Research Article

Received: 30 March 2021 / Accepted: 3 June 2021 / Published: 8 July 2021

Designing of Wet Transformers as Artificial Soil for Flower Tree Cultivation

Songwut Egwutvongsa

Somchai Seviset

Department of Architectural Education and Design,
King Mongkut's Institute of Technology Ladkrabang,
Bangkok, Thailand

DOI: https://doi.org/10.36941/ajis-2021-0098

Abstract

This research is focusing on designing of wet garbage transformers as artificial soil. According to the result, it represented that the artificial soil can be brought to cultivate Marigold trees to be abundant with giving for Grade B flowers. Moreover, it has the duration to bloom in short times with good quality of tree's height and suitable size of flower's diameter. However, the customer satisfaction is depending on equipment uniqueness and applying convenience with the regression equation that is congruent to $\hat{y}$ = (4.478) +(-0.002 X1) +(-0.066 X2) +(0.011 X3) +(0.074 X4) as in the form of criteria scores which is congruent to Z = (-0.003 X1) +(-0.088 X2) +(0.017 X3) +(0.095 X4).satisfaction at the excellent level for people in the development communities (Mean=4.10, S.D. =0.78).

Keywords: *Designing, Wet Transformers, Artificial Soil, Flower Tree Cultivation*

1. Introduction

In this current day, the environment conservation is in the worldwide trend that our human beings have given with importance, especially for our world situation to face with the global warming problem. Besides, it has affected in negative way to our human beings throughout the world severely in this age including of the occurring of natural phenomenon to make our lifestyles change, such as drought, flood, fire, inclement weather, etc. In this case, nowadays Thailand is facing with the problem of high quantities for litters in the big towns, and it results from the expanding ratios of the two times enlarged towns in each year and the movements of the rural populations into the towns to cause the garbage problem. On the same way, it is also involving with the consuming behaviors of people changed from the past with the increasing ratios from times to times, (Steward, F., 2012; Marzbali, M. H., *et al*, 2021).

Thus, in this age there are more litter quantities with the averages per day with 9,747 tons to cause the environment problems in the surrounding areas, such as bad smelling problem, decaying atmosphere, infected disease problem, polluted water problem, etc., (Apipattanavis, S. *et al*., 2018).

The general garbage problem and the wet garbage of Thailand, it should have the measurement to place of the big town expanding by stimulating for common people to realize about the environment conservation. Then, it is capable to reduce for the litter quantities in households with increasing of the procedures to reuse the litters for being applied once again. Therefore, it enables to

reduce the removed litter quantities and adds more values to the wet garbage or the left over from households until becoming to be the valuable things for being transformed to have the positive results for our environments. As the result, it must be operated through the transformation process for being the sustainable development to our human-beings and our surrounding environments in the communities.

Additionally, the artificial soil from the wet garbage it represented that in this research it has the improvement guideline for the wet garbage's transformation procedure for being the artificial soil. Then, it enabled to reduce the releasing of greenhouse effect quantities based on the perfect procedure of wet garbage management with the full circle for reducing of laborers as well as the expenses for the wet garbage procedures and the transformation steps in the most way. Thus, it affected to the applying for agricultural works in households and communities. Similarly, it has the improvement guideline for the wet garbage transformation procedure as the artificial soil with the ability to reduce for carbon releasing ratios in the environments according to the concept idea of carbon credit. Therefore, it is called the management to release of the greenhouse effect quantities based on the perfect procedure of full circle wet garbage management for solving with the above problems applying with some friendly agricultural works. Consequently, it brought to the promotion of waste reduction, especially for the numerous wet litters in households and communities for enabling to manage by themselves as well as making environment conservation. As the result, the wet garbage could be transformed as the artificial soil with the abundant of plant nutrients created as Protocol including of the benefits to communities and local areas directly with the participation in Green and Low Carbon Society.

In this research, it is focusing on the creation of realization and views to bring the society into the sustainable development. Furthermore, it is the action for prevention in society and relieve of the natural disasters in the future from the wet garbage management to cause the environment problems to our society in the country as overall (Hazra, T. & Goel, S., 2008). What is more, it can make expectation from the care in public sector and in the social sector or in the organization sector to join in the environment management procedure with development as well as the garbage reduction problem with the people participation in communities or society as the sustainable wet garbage management. Then, it can build up the friendly society to environment with good creation regaining to our world in the future (Seadon, J., 2010; Saxena, N., *et al*, 2020).

According to the procedure learning it is related with the bringing of the left over in households or the wet garbage in community areas to be reused, such as food waste, vegetable waste and fruit waste. Thus, these litters caused the environment problem in high level by releasing the bad smell from the rotted waste and becoming as the disease sources. Thus, provided that these litters are transformed as the artificial soil for plant cultivation it could be the guideline to be managed easily, especially through the suitable transforming procedure to gain the good potential of artificial soil with excellent natural balancing (Cheuk, W., *et al*, 2003). Similarly, the artificial soil made from wet garbage to the organic plant cultivation is capable to increase the benefits as the economical values increasingly (Abdallah, M., *et al*, 2020; Xuan, L., *et al*, 2021). In this case, the unvaluable wet garbage can be valued up to be beneficial for environments as well as contributing as garbage quantity reduction in households, air pollution reduction and dirty reduction with sources to infect diseases. As the result, the people can apply for firm jobs from the wet garbage transformation.

2. Methodology

Research Objectives

- To design the wet garbage transformers as the artificial soil for flower trees to obtain the satisfaction assessment results from the sugar palm fiber products.
- To make comparison of growth ratios for flower trees from artificial soil made from wet garbage.
- To take suitability assessment from wet garbage transformers as the new artificial soil.

3. Research Framework

The concept framework, it is based on the designing of wet garbage transformers as the artificial soil. Then, it can bring this concept idea with the environment cares and the joining of wet garbage removing in each household or community for being transformed as the artificial soil; it can applied for plant cultivation in households or communities to regain the balancing for natural and environments (Keativipak, K., *et al*, 2020; Liu, D., *et al*, 2020; Tamaki, S., *et al*, 2021). Then, it can make view and realization creation in society and communities through the transforming procedure for environment effect reduction or ZERO=0 according to the policy of Thailand 4.0. In this case, it is the policy vision to alter the original economics to be the new one for being moved with friendly innovations.

The concept framework with three-dimension balancing, it contributes to the sustainable development in the context of the future development for developing countries, (Agamuthu, P. & Herat S., 2014; Trifonov, S. V., *et al*, 2019) comprising with this following:

- Economic Balancing according to the concept idea of Askiner Gungor and Surendra M. Gupta, it enables to create economic values to become the unvaluable things with the added value incomes returning in the product cycle system for once again, (Gungor, A. & Gupta S. M., 1999; Pan, D., *et al*, 2020).
- Social Balancing can contribute the sustainability and the strength to human lifestyles occurring to the stabilization in communities and local areas to have good potential in themselves (Rosa, Friska Octavia, *et al*, 2020; Schwabl, D., *et al*, 2021; Zorpas, A. A. 2020).
- Environment Balancing can be developed with the utilization representing to the friendliness of environments and the ecology system with the positive effects by focusing on the sustainable utilization (R. P. Singh, *et al*, 2010; Mak, T. M. W., *et al*, 2020).

4. Methods

It begins with the designing step by using the wet garbage transformers as the artificial soil for flower trees to reduce the environment effects for learning society as well as bringing people dwelling in local areas to have participation of solving problems together based on the influencing factor learning to the designing (Dururu J. *et al*., 2015; Wojnowska-Baryła, I., *et al*, 2020).

- Population is the head group of people in the model community areas as the name of Bulamduan Community for removing of garbage located at Muang Municipality, Muang District, Buriram Province of Thailand with totals of 8 people according to the Community Head Numbers in this area of A.D. 2019.
- Group Sampling: Head Community in the model community area to remove the garbage located at Bulamduan community, Muang Municipality, Muang District, Buriram Province of Thailand with the totals of 6 people by selecting the Purposive Sampling as the attributions of the leader community in Muang Municipality area of Thailand. Besides, most people in this community have the knowledge and understanding about the wet garbage management in their own community area.
- Research Tool: Questionnaires to be qualified from the checking of content validity as the structured one with 5 rating scale that is comprising of Reliability, Cronbach's Alpha Coefficient in the level of 0.98 by analyzing data with the descriptive statistics, according to the concept idea of Cohen (Cohen, S.M., *et al*., 1989), such as Analytic Hierarchy Process: AHP (Ruoning, X. & Xiaoyan, Z., 1992).

It is relying on the testing step of flower tree cultivation with Marigolds by using of the artificial soil from the wet garbage through the transforming procedure. Moreover, it must be applied with the new developed artificial soil as completely randomized design from bringing the samplings to send into the Science Office for Land Development of Department of Land Development in Thailand. After that, it would be checked with analyzing of N, P, K, pH, EC, Moisture as the criteria of artificial soil in

3 formulas wet garbage and the trade mixed soil. In this case, all soil could be tested for Marigolds cultivation. Additionally, in this research it should apply the Marigolds as the testing trees for studying the growth beginning with moving the little trees into the planting bags with 6 inches size after 15-60 days. Later, it should study the duration of full blooming to measure with the flower numbers per each tree including of the height and the diameters for making the data analysis of ANOVA, (J. Aleong & D. Howard, 1985). Thus, it can make comparison for the growth and the production of Marigolds in each testing group by making comparison of differences for Means between Treatments according to the applying with the Method of Duncan's Multiple-Range Test, (DMRT) (Adam, A. *et al*, 2015).

According to the suitability assessment for wet garbage transformers as the artificial soil, it can make the prediction equation of satisfaction values for the customer groups affecting to the wet garbage transformers as the new developed artificial soil.

- Population is the group of people located in Muang Municipality Area of Buriram Province in Thailand with the totals of 26,206 people according to the National Statistical Office of A.D. 2019.
- Group sampling is the customer group located in Muang Municipality of Buriram Province with the totals of 416 people by using the Stratified Random Sampling classifying into with eighteen communities in Muang Municipality of Buriram Province in Thailand.
- Research tool is being applied with the checklist structure questionnaire as 5 Likert's scale according to the satisfaction value level from testing the new developed model wet garbage transformers (Santos, A. D. P, *et al*., 2019). With this case, it should measure the statistical value of reliability from 10 group samplings. As the result, it represented that the value of Cronbach's alpha was in the level of 0.824 to make data analysis with statistical descriptive value (Cohen, S.M., *et al*., 1989), such as Means, Standard Deviation, Multiple Regression Analysis and T-test Independent (Scaletsky, C. C, *et al*, 2019).

5. Results and Discussion

The research result from the designing of wet garbage transformers for flower trees or Marigolds, it used the research to solve the wet garbage problems in communities. Besides, this is the procedure to promote the communities conforming with the Community Research and Community Development Planning as the research procedure. With this case, it is emphasizing on study and analysis with the good context of community to make understand about the designing factors with the sustainable development of the potential costs in communities (Agamuthu P, *et al*, 2009). Thus, it is involving with the brainstorm for the model community group as the wet garbage management and the expert engineering group for the mechanism system of machine. As the result, it aims to create the concept idea of the wet garbage transformer as the artificial soil with the studying step influencing to the model product designing as these details:

Customer Group Data: it focuses on the suitable transformer procedure in communities or in local area with numerous wet garbage to response of the behaviors for applying conveniently, rapidly, and not dirtily. Then, according with the aspect in the past people in communities viewed that the wet garbage is the valuable matters to add for the economic values as well as building up the environments in society to be better in the future (Egwutvongsa, S. *et al*, 2018; Yousefloo, A. & Babazadeh, R. 2020).

Technology Data: it focuses on the building up of technology integration in communities or in local area to be capable for maintaining and taking care easily as well as being beneficial to apply conveniently with the steps; namely, throwing the litters in the bin, transformation and gaining the results as the effective artificial soil for flower tree cultivation.

Wet garbage transformer: it focuses on the wet garbage transformation with the procedure data as artificial soil for flower trees cultivation by using for the mixing integration, such as wet garbage remaining, black husk and manure as the main mixing to develop for the suitable artificial soil

formula. What is more, the three main mixing integration can be found easily because it is the remaining from agriculture in their own community areas as the potential materials in community areas.

Responding data as the low carbon society concept idea: it focuses on the procedure design as the sustainable development to reduce the green gas effect from the transforming procedure of wet garbage as the artificial soil causing the increasing expenditure or gaining the new procedure as the result to promote the low carbon society (Shams, S., *et al*, 2017), as well as reducing the releasing of Co2 in transformation procedure suitably (da Graça Carvalho, M., *et al*, 2011; Wu, H., *et al*, 2020).

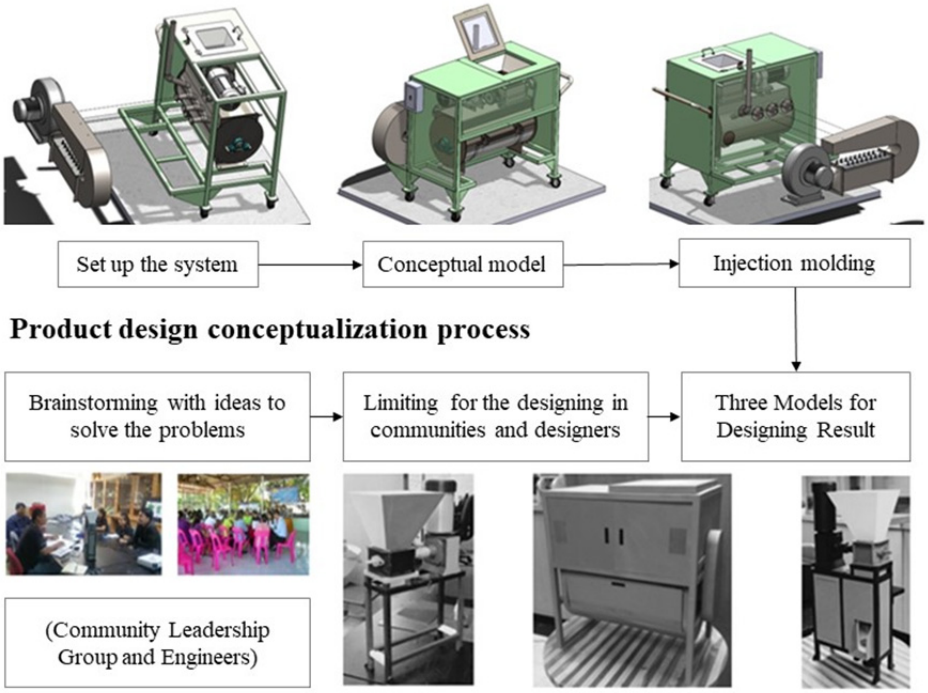


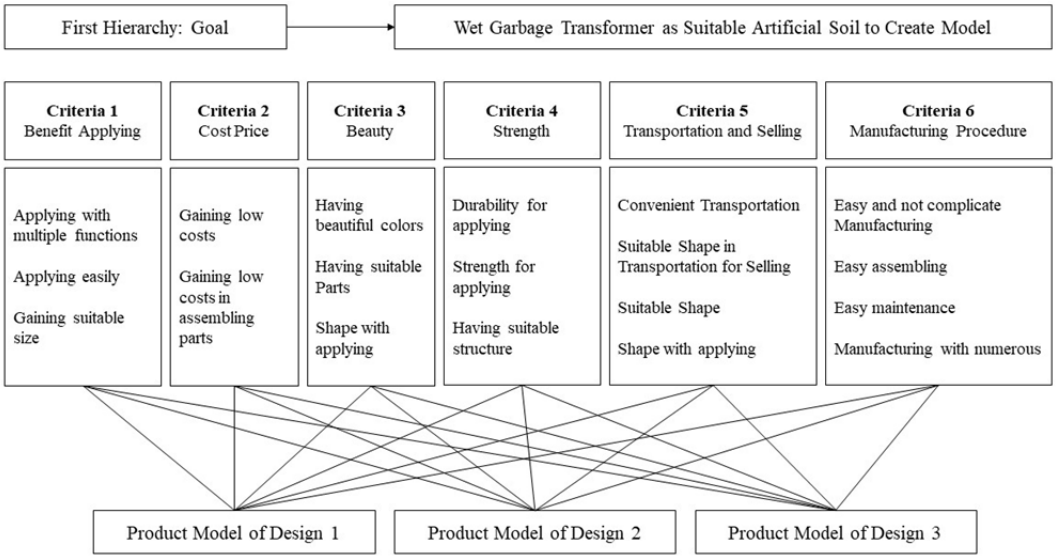
Figure 1: Three patterns of brainstorming ideas for community leaders and people group joining to show concept idea with modeling design.
Source: Author

It brought three patterns of wet garbage transformers to make analysis by applying AHP or Analytic Hierarchy Process as creating the orders and the decision steps applying to solve the problems with gaining the most effectiveness (Vaidya, O.S. & Kumar, S., 2006; Sharma, H., *et al*, 2020).

The checking procedure to make the comparison of importance for the decision criteria, it applied six ones to make for Pair Wise Comparison as well as determining the weight value based on the assessment result from engineering group and community representatives with the totals of six people. Therefore, it enables to remove the model garbage superbly (Xu, Z. & Wei, C., 1999).

The using of questionnaires as the characteristic of positive attitude and negative attitude by focusing on quality knowledge response, it is the own feeling to alter with the assessment result as the valid quantity by checking with significance.

Table 1: Hierarchy of decision structure affecting to wet garbage transformers as new developed artificial soil.



Source: Author

The assessment result to calculate through Metrix table of Pair Wise Comparison for significant number values from the informants, it represented that the total of first criteria to be equaled to 2.26 as well as the total of second criteria to be equaled with 1.24, the total of third criteria to be equaled to 0.91, the total of fourth criteria to be equaled to 0.74, the total of fifth criteria to be equaled with 0.54 and the total of sixth criteria to be equaled with 0.29 as showed in the table 2.

Table 2: Calculating of eigenvector value.

Criteria	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Horizontal Sum	Eigenvector Value
Criteria 1 for applying	0.40	0.57	0.60	0.19	0.33	0.17	2.26	0.377
Criteria 2 for Price Costs	0.13	0.19	0.25	0.28	0.17	0.22	1.24	0.211
Criteria 3 for beauty	0.06	0.06	0.08	0.37	0.17	0.17	0.91	0.151
Criteria 4 for Strength and Durability	0.20	0.06	0.02	0.09	0.28	0.09	0.74	0.123
Criteria 5 for Transportation and Selling	0.08	0.06	0.03	0.02	0.05	0.31	0.54	0.090
Criteria 6 for Manufacturing Procedure	0.13	0.04	0.02	0.05	0.01	0.04	0.29	0.048
Totals	1.00	1.00	1.00	1.00	1.00	1.00	6.00	1.000

Source: Author

The assessment result with Eigenvector value, it was found that the applying attribution was in the level of E = 0.377 following by the second rank or the price and the manufacturing costs in the level of E = 0.211, the third rank or the beauty in the level of E = 0.151 , the fourth rank or the strength and the durability in the level of E = 0.123 , the fifth rank or the transportation and the selling in the level of E = 0.090 and the sixth rank or the manufacturing procedure with 0.048 as CI. Value = 1.599/5 = 0.319 including of RI. Value = 1.24 by making comparison with table N = 6 and Random Consistency Index: RI. And CR. Value = 0.319/1.24 = 0.25 to be found that CR. Value gaining the Criteria Aviation in the level of 0.25.

Table 3: Metrix with alternative comparison as the regulated rules.

Criteria	Criteria 1 for Applying	Criteria 2 for Price Cost	Criteria 3 for Beauty	Criteria 4 for Strength and Durability	Criteria 5 for Transportation and Selling	Criteria 6 for Manufacturing Procedure
Weight Criteria	0.377	0.21	0.151	0.123	0.09	0.048

Source: Author

According to table 3, it is relating with the transformer pattern as the first concept idea to receive Eigenvector value = 0.380 as well as the transformer pattern with the second concept idea to receive Eigenvector value = 0.536 and the third transformer pattern with Eigenvector value = 0.079. In this case, Eigenvector value can be ordered with the alternative way as each guideline of designing concept idea for wet garbage transformers as the new developed artificial soil.

Table 4: Calculation of eigenvector value for three designing patterns.

Criteria	Pattern of Design 1	Pattern of Design 2	Pattern of Design 3	Horizontal Sum	Eigenvector Value
Pattern of Design 1	0.318	0.294	0.530	1.142	0.380
Pattern of Design 2	0.636	0.588	0.384	1.608	0.536
Pattern of Design 3	0.045	0.117	0.076	0.238	0.079
Vertical Sum	1.000	1.000	1.000	3.00	1.000

Source: Author

CI. = [3.113-3]/[3-1] = 0.113/2 can be made as the value of CI. = 0.056, RI value. = 0.58 (Comparing as the table of N=3 with Random Consistency Index: RI.) The value of CR. = 0.056/0.58 = 0.096 to be found as CR. = 0<0.01 to be accepted.

According to Consistency Ratio: C.R., it was in the level of 0.096 which the result assessment of the questions had the acceptable Criteria Aviation with Rational Consistency less than 0.1. Then, it enables to bring the analysis result to determine the alternatives in each pattern for the wet garbage transformers as the new designed artificial soil.

The conclusion of AHP (Analytic Hierarchy Process), it can design the wet garbage transformers as the artificial soil from six criteria as well as selecting the designing result by the engineers and the community leaders. In addition, it can give the alternative relationship weight in each designing guideline according to the considering criteria with significance. Thus, it can check for the consistency of criteria to be in the acceptable level with analysis result.

Table 5: Ordering choices to the model product selection.

Criteria and Choice	Criteria 1 for Applying	Criteria 2 for Price Cost	Criteria 3 for Beauty	Criteria 4 for Strength and Durability	Criteria 5 for Transportation and Selling	Criteria 6 for Manufacturing Procedure	Weigh the importance of choice
Threshold value	**0.37**	**0.21**	**0.15**	**0.12**	**0.09**	**0.04**	
Design 1	0.06	0.05	0.03	0.02	0.01	0.01	0.18 [3]
Design 2	0.11	0.03	0.01	0.03	0.01	0.01	0.20 [1]
Design 3	0.11	0.03	0.02	0.03	0.00	0.00	0.19 [2]

Source: Author

According to the table 5, it can make the analysis conclusion from the alternative weight values according to six criteria as well as selecting the designing concept idea for three patterns. In this case, it was found that the concept ideas of Design 2 is the suitable one to be applied as the model products of wet garbage transformers for being the first alternatives in the level of 0.20, the concept idea of Design 3 as the second alternatives in the level of 0.19 and the concept idea of Design 1 as the third alterative in the level of 0.18.

Later, it brought the pattern of Design 2 by making analysis of physical components for work

pieces and analyzing the problems of CAE: Computer-Aided Engineering with using of Boundary condition. Similarly, it used load to explain the releasing of Semiliquid discharge characteristics as the physical food waste or the wet garbage falling from the top box through the small grinding blade. After that, it moved from the below box to be mixed with other components. Therefore, according to the analysis result it was found that the internal pressure value inside the small grinding blade had the least value in the blue zone. With this case, the wet garbage was brought into the transforming procedure prior to be separated for the food waste from the water. Thus, the remaining of wet garbage was moved into the mixing step by using razor blade with constant increasing pressure while the remaining of wet garbage would be cut by the small grinding blade as the final stage slowly than the beginning step on the top box. After that, the wet garbage remaining was crushed prior to be flown slowly and then dispersed in every direction that the razor blade has turned. As the result, the action force value affected to wet garbage prior to be crushed and flown into the placing area and mixed with the material and other components.

The analysis of simulation pattern, it is related with the Default setting and the Semi-liquid for flowing ratios of 2 kg/s and the small cog blade with the rotating blade value of 151.844 rad/s equally with 1450 rpm. Besides, according to the result analysis or Pressure/Pa it had the lowest pressure value in the level of 99343.31 [Pa] and the highest-pressure value in the level of 104046.23 [Pa]. With this case, as the part of flowing for the wet garbage remaining as the essential nutrient mixing of plants it represented to the flowing through the crushing channel of blade with the speed ratio value or m/s in the level of 0.748 m/s with Meter per second. In addition, according to the speed ratios in this level it represented that it enables to crush the wet garbage remaining finely for applying.

Table 6: Analysis of simulation pattern in crushing part inside the machine.

Analysis Value	Lowest Value	Highest Value
Pressure [Pa] /pressure value	99343.31	104046.23
Velocity [m/s]/speed ratios	0	0.748

Source: Author

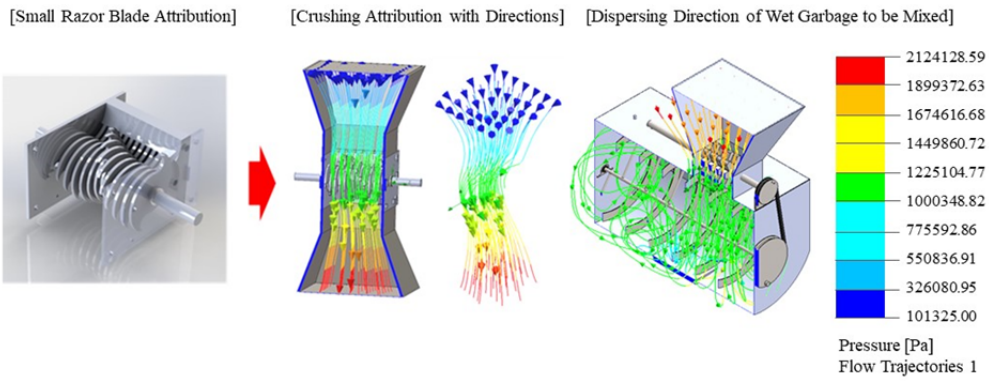


Figure 2: Simulation to appear the pressure value or pa in the lowest level of 99343.31 pa with the highest level for 104046.23 pa, the speed ratios value or m/s in the highest level of 0.748 meters per second.
Source: Author

According to figure 2, it was found that the result of density fluid in materials from the system had the value in the level of 1000 kg/m^3 with the pressure value or Pa in the lowest level of 99343.31 [Pa]

or in the highest level of 104046.23 [Pa] with the temperature value or K. Besides, it had the small crushing procedure with wet garbage and the flowing combination by using the mechanism of small grid as the temperature to the material surface in the level of 293.20 K and the temperature value of crushed wet garbage in the level of 392.10 K. What is more, it is in the speed ratios from the system as the highest level or 0.748 m/s (Meter per second) to be appeared with the Relative Pressure/Pa as the lowest level or 1981.69 [Pa] and the highest level or 2721.23 [Pa]. Therefore, it still has the shear stress force resulting from the shear stress value [Pa] in the lowest value ratios or 0.02 [Pa] and the highest-level value ratios or 129.90 [Pa]. As the result, according to the simulation it was found that the pattern of Design 2 is suitable for the shapes and the mechanism system with the manufacturing readiness as being the product models for the real test.

Figure 3: The Design 2 model is used to produce the wet waste converting machine into the prototype artificial soil.
Source: Author

The property test for artificial soil from wet garbage and Marigolds cultivation test by using artificial soil from wet garbage, it was tested in the model community areas with the garbage management of Thailand through the new designed machine. Then, it brought the artificial soil from wet garbage to be tested for the artificial soil nutrient value from wet garbage as two patterns:

1. The property test of artificial soil from wet garbage
2. Flowering plant cultivation test for marigolds in four soil formulas, such as three formulas artificial soil from wet garbage remaining in the new pattern transformers, one kind of mixing soil for trade to be tested for planting with 60 days and result record of marigolds growth.

In this case, the new developed artificial soil from wet garbage transformers can be produced with the mixing ratios: 1. Mixing of artificial soil from first formula wet garbage, such as wet garbage remaining with 10 percent, burnt rice husk with 30 percent, soybean meal with 30 percent, cow dung with 30 percent 2. Mixing of artificial soil from wet garbage in the second formula, such as wet garbage remaining with 20 percent, burnt rice husk with 30 percent, soybean meal with 30 percent, cow dung with 30 percent 3. Mixing of artificial soil from wet garbage in the third formula, such as wet garbage remaining with 20 percent, husk with 20 percent, burnt rick husk with 20 percent, soybean meal with 20 percent and cow dung with 20 percent.

Table 7: Analysis result to find the value of N, P, K, pH, EC, moisture, GI.

Soil Sampling	N (%)	P (%)	K (%)	pH	EC	Moisture (%)	GI (%)
[1] Soil for Selling	0.29	0.33	0.43	6.70	0.67	4.32	81.07
[2] First Soil Formula from Wet Garbage	0.80	0.41	0.85	8.35	1.99	4.58	88.07
[3] Second Soil Formula from Wet Garbage	1.32	2.19	1.04	7.36	2.59	2.97	90.15
[4] Third Soil Formula from Wet Garbage	1.49	1.23	1.47	8.13	3.47	6.36	95.90

Source: Author

According to table 7, it was found that the soil for trade had the chemical value less than artificial soil from three formulas of food waste as some characteristics. In addition, it had the density value in the level of 4.32 (percent w/w), germination index with 81.07 percent, nitrogen nutrient quantities with 0.29 percent, phosphorus nutrient quantities with 0.33 percent, potassium nutrient quantities with 0.43 percent as well as pH value in the level of 6.70 and EC value in the level of 0.67. What's more, it is including with three formulas of artificial soil from wet garbage as density value in the level of 4.58, 2.97 and 6.36, germination index value in the level of 88.07, 90.15 and 95.90 percent, nitrogen nutrient quantities in the level of 0.80, 1.32 and 1.49 percent, phosphorus nutrient quantities in the level of 0.41, 2.19, 1.23 percent and potassium nutrient quantities in the level of 0.85, 1.04 and 1.47 percent and pH value in the level of 8.35, 7.36 and 8.13 respectively.

Figure 4: Experiment to cultivate marigold plants with artificial soil from wet wastes that are transformed with the new design.
Source: Author

Table 8: Comparison of marigolds cultivation from artificial soil of wet garbage.

Soil Sample \ Marigolds	Flowering Period (Day)	Flower Buds Per Each Tree	Blooming Flowers Per Each Tree	Average Height (cm)	Diameter Size of Flowers (cm)	Flower Quality
Soil for Trade	$40^{a\ 2/}$	$2.83^{a2/}$	2.08^{b}	$42.75^{a2/}$	$6.15^{a2/}$	Grade level A
First Soil Formula of Wet Garbage	45^{b}	1.41^{b}	$2.66^{a2/}$	35.21^{c}	5.18^{ab}	Grade level B
Second Soil Formula of Wet Garbage	44^{b}	0.66^{c}	3.58^{a}	38.55^{b}	4.93^{b}	Grade level B
Third Soil Formula of Wet Garbage	49^{a}	2.58^{a}	1.08^{c}	25.66^{d}	2.20^{c}	Grade level C
F-test	*1/	*1/	*1/	*1/	*1/	
% CV	7.87	63.79	60.38	20.60	43.73	

1/ The Statistical Difference with Significance of 0.05
2/ Vertical Average with same fonts with no difference for statistical significance of 0.05 comparing to Means between testing materials by using of the method for Duncan's New Multiple Ranges Test

Source: Author

The average blooming period of marigolds as 60 days, it was found for the difference of statistical significance, such as the marigolds planted in the mixing soil for trade to bloom in the most quick times for 40 days following by the artificial soil from wet garbage remaining in the second formula to bloom in the most quick times for 44 days, the artificial soil from wet garbage in the third formula to bloom in the most quick times for 49 days.

The flower buds per each marigolds recorded in the test as 60 days, it was found for the difference of statistical significance. Moreover, it was planted in the mixing soil for trade with the average flower buds for 2.83 flowers following by the artificial soil from wet garbage remaining in the third formula with the average flower buds for 2.58 flowers , artificial soil from wet garbage in the first formula with average flower buds for 1.41 flowers , artificial soil from wet garbage remaining in the second formula with average flower buds for 0.66 flowers and the test of marigolds planted in the mixing soil for trade with the most numbers of flower buds by showing the difference of statistical significance.

The blooming flower numbers per average trees of marigolds recorded with the test for 60 days, it was found for the difference with statistical significance from the marigolds in artificial soil of wet garbage as the second formula with blooming flowers average for 2.66 flowers following by mixing soil for trade with the blooming flowers average for 2.08 flowers, artificial soil from wet garbage remaining with the blooming flowers average for 1.08 flowers and the marigolds test planted in the artificial soil from wet garbage remaining as the second formula with the most blooming numbers with difference of statistical significance.

The average height of marigolds recorded with the test for 60 days, it was found for the difference of statistical significance from the marigolds planted in the mixing soil for trade with average height of 42.75 cm. following by the artificial soil from wet garbage remaining in the second formula with average height of 38.55 cm., artificial soil from wet garbage remaining in the first formula with average height of 35.21 cm., artificial soil from wet garbage remaining in the third formula with average height of 25.66 cm. In this case, the average height of marigolds planted in the mixing soil for trade had the average height in the most way with the difference of statistical significance.

The diameter of marigolds planted in the mixing soil for trade during the blooming, it was found for the differences of statistical significance; namely, the diameter size of the marigolds planted in the mixing soil for trade with 6.15 cm. following by the marigolds planted with the artificial soil from wet garbage as the first formula with the size of 5.18 cm., the marigolds planted with the artificial soil from wet garbage remaining in the second formula with the size of 4.93 cm., the marigolds planted with the artificial soil from wet garbage remaining in the third formula with the size of 2.20 cm. In this case, it represented that the full blooming in grade A of marigolds planted in the mixing soil for trade had the diameter size of average height as the most way with showing of the difference of statistical significance.

The conclusion, it was found that the three artificial soil from wet garbage applying the transforming procedure by using the new developed transformers prior to be compared with one mixing soil formula for trade. In this case, it used the marigolds for being the test plants, and it was found that there was the growth result with different production by using the artificial soil from wet garbage remaining to be planted.

On the other hand, although it hasn't seen the better growth result and production equally to apply the mixing soil for trade, it is related with the analysis result of the value of N, P, K, pH, EC, Moisture. In addition, it showed that the artificial soil from three formulas of artificial soil from wet garbage remaining had the high level of pH value to be suitable for applying with marigolds with gaining pH value in the level of 6.5 – 7.0 Similarly, it showed that the artificial soil from wet garbage remaining had the alkali condition with high level of pH value affecting to alter the nitrogen, iron, manganese, copper and zinc to be in the form that the plants can't absorb. However, according to the artificial soil from wet garbage in the second formula it can use the plants with gaining the excellent growth result as the similar level of production for the mixing soil of trade following by the artificial soil from wet garbage remaining in the first formula and in the third formula.

The Suitability Assessment Value for Wet Garbage Transformers as New Developed Artificial Soil as these details:

1. It is involving with the analysis result for the effectiveness of greenhouse effect releasing from wet garbage transformers as artificial soil using the working mode of electric from solar cell panel. Then, the releasing ratios of carbon dioxide from the wet garbage transforming system was in the level of -6,276.92 kilograms with wet garbage in tons. Similarly, it enabled to take the result assessment from greenhouse effect releasing in each month in the level of -1.9 tons with the energy usage for the transforming procedure as the greenhouse effect releasing of MBT system in the level of 0 kilogram for wet garbage in tons. Thus, it is in the solar cell energy mode as the alternative to represent the high level of world friendliness sustainably with the least level of world effects. In this case, the wet garbage transforming procedure aided to reduce for the fertilizing production ratios as well

as the reduction of wet garbage waste and accumulated garbage and others. As the result, the above detail can develop for the new developed transformer procedure to place of the credit carbon guideline of Thailand in the future.

2. It is involving with prediction equation for customer satisfaction affecting to the new designed wet garbage transformers with the solving guideline of communities: factor assessment step influencing to the customer satisfaction levels to the new developed wet garbage transformers. In this case, it brought the model to test for real by testing in the targeted community areas as well as assisting the customers to have the real test and take assessment with the feeling during new model applying. Later, it can represent to the result assessment from four factor components based on the Multi-Criteria Decision Analysis by using the decision procedure for answer selection from the required condition problems with solving AHP technique shown in table 9.

Table 9: Representation of means, standard aviation, and influencing factors to satisfaction of wet garbage transformers as new developed artificial soil for customer groups (n=416).

Influencing Factors to Satisfaction of Wet Garbage Transformers as New Developed Artificial Soil	n=416 People		
	Mean	S.D.	Factor Level
Satisfaction to New Developed Transformers	4.54	0.55	Most level
X1) Beauty of Transformers	4.34	0.66	Excellent Level
X2) Specific Uniqueness of Transformers	4.08	0.74	Excellent Level
X3) Result of Wet Garbage Transformers	4.01	0.86	Excellent Level
X4) Convenience for Applying	4.04	0.69	Excellent Level

Source: Author

The factor assessment result of four study variables, it was found that the customer groups inside the communities were tested with the satisfaction ordering from the most level to the least level; namely, factor of X1 or beauty of transformers with excellent level of satisfaction with Mean = 4.34, S.D.=0.66, factor of X2 or specific uniqueness of transformers with excellent level of satisfaction with Mean = 4.08, S.D.=0.74, factor of X4, or convenience for applying with excellent level of satisfaction with Mean = 4.04, S.D.=0.69 and last factor of X3 or result of wet garbage transformers with excellent level of satisfaction value with Mean = 4.01, S.D.=0.86. Therefore, in overall it was found that there was the satisfaction to the new developed transformers in excellent level with Mean = 4.54, S.D.=0.55. As the result, it can make conclusion with the pairwise of correlation with significance by using t-test as the statistical testing shown in the table 10.

Table 10: Showing of multiple linear regression with satisfaction prediction of wet garbage transformers as new pattern artificial soil influencing to common designing factors (n=416).

Prediction Variable	*b*	*S.E.b*	*B*	*T*	*P*
Constant	4.478	0.316		14.190	0.000
X1) Beauty of Transformers	-0.002	0.043	-0.003	-0.055	0.956
X2) Specific Uniqueness of Transformers	-0.066	0.040	-0.088	-1.663	0.097
X3) Result of Wet Garbage Transformers	0.011	0.033	0.017	0.322	0.747
X4) Convenience for Applying	0.074	0.039	0.095	1.920	0.056

*The relationship with statistical significance of 0.05.

Source: Author

According to table 10, it represented to the relationship factors, such as satisfaction to the new developed transformers or (Y) with the specific uniqueness of the transformers or (X2) and the convenience for applying (X4). Then, when comparing to pair-wise variable it was found that the beauty of transformers or X1 had the relationship with the specific unique factor of transformers or

X2 and the specific uniqueness factor of transformers or X2 with the result factor relationship from the wet garbage transformation or X3 and beauty factor of transformers or X1 relating with convenience factor for applying or X4.

Table 11: Decision coefficient or R2 with influencing factors to satisfaction of wet garbage transformers as artificial soil with the new pattern (n=416).

Model	R	R Square	Adjusted R Square	Std.Error of the Estimate
Testing	0.1388	0.0193	0.0097	0.555

Source: Author

According to the table 11, it represented to the test result of factor that the decision coefficient or R2 had the value of 0.0193 or the test factor with the influencing to the designing of wet garbage transformers as artificial soil. Then, it can explain for the changing of satisfaction in the level of 1.93 percent by applying the effected factors to the designing satisfaction for the wet garbage transformers as the new pattern artificial soil. As the result, it can determine for the regression equation which;

$$\hat{Y} = (4.478) + (-0.002\,X1) + (-0.066\,X2) + (0.011\,X3) + (0.074\,X4)$$
$$Z = (-0.003\,X1) + (-0.088\,X2) + (0.017\,X3) + (0.095\,X4)$$

Table 12: Analysis of relationship between designing factors with satisfaction.

Test	SS	df	MS	F	Sig.
Regression Equation	2.491	4	0.623	2.018	0.091
Discrepancy	126.814	411	0.309		
Total	129.305	415			

Source: Author

According to the table 12, it is based on the predictors consisting of X1 or the beauty of transformers, X2 or the specific uniqueness of transformers, X3 or the result of wet garbage transformers and X4 or convenience for apply. In this case, it is depending on the Dependent Variable, such as satisfaction to the new developed transformers according to the analysis result or F-test = 2.018 > F-table = 2.400, and it was found that some independent variable or X had no relationship with the Dependence Variable or (Y).

According to table 10-12, it represented to multiple linear regression for satisfaction prediction of customers in the targeted community area affecting to the wet garbage transformers as new pattern of artificial soil. What's more, it was found that it had the specific uniqueness for transformers or X2 and convenience for applying or X4 with satisfaction relationship of machine or Y. With this case, it can make conclusion that the prediction equation of designing for wet garbage transformers as new pattern of artificial soil represented as these details:

a. Prediction Equation Creation in Raw Scores as these details:
   ŷ=[4.478] + [-0.002 (Beauty of Transformers)] + [-0.066 (Specific Uniqueness of Transformers)] + [0.011 (Result of Wet Garbage Transformers)] + [0.074 (Convenience for Applying)]
b. Prediction Equation Creation as Standard Scores as these details:
   Z=[-0.003 (Beauty of Transformers) + [-0.088 (Specific Uniqueness of Transformers)] + [0.017 (Result of Wet Garbage Transformers)] + [0.095 (Convenience for Applying)]

Thus, it brought the satisfaction assessment for the customer groups to be tested for real with both original product patterns and the new developed patterns and the new developed patterns in markets shown as the table 13.

Table 13: Analysis of means and standard aviation from satisfied behavior assessment with the test of wet garbage transformers as new pattern and original pattern artificial soil (n=416).

Wet Garbage Transformers as New Pattern Artificial Soil

Original Wet Garbage Transformers

Assessment List	Mean	S.D.	Satisfaction	Mean	S.D.	Satisfaction	t	Stg.
[1] It can transform the wet garbage as artificial soil.	4.02	0.74	Excellent	3.29	0.67	Moderate	-14.846	0.000*
[2] It has quick and convenient applying.	3.83	0.80	Excellent	3.49	0.72	Moderate	6.369	0.000*
[3] It has not complex transforming step.	4.45	0.60	Excellent	2.95	0.93	Moderate	-27.562	0.000*
[4] It has the quality artificial soil suitably with plant cultivation.	4.26	0.69	Excellent	2.17	0.86	Less	-38.705	0.000*
[5] It can maintain easily.	3.62	0.72	Excellent	2.92	0.74	Moderate	-13.905	0.000*
[6] It has beautiful shape for applying.	3.71	0.78	Excellent	3.03	0.67	Moderate	-13.546	0.000*
[7] It has suitable price for applying.	4.45	0.60	Excellent	4.40	0.68	Excellent	-1.096	0.137
[8] The cost of transformation per unit is suitable.	3.92	0.85	Excellent	3.17	0.79	Moderate	-13.227	0.000*
[9] It has friendliness to environments.	4.32	0.71	Excellent	3.77	0.87	Excellent	-10.088	0.000*
Overall Summary	**4.06**	**0.32**	**Excellent**	**3.24**	**0.62**	**Moderate**	**-3.540**	**0.000***

* It is different with statistical significance of 0.01.

Source: Author

According to table 13, it represented to the customer satisfaction in communities with the test. Moreover, it had the satisfaction to the wet garbage transformers as new pattern artificial soil in the higher level than the original ones with statistical significance of 0.01. Similarly, it represented that the new pattern wet garbage transformers with high level of satisfaction or Mean = 4.06, S.D. = 0.32 and original wet garbage transformers with moderate level of satisfaction as Mean = 3.24, S.D. = 0.62. With this case, the new developed wet garbage transformers had the satisfaction with eight criterions for statistical significance of 0.01, except for the suitable price for applying with no statistical significance.

6. Conclusion

This research is the integration of knowledge, designing, agriculture and environmental fields with the research. Besides, it is depending on the requirement to build up the effective wet garbage transformers from households or communities as gaining the suitable artificial soil with flowering tree cultivation. In this case, it is the friendly aspect to separate each subject to be discussed with the research results:

Designing of wet garbage transformers as artificial soil for flowering trees: the result study with the community requirements of designing procedure for wet garbage transformers to be applied in their own community

According to the above detail, it is involving with the increasing of wet garbage quantities according to the population numbers in Municipality as the quite high level of expanding ratios in each day. On the same way, it occurred the bad smell problem and becomes as the breeding sites of diseases, such as mosquitos, mouses, flies and others, (Mongkolnchaiarunya, J., 2005; Guo, X.-X., *et al*, 2020) including of being affected to the environments in the area of garbage disposal, (McBride, C. S., *et al*, 2014; Verovšek, Špela., *et al*, 2021).

Significantly, it resulted in the problems of Community Development Plan for making solutions sustainably for the partners from the garbage problem (Joseph, K., 2006). In this case, it can made conclusion with the guidelines of effective integration for communities, lifestyles, and environments to be the framework of the wet garbage transformer creation as the artificial soil; it contributed to the boosting up in our society bringing into the excellence of agriculture and sustainable lifestyles in communities (Mahmud, J., 2011). Therefore, it was the cooperate solving method from wet garbage in communities as the representation of activity guideline. With this case, it became to be the

integration with the research team conforming with the requirements and effective lifestyles for people in communities during the brainstorm procedure (Bren d'Amour, C., *et al*, 2017; Ferrari, F., *et al*, 2020; Kaszycki, P., *et al*, 2021).

After that, the researcher would make presentation of three wet garbage transformer patterns as the artificial soil to the community groups and people living inside the model communities by applying for the implying results with the six assessment criteria to make analysis through AHP or Analytic Hierarchy Process (Saaty, T.L., 1980). According to the above detail, it represented that the first concept idea pattern had the highest level of Eigenvector value as the concept idea to take assessment. Therefore, the first concept idea pattern is accounted as the suitable one to be applied in the most way with the rational consistency in the less level than.01 acceptably with the analysis of Consistency Ratio: C.R. (Ho, W. & Ma, X., 2018).

What's more, it is involving with the analysis pattern for reasonableness based on Decision Making Function by aiming at the guideline selection with connections between each criterion. Later, it effected to the satisfaction for the product users with the concept idea of selection as the most suitable level under the situations according to the criteria (J. Aczél & Saaty T.L., 1983). In other words, it is including with applying for the first concept idea pattern with simulation into the flowing of wet garbage with essential nutrient mixing of flowering trees; it wouldn't make the obstruct in the part of small grid. On the other hand, the density fluid would be in suitable level conforming with the applying of decision structure from the people group relevantly to the applying problems to create the solving guidelines. Then, it would be related with the confidence of making solution increasingly as the abstract simulation of required problems, (Saaty T. L. & Shih, H.-S., 2009).

The comparison of growth ratios for flowering trees by cultivating with wet garbage as artificial soil: the test result from the wet garbage transformers as artificial soil in model communities with research.

According to the above detail, it is involving with the physical attribution of artificial soil with three formulas of soil transformed by the wet garbage as the fine texture with brown color. Additionally, all formulas of soil from wet garbage had pH value in the high level, and the artificial soil from wet garbage applying the transforming procedure from the new developed machine of the second formula comprising of wet garbage mixing with 20 percent, ashes with 30 percent, soybean meal with 30 percent and cow dung with 30 percent. After that, it can be brought for the cultivation of flowering trees as marigolds superbly with the similar effectiveness for the mixing soil to sell in the current markets.

In addition, it is conforming to the concept idea of Martin A. Hubbe (Hubbe, M. A., *et al*, 2010) saying that the cellulose plant materials have the significant role to the creation of organic waste transforming procedure by fermentation process; it is beneficial to the soil layers for cultivation as the biomass alteration to be the organic humus (W. Czekała, *et al*, 2017). In this case, it is able to absorb water and exchange the ions significantly to cultivate for plants from using soil, and this concept idea has the direction of aiming to apply the beneficial procedure from decomposed organic garbage. After that, the soil would be full with nutrients to be applied in the agriculture area as accounting to be the solving method of wet garbage in the area of communities sustainably and friendly to environments. As the result, it can be one guideline to dispose the rotted waste as becoming to be beneficial from using natural procedure (Badgett, A. & Milbrandt, A., 2020).

Suitability assessment of wet garbage transformers as artificial soil: the new developed wet garbage transformers with effectiveness for greenhouse effect releasing reduction from wet garbage transformers into the world atmosphere (S. N. Seenappa, 2011). In addition, according to the activities of wet garbage transformers as new developed artificial soil it is based on the electric energy from solar cell panel with the positive attitude for reducing of carbondioxide quantities into the world atmosphere. Thus, it is friendly to our world environment in the high level (Milbrandt, A., *et al*, 2018; Beck-Broichsitter, S., *et al*, 2020), as well as reducing the chemical fertilizer and spoilage ratios of wet garbage to release carbon dioxide into the world atmosphere as one way. With this case, it is compared to the operation guideline conforming with the preparation plan in the project of

greenhouse effect reduction with Thailand Voluntary Emission Reduction Program: T-VER in the future. Therefore, it is accounted as the garbage management procedure in communities with sustainability (Challcharoenwattana, A. & Pharino, C., 2018). Similarly, according to the result from satisfaction assessment of the community groups it represented that the users of wet garbage transformers as artificial soil had the beauty factor of transformers with the specific uniqueness (S. N. Seenappa, *et al*, 1995; Badgett, A., *et al*, 2020). In this case, according to the result of wet garbage transformers with four factors of convenience it represented with none of relationship to the satisfaction of the community groups by the testing users.

In other words, according to the satisfaction of community groups in the original pattern of wet garbage transformers it was found that the new developed wet garbage transformers as artificial soil had the satisfaction level in eight criterions differentiating from the original ones with statistical significance of .01. However, it is not including with only one criterion as the suitable price for applying. Then, although the new pattern had the high level of satisfaction value than the original ones, it isn't different with statistical significance of .01. What's more, it is conforming with the designing concept idea to the community participation for representing of the concept idea for solving problems in society of local area (Silapasuwan, P., 2014), including of the solving guideline participation to gain effectiveness (L. Luning, *et al*, 2003; Badgett, A., *et al*, 2019).

7. Acknowledgements

Thank you to Buriram Municipality in Thailand, by supporting the research area and sample groups in this time.

The design results from this research Got a patent: 1) Patent No. 75357: Wet waste converters. 2) Patent No. 62552: Wet Waste Sorting and Grinding Machine. Information on this research process is published through the Thai news agency (MCOT). By publishing through online media "https://www.youtube.com/watch? v=mMI1Rm-y-rw" including the production process and utilization. This research was funded by National Research Council of Thailand (NRCT), Project number A118-59-027.

References

Abdallah, M., Abu Talib, M., Feroz, S., Nasir, Q., Abdalla, H. & Mahfood, B. (2020). Artificial intelligence applications in solid waste management: A systematic research review. *Waste Management*, *109*, 231-246. https://doi.org/10.1016/j.wasman.2020.04.057

Aczél, J. & Saaty, T.L. (1983). Procedures for synthesizing ratio judgements. *Journal of Mathematical Psychology*, *27*(1), 93-102. https://doi.org/10.1016/0022-2496(83)90028-7

Adam, A., Adam, M. Mohamed, I., Abdalla, F., Abdelkreim, M. & Gammareldain, A. (2015). A. Analysis of Soil NPK, Ph And Electrical Conductivity at Adham Area-Renk, Upper Nile State. *International Journal of Scientific & Technology Research*, *4*(12), 341-347.

Agamuthu, P. & Herat S. (2014). Sustainable waste management in Small Island Developing States (SIDS). *Waste Management & Research*, *32*(8), https://doi.org/10.1177/0734242X14544869

Agamuthu P., Khidzir K. M. & Hamid F.S. (2009). Drivers of sustainable waste management in Asia. *Waste Management & Research*, *27*(7), 625-633. https://doi.org/10.1177/0734242X09103191.

Apipattanavis, S., Ketpratoom, S. & Kladkempetch, P. (2018). Water Management in Thailand. *Irrigation and Drainage*, *67*(1), 113-117. https://doi.org/10.1002/ird.2207

Badgett, A., Newes, E. & Milbrandt, A. (2019). Economic analysis of wet waste-to-energy resources in the United States. *Energy*, *176*, 224-234. https://doi.org/10.1016/j.energy.2019.03.188

Badgett, A. & Milbrandt, A. (2020). A summary of standards and practices for wet waste streams used in waste-to-energy technologies in the United States. *Renewable and Sustainable Energy Reviews*, 117, 109425, https://doi.org/10.1016/j.rser.2019.109425

Beck-Broichsitter, S., Fleige, H., Gerke, H. H. & Horn, R. (2020). Effect of artificial soil compaction in landfill capping systems onanisotropy of air-permeability. *Journal of Plant Nutrition and Soil Science*, *183*, 144-154. https://doi.org/10.1002/jpln.201900281

Bren d'Amour, C., Reitsma, F., Baiocchi, G., Barthel, S., Güneralp, B., Erb, K. H., Haberl, H., Creutzig, F. & Seto, K. C. (2017). Future urban land expansion and implications for global croplands. *PNAS*, *114*(34), 8939-8944. https://doi.org/10.1073/pnas.1606036114

Challcharoenwattana, A. & Pharino, C. (2018). Analysis of Socioeconomic and Behavioral Factors Influencing Participation in Community-Based Recycling Program: A Case of Peri-Urban Town in Thailand. *Sustainability*, *10*(12). https://doi.org/10.3390/su10124500.

Cheuk, W., Lo, K. Victor, Branion, Richard M. R. & Fraser, B. (2003). Benefits of Sustainable Waste Management in the Vegetable Greenhouse Industry. *Journal of Environmental Science and Health*, Part B *38*(6), 855-863. https://doi.org/10.1081/PFC-120025565

Cohen, S.M., Bronner, G., Kuttner, F., Jurgens, G. & Jäckle, H. (1989). Distal-less encodes a homoeodomain protein required for limb development in Drosophila. *Nature*, *338*, 432-434, https://doi.org/10.1038 /338432a0

Da Graça Carvalho, M., Bonifacio, M. & Dechamps, P. (2011). Building a low carbon society. *Energy*, *36*(4), 1842-1847. https://doi.org/10.1016/j.energy.2010.09.030

Dururu, J., Anderson, C., Bates, M., Montasser, W. & Tudor, T. (2015). Enhancing engagement with community sector organisations working in sustainable waste management: A case study. *Waste Management & Research*, *33*(3), 284-290. https://doi.org/10.1177/0734242X14567504.

Egwutvongsa, S., Seviset, S. & Charoensettasilp, S. (2018). Results of artificial soil from wet garbage produced from thermal drum reprocess machine on the growth of Green Oak. *AIP Conference Proceedings 2018*, *1986*(1). https://doi.org/10.1063/1.5047124

Ferrari, F., Striani, R., Minosi, S., De Fazio, R., Visconti, P., Patrono, L., Catarinucci, L., Esposito Corcione, C. & Greco, A. (2020). An innovative IoT-oriented prototype platform for the management and valorisation of the organic fraction of municipal solid waste. *Journal of Cleaner Production*, *247*, 119618. https:// doi.org/10.1016/j.jclepro.2019.119618

Gungor, A. & Gupta S. M. (1999). Issues in environmentally conscious manufacturing and product recovery: a survey. *Computers & Industrial Engineering*, *36*(4): 811-853. https://doi.org/10.1016/S0360-8352(99) 00167-9.

Guo, X.-X., Liu, H.-T. & Zhang, J. (2020). The role of biochar in organic waste composting and soil improvement: A review. *Waste Management*, *102*, 884-899. https://doi.org/10.1016/j.wasman.2019.12. 003

Hazra, T. & Goel, S. (2009). Solid waste management in Kolkata, India: Practices and challenges. *Waste Management*, *29*(1), 470-478. https://doi.org/10.1016/j.wasman.2008.01.023

Ho, W. & Ma, X. (2018). The state-of-the-art integrations and applications of the analytic hierarchy process. *European Journal of Operational Research*, *267*(2), 399-414. https://doi.org/10.1016/j.ejor.2017.09.007

Hubbe, M. A., Nazhad, M. & Sánchez, C. (2010). Composting as a way to convert cellulosic biomass and organic waste into high-value soil amendments: a review. *Bio Resources*, 5(4), 2808-2854. https://doi.org/10.15376 / biores.5.4.2808-2854

J. Aleong & D. Howard. (1985). Extensions of the Duncan's Multiple Range Test for unbalanced data. *Journal of Applied Statistics*, *12*(1), 83-90. https://doi.org/10.1080/02664768500000009.

Joseph, K. (2006). Stakeholder participation for sustainable waste management. *Habitat International*, *30*(4), 863-871. https://doi.org/10.1016/j.habitatint.2005.09.009.

Kaszycki, P., Głodniok, M. & Petryszak, P. (2021). Towards a bio-based circular economy in organic waste management and wastewater treatment – The Polish perspective. *New Biotechnology*, *61*, 80-89. https://doi.org/10.1016/j.nbt.2020.11.005

Keativipak, K., Seviset, S. & Eakwutvongsa, S. (2020). Principles of thought to adopt cultural dimension into creative design in Thailand. *Revista espacios*, *41*(31), 66-80. https://www.revistaespacios.com/a20v41n 31/a20v41n31p06.pdf

L. Luning, E.H.M. van Zundert & A.J.F. Brinkmann. (2003). Comparison of dry and wet digestion for solid waste. *Water Science & Technology*, *48*(4): 15-20. https://doi.org/10.2166/wst.2003.0210

Liu, D., Xie, B., Dong, Y. & Liu, H. (2020). Semi-continuous fermentation of solid waste in closed artificial ecosystem: Microbial diversity, function genes evaluation. *Life Sciences in Space Research*, *25*, 136-142. https://doi.org/10.1016/j.lssr.2019.10.003

Mahmud, J. (2011). City foresight and development planning case study: Implementation of scenario planning in formulation of the Bulungan development plan. *Futures*, *43*(7), 697-706. https://doi.org/10.1016/j. futures.2011.05.011

Mak, T. M. W., Xiong, X., Tsang, D. C. W., Yu, I. K. M. & Poon, C. S. (2020). Sustainable food waste management towards circular bioeconomy: Policy review, limitations and opportunities. *Bioresource Technology*, *297*, 122497. https://doi.org/10.1016/j.biortech.2019.122497

Marzbali, M. H., Kundu, S., Halder, P., Patel, S., Hakeem, I. G., Paz-Ferreiro, J., Madapusi, S., Surapaneni, A. & Shah, K. (2021). Wet organic waste treatment via hydrothermal processing: A critical review. *Chemosphere*, *279*, 130557. https://doi.org/10.1016/j.chemosphere.2021.130557

McBride, C. S., Baier, F., Omondi, A. B., Spitzer, S. A., Lutomiah, J., Sang, R., Ignell, R. & Vosshall, L. B. (2014). Evolution of mosquito preference for humans linked to an odorant receptor. *Nature*, *515*(7526), 222-227. https://doi.org/10.1038/nature13964

Milbrandt, A., Seiple, T.E., Heimiller, D., Skaggs, R.L. & Coleman, A.M. (2018). Wet waste-to-energy resources in the United States. *Resources, Conservation and Recycling*, *137*, 32-47. https://doi.org/10. 1016/j.resconrec.2018.05.023.

Mongkolnchaiarunya, J. (2005). Promoting a community-based solid-waste management initiative in local government: Yala municipality, Thailand. *Habitat International*, *29*(1), 27-40. https://doi.org/10.1016 /S0197-3975(03)00060-2.

Pan, D., Su, F., Liu, C. & Guo, Z. (2020). Research progress for plastic waste management and manufacture of value-added products. *Adv. Compos Hybrid Mater*, *3*, 443–461. https://doi.org/10.1007/s42114-020-00190-0

R. P. Singh, M. Hakimi Ibrahim, Norizan Esa & M. S. Iliyana. (2010). Composting of waste from palm oil mill: a sustainable waste management practice. *Reviews in Environmental Science and Bio/Technology*, *9*, 331-344. https://doi.org/10.1007/s11157 -010-9199-2

Rosa, F. O., Mundilarto & I. Wlujeng, (2020). The conception of local wisdom value of Piil Pesenggiri (Indonesia) and scientific attitudes. *Revista espacios*, *41*(30), 259-268. https://www.revistaespacios.com /a20v41n30/a20v41n30p21.pdf

Ruoning, X. & Xiaoyan, Z. (1992). Extensions of the analytic hierarchy process in fuzzy environment. *Fuzzy Sets and Systems*, *52*(3): 151-157. https://doi.org/10.1016/0165-0114(92)90236-W

S. N. Seenappa (2011). Transformation of Wet Garbage of Indian Urbanites at Household Level. Universal *Journal of Experimental Research and Technology*, *1*(2), 169-175.

S. N. Seenappa, J. Rao & R. Kale (1995). Conversion of Distillery Wastes into Organic Manure by Earthworm Eudrillus euginae. *Journal of IAEM*, *22*(1), 244-246.

Saaty, T.L. (1980). *The Analytic Hierarchy Process*. New York: McGraw-Hill, 57-66.

Saaty T. L. & Shih, H.-S. (2009). Structures in decision making: On the subjective geometry of hierarchies and networks. *European Journal of Operational Research*, *199*(3), 867-872. https://doi.org/10.1016/j.ejor. 2009.01.064.

Santos, A. D. P., Medola, F. O. & Botura Junior, G. (2019). Innovation in the Design of Inclusive Toys: Development and Evaluation of a Prototype for Visually Impaired Children. *Strategic Design Research Journal*, *12*(3), 338-360. https://doi.org/10.4013/sdrj.2019.123.04

Saxena, N., Sarkar, B. & Singh, S. R. (2020). Selection of remanufacturing/production cycles with an alternative market: A perspective on waste management. *Journal of Cleaner Production*, *245*, 118935. https:// doi.org/10.1016/j.jclepro.2019.118935

Scaletsky, C. C. & Costa, F. C. X. (2019). Design Management & Strategic Design: Cross Perspectives. *Strategic Design Research Journal*, *12*(1), 27-42. https://doi.org/10.4013/sdrj.2019.121.03

Schwabl, D., Bauer, M. & Lehner, M. (2021). Advancing Plastic Recycling by Wet-Mechanical Processing of Mixed Waste Fractions. *Processes*, *9*, 493. https://doi.org/10.3390/pr9030493

Seadon, J. (2010). Sustainable waste management systems. *Journal of Cleaner Production*, *18*(16-17), 1639-1651. https://doi.org/10.1016/j.jclepro.2010.07.009

Silapasuwan, P. (2014). *Municipal solid waste: The Significant problem of Thailand*. Bangkok: Secretariat of the Senate. 57-70.

Shams, S., Sahu, J.N., Rahman, S.M. & Ahsan, A. (2017). Sustainable waste management policy in Bangladesh for reduction of greenhouse gases. *Sustainable Cities and Society*, *33*, 18-26. https://doi.org/10.1016/ j.scs.2017.05.008

Sharma, H., Vanapalli, K. R., Cheela, VR. S., Ranjan, V. P., Jaglan, A. K., Dubey, B., Goel, S. & Bhattacharya, J. (2020). Challenges, opportunities, and innovations for effective solid waste management during and post COVID-19 pandemic. *Resources, Conservation and Recycling*, *162*, 105052. https://doi.org/10. 1016/j.resconrec.2020.105052

Steward, F. (2012). Transformative innovation policy to meet the challenge of climate change: sociotechnical networks aligned with consumption and end-use as new transition arenas for a low-carbon society or green economy. *Technology Analysis & Strategic Management*, *24*(4), 331-343. https://doi.org/10.1080/ 09537325.2012.663959.

Tamaki, S., Hidaka, T. & Nishimura, F. (2021). Effects of using lactic acid bacteria in the storage and subsequent anaerobic co-digestion of crushed kitchen garbage. *Bioresource Technology Reports*, *13*, 100640. https://doi.org/10.1016/j.biteb.2021.100640

Trifonov, S. V., Morozov, Ye. A. & Kozlova, T. A. (2019). Processing of household waste in the BTLSS using the wet combustion method. *Life Sciences in Space Research*, *21*, 22-24. https://doi.org/10.1016/j.lssr. 2019.02.003

Vaidya, O.S. & Kumar, S. (2006). Analytic hierarchy process: An overview of applications. *European Journal of Operational Research*, *169*(1), 1-29. https://doi.org/10.1016/j.ejor.2004.04.028

Verovšek, Špela ., Zupančič, T. ., Juvančič, M. ., Petrovčič, S. ., Svetina, M. ., Janež, M. ., Pušnik, Žiga ., Bajec, I. L. ., & Moškon, M. . (2021). The Aspect of Mobility and Connectivity While Assessing the Neighbourhood Sustainability. *Academic Journal of Interdisciplinary Studies*, *10*(3), 37. https://doi.org/ 10.36941/ajis-2021-0062

W. Czekała, J. Dach, R. Dong, D. Janczak, K. Malinska, K. Józwiakowski, A. Smurzynska & M. Cieslik. (2017). Composting potential of the solid fraction of digested pulp produced by a biogas plant. *Biosystems Engineering*, *160*, 25-29. https://doi.org/10.1016 /j.biosystemseng. 2017.05.003

Wojnowska-Baryła, I., Kulikowska, D. & Bernat, K. (2020). Effect of Bio-Based Products on Waste Management. *Sustainability*, *12*(5), 2088. https://doi.org/10.3390/su12052088

Wu, H., Tao, F., Qiao, Q. & Zhang, M. (2020). A Chance-Constrained Vehicle Routing Problem for Wet Waste Collection and Transportation Considering Carbon Emissions. *International Journal of Environmental Research and Public Health*, *17*(2), 458. https://doi.org/10.3390/ijerph17020458

Xu, Z. & Wei, C. (1999). A consistency improving method in the analytic hierarchy process. *European Journal of Operational Research*, *116*(2), 443-449. https://doi.org/10.1016/S0377-2217(98)00109-X

Xuan, L., Gan, T., Hong, W. & Yang, X. (2021). Design and development of a domestic garbage removal management platform based on the Internet of Things. *Journal of Physics: Conference Series ICETIS 2021*, *1827*, 012197. https://doi.org/10.1088/1742-6596/1827/1/012197

Yousefloo, A. & Babazadeh, R. (2020). Designing an integrated municipal solid waste management network: A case study. *Journal of Cleaner Production*, *244*, 118824. https://doi.org/10.1016/j.jclepro.2019.118824

Zorpas, A. A. (2020). Strategy development in the framework of waste management. *Science of The Total Environment*, *716*, 137088. https://doi.org/10.1016/j.scitotenv.2020.137088