Study of motion comfort on the roof slope to optimize urban farming

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Study of motion comfort on the roof slope to optimize urban farming

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Abstract. One of the efforts of urban food problems can be resolved by urban farming activities with green roofs application on sloping roofs in crowded settlement. The study aims to know the body movements comfort in the planting activity on the green roof for productive plants with a case study of sloping roofs using simulation. This study is an experimental research by using simulation methods. The experimental variables in this study were height, sex and the range of the planting process. The simulation research uses a growing media module which is placed at an angle of 15 degrees and 30 degrees. The obtained data tested T test method to find the differences level of male and female respondents data. After the T test, a simple regression test was performed to determine the effect of the respondent's height on the range of the planting process. T test results show that male and female data in each module with slopes 15 degrees and 30 degrees have different results. ANOVA test regression analysis results showed a significant influence between height and distance of planting range in male respondents was 47.5 percent in the 15 degrees module and 49.02 percent in the 30 degrees module, while in the female respondents had a 31.64 percent result at modules 15 degrees and 54.44 percent in the 30 degrees module. The results of both data (male and female) showed that the slope of 30 degrees is more comfortable than the slope of 15 degrees.

1. Introduction

High population growth in urban areas is a common problem of big cities in Indonesia. The cause is natural population growth and urbanization factors. Each population growth will be accompanied by the increase of basic needs (food, clothing and shelter). High population growth and development activities in various fields will increase land demand. It will change agricultural land into non-agricultural land and will reduce the food supply [1]. Surabaya Department of Agriculture explained that urban farming is an effort to utilize limited and dirty land into productive, clean and green [2]. One of the benefits of plants is that plants are able to lower both ambient temperature and the temperature inside the building [3]. Usually some areas in dense settlements do not have areas for urban agriculture because the area is limited and does not meet the requirements for growing productive plant, see figure 1. One thing that can be done to carry out urban farming activities in dense settlements is to utilize the roof of the house to become a green roof. House roofs in dense settlements generally have a slope between 15 degrees to 30 degrees depending type of roofing material used. Green roof applications are more often and

commonly applied to concrete flat roof, so it needs to be done a study of green roof for productive plants on the sloping roof of the house building.

Figure 1. Urban dense settlements in Malang that do not have yards.

1.1. Literature review

1.1.1. Green roof. Green roof is a flat or sloping roof with vegetation on it. The roof is designed to provide greening at urban buildings [4]. Green roofs as a sustainable aspect of urban ecology are engineered from abiotic and biotic components to function as green open spaces in urban environments [4]. The benefits of green roofs are increasing the life of the roof covering by preventing excess heat, reducing the effects of urban heat when many green roofs are installed by providing media that uses excess heat to evaporate water, reduce rainwater runoff by holding precipitation, absorbing carbon dioxide and pollutants in biomass, enhance aesthetic value or provide recreational benefits, create wildlife habitat and provide noise reduction in buildings [4]. The rooftop garden also has benefits as a supporter of urban food production [5]. Vegetable plants can reduce room temperature and produce oxygen [6].

The green roof system is defined into two general category systems, namely intensive and extensive green roof systems. The intensive system has a heavier component weight and deeper media thickness. Types of plants for this system is grass, perennials, shrubs and trees. Extensive system is a type of green roof with a light weight and has a shallow media thickness [4]. Plants that are suitable for this system are sedum, herbaceous and grass plants with an easy level of care and are not treated too often [7].

1.1.2. Ergonomy. Ergonomics is the science that finds and collects information about human behavior, abilities, limitations, and characteristics for the design of machines, equipment, work systems, and environments that are productive, safe, comfortable and effective for humans [8]. The main focus of ergonomics in design is to consider the human element in the objects design, work procedures and work

environment. Human characteristics are very influential on the design to increase human work productivity in achieving goals that are effective, healthy, safe and comfortable [8].

In a design, to obtain accurate body size data as an ergonomic consideration, anthropometric measurements can be used. Anthropometry is the science that deals with the measurement of dimensions and ways to apply certain characteristics of the human body. The functional comparison of individual adults and children can be determined by an anthromorphic proportion system based on the dimensions of the human body. One way is to measure the body in a variety of standard positions and not moving (static anthropometry), as well as when performing certain movements related to activities that must be completed (dynamic anthropometry) [8].

1.2. Research question

The main problem in this research are:

- Does gender, age and height affect the reach of urban farmers, especially during the planting process?
- Does the level of comfort is determined by the reach of urban farmers?
- Does that the roof slope affects the comfort level of urban farmers in the planting process?

1.3. Purposes

There are 3 research purposes to be achieved:

- Analyze and formulate that gender, age, and height affect the reach of urban farmers, especially
- during the planting process
- Analyze and formulate that the level of comfort is determined by the reach of urban farmers
- Analyze and formulate that the roof slope affects the comfort level of urban farmers in the planting process

2. Research methodology

This research is an experimental research based on a case study of city house buildings in a dense residential area in Malang that does not have yards by utilizing the roof of the building to apply green roofs on sloping roofs as an effort to realize urban farming programs. To make it easier for research process, this research used module as a simulation of actual conditions. Simulations were carried out on a growing media module with a slope of 15 degrees and 30 degrees. The module used square design with size 120 centimeters x 120 centimeters x 20 centimeters. To provide a motion experience that can resemble the actual conditions when gardening on the roof, in this activity respondents will rise on a wooden platform that has been modified with a minimum of 40 centimeteres with a standard lower boundary position of the planting media module to the waistline of the respondent. See figure 2 and 3.

Table 1. Research variables.

No	Variable	Information
1.	Module Slope	15 degrees
		30 degrees
2.	Respondent Gender	Male
		Female
3.	Height of Respondents	Male : 160 centimeters to 170 centimeters
		Female : 150 centimeters to 160 centimeters
4.	Planting Reach	Measured on each respondent on each slope module

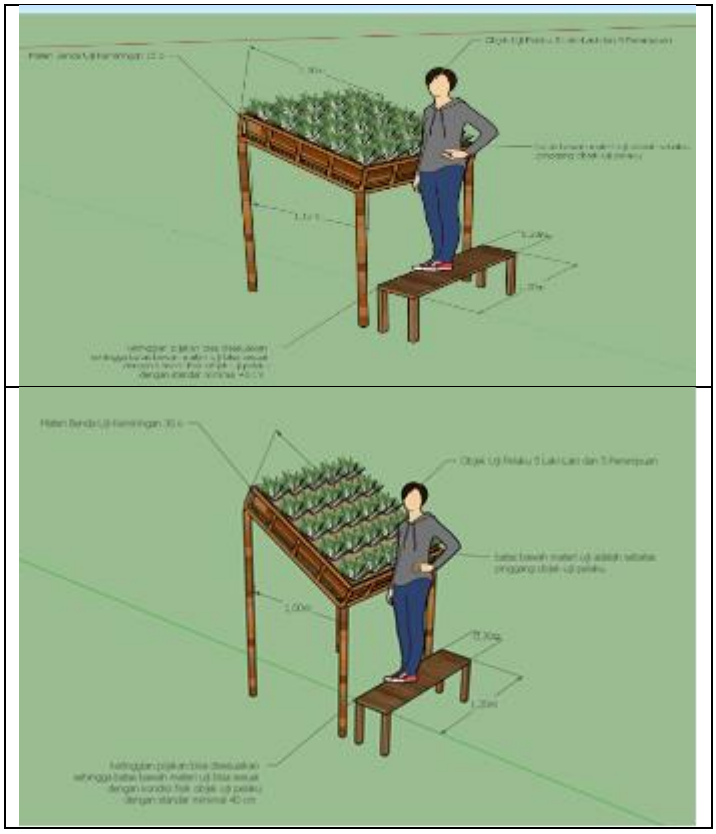

Figure 2. Visualization of the sloping plant media module 15 degrees and 30 degrees.

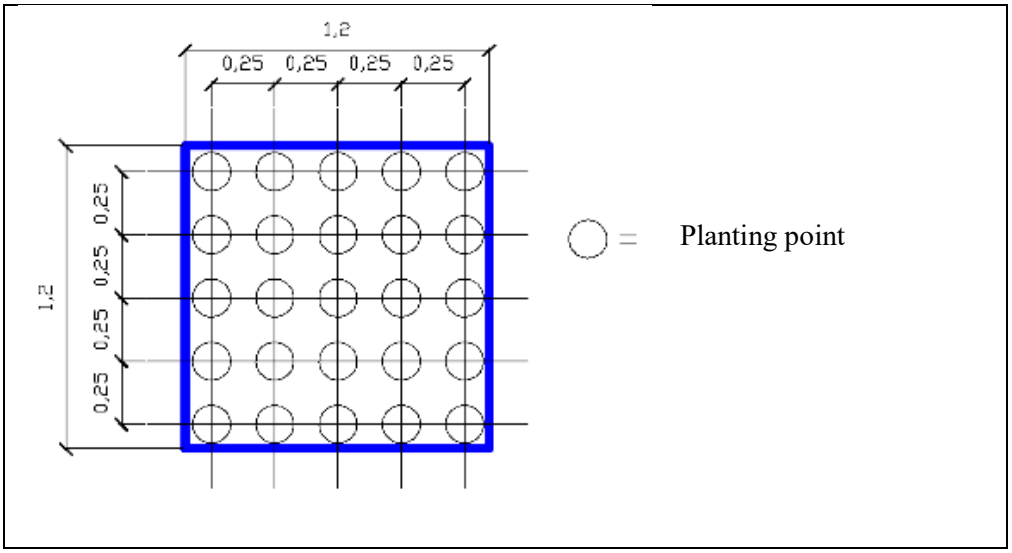

Figure 3. Detailed planting point.

The results of the research data will be tested with a different test (T test) to compare the reach data based on the respondent's gender. After a different test (T-test), a simple regression analysis is performed to determine the effect of height on the planting range. Data to be analyzed using simple regression refers to the results of the different tests (T test). If the data from the different test results (T test) shows that the range planting data of male and female respondent show different results, then a simple regression analysis is done by analyzing the data according to the gender type of each respondent,

however the regression analysis will be combined without looking at gender differences if the results of the different tests (T-Test) show no different results.

3. Results and discussion

The result show that:

- The results of the experimental trials of planting activities on the planting media module with a slope of 15 degrees and 30 degrees show that in both treatments have the same results, there is a significant effect between height and planting range variables on male and female respondents.
- The results of the average of all respondents to the experiment of planting activities in the planting media module with a slope of 15 degrees and 30 degrees showed that the module with a slope of 30 degrees has a range value further than the module with a slope of 15 degrees. The result showed in figure 4 and 5, table 1 and 2.

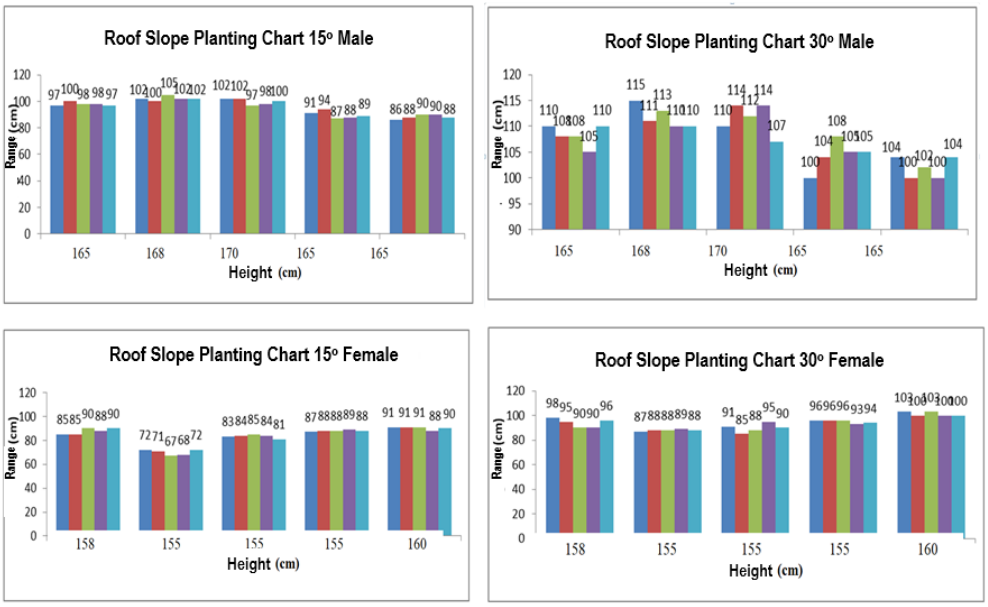

Figure 4. Planting range chart.

Table 2. Difference test results (t test) data planting.

Activity	Module Slope	Average Reach (cm)		Average Difference	P Value	Signification Result
		Male	Female			
Planting	15	95,56	83,84	11,72	0,00	Different
	30	107,56	93,56	14	0,00	Different

Table 3. Simple regression test results for planting data.

Gender	Module Slope	R Square Value	Observations (Population Sample)	F	P - Value	Results of Signification of Effect of Height on Reach
Male	15	0,4757	25	20,875	0,000	Significant
Male	30	0,4902	25	22,121	0,000	Significant
Female	15	0,3164	25		0,003	Significant
Female	30	0,5444	25	27,490	0,000	Significant

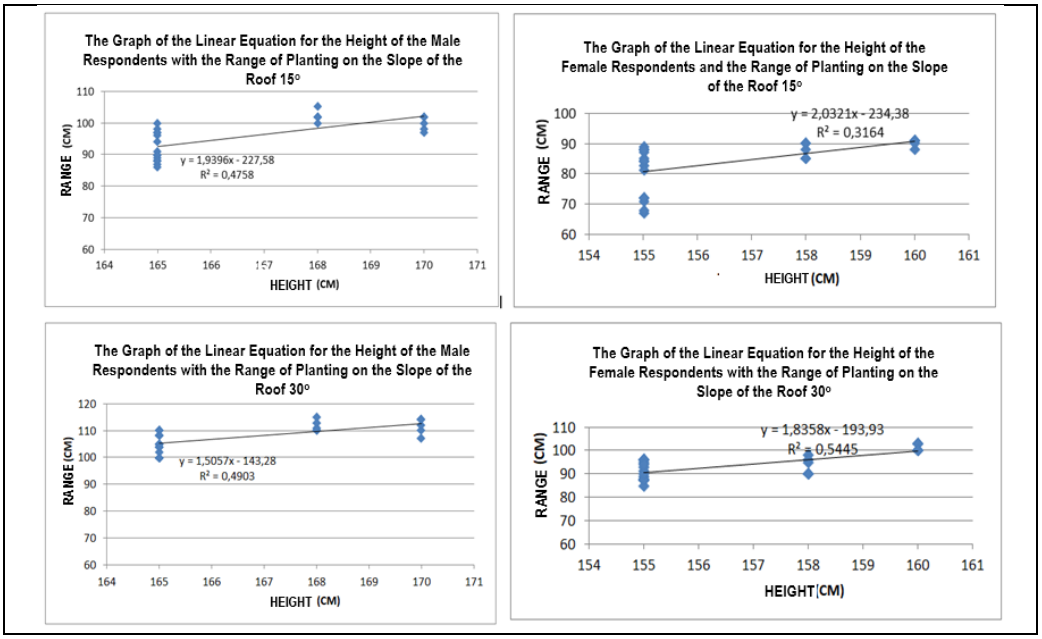

Figure 5. Planting data linear equation chart.

4. Conclusion

There are 3 research conclusion:

- Gender, age and height affect the length of reach of urban farmers, especially during the planting process.
- The level of comfort is determined by the reach of urban farmers.
- The slope of the roof affects the comfort level of urban farmers in the planting process. The results of both data (male and female) showed that the slope of 30 degrees is more comfortable than the slope of 15 degrees.

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