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Designing Tools to Increase Productivity and Efficiency in the Agricultural Sector by Paying Attention to User Needs and Product Design

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ABSTRACT
The agricultural sector is one of the important sectors that can improve the industrial economy of a country. Indonesia is a country with a high level of agricultural sector. One important aspect that needs to be considered in the agricultural sector to increase the country's income is the level of welfare of agricultural actors themselves. This welfare can be in the form of adequate agricultural tools that can streamline the flow and processes in their business. With the development of time and modernization changes, the agricultural sector is the most impacted sector in industrialization. Farmers must strive to understand technological changes that make it difficult for them to use modern agricultural tools. This research intends to innovate traditional tools such as shovels and forks called the Multifunctional Folding Shovel with product specifications including (1) hinges that rotate 90', and (2) product prices that are less than Rp. 90,000, (3) the product has a brown color, (4) the height of the product is following the average Indonesian, (5) iron that does not rust easily, (6) rubber that is not slippery, (7) product that can be folded, and (8) iron that does not get hot easily. The main purpose of this innovation development is diverse, namely to increase the effectiveness and efficiency of shovels and forks, and to facilitate farmers in carrying out their business processes without having to think about their limited ability to use technology.

INTRODUCTION

The agricultural sector is one of the important sectors that can improve a country's industrial economy. Indonesia is a country with a high level of agricultural sector. According to the Ministry of Agriculture of the Republic of Indonesia, approximately 100 million people, or half of the Indonesian people work in the agricultural sector. Various supports to improve the performance and contribution of the agricultural sector in Indonesia must still be prioritized. The agricultural sector is the main economic activity of the people in Indonesia and also a source of strengthening the people's economy where this makes the priority direction for the development of the agricultural sector to be precise, including innovation and technology (Harini, Susilo and Nurjani, 2015).Various policies have been carried out by the government in increasing economic strength through the development of the agricultural sector, such as providing production facilities, providing assistance and subsidies for production facilities, providing counseling and guidance in farming, and implementing basic pricing policies for certain agricultural commodities (Junaidi & Jannah, 2020). However, this is not worth itproductivity of food crops significantly slowed down. As a result, most farmers operate on less than half a hectare, so the crop provides less potential for generating revenue growth for the country (Rahmah, 2017). It is supportedbased on statistical data Research Department,2022 which states that the GDP share of Indonesia's agricultural sector has declined as the country shifts towards industrialization. In 2022, the real gross domestic product growth in the agricultural sector in Indonesia is expected to decline to 2.8 percent where previously there was 3.6%.

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One important aspect that needs to be considered in the agricultural sector to increase state revenue is the level of welfare of the agricultural business actors themselves. Welfare can be in the form of adequate use of agricultural tools that can expedite the flow and process of the business. Traditionally, agricultural business actors or farmers have used various agricultural tools in their daily lives both for agricultural activities and other household needs. Traditional tools refer to tools that were invented in ancient times, and used for a long time, until now, or are still used today to increase agricultural production (Elzubeir, 2014).

Along with the times and changes in modernization, the agricultural sector is the sector that has the most impact on industrialization. Welfare in the form of changes in behavior patterns and lifestyles of farmers who initially used the principles of subsistence farming to become modern agriculture is crucial(Adister & Pd, 2015). Farmers must try to understand the technological changes that make it difficult to use modern farming tools. If the application of information technology is complicated, farmers tend not to want to use it because of their limited ability to use it (Lisa Ernawatiningsih, 2023).

This study intends to innovate the traditional shovel and fork named Multifunctional Folding Shovel. This tool was developed to add value to its existing products, namely shovels and earth forks. With this product, users get a 2 in 1 feature, namely digging, moving soil, and loosening the soil with only one product. The main purpose of developing this innovation is also diverse, namely to increase the effectiveness and efficiency of the shovel and fork and make it easier for farmers to carry out their business processes without having to think about their limited technological capabilities.

METHODS

The type of research used in this research is research descriptive. Descriptive research is a research method used to describe an existing phenomenon and aims to systematically describe and analyze the phenomenon under study (Atmowardoyo, 2018)

This time the data collection technique was carried out using three techniques, namely observation, FGD, and interviews. Observations are made by finding and identifying deficiencies in existing products or products. These deficiencies become input for the next proposed product. FGD or focus group discussion is carried out by discussing with farmers to find information data such as deficiencies of existing products and provide suggestions and input for existing products. The interview method is carried out by asking questions to users of existing products, from the answers of customers or users.

The population in this study was 12 samples. Following the research Crouch & McKenzie (2006) said that qualitative research with less than 20 people can assist researchers in gaining close relationships and exchanging information more openly and honestly. The subject that will be studied in this research is farmers and agricultural workers who still use traditional tools in their business processes.

The method used is Quality Function Deployment (QFD). Quality Function Deployment (QFD) is a powerful tool used in product development to obtain and improve information on customer wants, and communicate customer requirements in design engineering to increase user satisfaction (user satisfaction) (Li et al., 2022). In the process of QFD with the house of quality (HOQ) to help obtain technical aspects in product development. According to Cohen (1995), House of Quality is a kind of conceptual map, which provides a means for inter-functional planning and coordination of product improvement and product development.

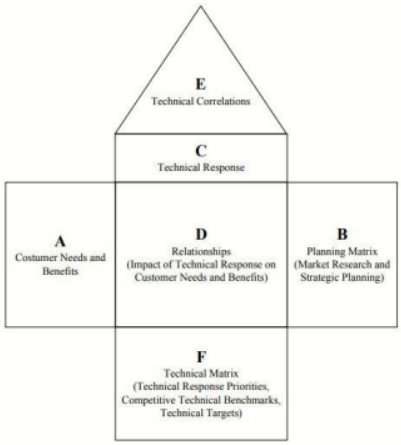

Figure 1. House of Quality

There are also categorized need statements by using 7 product quality dimensions of work (Garvin 1987) which contain performance, conformance, features, reliability, durability, aesthetics, and serviceability.

RESULTS

Need Statement

Table 1. Need Statement

Product Quality Dimensions	Need Statement	Variable
performance	Efficient product	V1
	Long lasting product	V2
Features	The product has a dark color	V3
	Easy to carry product	V4
conformance	Ergonomic product	V5
	Products that are safe to use	V5
	Product materials are safe	V7
	Products that are comfortable to use	V8
reliability	-	
durability	Light product material	V9
Aesthetics	-	
serviceability	Affordable product prices	V10

Furthermore, the WAP calculation stage is carried out for the level of interest and consumer satisfaction of respondents by asking 10 questions according to the product quality dimension and need statement. The function of the Customer Importance WAP is to determine the customer's interest in existing products. As for the calculation of the intersection point (X) which is the average result of the WAP variables.

Table 2. Weighted Average Performance (Customer Satisfaction)

Weighted Average Performance (Customer Satisfaction)										Intersection point (X)
V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	3.15
3.17	3.10	2.93	3.27	3.20	3.17	3.20	3.23	3.27	2.97	

Table 3. Weighted Average Performance (Customer Importance)

Weighted Average Performance (Customer Satisfaction)										Intersection point (Y)
V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	3.34
3.47	3.37	3.40	3.30	3.40	3.30	3.33	3.03	3.60	3.23	

In the Klein Grid Matrix Diagram, the results show that what is included in Expected is V3 and V10. Those included in High Impact are V1, V2, V4, V5, V6, V7, V9. What goes into Hidden is V8. And from the graph, it is also found that nothing is included in the Low Impact variable.

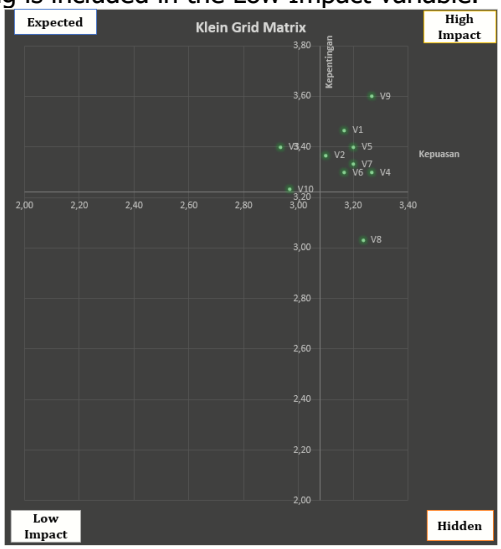

Figure 2. Klein Grid Matrix

Planning Matrix

According to Cohen (1995), a planning matrix is a tool that can help researchers to prioritize customer needs and know how important the needs of users are.

Table 4. Planning Matrix

NO	Needs Statement	The Klein Grid Matrix	Customer Satisfaction Performance	Importance to Customers	goal	Improvement ratio	sales point	Raw weights	Normalized raw weight
1	Ergonomic product	HIM	3,17	3,47	3.30	1.04	1.5	5,42	0.11
2	Easy to carry product	HIM	3,10	3.37	3,20	1.03	1.5	5,21	0.11
3	Products that are safe to use	EXP	2.93	3,40	3,20	1.09	1,2	4.45	0.09
4	Efficient product	HIM	3,27	3.30	3,25	0.99	1.5	4.92	0.10
5	Product materials are safe	HIM	3,20	3,40	3.30	1.03	1.5	5,26	0.11
6	Product is comfortable to use	HIM	3,17	3.30	3,20	1.01	1.5	5.00	0.10
7	Affordable product prices	HIM	3,20	3,33	3.30	1.03	1.5	5,16	0.11
8	The product has a dark color	HID	3,23	3.03	3,10	0.96	1.5	4.36	0.09
9	Long lasting product	HIM	3,27	3.60	2.40	0.73	1.5	3.97	0.08
10	Light product material	EXP	2.97	3,23	3,10	1.04	1,2	4.05	0.08
TOTAL								47,81	1.00

Based on Table. 1 raw weight value of 47.81. *Raw weights* are decision modeling obtained from the points that have been calculated previously. Next is normalizing the raw weight percentage value for each attribute of consumer needs and obtaining a value of 1.00.

House of quality (HOQ)

Cohen's (1995) House of Quality is a kind of conceptual map, which provides a means for inter-functional planning and coordination of product improvement and product development. The HOQ function is to direct consumer needs to contribute to designing products and services.

	Direction of Goodness	LTB	LTB	TB	TB	TB	TB	MTB	TB	TB	TB							
	Metric / Needs Statement	Number of Parts	Product Mass	Product Width	Product Height	Product Length	Material Melting Point	Color Variance	Usage Age	Product features	Product Price	Customer satisfaction perfomance	Importance to customers	Goal	Improvement ratio	Sales point	Raw weight	Normalized raw weight
		1	2	3	4	5	6	7	8	9	10							
1	Ergonomic product	0	0	3	3	3	0	0	0	0	0	3,17	3,47	3,30	1,04	1,50	5,42	0,11
		0	0	0,3400	0,3400	0,3400	0	0	0	0	0							
2	Easy to carry product	0	0	3	3	3	0	0	0	0	0	3,10	3,37	3,20	1,03	1,50	5,21	0,11
		0	0	0,3271	0,3271	0,3271	0	0	0	0	0							
3	Products that are safe to use	0	0	0	0	0	9	0	0	0	0	2,93	3,40	3,20	1,09	1,20	4,45	0,09
		0	0	0	0	0	0,8379	0	0	0	0							
4	Efficient product	0	9	0	0	0	0	0	0	0	0	3,27	3,30	3,25	0,99	1,50	4,92	0,10
		0	0,9271	0	0	0	0	0	0	0	0							
5	Product materials are safe	3	0	0	0	0	0	0	0	3	0	3,20	3,40	3,30	1,03	1,50	5,26	0,11
		0,3300	0	0	0	0	0	0	0	0,3300	0							
6	Product is comfortable to use	0	0	3	3	3	0	0	0	0	0	3,17	3,30	3,20	1,01	1,50	5,00	0,10
		0	0	0,3139	0,3139	0,3139	0	0	0	0	0							
7	Affordable product prices	3	0	0	0	0	0	0	0	0	9	3,20	3,33	3,30	1,03	1,50	5,16	0,11
		0,3236	0	0	0	0	0	0	0	0	0,9707							
8	The product has a dark color	0	0	0	0	0	0	9	0	0	0	3,23	3,03	3,10	0,96	1,50	4,36	0,09
		0	0	0	0	0	0	0,8212	0	0	0							
9	Long lasting product	0	0	0	0	0	3	0	9	0	0	3,27	3,60	2,40	0,73	1,50	3,97	0,08
		0	0	0	0	0	0,2489	0	0,7468	0	0							
10	Light product material	3	9	0	0	0	0	0	0	0	0	2,97	3,23	3,10	1,04	1,20	4,05	0,08
		0,2544	0,7632	0	0	0	0	0	0	0	0							
	Unit	unit	kg	cm	cm	cm	celcius	binary	year	binary	Rp.							
	Difficulty Level	3	3	1	2	2	3	1	3	2	2							
	Raw Weight	0,9080	1,6903	0,9810	0,9810	0,9810	1,0868	0,8212	0,7468	0,3300	0,9707							
	Normalized Raw Weight	0,0956	0,1780	0,1033	0,1033	0,1033	0,1144	0,0865	0,0786	0,0348	0,1022							
	Ranking	7	1	3	3	3	2	8	9	10	6							

Figure 3. House of Quality

Based on the HOQ calculation results, it is known that product mass has the highest rank with a normalized raw weight value of 0.1780. So, it can be said that product mass is a top priority in designing multifunctional folding shovel products. Furthermore, a systematic exploratory analysis of several concepts was carried out to determine alternative concepts that would be selected to be implemented in multifunctional folding shovel products. Each concept has differences in product specifications. Starting from the differences in price, weight, color, materials used, ergonomics, and products that are easy to carry. Some of these concepts are screened and selected using a decision matrix with selection criteria including easy-to-use products, ergonomic products, products that comply with product standards, have additional product features, products that are easy to store, attractive product appearance, standard product prices, low production prices, and guaranteed product safety. As a result, the concept of creation is selected based on the highest rating and weighted score. After calculating the rating and weight score, there is a total score that can help choose the concept to be developed. It is found that concept A is the first rank, which consists of (1) hinges that rotate 90', and (2) product prices that are less than Rp. 90,000, (3) the product has a brown color, (4) the height of the product is following the average Indonesian, (5) iron that does not rust easily, (6) rubber that is not slippery, (7) product that can be folded, and (8) iron that does not get hot easily.

Table 5. Concept Selection

		Concepts					
		A		***C***		***B&D***	
Selection Criteria	**Weight**	**Rating**	**Weighted Score**	**Rating**	**Weighted Score**	**Rating**	**Weighted Score**
Easy to use	15,79%	3	0,47	**4**	0,63	3	0,47
Ergonomic product	8,30%	5	0,41	**5**	0,41	3	0,25
According to product standards	8,61%	3	0,26	3	0,26	**4**	0,34
Additional product features	7,90%	**5**	0,39	2	0,16	2	0,16
Easy to store	7,90%	4	0,32	**3**	0,24	3	0,24
Product display	7,26%	**3**	0,22	3	0,22	3	0,22
Total Score		2,08		1,92		1,68	
Rank		1		2		3	
Continue?		**DEVELOP**		**NO**		**NO**	

Selected Concept 3D Design

Figure 4. 3D Design

Concept A was selected in the calculation of the total score, so this product concept will be developed. The image above is a sketch of the product to be developed. The Multifunctional Folding Shovel can be used as needed in agriculture and has a function as a rake, by design elaborating the functions of shovels and hoes. The Multifunctional Folding Shovel is very effective and efficient to use by the user. Then with the material,

this product is durable and the handle is given rubber or rubber so that users feel comfortable when using it, the price of the product is affordable and economical in the market.

DISCUSSION

PreviousResearch

According to (Mehrjerdi, 2010; Sutanto et al., 2015), the success of new product development (NPD) depends on identifying customer needs and converting them into technical aspect requirements. So the authors review some of the fundamental concepts that can be applied by previous researchers in product development. Study(Lestari & Abdurahman, 2020), QFD has proven to be effective and successful in meeting the needs and desires of consumers, which begins with the creation of a product planning matrix (House of Quality), followed by the creation of a Product Planning matrix, Part Deployment, process planning and Production Planning. QFD is a method of systematic approach to meeting customer needs and is properly linked to engineering design, production planning, and production processes (Parsaei er al., 2007).

On research (Lestari & Abdurahman, 2020), researchers used QFD to identify the quality characteristics and level of preference for the ground coffee of the Gusto Coffee UKM tested, analyzed efforts to develop and improve ground coffee products of the Gusto Coffee UKM, research(Kumar et al., 2015), doneimplementation of QFD to identify the main needs and problems of farmers for the design and development of machinery based on their opinions at the level of agro-industrial production. As for research(Lombardi & Fargnoli, 2018)using the QFD approach could with the aim of providing an easier-to-use tool, which can be used in risk assessment activities in critical contexts on agricultural machinery.

CONCLUSION

In making an innovative product, it takes several stages that must be considered. Innovation is what is called product development. Product development is one of the efforts to increase the value of a product in terms of design, color, size, material, and function. The Multifunctional Folding Shovel is a product of a combination of 2 agricultural tools, namely a hoe and a fork. The function of this product varies, among others, it can function to scratch the ground and move the soil. In developing this product several stages are needed, including identifying product opportunities, looking for what consumer needs are, and looking for product specifications. The next steps are concept selection, product architecture, engineering, material selection, and loss prevention.agricultural sectorand make it easier for farmers to carry out their business processes without having to think about their limited technological capabilities.

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