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New design of nano-porous pottery for water saving and possibility for commercialization

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Abstract. Nano-porous pottery for this experiment was produced using calcined waste sediment from tap water production as an additive in pottery clay. For a new design of water saving pot, nano-porous pottery was placed in a container and surrounded with an amount of water. Then, water diffusion through the pottery was the method to provide water for a plant. Compared to general pots in which the plant was daily watered, the new nano-porous design of the pots showed 2 times lower water consumption than general pots. This new kind of pot is useful for people who live in skyscrapers and there is no time to water their plants. The result from consumer survey showed that it has potential for commercialization.

Keywords: design, nano-porous pottery, water saving, commercialization

1. Introduction

In nature, plant and human have coexisted for ages because of the many advantages of plants. Although nowadays peoples' daily lives have changed, they still realize the importance of plants and thus they decorate their living quarters with various kinds of plant. As even workplace and apartments are nowadays located in skyscrapers, people need to grow their plants by using either container or pot. Nano-porous pottery was developed using calcined waste sediment from tap water production as an additive in pottery clay [1]. After firing at 900oC, the pottery showed higher porosity, water absorption and flexural strength than general pottery. Therefore this research is to design a new type of plant pot from nano-porous pottery when water diffusion through pot is a way to provide water for plant without watering. Finally, consumer survey is a process to study the possibility for commercialization. Suggestions and interview transcripts are summarized and analyzed for new forms of plant pot. This is done by considering the project requirements which are comprised of three components: needs or benefits, forms and technologies which applied the widely-accepted new product development by Ulrich and Eppinger [2].Consumer survey emphasizes user needs and establishes acceptances after production. Following NPD, a questionnaire is designed by adapting Technology Acceptance Model: TAM concepts in order to use it as acceptance indicators of the proposed pot [3]. Then commercialization is considered by studying 4 dimensions of feasibilities: Marketing, Technical, Management and Financial in order to evaluate its potential for launching into the market.

2. Experiments

2.1 Product Testing

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2.1.1 Water absorption

Two types of pots, i.e. nano-porous pottery and general pottery, were used for this experiment. A simple method for water absorption test was performed by soaking the pots in water for 24 h. The percent of water content in the pots was calculated from weight measurement of dried pot and wet pot after soaking in water for 24 h by equation as below:

$$\textit{Water absorption (\%)} = \frac{\text{Wafter} - \text{Wbefore}}{\text{Wbefore}} \times 100$$

*Wafter = Weight of a wet pot after soaking

Wbefore = Weight of a dried pot before soaking

2.1.2 Water consumption

A new form of pot was designed by placing the nano-porous pot without hole at the bottom of a container and surrounding it with water (Fig.1). Water consumption and plant growth were studied in four conditions of planting.

Condition 1 : Planting in nano-porous pot with 450 ml of water surrounding and no watering.

Condition 2 : Planting in general pot without watering.

Condition 3 : Planting in general pot and daily watering 10 ml.

Condition 4 : Planting in general pot and daily watering 30 ml.

Fig. 1 New design of nano-porous pottery.

2.2 Possibility for commercialization

2.2.1 Consumer Survey

Survey methodology was used for an empirical analysis. The questionnaire was designed and developed by authors from a thorough literature review. It was validated in a pre-test carried out by means of several personal interviews with interior designer, landscaper, gardener, skyscraper resident and employee, altogether around 10 people. The interview results allowed us to purify our survey items and rectify any potential deficiency.

The first identification of the new and innovative product by exploratory research with references to the product specifications identifies the ability to absorb water, which focused the lighter weight and durability of product shelf life. Then the results of the survey were analyzed to resolve by the Ulrich and Eppinger [2] theory which spells out the unmet needs of consumers as the most important ones. One result of the interviews was that most users are concerned with the sustainability of the plants. If a consumer purchases a plant at an affordable price, he needs to water the plant every day and complains that the current heavy pots exhaust him, especially when they have to be lifted. Nowadays Bangkok is growing up in the real estate industry highly visible from the table 1.

Table 1 The number and percentage of skyscrapers in Bangkok ,Thailand

Type of living quarters	Jan-Sep	
	2006	2007
Townhouse and Office Building	13,333	9,724
Proportion of Townhouse and Office Building	20%	19%
skyscraper Residential (unit)	13,243	13,146
Proportion of skyscraper Residential	20%	25%

Source : Government Housing Bank, Thailand

In Bangkok and its vicinity the proportion of skyscraper residential units makes up around 20% of all types of housing. The figures indicate that there is a change of lifestyle. Housing is decorated by plants as they also serve as a natural way to reduce toxic pollution. With limited space for planting in townhouse and skyscrapers as well as residential units close to nature, pots are always in high demand.

For a new form of plant pot, the acceptance studies were conducted from samples which are indicators of approvals and disadvantages of the general pot. Inquiries and interviews were done by focusing on people who are experts in planting industry, condominium and apartment residents, and organizational gardeners. It has to be ensured that the product has potential to maintain the humidity, which is important for the growth of the plants.

3. Results and Discussion

3.1 Product characteristics

Table 2 Water absorption of pottery

Type of pottery	Water Absorption (%)
Nano-Porous Pottery	17.49 ±11.3
General Pottery	9.31 ± 8.47

From table 2, the nano-porous pottery shows higher water absorption than general pottery. This finding indicates that the nano-porous pottery is more porous than general pottery; therefore, water diffusion through pot is improved for plant.

Table 3 Water consumption of plant in different conditions

Condition	Total water consumption (ml)	Days	Feature of plants
Nano-porous pot	450	30	Straight trunk, natural green leaves
General pot without watering	0	10	yellow and dark brown leaves, swaying trunk
General pot with daily watering 10 ml	130	13	yellow and dark brown leaves, swaying trunk

General pot with daily watering 30 ml	900	30	Straight trunk, natural green leaves

From Table 3, the plant in general pot without watering died after it was left for 10 days. In the case of daily watering at 10 ml, the plant survived only for 13 days, and the total amount of water consumption was 130 ml. There were only two scenarios that allowed the plant to survive for 30 days, namely the plant in the nano-porous pot and in the general pot with daily watering at 30 ml. However, total water consumption of plant in the nano-porous pot is only 450 ml of water when the general pot with daily watering 30 ml. needs 900 ml of water.

Finally, samples were randomly selected from people who are involved in planting: employees, gardeners and skyscraper residents. Ten samples were required to figure out a form of nano-porous pottery product and acceptance of the product. The results showed that the interviewees were interested in the product because it was an easier way to take care of their plants.

3.2 Limitation and future research direction

This study is only at the beginning of research. It has some limitations. First, this study uses only samples from Bangkok, Thailand, but not different other places in the world. Second, the innovative design size of the pottery product is small enough to be used as examples in the trial process only. However, the limitations also provide opportunities for the future research discussed in the next section.

4. Conclusion

New design of the nano-porous pot is another way to reduce water consumption for watering plants. The nano-porous pot satisfied the needs of those who live in skyscrapers and for those who have to travel for long periods of time and are thus absent from home. Therefore, this research is an innovation of a useful product and suited for using in daily life.

5. Acknowledgements

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6. References

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