Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 12, Issue 6, June 2021: 1779-1787

The Design and Construction of a Machine to Improve Production Productivity

Chanchai Laoha[a]*, Naphatara Intanon[b], Anun Saengkaw[c], and Oangkhan Kurakanok[d]

[a* ,b,c,d]Department of Industrial Technology, Faculty of Technical Education,
Rajamangala University of Technology Isan Khonkaen Campus, Thailand

*Corresponding author. E-mail: [a]chanchai.la@rmuti.ac.th

Abstract

SMEs need to provide machines to work on behalf of workers. In the past, SMEs have only considered the factors that benefit customers, but not what employees and society receive from doing so. Therefore, this research intended to: (1) increase the efficiency in execution and (2). increase the reliance on satisfied stakeholders. This research is an applied research that was conducted concerning the topic of determining the replacement of machinery for workers. The problem selection was information obtained from a Thai restaurant that replaced their machinery with the prototype machine. Evaluation of operations resulted to objective of the research as: (1) the cost of investment was low and the payback period was short, which is appropriate in the uncertainty of the Covid-19 outbreak. Objective (2) increased stakeholder reliance which was found to be due to the high productivity rate.

Keywords: Papaya Salad, SMEs, Labor Cost Reduction, Stakeholder Satisfaction

1. Introduction

The Covid-19 outbreak has resulted in a significant decrease in the number of goods that customer need. As a reason, Small and Medium Enterprises (SMEs) have to reduce production capacity and product costs. Product costs consist of direct cost, indirect cost, and overhead cost. Labor costs are not only the direct cost, but also indirect costs associated with the production costs, such as: employee uniforms and the benefits entitled to employees. SMEs have to work against time and in a rush at certain times which directly affect the quality of the products to not likely meet the standards set. This is another reason contributing towards stakeholder dissatisfaction. To reduce labor costs, therefore, SMEs should consider supplying machines to work on behalf of workers to reduce direct costs. This is one of the methods in productivity and stakeholder satisfaction improvement. SMEs in Thailand need to primarily use workers because there are jobs that require advanced skills but are repetitive and have to be done continuously, which is the point that SMEs should consider supplying machines to work on behalf of workers. SMEs should take urgent action to address these issues which are clearly elements in production process. The provision of machinery to replace workers has the following components considered by the researchers: reviewing the literature of the past period, from 2015-2020, using the website www.Google scholar.com with the keywords as "Design and Build". There were about 206 copies and the research team examined the list of research articles, finding that there were 24 pieces of research. A literature review showed that the factors to consider were: (1) the revolutions per minute (RPM) of a unit; (2) Effectiveness which refers to the proportion of work piece output of the machine produced per the raw material used; (3) The production capacity which is a unit of quantity/volume per time; (4) The cost of the goods in baht per piece to bring the value to the breakeven point with unit of the weight/volume per year; (5) Most research presented the payback period of investment of machine construction as not more than 1 year (Kassanuk &

Phasinam, 2020; Pimpan, 2020; Jaturong, Sunan, Roongruang, Anothai & Nanthapong, 2017). However, some machines have 1-3 years payback period while some do not present an economic value (Paitoon, Suthiwat, Kunthon & Sirichai, 2018). Some machines offer only machine performance and manufacturing capabilities (Surapong, 2019; Jittiwat & Manote, 2015; Nitipomg, Theearnai, Thawatchai & Pakorn, 2019; Paphawin, et al., 2019; Korrawat, Surasit, & Katayut, 2018; Jenjjra, Cherdpong, Juckamas, Phirayot, & Suphan, 2013; Man, Somchai, Saksit, Kerkchai & Kriangkrai, 2019.; Manop, 2018; Chongkol, Chaowarit & Sirichai, 2018) In addition, some machines charge for the opportunity to sell goods without such tools (Niwatchai, et al., 2021). SMEs have to also consider the power consumption of the machine (Roongruang, Napol, Jaturong, 2019; Roongruang, Wootichai, & Jaturong, 2018; Jaturong, Sunan, Purin, Sukrit, & Supanat, 2016; Jaturong, et al., 2018).

There are 3 views of productivity in line with machinery to replace workers on production: customer view, workers view, and stakeholder view. Based on past research, SMEs need to consider all the factors as customer's views are based on the composition of productivity: Quality Cost and Speed (Delivery and mostly lack the views of workers and stakeholders. The view of workers is safety and morality. Workers need safety in the workplace and if they have it then morality based on safety to all is achieved (Punnapoth & Udomvit, 2020). Workers work for long periods of time resulting to fatigue and lack of focus which could lead to fatal accidents resulting from work activity or exposures (Pathomchai, 2011). A high prevalence of work-related injuries (84%) and musculoskeletal disorders (70%) was reported among restaurant workers. Cuts and lacerations arising from accidents with knives were the most common injuries seen, followed by burns, falls, slips and trips (Jahangiri, et al., 2019). If the accidents occur frequently, it is also considered a lack of morality from the entrepreneur which is not taking care of the welfare of employees at work. Morality and safety mean gaining workers' trust and can work together for a long time.

The view of stakeholder is environment and ethics. This covers the main measures available to minimize environmental impacts attributable, directly and indirectly, to operations in SME. They have some input into production selection, especially, in terms of material efficiency, waste from available equipment and can make a significant contribution to the life cycle of environmental value chains. Specifically, the disposal of waste of material in landfill leads to significant emissions and other impacts In addition, waste contributes to unnecessary production impacts whilst the behavior of staff is largely determined by a need to deliver quality and service using the equipment available. Today, there is pressure from stakeholders to make SMEs about the ethics of business practices that will ensure fairness in society and also worker protection.

So, this research aims to: (1) increase productivity in the implementation. (2) Increase the satisfaction from stakeholders. Moreover, there are indirect costs associated with production costs, such as: employee uniforms and the benefits entitled to employees. Accidents partly caused by an employee (Punnapoth & Udomvit, 2020). For example, employees working for long periods of time resulting to fatigue and being unfocused which causes accidents in work regularly (Pathomchai, 2011). Today, there is pressure from stakeholders to make organizations think about the ethics of business practices that will ensure fairness in society, and also environmental protection. SMEs should take urgent action to address these issues which are clearly elements of increased productivity and if no action is taken, the stakeholders will not be satisfied.

2.Methods

This research is an applied research conducted concerning the topic of machinery, labor substitution, problem selection, and collecting data from the machine trial method of gathering data.

Information, documents, thesis, and research articles related to the research gap that meet the desired impact of stakeholders in the manufacturing industry was analyzed and synthesized in the subject of the research study as detailed in Figure 1.

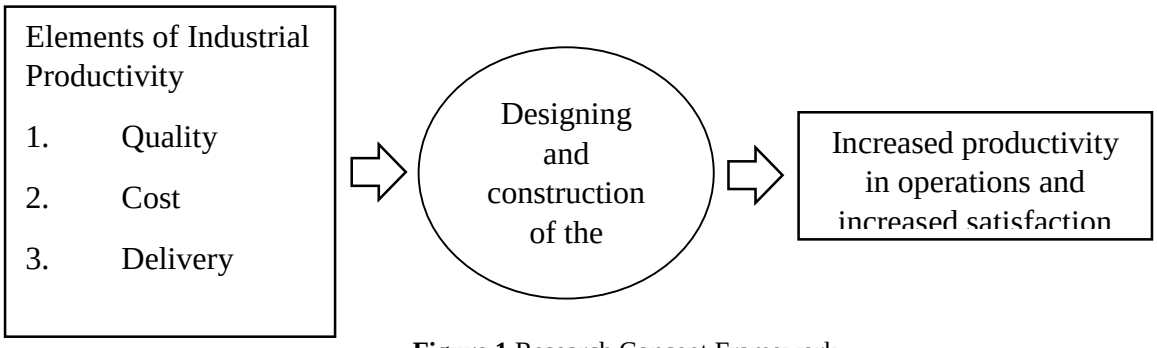

Figure 1 Research Concept Framework

Restaurant sector is one of the most rapidly developing sectors in the world and there is evidence that restaurant industry has high levels of work-related diseases and injuries. Papaya salad is one of Thai national foods with favorites nationwide; restaurants have papaya salad as one of the best sellers in the menus. The main ingredient of papaya salad is green papaya which is grated or sliced by employees who continuously peel and grate or slice the papaya due to constantly needing fresh ingredients. The employees find that the 3 common problems that occur in rush time when many customers are at the restaurant at the same time are: (1) injuries of an employee from sharp knives, (2) fatigue, and (3) increased job quantity. A knife cutting employee's fingers is one of the most common accidents in restaurants. Such accidents do not occur often but are dangerous and may affect the mental state of employees and friends. Safe climate perceptions, working conditions perceptions, and safety behavior levels of the workers are related to the occupational accidents and injuries in their organizations (Selahattin, 2013). Fatigue is another problem of working from grating sliced papaya. The fatigue that occurs in the body is divided into two types as muscle fatigue and general fatigue. Muscle fatigue can work in 2 ways: (1) rhythmic muscle contraction when muscles contract and relax alternately when grating the sliced papaya and (2) continuous contraction while sitting to grate. General fatigue is mainly caused by eye fatigue, hot weather, and hard work. Research on muscle fatigue suggests that greater fatigue resistance may be evident in females compared with males (Audrey, Jane & David, 2001). If a restaurant owner wants to increase the number of papaya strips, they must hire more employees which in turn causes the labor costs to increase. An employee can peel and grate 6 kg of sliced papaya per hour and the chef wants 24 kg of papayas per day. Therefore, the restaurant must assign an employee to grate the sliced papaya. The minimum wage of an employee is 300 bath/day or 9000 bath/month. In addition to labor costs, workers are also prone to fatigue during work.

The physical characteristics of papaya used as data in the designing and construction of a machine were size and circumference as shown in Figures 2 and 3. Papayas had sample size of 50 pieces which were randomly selected from 5 markets, 10 fruits from each

Figure 2 Measuring the Length

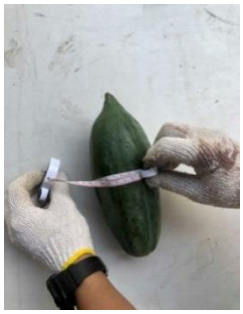

Figure 3 Measuring the Circumference

Table 1 shows the dimensions of the papaya sample with the height between 21-17 centimeters with an average of 19 ± 1.568 centimeters. The circumference was between 32-27 centimeters with an average of 30 +/- 1.940 centimeters.

Table 1 Dimensions of Papaya.

	Dimension (cm.)*	
Details	Length	Circumference
Max	21	32
Min	17	27
Average	19	30
Standard Deviation	1.568	1.940

Remark: *The data is based on the average sample test of 50 samples.

A machine to grate and slice papaya was designed. The machine has 4 main components: (1) a fixing set, (2) a peeling set, (3) a grater for slicing, and (4) an automatic electrical control system set. When the switch of the control system is turned on at (0) it powers the motor of the fixing set; at (1) it sends power via a belt (2) to the fixed set (3) in order to rotate the papaya clockwise. At the same time, the motor of the peeling unit (4) sends

power to the spiral grater (5) causing the peeling knife (6) to peel the papaya up to touch the limit switch (7)., a coring knife set attached at the base penetrates into the papaya's bottom while spinning the seeds when the knife set moves down to the bottom. The seeds fall into a pipe inserted in the papaya. Then the peeling knife sets down to touch the limit switch (8). When the motor of the peeling unit (4) stops, the motor of the papaya scraping set (9) transmitted by a stainless steel shaft connected to the scraping knife (10) by rotating the crank diagonally causing the blade to grind to rotate scraping the papaya up and down until the papaya scraping knife set taps limit switch (11). The papaya scraping machine stops automatically as shown in figure 4.

The structure of the machine should support a lot of weight. Therefore, it was designed to use box steel. The dimensions of the structure were width of 55.5 cm., length of 55.5 cm. and height of 135.4 cm.

This section describes how the machine was tested. 30 pieces of papaya were input to the machine. Figure 5 shows the operation of the machine during grating.

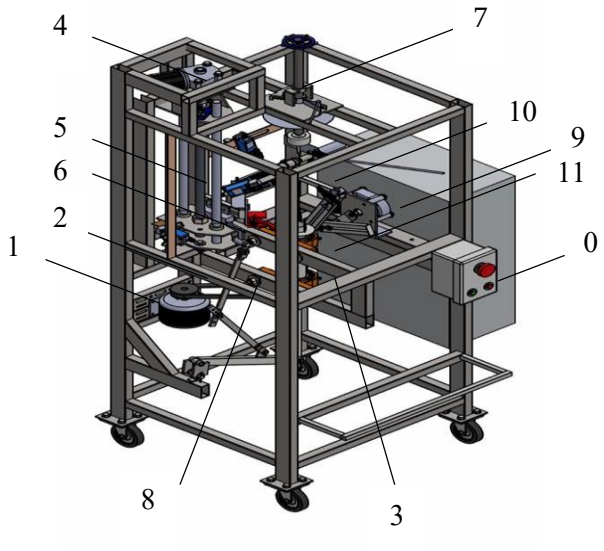

Figure 4 An automatic electrical control system set.

Figure 5 Operation of the Machine During Grating

The sample used in the study is the process of scraping the papaya slices. For productivity measurements, the tools used to collect data were the actual tools used in transcripts, and the tools for evaluating the satisfaction of 4 stakeholders, the specific number of customers, employees, communities, and owners were interviewed based on the composition of productivity of 12 months; from Jan – December 2020 with the key independent variables stipulated in the study as: quality, cost, delivery, morale, environment, and ethics.

Productivity is the responsibility of everyone involved. For customers to get what they want in terms of quality, cost, and delivery, employees need to cooperate by working to their full esteem and increase their work skills. Safety Morale also requires cooperation from other agencies in order to cooperate with ethical operations. This result in an increase in the overall productivity of the country, which will lead to raising o the living standards for the people of the country, which is the ultimate goal of increasing productivity. Qualitative data analysis was conducted as follows:

Increased labor productivity = Revenue from sales of papaya salad/ (labor cost) (1)

Payback Period = Initial Investment/Net Cash Flow per Period (2)

Energy consumption as follows

Formulation = T ● (P/100) ● n (3)

Where;

P; Wattage of the electrical appliance in watt.

T; Hours of use per day base on 1 hr.

n ; Number of device.

Increased reliance on stakeholders. Data from open-ended inquiry made respondents express their opinions freely (Gündüz, G.F., 2020). Using average analysis for before/after, the assessor performed a content

analysis.Multiple case study with three cases were conductedin three different educational programs (Battal, A. & Toke, T.S., 2020) There were 5 satisfaction levels as follows:

Level 5 means the most satisfied.

Level 4 means satisfaction.

Level 3 means not sure.

Level 2 means dissatisfaction.

Level 1 means not satisfied the most.

Analysis and interpretation of the data were performed through the presentation of the findings based on descriptive statistics. When the data was collected and distributed, the average score of the respondents were used to determine the level of satisfaction.

Satisfaction was as follows: Width of tier = (highest score – minimum score)/number of layers = 0.80 = (5 – 1)/5 which can be interpreted by the satisfaction score level as follows:

An average score of 4.21 – 5.00 means the most satisfaction level.

An average score of 3.41 – 4.20 means satisfaction level.

An average score of 2.61 - 3.40 means there is a degree of uncertainty.

An average score of 1.81 - 2.60 means a level of dissatisfaction.

An average score of 1.00 - 1.80 means the highest level of dissatisfaction.

3.Results

The results of this research concerning the intended objectives were as: (1) increase the efficiency of the operation whereby the following detailed findings were presented: quality is the first factor in which stakeholders considered by comparing the size of papaya slices during the scraping of papaya by machine and by labor. It was found that the machine was unable to perform the desired operation. Papaya slices from the labor workers were longer although both had the same thickness. This may have been due to the mechanical stroke, the shorter distance and the degree to which the papaya clamp is not suitable. The output from machine is shown in figure 6 and figure 7 shows output from a worker.

Figure 6 Shows papaya made by the prototype machine.

Figure 7 Shows papaya made a worker.

This research built a prototype with a transmission speed of around 380 rpm. This is in accordance with (Pimpan, 2020; Kassanuk, Phasinam, 2020; Jaturong, Sunan, Roongruang, Anothai & Nanthapong, 2017) so that the machine can only scrape papaya to the desired size and appearance. Cost is a subsequent factor that stakeholders considered as it is an important issue. The goal of this research was to provide machinery to replace workers and to achieve the same objectives. Currently, the minimum labor cost in Thailand is 300 bath per day, and the cost of designing and building machines is 45,000 baht. Therefore, the cost per day is 45000/(5 years x 365 days) = 24.65 or 25 baht, so if labor costs were compared with machine costs, the cost would be reduced by 91.66% or 92%. Thus, the cost is low.

The cost of an initial investment of a grater for the prototype was 45000 Baht. The lifespan is 5 years or equal to 9000 Baht per year. The restaurant owner provided a net cash flow per period of information that papaya salad only had an average profit of 1,000 Baht per day. The restaurant was open for 24 days a month. A net cash flow of the period was 24,000 Baht. Therefore, the calculation of the payback period in the formulation (2) of the machine is 1.87 months. Presenting the payback period as is also imperative for SMEs to take decision-making into account. In most cases, the payback period is not more than 1 year in accordance with (Pimpan, 2020; Kassanuk, Phasinam, 2020; Jaturong, Sunan, Roongruang, Anothai & Nanthapong, 2017).

In this research, we considered the prototype machine speed to have the average grating speed of 7 minutes/kg, which was 10 minutes/kg faster than an average laborer takes./ kg. This may have been because people were tired from other duties so they could not work any faster and it is important to exercise caution to avoid causing accidents which make the working time slower than the machine. The production rate is the quantity of papaya output made by the machine in kg/HR. The maximum production rate was 81 kg. /HR. and a minimum of 64 kg. /HR with an average of 72 kg. /HR. and a standard deviation of 5.779. It is evident that the presentation of machine performance is the basis of SMEs' decision on whether the machine's capabilities can support current and future customer order volumes consistent with research. (Surapong, 2019; Jittiwat, & Manote, 2015; Nitipomg, Theearnai, Thawatchai, & Pakorn, 2019; Paphawin, et al., 2019; Korrawat, Surasit, & Katayut, 2018; Jenjjra, Cherdpong, Juckamas, Phirayot & Suphan, 2013; Man, Somchai, Saksit, Kerkchai, & Kriangkrai, 2019; Manop, 2018; Chongkol, Chaowarit, & Sirichai, 2018) But in this research, it was not possible to study the cost of opportunity because the prototype was not produced like in research. (Niwatchai, et al., 2021)

Safety is the welfare of the employees while using the machinery or in the process of scraping papaya. According to the data, no accidents were caused by finger cutting edge or any incidence, while scraping papaya by workers were found to be hurt on an average of 3 times/year, although they were less likely to stop working.

Morale is a feeling of confidence in working at safe mode which in turn promotes safety at work. An interview with the employees showed that if the papaya machine was used medical fees would not be incurred from nursing the accumulated pain derived from long working hours of repetitive nature.

Environmental care effectively refers to the proportion of work piece from output of the machine produced per the raw material used. There are 2 items that use energy consumption of 0.35 units/hrs as on table 2. However, according to the data, scraping papaya with the machine was at an average of 88% a loss of only 12% while the target is 95%; this is because the papaya clamping design was not suitable. This caused slices of papaya to fall out of the clamp. The amount of papaya scraping was more than 80% so the research calculated the energy consumption rate as the table below, but did not focus on the energy consumption of the machine, like research (Roongruang, Napol & Jaturong, 2019; Roongruang, Wootichai & Jaturong, 2018; Jaturong, Sunan, Purin, Sukrit & Supanat, 2016; Jaturong, et al., 2018)

Table 2 Energy Consumption of the Prototype Grater

Items	Function	Power	Quantity	Calculation $T \cdot \frac{P}{1,000} \cdot n$	Answer (Units / hr)
1	1) A peeling set. 2) A grater of sliced papaya set	DC 12V 50 w	2	$1 \cdot \frac{50}{1,000} \cdot 2$	0.1
2	1) A fixing set.	DC 24 V 250 w	1	$1 \cdot \frac{250}{1,000} \cdot 1$	0.25
Total					0.35

On ethical pricing, the research found that the cost per kg decreased by 92%, but that was only 10% of the cost of making papaya salad, so it was necessary to reduce the price of the storefront. This is to achieve fairness to the customer and to promote marketing.

The results in regard to the second objective research: increasing stakeholder satisfaction showed that the average satisfaction level before was at 4.185. The satisfaction level were analysed as before and after the prototype machine as detailed in Table 3.

Table 3: Average Income List for Assessing Stakeholder Satisfaction

Individual Assessment Issues	Average ($\bar{x}$)	
	Before application of machine	After application of machine
Quality	4.17	4.20
Cost	3.38	4.28
Delivery/Speed	4.20	4.32
Safety	3.88	4.20
Morale	4.09	4.21
Environment	4.01	3.51
Ethics	4.11	4.58

Satisfaction was $\bar{x}$ = 4.185 in average that is translated into a high level of satisfaction. The most average estimate was Ethics ($\bar{x}$=4.58). The second rank was Delivery/Speed ($\bar{x}$=4.32), The results can be translated into a level of satisfaction that has an average score of 3.41. This may be because the environment capability is still significantly lower than level 4 which makes the total average score low.

4.Conclusion and Recommendation

Results showed that the composition of productivity covers all the parts involved in the implementation of productivity increase. The provision of renewable machinery for labor work is necessary in the present and in the future. The more outbreaks of covid 19, the more stimulus SMEs need to implement, with investment costs of only 45,000 baht in volume compared to the traditional labor, and the fact that the payback period is shortall these make sense in the uncertainty of the Covid-19 outbreak. At present, the reliance on stakeholders has been increased and the stakeholder sees a change in the use of renewable machinery for workers. Considering the composition of the productivity increase, the reliance achieved good satisfaction level. Although at the same level, the score scoring increased. The panel of researchers suggested that there should be more research on the speed around which quality can meet the needs of customers, and more importantly, the environment in which the proportion of raw materials did not reach 95%, yet.

As a result, SMEs have discovered that the replacement of machines in the workforce has achieved a satisfactory level. And if funded by the Ministry of Higher Education and Science to develop the machine into more completeness, and to transfer technology to employees or interested parties, it will be a further extension to this improvement in the future. A suggestion of further research is necessary to improving the quality of machine-generated products as well as increasing the value of raw materials which is also necessary.

References

[1] Audrey, LH. & Jane, KB. & David SD. 2001. “Sex Differences in Human Skeletal Muscle Fatigue.” Exercise and Sport Sciences Reviews 29(3) :109-112.

[2] Battal, A. & Toke, T.S. 2020. “Investigating the Factors Affecting Students’ Satisfaction in a Programming Course Designed in 3D Virtual Worlds.” Turkish Online Journal of Qualitative Inquiry (TOJQI). 11(2): 218-246

[3] Chongkol, S. & Chaowarit, I. & Sirichai, T. 2018. “Design and development of Shallot frying machine.” Journal Rajamangala University of Technology Thanyaburi 15(2): 51-57.

[4] Gündüz, G.F. 2020. “Opinions of Primary School Teachers in Relation to Effectiveness and Applicability of Design Skill Workshops.” Turkish Online Journal of Qualitative Inquiry (TOJQI) 11(4): 533-570

[5] Jaturong, L. & Sunan, P. & Purin, A. & Sukrit, S. & Supanat, S. 2016. “Design and Fabrication of A Ripe Palmyra Fruit Pulp Separating Machine.” Journal Rajamangala University of Technology Thanyaburi 14(1): 47-54

[6] Jaturong, L. & Sunan, P. & Roongruang, K. & Anothai, N. & Nanthapong, D. 2017. “Design and Fabrication of Palmyra Fruit Fibre Separating Mechine.” Journal Rajamangala University of Technology Thanyaburi 14(2):37-44

[7] Jaturong, L. & Sunan, P. & Roongruang, K. & Grianggai, S. & Parisa, K. & Therapat, J. 2018. “Design and Fabrication of a Lotus Seed Membrane Peeling Machine.” Journal Rajamangala University of Technology Thanyaburi 17(1) :127-137

[8] Jenjjra, C. & Cherdpong, C. & Juckamas, L. & Phirayot, K. & Suphan, Y. 2013. “Design and Development of Machine for Soaking and Germination of Paddy in One Step.” Thai Society of Agricultural Engineering Journal 26(1): 44-51

[9] Jittiwat, N. & Manote, R. 2015. “Design and Construction of Appropriate Variantfor Yarn Twisting Machine.” UBU Engineering Journal. 8(2):116-123

[10] Kassanuk, T. & Phasinam, K. 2020. “Design and Construction of Water Hyacinth Chopper.” RMUTI JOURNAL Science and Technology 13(3): 57-68.

[11] Korrawat, W. & Surasit, T. & Katayut, K. 2018. “Design and Invention of Cleaning Machine for Children Plastic Balls..” RMUTL Engineering Journal (3)2: 8-14.

[12] Man, F. & Somchai, P. & Saksit, C. & Kerkchai, M. & Kriangkrai, T. 2019. “The Creation of the Soil Shredder for Use in the Manufacture of Brick Blocks.” RMUTL. Eng. J 4(2): 23-29

[13] Jahangiri, M. & Eskandari, F. & Karimi, N. & Hasanipour, S. & Shakerian, M. & Zare, A. 2019. “Self-Reported, Work-Related Injuries and Illnesses Among Restaurant Workers in Shiraz City, South of Iran,” Annals of Global Health 85(1): 1–9. [25]

[14] Manop, Y. 2018. “Design and Construction of Water and Oil Removal Machine for Pork Snack Production.” Journal Rajamangala University of Technology Thanyaburi 17(2): 99-111

[15] Nitipomg, S. & Theearnai, Y. & Thawatchai, K. & Pakorn, S. 2019. “Design and Construction of Planting Coconut Husk Material Grinding Machine with PLC Controller.” JOURNAL ITRM. 6(2):47-56

[16] Niwatchai, J. & Amnuay, K.. & Worapot, S. & Peerawat, L. & Jaruwat, K.. & Nithikoon, K.. & Udon J. 2021. “The Design and Development Packing Machine for Increase Packing Process Efficiency of Nam Ngiao Chili.” Journal of Innovative Technology Research 3(1):68-76.

[17] Paitoon, P. & Suthiwat, W. & Kunthon, T. & Sirichai, T. 2018. “Design and Development of Prototype Machine for Peeling Shallots for Small to Medium Enterprises.” Journal of Engineering 16(1): 43-50.

[18] Paphawin, W. & Potchara, K. & Apiwit, P. & Prysathyd, S. & Kreetha, S. & Chinnathan, A. & Chootrakul, S. & Thanya. K. 2019. “Design and Fabrication of Prototyping Automatic Noodle Flavoring Machine.” Thai Society of Agricultural Engineering Journal 25(2): 36-41.

[19] Pimpan, P. 2020. “Design of Banana Leaf Sheath Preparing Machine for Making Banana Rope.” Thai Society of Agricultural Engineering Journal 26(1): 9-9.

[20] Pathomchai, S. 2011. “Multi Dimensional data analysis for causes of rework in wheel alignment process.” A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Engineering Program in Industrial Engineering Department of Industrial Engineering Faculty of Engineering Chulalongkom University.

[21] Punnapoth, B. & Udomvit, C. 2020. “The study of accident cause and Guidelines for prevention of construction : A case study of MRT Orange Line project (Taling Chan - Min Buri).” The 25th National Convention on Civil Engineering July 15-17, 2020, Chonburi, THAILAND. CEM40-1-7.

[22] Roongruang, K. & Napol, L. & Jaturong, L. 2019. “Design and fabrication of Green Fodder Shredding and Compressing Machine for Small Scale Farmer Research.” Journal Rajamangala University of Technology Thanyaburi, 18(1): 40-51.

[23] Roongruang, K. & Wootichai, C. & Jaturong, L. 2018. “Design and Fabrication of Continuous Type Barking Deer’s Mango Nut Sheller.” Journal Rajamangala University of Technology Thanyaburi 16(2):119-128.

[24] Selahattin, K. 2013. “The Relationships among Working Conditions, Safety Climate, Safe Behaviors and occupational Accidents: An Empirical Research on the Marble Workers.” The Macrotheme Review. 2(4):173-182

[25] Surapong, R. 2019. “Design and development of charcoal screw-press briquette machine with automatic cutting.” Journal of I-Tech. 14(2): 9-13