 16.997.498	Rp 5.549.809	-Rp 6.871.089
Earning After Tax		Rp 121.733.471	Rp 128.342.795	Rp 167.265.572	Rp 183.522.349	Rp 188.049.807	Rp 217.148.919	Rp 176.724.427	Rp 118.982.484	Rp 38.848.664	-Rp 48.097.624
Cashflow											
Earning After Tax		Rp 121.733.471	Rp 128.342.795	Rp 167.265.572	Rp 183.522.349	Rp 188.049.807	Rp 217.148.919	Rp 176.724.427	Rp 118.982.484	Rp 38.848.664	-Rp 48.097.624
Salvage Value											Rp 133.664.500
Investation	-Rp 787.445.000										
Net Cashflow	-Rp 787.445.000	Rp 121.733.471	Rp 128.342.795	Rp 167.265.572	Rp 183.522.349	Rp 188.049.807	Rp 217.148.919	Rp 176.724.427	Rp 118.982.484	Rp 38.848.664	Rp 85.566.876
Cash Accumulation	-Rp 787.445.000	-Rp 665.711.529	-Rp 537.368.734	-Rp 370.103.162	-Rp 186.580.813	Rp 1.468.994	Rp 218.617.913	Rp 395.342.341	Rp 514.324.824	Rp 553.173.489	Rp 638.740.365

From the cash flow, the payback periods for this company can be seen in Table 11.

Table 11. Payback Periods

MARR	10%
NPV	Rp 104.823.393
IRR	13%
B/C Ratio	1,13
Payback Period	4,007 years
Break Even Point	6775,332601 unit

5.4 Proposed Improvements

Based on this research on customers' concerns and needs when shopping at supermarkets during the pandemic, many customers are concerned about the trolley. In the customer's view, the trolleys people use are not hygienic and clean, supporting the transmission of the Covid-19 virus. Based on the customer's concerns and needs, created "Smart Trolley". Features implemented in our product, "Smart Trolley", are automatic trolleys that could prevent users from touching the trolley handle. This feature will overcome those customers' concerns and needs easily. Improvements for "Smart Trolley" are extensive. There will be several improvements that can still be implemented on "Smart Trolley" because of the development product process. Present ideas and proposed improvements for this machine add features like sterilizer, automatic hand sanitizer, and place for gloves, price scanner, and bag hanger. This improvement was created to fulfil the customer's concerns, needs, and wishes. Using Polypropylene Plastic for this trolley because the material has high durability and light. This material could make the trolley move easily, even carrying many products at supermarkets. These additional improvements can boost the market for a "Smart Trolley", and its demand can undoubtedly be increased drastically. (Geraldo et al. 2021)

5.5 Sensitivity Analysis

The sensitivity analysis is important to find when the company will not be feasible for selling the product. The company's sensitivity analyisis for the company based on three things: material price increase, general fee increase, and profit loss. The sensitivity analysis when the material price increase can be seen in Table 12.

Table 12. Sensitivity Analysis when Material Price Increased

Material Price	MARR	NPV	IRR	B/C	*Payback Period*	Analysis
Material Price Increase 2%	10%	Rp 199.504.983	16,34%	1,25	6,632268309	Company Still Feasible (NPV>0, IRR>MARR, B/C>1)
Material Price Increase 3%	10%	Rp 143.835.743	14,66%	1,18	6,406002859	Company Still Feasible (NPV>0, IRR>MARR, B/C>1)
Material Price Increase 4%	10%	Rp 88.166.503	12,92%	1,11	6,152075128	Company Still Feasible (NPV>0, IRR>MARR, B/C>1)
Material Price Increase 5%	10%	Rp 32.497.264	11,10%	1,04	5,865082024	Company Still Feasible (NPV>0, IRR>MARR, B/C>1)
Material Price Increase 6%	10%	-Rp 23.171.976	9,19%	0,97	4,574510254	Company Not Feasible (NPV<0, IRR<MARR, B/C<1)

The interpolation for sensitivity analysis when the material price increases can be seen in Table 13.

Table 13. Interpolation when Material Price Increased

x1	1,04
y1	5%
x2	0,97
y2	6%
x	1
y	5,571%

The sensitivity analysis when the general fee increased can be seen in Table 14.

Table 14. Sensitivity Analysis when General Fee Increased

General Fee	MARR	NPV	IRR	B/C	*Payback Period*	Analysis
General Fee Increase 10%	10%	Rp 256.743.579	18%	1,33	4,54090452	Company Still Feasible (NPV>0, IRR>MARR, B/C>1)
General Fee Increase 20%	10%	Rp 202.643.696	16,43%	1,26	6,642457574	Company Still Feasible (NPV>0, IRR>MARR, B/C>1)
General Fee Increase 30%	10%	Rp 148.543.813	14,80%	1,19	6,423485219	Company Still Feasible (NPV>0, IRR>MARR, B/C>1)
General Fee Increase 40%	10%	Rp 94.443.930	13,11%	1,12	6,178892773	Company Still Feasible (NPV>0, IRR>MARR, B/C>1)
General Fee Increase 50%	10%	Rp 40.344.047	11,36%	1,05	5,903904467	Company Still Feasible (NPV>0, IRR>MARR, B/C>1)
General Fee Increase 60%	10%	-Rp 13.755.837	9,52%	0,98	5,592478908	Company Not Feasible (NPV<0, IRR<MARR, B/C<1)

The interpolation for sensitivity analysis when the general fee increases can be seen in Table 15.

Table 15. Interpolation when General Fee Increased

x1	1,05
y1	50%
x2	0,98
y2	60%
x	1
y	57,143%

For the sensitivity analysis, the limit of loss can be seen in Table 16.

Table 16. Sensitivity Analysis when Profit Loss

Profit Loss	MARR	NPV	IRR	B/C	*Payback Period*	Analysis
Profit Loss 0,5%	10%	Rp 175.586.822	15,62%	1,22	4,26915499	Company Still Feasible (NPV>0, IRR>MARR, B/C>1)
Profit Loss 0,75%	10%	Rp 107.958.502	13,54%	1,14	4,013653801	Company Still Feasible (NPV>0, IRR>MARR, B/C>1)
Profit Loss 1%	10%	Rp 40.330.182	11,36%	1,05	4,273496222	Company Still Feasible (NPV>0, IRR>MARR, B/C>1)
Profit Loss 1,25%	10%	-Rp 27.298.138	9,05%	0,97	4,598563825	Company Not Feasible (NPV<0, IRR<MARR, B/C<1)

The interpolation for sensitivity analysis when the material price increases can be seen in Table 17.

Table 17. Interpolation when Profit Loss

x1	1,05
y1	1%
x2	0,97
y2	1,25%
x	1
y	1,156%

6. Conclusion

The research could conclude that the product "Smart Hygiene Trolley C-19" was designed to fulfil customers' concerns and needs during shopping at supermarkets during the pandemic. With this product, a trolley will maintain hygiene after using by other people. In designing "Smart Hygiene Trolley C-19," some steps have been taken. First, do market research to know customers concerns and needs during shopping at the supermarket during the pandemic. Based on market research results, customer concerns when shopping at supermarkets are not hygienic, the trolley handle and body not hygienic, and unavailability of tools to protect the hand when touching supermarket products.

The market research then created three products concepts of "Smart Hygiene Trolley C-19" created using reversed engineering method and VDI 2221 then using Autodesk Fusion 360 to create the design of "Smart Hygiene Trolley C-19". After creating six product concepts, do some concepts screening and assessment to get the final concept of the trolley that will fulfil the customer's concerns and needs. After getting the product's final concept, measured the "Smart Hygiene Trolley C-19" dimensions using an ergonomic approach. This design is based on anthropometric data from Indonesian people, men and women. All users can comfortably use this tool and not interfere with activities people do when shopping at supermarkets. The "Smart Hygiene Trolley C-19" framework mostly uses polypropylene plastic to make it durable and light, so this trolley could move easily and carry many products at the supermarket.

Then the layout of the company was created using the SLP method. The process to make the layout by making activity relationship chart, then continue making activity relationship diagram, making area allocation diagram, and the layout of the company. This company department has a different kind of land area, which consist of production floor with large 334.296 m^2, office area with large 260.32 m^2, outer plant service area with large 1068.22 m^2, inner plant service with large 171.335 m^2, raw material warehouse with large 44.16 m^2, auxiliary material warehouse with large 4.8 m^2, and final product warehouse with large 243.36 m^2. The total land area for this company is 2126.491 m^2, using 40% tolerance for the road. The land area for this company is 2977.087 m^2. This company located at Tanah Marunda, Cilincing, Jakarta Utara, Jakarta, Indonesia. The location has been chosen using the pairwise comparison method to find the best location for the company considering three aspects: area price, location of the material supplier, and location of the consumer.

From the cash flow that has been made, the payback period for this company by selling "Smart Hygiene Trolley C-19" is 4,007 years, with a total product that is required to be sold is 6776 units. The IRR for this company is 13%, the NPV is Rp.104.823.393, and the B/C Ratio is 1.13. From the sensitivity analysis, this company will not be feasible if the material price increases by 5.57%, the general fee increase by 57.14%, and profit loss of 1.16%. This company have 45 workers, which contain 17 office workers, 14 plant service workers, and 14 production operators. The total salary per month for the first year is Rp. 3.133.320.000.00 and the salary will increase 7% every year.

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Biographies

Geraldo Rafael, was born in Jakarta, 27 Desember 2001 the capital city of Indonesia. In the present time, I am an ordinary second-year college student who studies at Tarumanagara University. I'm currently majoring in industrial engineering. I frequently use my knowledge to bring a lot of innovative ideas to life. The journal titled "Smart Trolley as a Sophisticated Supermarket Facility", is my first real move and effort to push my ideas into reality.

Willy Harianto, a student from Tarumanagara University who is currently studying Industrial Engineering in Jakarta, Indonesia. I am an ordinary second-year college student who studies at Tarumanagara University. I love to read a science fiction book, watch science fiction film and playing chess during my free time.

Gabrielle Halim, an second-year college student majoring industrial engineering at Tarumanagara University. I was graduated from 23 high school of Jakarta where I learned about science. I love animals like dogs, turtles, rabbit, fish, and many other animals. I also love to read about science journal to increase my knowledge.

Jonathan Albert, an industrial engineering student at Tarumanagara University. I graduated from Tarakanita 2 HighSchool, where I studied science. During my free time I like to learn about automotive. I love to dismantle objects, and assemble that objects again because that thing could increase my knowledge at that objects. I like to learn English subject.

Lithrone Laricha Salomon is a lecturer at the Industrial Engineering Department of Universitas Tarumangara since 2006. She graduated with her Bachelor's degree at Tarumanagara University, Jakarta - Indonesia, then she got her Master's Degree at University Indonesia, Jakarta – Indonesia. She teaches Statistics, Quality Control, Quality Management, and Experimental Design. She created many kind of research about product development strategy, total quality management, knowledge management, and many kind of other researches.

Lina Gozali is a lecturer at the Industrial Engineering Department of Universitas Tarumangara since 2006 and a freelance lecturer at Universitas Trisakti since 1995. She graduated with her Bachelor's degree at Trisakti University, Jakarta - Indonesia, then she got her Master's Degree at STIE IBII, Jakarta – Indonesia, and she recently got her Ph.D. at Universiti Teknologi Malaysia, Kuala Lumpur – Malaysia in 2018. Her apprentice college experience was in paper industry at Kertas Bekasi Teguh, shoes industry at PT Jaya Harapan Barutama, and automotive chain drive industry at Federal Superior Chain Manufacturing. She teaches Production System and Supply Chain Management Subjects. She did a research about Indonesian Business Incubator for her Ph.D. She has written almost 70 publications since 2008 in the Industrial Engineering research sector, such as Production Scheduling, Plant Layout, Maintenance, Line Balancing, Supply Chain Management, Production Planning, and Inventory Control. She had worked at PT. Astra Otoparts Tbk before she became a lecturer.

Frans Jusuf Daywin was born in Makasar, Indonesia on 24th November 1942. is a lecturer in the Department of Agricultural Engineering at Faculty of Agricultural Technology Bogor Agricultural University since 1964 conducted teaching, research, and extension work in the field of farm po r and machinery and become a professor in Internal Combustion Engine and Farm Po r directing and supervising undergraduate and graduate students thesis and dissertation and retired as a professor in 2007. In 1994 up to present as a professor in Internal Combustion Engine and Farm Po r at Mechanical Engineering Program Study and Industrial Engineering Program Study Universitas Tarumanagara, directing and supervising undergraduate student's theses in Agricultural Engineering and Food Engineering Desain. In 2016 up to present teaching undergraduate courses of the introduction of concept technology, research methodology, and seminar, writing a scientific paper and scientific communication, and directing and supervising undergraduate student's theses in Industrial Engineering Program Study at the Faculty of Engineering Universitas Tarumanagara. He got his Ir degree in Agricultural Engineering, Bogor Agricultural University Indonesia in 1966, and finished the Master of Science in Agricultural Engineering at the University of Philippines, Los Banos, the Philippines 1981, and got the Doctor in Agricultural Engineering, Bogor Agricultural University Indonesia in 1991. He joined 4-month farm machinery training at ISEKI CO, AOTS, Japan in 1969 and 14 days agricultural

engineering training at IRRI, Los Banos the Philippines, in March 1980. He received the honors "SATYA LANCANA KARYA SATYA XXX TAHUN" from the President of the Republic of Indonesia, April 22nd, 2006, and received appreciation as Team Jury from the Government of Indonesia Minister of Industry in Industry Start-Up 2008. He did several research and survey in the field of farm machinery, farm mechanization, agricultural engineering feasibility study in-field performance and cost analysis, land clearing and soil preparation in secondary forest and alang-alang field farm 1966 up to 1998. Up till now he is still doing research in designing food processing engineering in agriculture products. Up to the present he already elaborated as a conceptor of about 20 Indonesia National Standard (SNI) in the field of machinery and equipment. He joins the Professional Societies as a member: Indonesia Society of Agricultural Engineers (PERTETA); Indonesia Society of Engineers (PII); member of BKM-PII, and member of Majelis Penilai Insinyur Profesional BKM-PII.

Helena Juliana Kristina . Helena Juliana Kristina, 47 years old, lecturer at the UNTAR Industrial Engineering Study Program, since 2019. Graduated from S1 Bachelor of Industrial Engineering at Atmajaya Yogyakarta University, Graduated from Masters Degree in Mechanical Engineering from the University of Indonesia Exploring research on the theme of Lean and Green manufacturing and Participatory Ergonomics since 2015, which has been published nationally and internationally. Explore community service activities for the waste bank community and garbage collectors. Produced two digital books with ISBNs from Community Service activities, entitled Guyup Garbage and Guyup Care for the Earth, Our Home Together.

Andres was born in Jakarta, Indonesia, on 17th June 1988, is a lecturer in Industrial Engineering Program Study, Universitas Tarumanagara since 2012. Obtained a Bachelor of Industrial Engineering from Faculty of Engineering, Universitas Tarumanagara (2010) and a Masters in Management from Universitas Tarumanagara (2012). Currently active as a practitioner in the Manufacturing industry, specific on Food and Beverages (Fast Moving Consumer Goods). More focus on supply chain area, with major of Procurement and Business/Portfolio Management Strategy.

Agustinus Purna Irawan was born in Mataram - Musirawas, South Sumatera, August 28, 1971. Is a Lecturer at Universitas Tarumanagara and has served as Chancellor since 2016 until now. Obtained a Bachelor of Mechanical Engineering from the Faculty of Engineering, Gadjah Mada University (1995), a Masters in Mechanical Engineering from the Faculty of Engineering, University of Indonesia (2003), a Doctor of Mechanical Engineering from the Faculty of Engineering, University of Indonesia (2011), Professional Engineer (Ir) Mechanical Engineering from the Faculty of Engineering, Gadjah Mada University (2019) and Professor of Mechanical Engineering from the Ministry of Education and Culture (2014). The fields of scientific research and publication include: Product Design and Development, Strength of Materials, Natural Fiber Composites with implementation in the field of prosthesis and automotive components. Obtaining Research and Community Service Grants for Higher Education / Research and Technology BRIN / Untar / Others ≥ 100 titles; Patents: 7 and still in process: 4; Copyright: 9 books; Textbooks: 6 books; Book Chapter: 2 chapters; Scientific articles ≥ 100 titles. Obtained a Professional Certificate, namely the Educator Certificate, the Intermediate Professional Engineer Certificate (IPM) of the Indonesian Engineers Association (BKM PII) Vocational Engineer Association (BKM PII), and the ASEAN Engineer Certificate (ASEAN Eng.) From the ASEAN Federation Engineering Organizations (AFEO). He is active in education, various scientific activities, the world of business, professional associations, and various social activities. Received several awards: Best Graduate S2 UI GPA 4.00 cum laude (2003); First best Lecturer Kopertis Region III DKI Jakarta (2011); Best Presentation at the Seminar on Research Results of the Centralized Program, PUPT Dikti (2014); Honorary Member of The ASEAN Federation of Engineering Organizations, AFEO (2018); Best PTS Chancellor for the Academic Leader Award Program (2019).

Harto Tanujaya was born in Pemalang, Central Java, Indonesia on 18th May 1972, is a lecturer in the Department of Mechanical Engineering at Faculty of Engineering, Universitas Tarumanagara since 2000 conducted teaching, research and has served as Dean of Faculty of Engineering since 2018 until now. Obtained a Bachelor of Mechanical Engineering from the Faculty of Engineering, Universitas Tarumanagara, a Masters in Mechanical Engineering from the Faculty of Engineering, University of Indonesia, and a Doctor of Philosophy (Ph.D.) from the Department of Mechanical Science and Bioengineering, Osaka University, Japan (2011). The fields of scientific research and publication include, Biomechanical, Heat Transfer, Heat Exchanger, Cooling, Numerical Methods. He joins the Professional Society as a member of ASHRAE. Obtaining Research and Community Service Grants from Ministry of Research & Technology and LPPM UNTAR. The publication of national and international scientific articles more than 30 articles.