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Designing Green Manufacturing with OECD Method on a Micro Business Oox Guitarmaker Ambarawa

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Abstract
This study aims to know level and design of green manufacturing application on Oox Guitarmaker Ambarawa. The level of green manufacturing can be measured using one of the theories from The OECD titled Sustainable Manufacturing Toolkit. Three levels of green manufacturing comprises Beginner, Intermediate, and Advance. The research on design uses the theory of green manufacturing proposed by Arindam (2011) comprising of green energy, green products, and green processes. The research found that the level of green manufacturing of Oox Guitarmaker Ambarawa is an intermediate with 11 of 18 indicators that are green This research also provides results in the form of suggestions to Oox Guitarmaker Ambarawa so that they can make improvements to the indicators that are not yet green.

Keywords: Green manufacturing, OECD

INTRODUCTION

Industry in 2020 should put green manufacturing as their main reference in conducting or running the business since the concept of green manufacturing is a manufacturing system that considers impacts of the company's production process on the environment. Environmentally friendly manufacture (green manufacturing) involves 3 transformation ways in industry operation: using green energy, developing and selling green product, and employing green processes in business operations (Arindam *et al*, 2011). Green manufacturing concept makes many firms to be aware of the environment and start to implement it in their business activities. The research on green manufacturing conducted by OECD (The Organization for Economic Co-operation and Development) popularizes the concept.

Prior to the popularization of green manufacturing concept and not many firms implement it in their business, firms consider only ways to manufacture products with lowest cost and get maximum profit without thinking about effect to the environment they may produce that can harm it as well as their future production activities. The Indonesian government issues regulations on sustainability of the environment under UU RI Number 32 Year 2009 about The Environment Protection and Management and UU RI Number 18 Year 2008 about Rubbish Management.

Waste and rubbish management is important for manufacturers and firms. Waste and rubbish that are not managed, given special treatment, and even thrown purposefully will not only harm the environment but also the manufacturer. A manufacturer that can use the waste it produces during the production process in their production activities and is able to reduce or eliminate negative impact of the waste to the environment is considered as implementing green manufacturing concept in the business.

Oox Guitarmaker is a business producing and repairing guitar. It is located in Jalan Tentara Pelajar No.99 Kerep Ambarawa. The business has existed for 11 years since its inception in 2009. Currently, Oox Guitarmaker produces not only electric and acoustic guitars but also percussion called *cajon.* It can produces 15-25 guitars per month.

It is identified that production process of Oox Guitarmaker has not yet green. The green related problems happened in this business are bad smell caused by the use of wood pernis and paint, wood ash spread around resulted from waste of guitar production (wood debris) that are not processed and well maintained, the usage of neon instead of LED that is more efficient for the lights, production process does not use renewable energy and still relies on electricity that is not yet renewable, and production space with no green space for green plants. Based on these problems, it cannot be stated yet that Oox Guitarmaker has not implemented green

manufacturing concept well. Thus, it is necessary to conduct further research on green manufacturing in Oox Guitarmaker using OECD method with its 18 indicators. They are unrenewable materials usage intensity, hazardous substances usage intensity, recyclable or reusable materials, water usage intensity, energy use intensity, proportion of renewable energy usage, greenhouse gas intensity, residual intensity, air pollution intensity, water pollution intensity, proportion of natural cover/land, recycle or reuse product, recyclable product, product with renewable material, unrenewable material intensity in the product, hazardous substance in the product, product energy consumption intensity, and greenhouse gas emission intensity of the product. Based on these 18 indicators, it can be identified green level of Oox Guitarmaker as beginner, intermediate, or advance.

The purpose of this research is to determine green manufacturing design of Oox Guitarmaker Ambarawa based on the level of green manufacturing of OECD.

LITERATUR REVIEW

Green Manufacturing

According to Deif (2011), green manufacturing is a sustainable approach for design and manipulation activities that involve in product development and/or system operation for minimizing environmental impact. Dornfeld (2013) in Govindan (2013) stated that green manufacturing covers environmental awareness in manufacture. Generally, 3 Rs (remanufacture, reduce, recycle) is one of main strategies of environmentally friendly manufacture which covers activities such as reducing volume of hazardous wastes, minimizing consumption of coolant during the production, and calculating precise energy mix for sustaining energy sources.

Melynk and Smith (1996) in Govindan (2013) define green manufacture as a system that integrates product design and process with manufacture plan and control in such a way in order to identify, measure, evaluate, and manage flow of environmental wastes with the purpose for reducing and ultimately minimizing environmental impact while trying to maximizing resource efficiency.

It can be concluded that green manufacturing concept is a concept about how a firm must do the business by giving attention to the environment and minimizing potential environmental damages.

OECD (The Organization for Economic Co-operation and Development) conducted a research on sustainable manufacturing which results in 18 indicators for evaluating environmental performance. The indicators are divided into 3 main components: input, proses, and output. The 18 indicators comprise unrenewable materials usage intensity, hazardous substances usage intensity, recyclable or reusable materials, water usage intensity, energy use intensity, proportion of renewable energy usage, greenhouse gas intensity, residual intensity, air pollution intensity, water pollution intensity, proportion of natural cover/land, recycle or reuse product, recyclable product, product with renewable material, unrenewable material intensity in the product, hazardous substance in the product, product energy consumption intensity, and greenhouse gas emission intensity of the product.

A firm's level in green manufacturing is determined based on the OECD Sustainable Manufacturing Toolkit. The level comprises 3: beginner (1-5 indicators), intermediate (6-12 indicators), and advance (13-18 indicators). Studies have implemented this in evaluating green manufacturing of a firm. Marietta (2018), Djohan (2017), and Reza (2017) evaluated level of green manufacturing businesses in Semarang. They found that the businesses were in intermediate with 8-11 indicators were identified as green.

This research applies the following framework for evaluating level of green manufacturing of Oox Guitarmaker. Based on the identified level, designing green manufacturing implementation is then set.

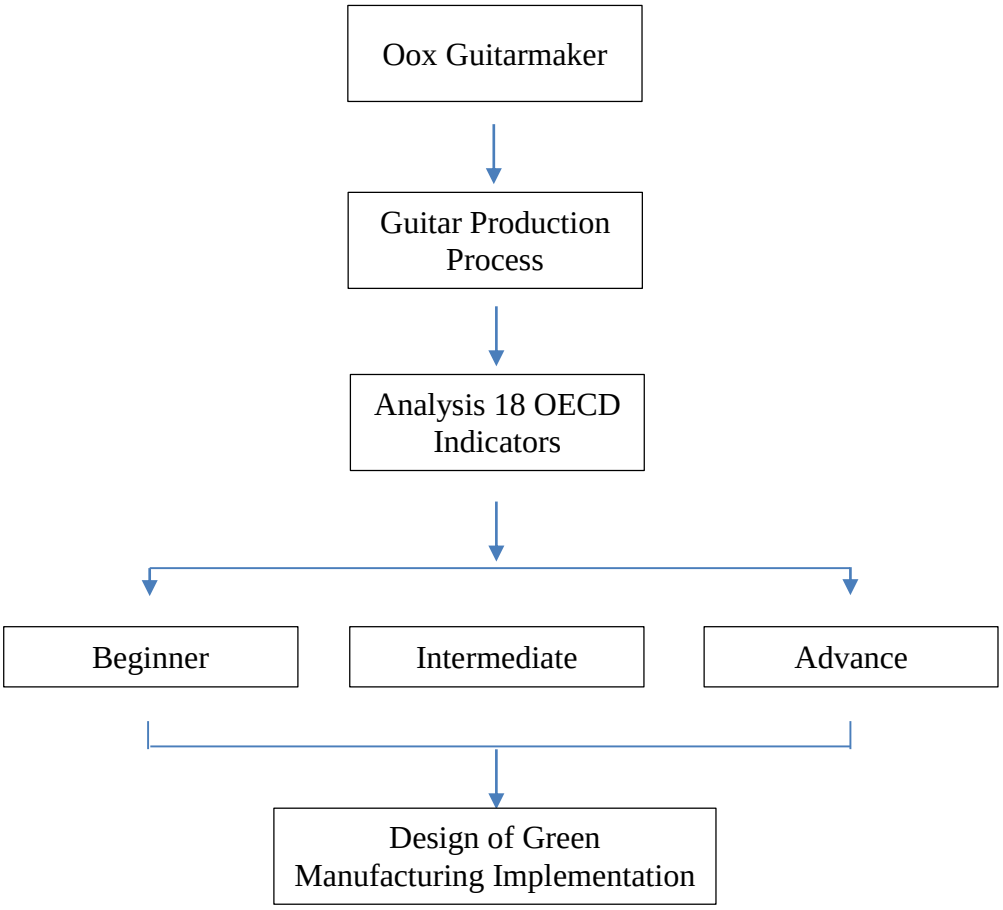

Figure 1. Research Framework

METHOD

This research address a micro business Oox Guitarmaker located in the SME market Gua Kerep on Jl. Tentara Pelajar No.99 Kerep, Ambarawa. Oox Guitarmaker producing electric and acoustic guitars is a micro scale business that has opportunity to be developed using the design of green manufacturing.

The method consists of 6 steps. The first step is to prepare material, schedule, tools for documentation, and questions for interview. The second step is data collection. Data was

collected using 3 methods: interview intended for gathering information about practical green manufacturing in the business; observation for spotting the production process; and documentation for collecting data about the business. Observation was conducted first directly on the site to understand input, process, and output. It was then followed by conducting interview to the owner that was particularly to gather information unavailable from the observation.

The third step is to analyze data gathered from observation and interview. The data was processed using formulas generated by OECD. The research used 18 indicators of OECD, applied level of green manufacturing (beginner, intermediate, and advance), and theory of green manufacturing transformation (green energy, green product, and green processes) presented by Arindam et al (2011) as the tool for data analysis.

On the fourth step, each result of the calculation on the 18 indicators was assigned assumption of green and not green. Then, on the fifth step, indicators that are green were separated from those that are not green to know how many green indicators of the 18 indicators. Based on this result, the category of either beginner, intermediate, or advance was determined.

The sixth step was to designing green manufacturing based on the indicators that are not green yet. By doing renovation on these indicators directs Oox Guitarmaker to be more environmentally friendly. The design was relied on the theory of transformation into green manufacture comprising green energy, green product, and green processes.

RESULT AND DISCUSSION

Table 1 presents the result of data analysis on green manufacturing level using 18 indicators of OECB. The analysis indicates 11 indicators that are relevant and thus Oox Guitarmaker can be categorized in the level of intermediate. Even though this level is relatively

satisfaction for a micro business, it however can be upgraded by improving components that are still irrelevant.

Designing Green Manufacturing

Designing green manufacturing on Oox Guitarmaker Ambarawa is conducted by referring to the theory stated by Arindam et al (2011) in the journal of Green Manufacturing which cover green energy, green product, dan green processes. The following is the design planned for Oox Guitarmaker Ambarawa.

Table 1. Summary of the Analysis of 18 OECD Indicators on Oox Guitarmaker

No	Indicator	Assessment	*Green*
1	Unrenewable materials usage intensity (input)	Irrelevant	No
2	Hazardous substances usage intensity (input)	Irrelevant	No
3	Recyclable or reusable materials (input)	Irrelevant	No
4	Water usage intensity (proses)	Relevant	Yes
5	Energy use intensity (proses)	Irrelevant	No
6	Proportion of renewable energy usage (proses)	Irrelevant	No
7	Greenhouse gas intensity (proses)	Relevant	Yes
8	Residual intensity (proses)	Relevant	Yes
9	Air pollution intensity (proses)	Relevant	Yes
10	Water pollution intensity (proses)	Relevant	Yes
11	Proportion of natural cover/land (proses)	Irrelevant	No

No	Indicator	Assessment	*Green*
12	Recycled or reused product (output)	Relevant	Yes
13	Recyclable product (output)	Relevant	Yes
14	Product with renewable material (output)	Relevant	Yes
15	Unrenewable material intensity in the product (output)	Irrelevant	No
16	Hazardous substance in the product (output)	Relevant	Yes
17	Product energy consumption intensity (output)	Relevant	Yes
18	Greenhouse gas emission intensity of the product (output)	Relevant	Yes
TOTAL GREEN			11

The first is green energy. This means that the business must use environmentally friendly energy in the production activity. The design of this green energy focuses on the use of solar energy and wind energy. The explanation for the design of each is presented in table 2 and 3.

Table 2. Design of Green Energy for Solar Energy

5W+1H	REMARK
WHAT	Oox Guitarmaker is still 100% using electrical energy and has not used alternative energies in its daily production activity. Located in a valley makes Oox Guitarmaker has good intensity of sunlight at day and sunlight is categorized as renewable energy. Thus, Oox Guitarmaker

5W+1H	REMARK
	can use the sunlight for the source of light to replace the use of neon during the day.
WHY	The use of sunlight as the light can make Oox Guitarmaker to be more efficient in lighting during the production activity and this can reduce expense for electricity and make the business to be more environmentally friendly.
WHO	This design relates directly to the owner of Oox Guitarmaker since this needs revision on the ceiling of the building.
WHEN	This design can be conducted at any time because it relates to the lighting during the day.
WHERE	The design applies on the whole areas of Oox Guitarmaker since all rooms need lighting.
HOW	Use transparent ceiling or glass ceiling so that sunlight penetrates the rooms in Oox Guitarmaker.

Table 3. Design of Green Energy for Wind Energy

5W+1H	REMARK
WHAT	Oox Guitarmaker is still using 100% electricity for its production process including for drying body of guitars after painting process. Oox Guitarmaker uses blower positioned on the wall for this purpose. The use of blower consumes a lot of electricity whereas Oox Guitarmaker is located in a valley with many advantages of alternative energies such as wind. This design focusses on harvesting wind energy to replace the function of blower in the process of drying of guitar body.

5W+1H	REMARK
WHY	The use of wind energy for drying process can make Oox Guitarmaker to be more efficient in using electricity, reduce electricity expense, and make the business to be more environmentally friendly.
WHO	The owner of Oox Guitarmaker is responsible for this design.
WHEN	The design can be used during the process of guitar drying.
WHERE	This design is applied in particularly room for painting and drying guitar body.
HOW	The design uses ventilator to harvest source of wind energy for replacing the function of blower. Basically, blower and ventilator have the same function to circulate the wind in a room so that there is no humid air trapped in the room. However, ventilator uses wind energy and blower uses electricity for each can function. Thus, the use of ventilator is better than of blower.

The second is green product. This means that the business must develop the product that has not been environmentally friendly to be the green one. The easiest way to do this is to recycle and reuse the product. Table 4 presents the design for green product.

Table 4. Design of Green Product

5W+1H	REMARK
WHAT	Recycle and reuse are important for businesses such as Oox Guitarmaker because without recycling them, wood waste resulted will be accumulated and this makes Oox Guitarmaker to be unfriendly to the environment. Currently, the production wastes were given away to people who use them for firewood and material for handicrafts. Thus,

5W+1H	REMARK
	recycle is important for Oox Guitarmaker since it has not yet done recycle and reuse well.
WHY	By doing recycle and reuse Oox Guitarmaker can reduce wastes resulted and opens new opportunity in guitar production and repair since there are many unused old guitars in the area. Processing them will give additional revenue for Oox Guitarmaker besides it can be more environmentally friendly.
WHO	The owner has responsibility for directing the employees.
WHEN	The design can be conducted during production activity.
WHERE	The design is applied on the guitar production section.
HOW	The design for recycle is implemented by processing bodies and parts of old guitars to produce new guitars having standard quality of the other guitars. Meanwhile the design for reuse is implemented by using the production residues as the materials for guitar repairmen service that also offered by Oox Guitarmaker. This enables Oox Guitarmaker does not need to use new material for repairing.

The third is green processes, which mean to do production activity with more environmentally friendly. This refers to action for reducing or saving on some aspects of production (reduce) such as save water, use materials more efficiently. Table 5 shows the design on this.

Table 5. Design of Green Processes

5W+1H	REMARK
WHAT	Reduce energy use intensity in Oox Guitarmaker is highly important since it is still using 100% electricity and the use is relatively high for operating the production machines of wood. Electricity saving cannot be applied on production machines since their energy consumption is already fixed and cannot be changed. Thus reduction on intensity of electricity use must be applied to other things such as the use of LED for lighting. The use of efficient materials is also important factor for making production process of Oox Guitarmaker becomes more environmentally friendly. Since the wood wastes were given to people who may use them wastefully. Thus, Oox Guitarmaker needs a design enabling it to maximize the use of the materials.
WHY	Oox Guitarmaker needs these two designs since they can save expenses for energy and materials and can make production process becomes more environmentally friendly.
WHO	The owner has the responsibility and observation on these two designs.
WHEN	The design can be conducted during the production process of guitar.
WHERE	The design is applied on production section of Oox Guitarmaker.
HOW	The design to reduce intensity of energy use can be conducted by replacing all neon with LED that is more environmentally friendly since LED is power saving and life longer compared to neon. The design for more efficient material use can be conducted by producing guitar accessories using residues that are small in size and

5W+1H	REMARK
	cannot be used in guitar repairing. Guitar accessories and costumed guitar are related each other because every buyer wants to have their ordered guitar to be different from the others'.

CONCLUSION

Oox Guitarmaker has 11 of 18 indicators that are green and its green level is intermediate. This indicates that green manufacturing practice on daily guitar production activity by Oox Guitarmaker is relatively good since Oox Guitarmaker is a micro business. Nevertheless, there are several sectors of Oox Guitarmaker that must be replenished to be better.

Oox Guitarmaker Ambarawa can be a role model for other micro businesses and make them to be environmentally friendly business. Therefore, bad issues on the environment can be minimized since businesses care about the environment. They can consequently do saving in several sectors in particularly expenses for materials. Costs of energy can be lowered more and this can direct micro businesses to get higher profit.

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