Indonesian Interdisciplinary Journal of Sharia Economics (IIJSE)
e-ISSN: 2621-606X
Vol. 9. No. 2 (2026)
Page: 17455-17463

DEVELOPMENT OF AN AUTOMATIC COMPOST FERTILIZER SIEVING TOOL USING DESIGN FOR MANUFACTURE AND ASSEMBLY (DFMA) METHOD

Wahyu Kurniawan[1]
Universitas Pembangunan Nasional "Veteran" Jawa Timur, Surabaya, Indonesia
21032010056@student.upnjatim.ac.id

Akmal Suryadi[2]
Universitas Pembangunan Nasional "Veteran" Jawa Timur, Surabaya, Indonesia
akmal.suryadi65@gmail.com

Abstract

Rapid technological advancements significantly impact various sectors, including agriculture, which demands high-quality products. One of the main challenges faced by Sakai Indah MSMEs is the manual compost fertilizer sieving process, which relies on conventional tools. This process is time-consuming and labor-intensive, leading to production inefficiencies, increased operational costs, and reduced competitiveness in meeting growing market demand. To address this issue, an automatic fertilizer sieving machine was developed using the Design for Manufacturing and Assembly (DFMA) method to enhance production efficiency. DFMA is a structured approach aimed at optimizing product design by reducing the number of components, improving stability, and simplifying assembly and maintenance, ultimately lowering manufacturing costs and production time. The developed iron sieving machine successfully reduced the sieving process from 800 seconds (13 minutes) to 120 seconds (2 minutes) per 50 kg of compost, enabling the MSME to efficiently handle 2,000-4,000 kg of compost per month. With 17 components, the new design improves durability, stability, and ease of assembly while reducing labor dependency. Cost analysis showed that the total manufacturing cost reached Rp7,651,000, with an assembly efficiency of 48%. These improvements significantly increase production capacity, reduce labor costs, and enhance the MSME's ability to meet growing market demands.

Keywords: DFMA, Automatic Compost Fertilizer Sifter, Production Efficiency

INTRODUCTION

Rapid technological advancements have brought significant changes across various sectors, including agriculture. In this digital era, the demand for high-quality products continues to rise, encouraging businesses, particularly Micro, Small, and Medium Enterprises (MSMEs), to adapt to these developments. For Sakai Indah MSME, which specializes in compost production, the biggest challenge lies in the sieving process, which is still performed manually. Currently, the method relies on conventional tools and requires two to three workers, making the process inefficient and time-consuming.

Sieving is a crucial stage in compost fertilizer production to ensure high-quality granules. However, the tools used are still basic and have limited durability. The current method, which involves sprinkling compost directly onto sieve nets, causes the nets to deteriorate quickly due to heat exposure and moisture content from the compost itself (Kurniadi, 2023). In addition to slowing down production, this manual process increases labor dependency, ultimately impacting overall efficiency and productivity (Firdaus & Hamdu, 2020). To better understand the scope of this issue, an analysis of production and demand data for compost fertilizer is conducted every six months.

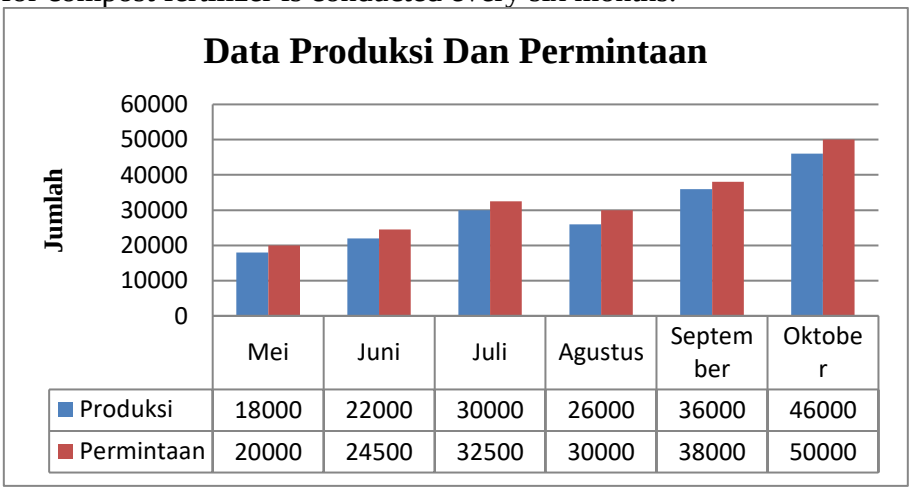

Figure 1
Production And Demand Data

Along with the increasing demand that reaches a spike of 2,000-4,000 kg per month, the current manual sieving method is no longer adequate, as the material used is still wood. To overcome this problem, innovation is needed in the form of an automatic compost sieving machine. The development of an automatic compost sifter uses the Design for Manufacturing and Assembly (DFMA) method, which aims to increase production efficiency by simplifying the design and speeding up the assembly process (Fauzi & Suryadi, 2021). DFMA is a systematic approach that integrates the design and manufacturing processes to minimize production costs and time (Chenio et al., 2024). Through this research, it is expected that the designed compost sieving machine can not only speed up the sieving time from 800 seconds to 120 seconds per 50 kg, but also reduce dependence on manual labor and increase the stability and durability of the tool. Thus, this research aims to identify and analyze the development of an efficient automatic compost sieving tool, and contribute to increasing productivity in Sakai Indah MSMEs. This research is expected to provide useful insights for

researchers, industry practitioners, and business people in applying innovative technology in agriculture, especially in compost processing.

REVIEW OF LITERATURE

Product development is a crucial step in improving the quality and effectiveness of a product. Kustandi and Darmawan (2020) state that development includes various efforts to improve conceptual, theoretical, and practical abilities through methods such as education and training. In the context of compost sieving tools, this development aims to create tools that are more ergonomic, efficient, and in accordance with user needs. Along with the increasing demand for quality compost fertilizer, MSMEs need to develop tools that can support production efficiency (Gustita'iroh, 2022).Innovation plays an important role in the development of a product. Sunarto (2020) explains that innovation is the process of transforming ideas into new products that provide more benefits to users. In this research, innovation is realized through the design of a compost sifter with a Design for Manufacture and Assembly (DFMA) approach. DFMA is a systematic method that aims to reduce production costs while increasing assembly efficiency. Chenio et al. (2024) revealed that DFMA integrates design principles for manufacturing and assembly, so as to simplify the production process and reduce the number of components used. This approach is very relevant in the development of compost sieving tools because efficiency and effectiveness are the main factors that must be considered.Production efficiency is an essential aspect of the tool development process. Ramdhani et al. (2024) mentioned that efficiency can be measured based on production time, the number ofcomponents used, and the costs incurred. In the manufacture of compost sieving tools, efficiency is assessed from the assembly time and the number of components used. By applying the DFMA method, product design and planning can be done more optimally, so as to reduce production costs and time.

RESEARCH METHOD

This research method was carried out at Sakai Indah Compost Fertilizer MSME, PKMT Project Village, Bathin Solapan District, Bengkalis Regency, Riau Province, from September to November 2024. This research consists of several steps, starting with a field study to observe the manual compost sifting process and identify existing problems, followed by a literature study to collect information from related literature. Furthermore, problem formulation was carried out by focusing on the development of an automatic compost sieving tool by applying the DFMA method. Tool design includes the selection of raw materials, number of components, and assembly techniques, followed by prototyping based on the design. Testing was conducted to evaluate the performance and efficiency of the tool, with data collected including production time and cost. Analysis was conducted quantitatively and qualitatively to assess the efficiency of the tool, as well as a comparison between manual and automatic sieving. The results of the research are expected to make a significant contribution to increasing productivity and efficiency in the Sakai Indah compost fertilizer MSME.

RESULTS AND DISCUSSION

a. Compost Fertilizer Sieving Device

Figure 2
Initial Compost Fertilizer Sieving Device

The compost sieving tool used in Sakai Indah MSMEs currently still relies on manual methods. This tool is made from wood and wire mesh, as shown in the picture, but has limitations in terms of strength and durability. This is due to the greater initial load received by the sieve as well as the influence of heat generated by compost fertilizer. Operating the initial compost sifter requires two to three people in the sieving process. Based on the experimental results with a compost load of 50 kg, the time required to produce fine sieve results is 1,680 seconds or 28 minutes

Table 1
Initial Product Assembly Time

No.	Process	Time (Seconds)	Time (Minutes)
1.	Wood measurement and cutting	1.200	20 minutes
2.	Measurement and cutting of green ram wire	600	10 minutes
3.	Nailing wood battens	900	15 minutes
Total		2.700	45 minutes

Based on the table above, the total time required for the manufacturing process of the compost sifter, which includes the measurement and cutting stages of batten wood, the measurement and cutting of green ram wire, and the process of stiffening the batten wood, is 45 minutes.

Table 2
Initial Product DFA Table Analysis

No.	Working process	NM	Time (Seconds)
1.	Wood measurement for body frame	12	900
2.	Installation of wood for body frame	12	2.700
3.	Wire measurement for body frame	1	300

5.	Wire attachment to the body frame	1	600
6.	Finishing	1	800
Total		27	5.300

Berdasarkan analisis pada **Tabel 2** mengenai ***Design for Assembly* (DFA),** diketahui bahwa total jumlah material atau komponen yang digunakan dalam perakitan alat ini adalah **27 bagian.** Sementara itu, total waktu yang diperlukan untuk merakit seluruh bagian tersebut adalah **5.300 detik** atau setara dengan **88 menit.** Adapun efesiensi perakitan produk awal untuk mengukur tingkat efisiensi dalam proses perakitan produk, dapat digunakan rumus berikut:

$$E_M = \frac{3\ X\ N_M}{T_M} \quad (1)$$

$$E_M = \frac{3\ X\ 27}{88}$$

$= 0{,}920$

$= 0{,}920 = 0{,}92 = 92\%$

Based on the results of the assembly efficiency calculation, product design has an efficiency level of 0.920 or 92%.

b. Proposed Compos Fertilizer Sifter

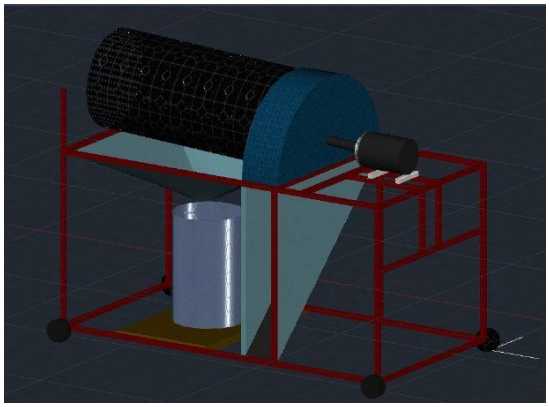

Figure 3
Proposed Compost Fertilizer Sifter

The compost sifter proposed in this research is designed using iron material, which has better strength and durability compared to the previously used wooden manual sifter. Ironmaterial was chosen to increase stability, load resistance, and tool life, so that the product can be used for a longer period of time and with more optimal performance. Based on the test results, this tool was tested with a compost load of 50 kg, and the results showed that the time required to produce a fine sieve was 300 seconds. This time is much faster than the manual sieving method which previously required 1,680 seconds or 28 minutes for the same amount of load. With this significant increase in time efficiency, the proposed compost sifter can directly increase productivity and production capacity at Sakai Indah MSMEs.

In addition, the use of this tool can also reduce labor requirements.In the manufacture of this proposed compost sieving tool requires a more specified processing time, namely:

Table 3
Assembly Time Of Each Component

No.	Process	Time (Seconds)	Time (Minutes)
1.	Measuring and cutting 4x4 angle iron	1.120	18 minutes
2.	Welding angle iron for sieving machine frame	13.800	230 minutes
3.	Measurement and cutting of strip plate for sieving tube	900	15 minutes
4.	Welding and installation of strip plate for sieving tube	2.400	40 minutes
5.	Installation of wire counters to the sieving tube	600	10 minutes
6.	Measurement and cutting of black iron plate to hold fertilizer compost	1.800	30 minutes
7.	Welding and installation of black iron plate to hold fertilizer	4.200	70 minutes
8.	Pillow bearing installation for sieving tube turning aid	360	6 minutes
9.	Installation of pully 10 and pully 3 for sieving tube turning assistance	2.100	35 minutes
10.	Wheel mounting for the sieving machine frame	900	15 minutes
11.	Installation of scales to weigh the sifted fertilizer	1.200	20 minutes
12.	Installation of a machine to help rotate the sieving tube	600	10 minutes
13.	Setting the sieving machine with pully 10 to use vanbel	1.500	25 minutes
14.	Setting the rotating speed of the sieving tube with the engine and pully	900	15 minutes
15.	Painting and finishing the compost sieving machine	2.700	45 minutes

Based on the table above, the total time required for the manufacturing process of the compost sifter is 584 minutes, which is equivalent to 9 hours and 12 minutes.

In filling in the DFA table, the installation process of each tool component is considered in detail. The theoretical quantity (NM) is obtained based on the number of components required. In addition, each installed component may go through several installation stages. Therefore, the theoretical quantity (NM) can be determined from the number of components or the frequency of the installation process performed.

Table 4
DFA Table Filling And Analysis

No.	Workmanship Process	NM	Time (Seconds)
1.	Measuring and cutting 4x4 angle iron	28	1.120
2.	Welding angle iron for sieving machine frame	28	13.800
3.	Measurement and cutting of strip plate for sieving tube	8	900

4.	Welding and installation of strip plate for sieving tube	8	2.400
5.	Installation of wire counters to the sieving tube	2	600
6.	Measurement and cutting of black iron plate to hold fertilizer compost	4	1.800
7.	Welding and installation of black iron plate to hold fertilizer	4	4.200
8.	Pillow bearing installation for sieving tube turning aid	1	360
9.	Installation of pully 10 and pully 3 for sieving tube turning assistance	2	2.100
10.	Wheel mounting for the sieving machine frame	4	900
11.	Installation of scales to weigh the sifted fertilizer	1	1.200
12.	Installation of a machine to help rotate the sieving tube	1	600
13.	Setting the sieving machine with pully 10 to use vanbel	1	1.500
14.	Setting the rotating speed of the sieving tube with the engine and pully	1	900
15	Painting and finishing the compost sieving machine	2	2.700
	Total	95	35,080 Seconds

Based on the analysis in Table 4 regarding Design for Assembly (DFA), it is known that the total number of materials or components used in the assembly of this tool is 95 parts. Meanwhile, the total time required to assemble all these parts is 35,080 seconds or 584 minutes. As for the efficiency of the proposed product assembly, to measure the level of efficiency in the product assembly process, the following formula can be used:

$$E_M = \frac{3\ X\ N_M}{T_M} \quad (2)$$

$$E_M = \frac{3\ X\ 95}{584}$$

$$= 0{,}048$$

$$= 0{,}488 = 0{,}48 = 48\%$$

Dimana E_m = Assembly efficiency

N_m = Theoretical minimum number of components

T_m = Total time required when assembling

The results of the efficiency analysis in the assembly process show that the new tool has an efficiency level of 0.488. The manufacturing process of the compost sifter involves 95 components with a total assembly time of 584 minutes. From these results, the assembly efficiency obtained is 0.48 or equivalent to 48%.

c. Comparison Of Iritial And Proposed Products

Using the DFMA concept, the product assembly analysis revealed the difference between the initial design and the proposed design. Based on the comparison of assembly efficiency, the initial product design had an efficiency level of 92%, while the proposed design only reached 48%. This difference occurred because the number of assembly elements in the proposed design increased from 27 to 95, while the total assembly time also increased from 88 seconds to 584 seconds. Although the assembly efficiency of the proposed design is lower, at 48% compared to the initial design which reached 92%, there are several advantages

that should be considered in its development. First, the automatic compost sieving machine offers a significant improvement in the speed of the sieving process, reducing the time from 1,680 seconds or 28 minutes to 300 seconds or 5 minutes per 50 kg of fertilizer. Secondly, the use of iron material in the new design increases the stability and durability of the equipment, allowing it to be used for a longer period of time with optimal performance. Thirdly, the reduced need for manual labor not only improves efficiency but also provides economic benefits to the sakai indah MSMEs. Considering theseadvantages, the proposed design still has the potential to improve productivity and efficiency in Sakai Indah MSMEs.

CONCLUSION

Based on the results of this research, the following conclusions can be drawn:The conclusion of this research shows that the development of an automatic compost sieving machine using the Design for Manufacturing and Assembly (DFMA) method has successfully improved production efficiency at Sakai Indah MSME. The new machine was able to speed up the sieving process from 1,680 seconds or 28 minutes to seconds per 50 kg of fertilizer, indicating a significant increase in production speed. In addition, the use of iron materials in the new design increases the stability and durability of the tool, and reduces reliance on manual labor. Although the total assembly time of the new tool reached 584 minutes with an efficiency rate of 48%, the benefits gained from increased productivity and reduced manual labor time are invaluable to the sakai indah MSMEs. This research is expected to provide insight for other entrepreneurs in applying technological innovations in agriculture, especially in compost processing.

REFERENCES

Azmin, N., Irfan, I., Nasir, M., & Hartati, H. (2022). Pelatihan Pembuatan Pupuk Kompos Dari Sampah Organik Di Desa Woko Kabupaten Dompu. *Jompa Abdi: Jurnal Pengabdian Masyarakat*, 1(3), 137-142.

Chenio, A., Zuya, N., & Ginting, R. (2024). Perancangan Perbaikan Microwave Oven dengan Design for Manufacturing and Assembly (DFMA). In *Talenta Conference Series: Energy and Engineering* (Vol. 7, No. 1, pp. 306-311).

Chenio, A., Zuya, N., & Ginting, R. (2024). Perancangan Perbaikan Microwave Oven dengan Design for Manufacturing and Assembly (DFMA). In Talenta Conference Series: Energy and Engineering (EE) (Vol. 7, No. 1, pp. 306-311).

Fauzi, M. E. N., & Suryadi, A. (2021). Pengembangan Produk Wastafel Portable Secara Manual Dengan Metode Design For Manufacture And Assembly (DFMA). Juminten, 2(2), 36-47.

Firdaus, S., & Hamdu, G. (2020). Pengembangan mobile learning video pembelajaran berbasis STEM (Science, Technology, Engineering And Mathematics) di sekolah dasar. JINOTEP (Jurnal Inovasi dan Teknologi Pembelajaran): Kajian dan Riset Dalam Teknologi Pembelajaran, 7(2), 66-75.

Gustita'iroh, U. M. Z. (2022). Pengembangan Flipbook Berbasis Hypermedia pada Materi Getaran Di MTs Negeri 2 Pati. *Doctoral dissertation, IAIN KUDUS*.

Ikhwanda, R. S., & Suryadi, A. (2021). Pengembangan Produk Alat Pengayak Pasir Secara Manual dengan Metode Design For Manufacture and Assembly (DFMA). *JUMINTEN*, 2(4), 37-48.

Kurniadi, R. (2023). PERANCANGAN MESIN AYAKAN PASIR OTOMATIS.

Kustandi, G., & Darmawan, A. (2020). Pengembangan Sumber Daya Manusia dengan Berbasis Inovasi Untuk Menghadapi Revolusi Industri 4.0. *Jurnal Ilmiah Manajemen, Ekonomi, & Akuntansi (MEA)*, 4(2), 397-407.

Ramdhani, A. P., Fidayanti, A., & Jakaria, R. B. (2024). PERANCANGAN PRODUK TALENAN MULTIFUNGSI MENGGUNAKAN METODE DESAIN FOR ASSEMBLY MANUFACTURE (DFMA). *Kohesi: Jurnal Sains dan Teknologi*, 4(1), 11-20.

Sunarto, A. (2020). Inovasi sebagai Proses Pengembangan Produk yang Efektif. *Jurnal Ilmiah Manajemen*, 4(2), 397-407.