INNOVATION THAT AFFECTS MANAGEMENT SUCCESS WASTE WOOD CRATES ARE RENEWABLE TO GENERATE ELECTRICITY

Pushpong Pongsiri, Sudawan Somchai and Anamai Damnet
Graduate School, Suan Sunandha Rajabhat University, Thailand

ABSTRACT:
The application of wood crate waste management technology into renewable energy to generate electricity has low electricity production cost, provides social benefits, and is environmentally friendly. The objective of this research is to study (1) the current condition of wood crate waste management as renewable energy to generate electricity, and (2) the innovation that affects the success of wood crate waste management into renewable energy to generate electricity. It is the mixed research using quantitative and qualitative research. The quantitative research was done by surveying and analyzing the composition structural equation model with 6 studied variables. The sample group was 400 people in the Eastern Economic Corridor with the criteria of 20 times the observed variable. The qualitative sample consisted of 49 wood traders and 40 community leaders. The data was collected through questionnaires and interviews to be analyzed by descriptive statistics and composition structural equation model analysis. The research results revealed that 1) the current condition of wood crate waste management into renewable energy to generate electricity is entirely successful resulting in the reducing amount of crate waste in the area by adopting modern technology to generate electricity that provides high energy. The community participates in reducing the use of natural resources and conserving the environment. They altogether sort the waste and wood chips to sell. The community has increased income. 2) The innovation affects the success of wood crate waste management into renewable energy to generate electricity. The studied variables were found to have positive relationship on the management of crate waste into renewable energy to generate electricity. These were consistent with the empirical data at a good level. The variable with the most direct influence was the knowledge factor in crate waste management of the community followed by the innovation factor in the development of community crate waste management system and the factor of parties in the wood crate waste management of the community, respectively. The factor with indirect influence was the participation in wood crate waste management of the community.

Keywords:
Innovation / management of wood crate waste / energy
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INTRODUCTION

Amidst the condition that the global economy tends to expand more, the consumption of resources are unnecessarily excessive resulting in the rapid decline in natural resources especially in fuel resources such as natural gas, oil and coal (Hussain, Haseeb, Tvaronavičienė, Mihardjo, & Jermsittiparsert, 2020; Vafaie, Pour, Nojavan, Jermsittiparsert, 2020). As this is consumed natural energy, the search for alternative energy is a global concern. From the situation of domestic electric power that requires more energy use, the power plants are unable to produce and supply electricity to the public in all areas. Meanwhile, the government has promoted the production of clean alternative energy without pollution, development of alternative energy such as biomass, energy from waste, solar energy, wind energy, hydropower, etc. According to the policy to generate electricity from renewable energy, the biomass energy from waste materials from firewood or charcoal, sawdust, bagasse, corn cob, agricultural products, and crate waste have been ranked among the top for use into renewable energy with sufficient quality, economical, and not polluting the environment because Thailand still has a lot of these kinds of materials with low production costs.

From conducting the field trips to study the preliminary information on the real condition and the sources of wood crate waste in the large industrial factories in the Eastern Economic Corridor, the researchers found that there were

very few factories using the wood crate waste into renewable energy to generate electricity compared to the market demand. Most of them belong to private companies. Meanwhile, there was substantial amount of crate waste from large industrial factories in the area. It was also found to be unmanaged. Neither machine nor tool was used to manage the crate wastes. These factories ordered raw materials and products from abroad to be assembled for the production in Thailand and sent back to sell abroad. The raw materials were mostly imported by air transport and by ship. In order to protect the products from being broken or damaged during transportation, it was necessary to use the pallet. When the factories had taken all of the products out, most wooden pallets were still in good condition and could be used for further benefits. Therefore, in order to reduce costs, the factories collected them until there was a large quantity and then sold them with other wastes by organizing the auction to sell to buying agents. This big pile of garbage would go through the process in separating the valuable things for further use such as plastic, metal, iron, brass, copper, and aluminum. The wood would be segregated last as it was cheap both for the wood crates and pallets in good and bad conditions. The small merchants came to buy the products for sorting the good wood to make furniture, tables, cabinets, and chairs. The damaged wood in unattractive condition but could be used further would be resold to small industrial factories to be used as pallets for products sold domestically and exported to neighboring countries. When the small traders or buyers had finished selling the wood, a lot of wood wastes still remained. However, it could no longer be used because the wood was not strong. It was broken, worn out and crumbled. This wood would become the piles of wood waste waiting to be discarded causing environmental problem. Some of them were piled until being decayed. Some of them went to landfill or incinerate causing air pollution affecting the health of people living nearby.

Nowadays, in the Eastern Economic Corridor, the private sector began to use the wood crate waste as fuel to generate electricity commercially. In 2017, the private sector developed a 1 MW micro-power plant using wood as fuel such as pine, eucalyptus, rubber, and other kinds of wood found locally. The wood was used as fuel to spin the turbine to generate electricity. Initially, the electricity was generated for using in the industrial plants to reduce the costs. The remaining electricity could also be sold to the Electricity Generating Authority of Thailand. Moreover, the investment promotion was requested from the Board of Investment (BOI). The wood crate waste management with modern technology was thus a suitable choice for the Eastern Economic Corridor of 3 provinces; Rayong, Chachoengsao, and Chonburi. As a result, the wood crate waste was utilized as renewable energy with modern innovation through the process of being converted into renewable energy to generate electricity. This was in line with the government policy towards zero waste society based on the 3R concept of Civil State focusing on upstream solid waste managing with the participation of the government and people (Pollution Control Department, 2019). Thus, the researchers were interested in studying the innovation affecting the success of wood crate waste management into renewable energy to generate electricity as a model of wood crate waste management for those interested in investing. It could be the academic database for the government, private sector and related civil society as well as being a way to promote job creation, career creation, income generation, and strengthening the community with stability, wealth and sustainability.

RESEARCH'S OBJECTIVES

1. To study the current condition of wood crate waste management into renewable energy to generate electricity.
2. To study the success of wood crate waste management into renewable energy to generate electricity.

RESEARCH'S CONCEPTUAL FRAMEWORK

From the study and extraction of variables, the researchers determined the variables for studying the model of waste management, storage and transfer of the local government organization, consisting of 6 variables; 1. Success in managing wood crate waste into renewable energy to generate electricity, 2. Factor of knowledge in crate waste management, 3. Factor of public policy of agencies involved in the wood crate waste management, 4. Factor of public participation in crate waste management 5. Factor of networking of agencies and people in the crate waste management, 6. Factor of innovation of agencies and people in the crate waste management.

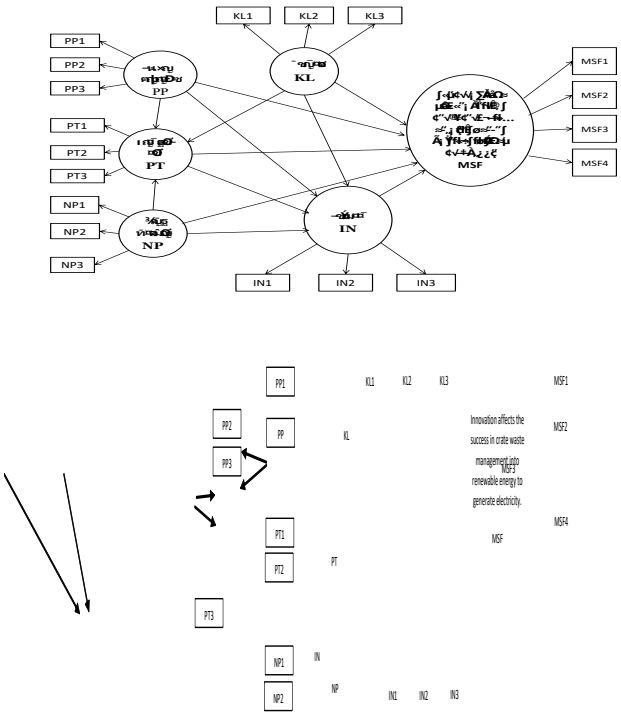

Figure 1: Conceptual framework of innovation affecting the success in crate waste management into renewable energy to generate electricity

RESEARCH'S METHODOLOGY

This research is the mixed research of both quantitative and qualitative. The sample group in this research was people in the Eastern Economic Corridor (EEC) area. The sample size was 20 times the observed variable. In this research, there were 19 observable variables equaling to 380 samples based on Klein's Criteria (Kline, 2005). As the researchers increased the sample size based on community characteristics and area number, the sample size became 400 samples using multi-step and specific sampling method from 3 provinces; Chonburi, Rayong and Chachoengsao. The total was 20 municipalities, 4 communities each, in a total of 80 communities, 5 individuals each. The tools used in the quantitative research were questionnaires distributed to people by surveying and analyzing the structural equation model (SEM), the tool quality was examined with Cronbach's alpha coefficient. The consistency index of the questionnaires followed the specified criteria (IOC $\geq$ 0.60). The data were analyzed by descriptive statistics using the measurements of mean, standard deviation, minimum, maximum, skewness, kurtosis, and structural element equation model for measuring medium and distribution to find relationships among variables, determine the harmonization of the established causal relationship model with empirical data using a correlation matrix. The qualitative research used the sampling on 20 timber merchants and 20 people in the community with wood crate waste totaling 40 samples dumps. The data was collected using in-depth interviews with timber traders and the public.

RESEARCH'S RESULTS

1. From studying the current condition of wood crate waste management into renewable energy to generate electricity in 6 areas; knowledge factor, public policy factor, participation factor, network partner factor, innovation factor, and the success of wood crate waste management into renewable energy to generate electricity, it was found that the overall picture of success was at the good level with the reducing amount of crate waste in the area by adopting modern technology to generate electricity that provides high energy, the community participation in reducing the use of natural resources and conserving the

environment along with sorting the waste and wood chips for sale making the community earn more income.

2. From studying the innovation that affect the success of wood crate waste management into renewable energy to generate electricity, it was found that the studied variables had positive relationship with the crate waste management into renewable energy to generate electricity. They were consistent with the empirical data at a good extent. The variable having the most direct influence was the knowledge factor in crate waste management in the community followed by the innovation factor in the development of the community crate waste management system, the network partner factor in the community wood crate waste management, respectively. The indirect influencing factor was the factor of participation in the community wood crate waste management. The study results were summarized as follows:

Factors	**Elements**	**FL**
1. knowledge factor	1) Knowledge in the community wood crate waste management	0.809
	2) Knowledge in the procedure of processing the crate waste into renewable energy to generate electricity	0.751
	3) Knowledge in the reduction of wood crate wastes in the community	0.752
2. Public policy factor	1) Conformity to the public policy in the wood crate waste management at the community level	0.794
	2) Conformity to the public policy in the wood crate waste management at the provincial level	0.763
	3) Conformity to the public policy in the wood crate waste management in the Eastern Economic Corridor (EEC) area	0.798
3 . Participation factor	1) Participation of community in the community wood crate waste management	0.774
	2) Participation of community in the transformation of crate waste into renewable energy to generate electricity	0.704
	3) Participation of community in the reduction of wood crate wastes in the community	0.806
4 . Network partner factor	1) Support and participation from the network partner in the community wood crate waste management	0.740
	2) Support and participation from the network partner in the transformation of crate waste into renewable energy to generate electricity	0.781
	3) Support and participation from the network partner in the reduction of wood crate wastes in the community	0.806
Factors	**Elements**	**FL**
5. Innovation factor	1) Development on the community wood crate waste management with modern technology	0.923
	2) Development on the machines to have standardized quality and increase of products	0.832
	3) Invention of innovation to eliminate the pollution from the wood crate wastes	0.905
6. Success of wood crate waste management into renewable energy to generate electricity	1) Reducing amount of wood crate wastes in the area	0.791
	2) Achievement of innovation in adopting the modern technology in the crate waste management into renewable energy to generate electricity	0.811
	3) Reducing the use of natural resources and conserving the community environment	0.718
	4) Creating jobs, careers, income, and strengthening the	0.732

Table 1: Elements in the factors of wood crate waste management into renewable energy to generate electricity

From the results of studying the innovation affecting the success of wood crate waste management into renewable energy to generate electricity, it was found that the success of wood crate waste management into renewable energy to

generate electricity depended on the knowledge factor, public policy factor, participation factor, network partner factor, and innovation factor. The knowledge factor affected the success of wood crate waste management into renewable energy to generate electricity the most followed by the participation factor, network partner factor, public policy factor, and innovation factors, respectively.

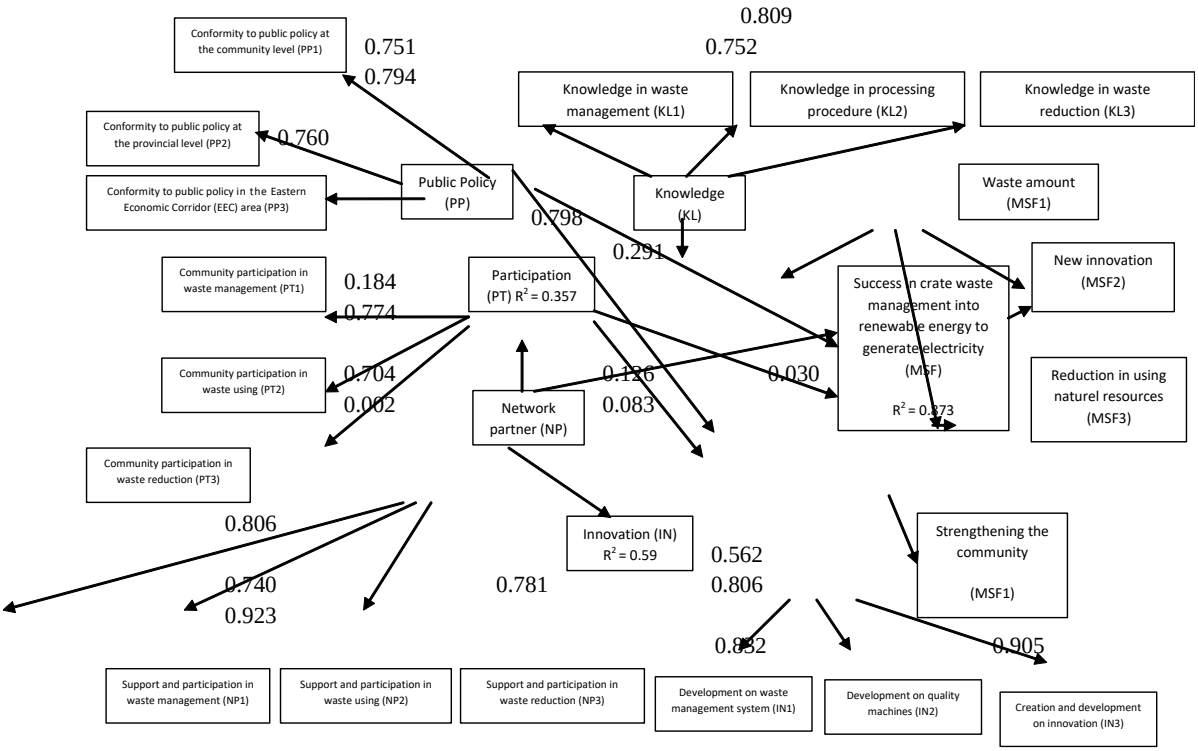

Figure 2: Processing of proper structural equations

3. From studying and reviewing the above concepts, theories, and related researches, the research results could be summarized as follows.

3.1. The knowledge factor had the reliability of internal consistency where the composite reliability (CR) was 0.751 which was higher than the criteria of 0.70 influencing the success of wood crate waste management into renewable energy to generate electricity. The knowledge factors were:

3.1.1 The knowledge of wood crate waste management in the community influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0.809 (positive correlation) which was higher than the criteria of 0.70.

3.1.2 The knowledge of the procedure for processing the wood crates into renewable energy for generating electricity influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0.751 (positive correlation) which was higher than the criteria of 0.70.

3.1.3 The knowledge in the reduction of crate waste in the community influenced on the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0.752 (positive correlation), which is higher than the criteria of 0.70.

3.2. The public policy factor had the reliability of internal consistency where the composite reliability (CR) was 0. 795 which was higher than the criteria of 0.70 influencing the success of wood crate waste management into renewable energy to generate electricity. The public policy factors were:

3 . 2.1 The conformity to public policy of wood crate waste management at the community level influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0. 7 9 4 (positive correlation) which was higher than the criteria of 0.70.

3 . 2.2 The conformity to public policy of wood crate waste management at the provincial level influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0. 7 6 3 (positive correlation) which was higher than the criteria of 0.70.

3 . 2.3 The conformity to public policy of wood crate waste management in the Eastern Economic Corridor (EEC) area influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0. 7 9 8 (positive correlation) which was higher than the criteria of 0.70.

3 . 3 The participation factor had the reliability of internal consistency where the composite reliability (CR) was 0. 7 6 4 which was higher than the criteria of 0.70 influencing the success of wood crate waste management into renewable energy to generate electricity. The participation factors were:

3.3.1 The participation of community in the wood crate waste management in the community influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0 . 7 7 4 (positive correlation) which was higher than the criteria of 0.70.

3.3.2 The participation of community in the use of wood crate wastes as the renewable energy to generate electricity influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0 . 7 0 4 (positive correlation) which was higher than the criteria of 0.70.

3 . 3 .3 The participation of community in the reduction of wood crate wastes in the community influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0 . 8 0 6 (positive correlation) which was higher than the criteria of 0.70.

3 . 4 The network partner factor had the reliability of internal consistency where the composite reliability (CR) was 0 . 7 15 which was higher than the criteria of 0.70 influencing the success of wood crate waste management into renewable energy to generate electricity. The network partner factors were:

3 . 4 . 1 The support and participation from the network partner in the wood crate waste management in the community influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0 . 7 4 0 (positive correlation) which was higher than the criteria of 0.70.

3 . 4 . 2 The support and participation from the network partner in the use of wood crate wastes as the renewable energy to generate electricity influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0 . 7 8 1 (positive correlation) which was higher than the criteria of 0.70.

3 . 4 . 3 The support and participation from the network partner in the reduction of wood crate wastes in the community influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0 . 8 0 6 (positive

correlation) which was higher than the criteria of 0.70.

3.5 The innovation factor had the reliability of internal consistency where the composite reliability (CR) was 0.835 which was higher than the criteria of 0.70. The innovation factors were:

3.5.1 The development on the wood crate waste management system in the community with modern technology influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0.923 (positive correlation) which was higher than the criteria of 0.70.

3.5.2 The development on the machines to have standardized quality and increase the products influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0.832 (positive correlation) which was higher than the criteria of 0.70.

3.5.3 The invention of innovations to eliminate the pollution from the wood crate wastes influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0.905 (positive correlation) which was higher than the criteria of 0.70.

3.6 The success of wood crate waste management into renewable energy to generate electricity had the reliability of internal consistency where the composite reliability (CR) was 0.702 which was higher than the criteria of 0.70. The factors of the success of wood crate waste management into renewable energy to generate electricity were:

3.6.1 The reducing amount of wood crate wastes in the area influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0.791 (positive correlation) which was higher than the criteria of 0.70.

3.6.2 The occurrence of innovations in adopting the modern technology to the wood crate waste management into renewable energy to generate electricity influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0.811 (positive correlation) which was higher than the criteria of 0.70.

3.6.3 The reduction in the use of natural resources and the conservation of environmental community influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0.718 (positive correlation) which was higher than the criteria of 0.70.

3.6.4 The creation of jobs, careers, income, and strengthening of community influenced the success of wood crate waste management into renewable energy to generate electricity. This could be used in describing the internal relationship of the factors measured by Loadings of 0.732 (positive correlation) which was higher than the criteria of 0.70.

New findings

Process of wood crate waste management into renewable energy to generate electricity (in the past)

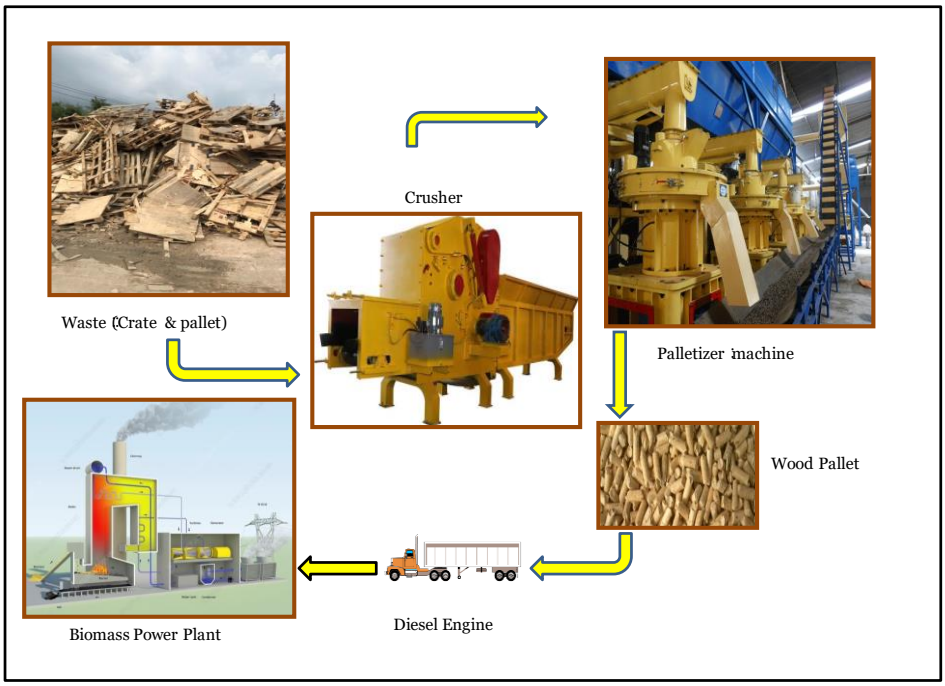

Figure 3: Model of wood crate waste management process into renewable energy to generate electricity (in the past)

New findings important for the development of wood crate waste management process

From studying the innovation affecting the success of wood crate waste management into renewable energy to generate electricity, this was the mixed research of quantitative and qualitative. The researchers collected the data with questionnaires and interviews. The analysis was made on the descriptive statistics and composition structural equation model. The research results revealed that in the process of transforming the wood crate waste into renewable energy to generate electricity in the Eastern Economic Corridor area of 3 provinces; Chonburi, Rayong, Chachoengsao, most of the large entrepreneurs in industrial estates, the small entrepreneurs, the private factories, and the people entrepreneurs who collected the wood crate wastes for selling had knowledge on how to properly manage crate wastes. They had the clear understanding of the management's public policy. From the meetings and seminars organized by the government agencies and monitoring the public relations news regularly, the innovation was developed through the use of technology to improve machine tools all the time in order to reduce complicated processes, reduce costs, and save production time resulting in the increasing productivity.

In this research, the researchers had found the significantly new findings. In the past, the small entrepreneurs or people with an extra job in wood crate waste management in the area of sample groups employed traditional methods without using machines, tools, and labor-saving tools or inventing modern innovations to assist in the correct crate waste management such as using the hammers, crowbars, steel beam to remove the nails. This was a waste of time and waste of labor. However, after the machines, instruments, and labor-saving tools had been introduced together with the invention of new innovations to replace the old system. They could be the model for communities or entrepreneurs and people in the areas to know to use new innovations for the benefits in increasing productivity, reducing the production costs, saving time and labor. The new findings can be classified as follows: 1) The invention of high speed conveyor to help increasing the speed in conveying wood into the wood chipper resulting in more productivity, 2)

The invention of magnetic separator that separates iron and nails which are obstacles to the wood chipper. When they are collected in large quantities, they can be sold as scrap metal to generate more income. 3) Bringing wood waste into the wood chipper to make 50 mm pieces can be delivered to the power plants immediately without being processed into pellet biomass fuel. When being tested in the laboratory, the resulting calorific value is 4235 Kcal / kg. The moisture content was 9.56% passing the factory standard and the heat value was similar to that of coal that used higher production costs. As a result, there was no need to use a pelletizer to produce pellet biomass fuel. This can reduce the investment in plant construction and reduce the use of tools causing the production cost to reduce for more than 30 million baht. It can save time, labor and the risk of substandard productivity. 4) Installing a large vacuum cleaner can help compiling the dust to be sold to the power plant for making more money. 5) The concept of development in transportation system using E-Truck car is accompanied by the plan to import electric trucks to replace fuel trucks in order to save the use of natural resources which are going to run out. 6) From the situation of the Corona Virus or COVID - 1 9 epidemic affecting the country's economy, most people suffer from unemployment and lack of income. However, it is found that people living in the community turn to pursue additional job by collecting wood crate waste to sell and earn the daily income averagely of 300-400 Baht. They can live sufficiently with the creation of jobs, generation of income, and strengthening the community.

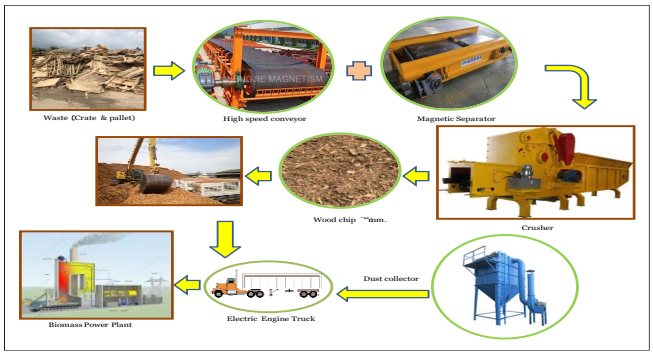

Figure 4 New findings in the wood crate waste management process into renewable energy to generate electricity

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