An ergonomic, mobile and portable design of porang cutting and drying machine on motorcycle

E Nurmianto 1, A Anzip 2, D E Kusrini 3

1) Dept. of Industrial Engineering, Sepuluh Nopember Institute of Technology, Surabaya, Indonesia
2) Dept. of Mechanical Industry Eng Dept, Sepuluh Nopember Institute of Technology, Surabaya, Indonesia
3) Business Statistics Dept, Sepuluh Nopember Institute of Technology, Surabaya, Indonesia

Corresponding author’s e-mail: nurmi@ie.its.ac.id

Abstract. This research is aimed to improve management of Porang (Amorphophallus Muelleri Blume, Indonesia Konjac), in Glucomannan Industrialization. The problem arises when they cut and dry manually on porang with very low productivity. Problems solved when there is a machine for cutting and drying porang on motorcycle which are Mobile, Portable and Ergonomic. This machine used to process with a higher production capacity. This porang processing innovation in the form of cutting and drying machine as well as processing porang into various preparations that combine several processing functions that are safe, comfortable, and healthy for its users and effective for their products. The conclusion is (1) from the data test of the machine it got 15 mm diameter of porang with maximum force of cutting machine is 22,1 kg, (2) Already build drying machine porang that can produce 1,061 kg/hours porang chips, (3) Based on the test and calculation, the porang’s cutting and drying machine can produce 190,89 kg/hours porang chips. Then if it observed from manual cutting that can only produce 65 kg/hours porang chips, so this machine can increase 3 times of productivity of the farmers. Finally, it is hoped that after using this machine, farmers will be prosperous.

1. Introduction
The existence of forests is very important for the community, because it has economic functions, namely as a buffer of the most essential life for people living around the forest area, climatological functions can affect the microclimate and oxygen producers, hydrological functions as a regulator of water systems, and ecological functions that prevent flooding and soil erosion, maintaining soil fertility and germplasm sources. In the future the forest in Nganjuk, East Java is expected to be a forest for food and life through the potential of non-timber forest products.
The Nganjuk Regency area is divided into 20 sub-districts and almost all sub-districts have the potential of forestry with approximately 200 forest farmer groups and LMDH whose lives are very dependent on forests.

In the era of autonomy with the breath of decentralization, the passion of Nganjuk Regency to build the forestry sector is shown by a commitment to manage, preserve, utilize and improve forest ecosystems on the basis of equitable community support so as to create a sustainable and environmentally sound system for community welfare.

Benefits of Porang Plant

Besides being used for food ingredients, the most important ingredient of porang plants is glucomannan content contained therein [1]. Ideally the higher the glucomannan content of the porang plants, the higher the commercial value it is possible. 3-year-old porang tuber originating from Indonesia, especially Nganjuk Regency can reach more than 5 kg while those from other countries, such as Japan and Korea, can only reach 2 kg. Therefore, even though porang plants are cultivated in Japan and Korea, but the production and consumption of porang tubers is not balanced so they import from Indonesia. The difference in glucomannan levels between people originating from Indonesia and those from other countries also needs to be further investigated because of the possibility of glucomannan levels which make consumption of porang in Japan and Korea very high. The uses of porang plants in general are as follows:

1. As the best glue
2. Water purifier and tablet formulation binder
3. Syrup thickener
4. Medicines and blackhead absorbers
5. Benefits for the health of the body, people can reduce blood cholesterol levels, slow down emptying the stomach and speed up the feeling of fullness so that it is suitable for diet food for diabetics.

![Figure 1. The process of cutting and drying conventional materials [1]](image)

2. Objective and research benefit

2.1. Research objective

The general objective of this study is to support the government in the empowerment program of coastal resource commodities with an easy and ergonomic method. While the specific objectives of this study are:
1. Created a design prototype of cutting tools and Porang On Motorcycle Dryers that are Mobile, Portable and Ergonomic with the use of motorized vehicles as an effort to create cutting tools and dryers for people who are mobile, portable, and environmentally friendly.

2. Applying the Design of Cutting Tools and Porang On Motorcycle Dryers that are Mobile, Portable and Ergonomic which are mobile, portable, and environmentally friendly in the coastal areas of East Java.

2.2. Research benefit
   The benefits obtained from this study are:
   1. Forest communities can more quickly cut and dry porang.
   2. Cutting tools and porang On Motorcycle dryers have advantages in terms of mobility when compared to traditional tools.
   3. Cutting tools and porang On Motorcycle dryers can support the economic improvement of forest communities.
   4. Cutlery and porang On Motorcycle dryers have a large porang storage capacity in one cutting process, so that the output of the products produced is greater when compared to conventional tools.
   5. Application of cutting tools and porang dryers On Motorcycle does not cause health and environmental problems (environmentally friendly), because the drying system is carried out closed with a chimney at the top.

3. Literature review

3.1. Supporting theory
   Porang is one of the Amorphophallus species. In popular Japan called Amorphopallus konjac while in Indonesia better known as Amorphopallus oncophillus. Porang is a type of iles-iles plant that grows in the forest. Porang is a family of Araceae which is a shrub (herb) plant that is rooted in the soil, and produces carbohydrates. Porang plants grow in the form of shrubs with a height of 100-150 cm, finely trunked, stems and leaves green to dark green with stripes with white spots.

   The main products of porang plants are tubers. There are two types of tubers in porang plants according to Wu et al., namely stem tubers that are in the ground, and tubers / frogs which are found in each base of branches or leaf bones which contains seeds [2,3]. This tuber is a change in the shape of the stem that serves as a food reserve. Tubers consist of the skin and tuber flesh. The tuber skin when harvested is grayish in color and if left several days it will turn black. Parts of the peeled tubers will release slippery sap and cause itching on the skin. Porang tuber flesh is yellowish, contains carbohydrates that serve for further growth. Porang plant roots are white fibrous roots. This large number of roots grows from the stem and skin of the tubers, which is useful for expanding the absorption of water and nutrients from the soil. Whereas the stems of the porang plant merge with the tubers and form a small part of the tubers.

3.2. Previous Research on Motorcycles
   The background of this research is that the two-wheeled motor vehicle in Indonesia called the motor, is a vehicle that is in great demand by the public as a motor vehicle whose price is affordable and can be used for various transportation purposes. Starting from self-transport (1 person), along with other people (2 people), along with 2 others (3 people), husband and wife with 1 or 2 children (4 adults and 2 children), carrying gallons of water, computer, merchandise such as household groceries, bakery cakes and others [5].

   The use of motors with excess capacity is not allowed in the Traffic Act, and is dangerous to both themselves and other users. Some motorcycle users have tried to add parts of the motor to increase
capacity, such as adding a rear-mounted box, pulling a two-wheeled train behind it, and some installing a side train permanently.

To get the right anthropometric size of Indonesian children, we can compare the size of British children with Indonesian children of the same age. From the ergonomic and gamber data of the above technique, we can create a scheme that shows how minimal and maximally this sidecar can be used by the child based on anthropometry that has been processed.

In the data below, note that children ages 5 and 8 years can easily board a sidecar in the position of 1 person who was transported. And in a position where the feet can be straightened easily in a sidecar. While in children aged 12 years, the legs began to bend when on the sidecar.

3.3. Design of Porang’s Cutting and Drying Machine (on Motorcycle)

In designing porang’s cutting and drying machine is based on designing design of a fish smoke device on an ergonomic motorcycle as illustrated in Figure 2. Musculoskeletal symptoms reported by 215 fishermen were followed at 6-month intervals for 18 months. Exposure information is collected through field observations and in-depth ethnographic interviews that enable the stressful potential of ergonomics to be identified and cataloged with tasks and work stages. Symptoms that caused work disorders in the last 12 months were reported at 38.5% from the initial cohort. Lower back symptoms are the most common cause of work disorders (17.7%), followed by pain in the hands or wrists and shoulders (7%). Symptoms in the body region are more likely to be reported among individuals who are not full-time and those who work other parts of the work or throughout the year have a much lower prevalence of symptoms; both may reflect the effect of a healthy worker. A number of ergonomic stressors are identified at all stages with variability in exposure dictated by several people who cannot predict factors such as weather; but also with the type of boat, equipment, crew size, and level of experience. Working among traditional workers is important, regardless of whether they directly cause or contribute to them musculoskeletal symptoms, or exacerbate existing pathology.

East Java Province has become an area that is capable of producing high marine commodities, but in the process it is still not well developed. Lack of capital makes them unable to increase production capacity and limited marketing. They still use traditional technology. Given these conditions, there are still opportunities to improve efficiency and effectiveness through the Small Business Development Program in accordance with the situation and conditions of the small industry. Management design, human resources, production, finance and design will in turn increase the competitiveness of small industries. The workforce at SME porang production has gained the skills from years of work experience and is informally transmitted.

3.4. Nordic Body Map

Nordic Body Map is one of the most commonly used forms of ergonomic checklist questionnaires to find out one’s discomfort with a product or object [8]. Nordic Body Map also aims to map the level of complaints a person as a material analysis and a particular action. The questionnaire uses a human body
image that is divided into 9 main parts, namely, neck, shoulder, upper back, elbow, lower back, wrist, waist, knee, and heels/feet.

![Nordic body map](image)

**Figure 3.** Nordic body map [5]

4. Research methodology

4.1. Research Steps

4.1.1. Identification of problem. The first step in this research is to identify the problems that occur. The problem raised was how to design a porang cutting tool that was in accordance with the wishes of the forest people.

4.1.2. Study literature. At this stage a study was conducted to gain an understanding of QFD, porang cutting tools, the process of drying porang.

4.1.3. Field study. Drying field studies were carried out through observations when carrying out porang drying training. This is intended to obtain initial information.

4.1.4. Data collection and processing. The following are the stages of data collection and data processing. Data collected will be processed according to each stage. In anthropometric testing, the steps taken are subjects using footwear are asked to sit on the observation object (motorcycle) with the freedom to set a sitting position until the subject feels comfortable with his sitting position. The front foot of the subject is then measured using graph paper placed in the gas tank. The coordinates of the foot position are then taken parallel to the footrest. The level of accuracy used is + 3 mm. Most subjects wear footwear (shoes / sandals) when measurements are made.

Data Collection Tool Repair
In retrieving data repair tools, the steps taken are:
1. Preparation of the VoC questionnaire
2. Weighting of the VoC Questionnaire results
3. Determine the technical response from the respondent
4. Perform tool repairs
5. Testing the recommended repair of cutting and drying machine

4.2. Designing Porang on Motorcycle Cutting and Drying Tools
The following is a picture of the machine that is mobile, portable, and environmentally friendly that is offered to partners.
Figure 4. Appropriate technology in the form of Porang Cutting and Drying Tools on Motorcycle which are mobile and portable

Figure 5. Design image of appropriate technology for porang’s cutting and drying machine on motorcycle that are mobile and portable

Specification of the cutting machine is as follow
- The amount of wheel on the disk is 120 rpm.
- Using 2 hoppers with 2 cutting knife that cutting at the same time.
- The diameters of pulley that used in the machine is
  - D_1 = 3 in = 76,2 mm
  - D_2 = 9 in = 228,6 mm
  - D_3 = 6 in = 152,4 mm
  - D_4 = 6 in = 152,4 mm
- Using type A belt with rubber canvas material.
  a. The distance of the first pulley to second pulley is 838 mm with 6275,539 hours lifespan (type A 33)
  b. The distance of the third to fourth pulley is 1295 mm with 225984,409 hours lifespan (type A 51)
- Using axis with AISI 1045 material and 40 mm diameter

Specification of the drying machine
- Heat transfer that out of drying system through conduction process with 118,814 watt of the amount.
- Heat transfer that out of drying system through smokestack with 345 watt of the amount.
- Heat transfer that into the drying system is 1139,24 watt of the amount
- Heat transfer inside drying system is 675,426 watt of the amount.
The consumption of LPG for drying process is 0.08676 kg/hours
Based on drying test it produces dried porang chip of 1.061 kg/ hours.

4.3. How the porang cutting and drying machine work:
1. Porang fruit is inserted from the top hole / door numbered (5).
2. Porang fruit will fall towards the rotating knife numbered (11) and produce a porang chip.
3. The porang chip that has been finished chopping will fall on the numbered feeder (12) and go towards the drying box numbered (9).
4. The drying box has three levels, if the first level is fully filled by the porang chip, the feeder can be stretched to fill the second drying box level, as well as to fill the third level the feeder can also be stretched again.
5. After the dryer box is fully loaded in three levels, then close the drying door numbered (7).
6. After the door is closed turn on the dryer heating box.
7. Wait until the desired time, if it has finished turn off the heater and porang chip ready to be processed into the next process.

4.4. Anthropometric Testing of Motorcycles
Two-wheeled motorized vehicles in Indonesia called Lasim are motorized vehicles, which are very popular with the public as motorized vehicles which are affordable and can be used for various transportation purposes. The physical dimensions of motorbike riders related to motorcycle design and other detailed parts such as fairing or other protective equipment whose effectiveness depends on the relative position of the body parts of the rider.

Motorcycle design provides its own problems for ergonomists because it has narrow constraints, making it difficult for them (ergonomics) to design a motorcycle that fits the user's body size in general. There are two forms of problems found in designing ergonomic motorbikes, namely:
1. Variation in the value of the body size of a motorcycle rider.
2. Relationship between the driver's body attitude and work effectiveness when the driver uses a motorbike.

There is very little information or data on anthropometry about sitting humans while riding motorbikes in the United Kingdom (UK). Previous studies have found that motorcyclists in the UK generally have height that is not in accordance with the motorbike they use. Therefore, a high level of ergonomics or comfort is needed to design a motorized vehicle modification. Ergonomics itself can be interpreted as a discipline that studies humans as one of the important factors in a production system that can significantly improve the effectiveness, efficiency, and performance of a work system that will be developed. Ergonomics also relates to the optimization, efficiency, health, safety and comfort of humans in the workplace, at home, and in recreational areas. In ergonomics, the study of systems where humans, work facilities and the environment interact with each other with the main goal is to adjust the working atmosphere with the people.

5. Results

5.1. Design of Mobile and Portable Porang Cutting and Drying Machine

The designer has made the design of mobile and portable cutting tools and dryer porang for direct application. This tool will be applied to various types of motorbikes with modifications that have been determined by the proposer. In its implementation, the tool will be installed behind the motorcycle by cooperating with a cutting tool and dryer with a motorcycle that will be used. Cutting tools and dryer porang on Motorcycle have a length of 81 cm and a height of 97 cm. At the bottom of the tool there are two fish storage areas that have been carried out fumigation. Each of these components has a length of 31.2 cm and a height of 36 cm. In the middle it has a length of 21 cm, where this size can flexibly adjust
to the width of the motorcycle seat. The design of the cutting tools and porang dryer on the motorcycle is shown in Figure 8.

![Figure 6](image1.png)

**Figure 6.** Design cut tools and porang dryers on ergonomic motorcycle

Figure 6 shows the design of porang cutting tools and motorcycle dryers in a closed and visible condition (open). This tool has several components which include drying room, upper door, porang storage after dried, and the bottom door. Chimney function to remove heat produced from the porang dryer, so that the temperature and the process of drying porang can be organized. The porang is in the drying chamber, the room where the porang drying takes place. Under drying porang there is a place, which is a place where charcoal or briquettes are placed. When the process of drying porang happen, then the top door will be closed so heat during the process can be evenly and stable. In addition, this tool is also equipped with a porang storage area that has gone through a drying process. Thus, users can save porang that have been dried. In its implementation, the use of porang cutting tools and motorcycle dryers for the process of drying porang does not take place on a motorcycle, but the top tool must be lowered. As the name implies, this tool has mobile and portable properties, that is mobile when moved from one place to another and portable when lifted for drying porang. This tool is equipped with a sliding wheel that is useful for making it easier for the upper tool components to be lowered and automatically 4 supporting wheels will come out. The designs related to the separation mechanism of the lower and upper porang drying tools are as follows.

![Figure 7](image2.png)

**Figure 7.** Open cut tools and dryers

Figure 7 shows the design of the separating mechanism for cutting and drying the lower and upper parts. In its application, the lower part of the tool will remain attached to the motorcycle seat, while the upper part of the tool will be lowered by sliding it to the process of drying porang. At the bottom of the tool there are 4 support wheels that will come out automatically when this component is lowered. When the
porang dried process is complete, the tool is re-installed in the motorbike seat by bending the four support wheels and returning to the starting position.

![Figure 8. Machine testing at the laboratory.]

![Figure 9. Body Part Discomfort Interview Guide [6,7,9]]

![Figure 10. Motorcycle experiment in the fields in the city of (1) Nganjuk and (2) Jombang]

In Figure 10, the creation of cutting tools and dryers porang stage 1. At this stage the tool has been applied. At this stage the cutters and dryers will be ready for testing in the field.

6. Conclusion
The conclusion of this research is as follow
1. From the data test of the machine it got 15 mm diameter of porang with maximum force of cutting machine is 22,1 kg.
2. Already build drying machine porang that can produce 1,061 kg/hours porang chips.
3. Based on the test and calculation, the porang’s cutting and drying machine can produce 190,89 kg/hours porang chips. Then if it observed from manual cutting that can only produce 65 kg/hours porang chips, so this machine can increase 3 times of productivity of the farmers.

Acknowledgements

Authors acknowledge funding support from Directorate General of Higher Education, Ministry of Technology Research and Higher Education, Republic of Indonesia through contract number 1420/PKS/ITS/2018.

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