

# The Applications of Toyota Production System to Reduce Wastes in Agricultural Products Packing Process: A Study of Onion Packing Plant

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**Abstract**—Agro-industry is one of major industries that have strong impacts on national economic incomes, growth, stability, and sustainable development. Moreover, this industry also has strong influences on social, cultural and political issues. Furthermore, this industry, as producing primary and secondary products, is facing challenges from such diverse factors such as demand inconsistency, intense international competition, technological advancements and new competitors. In order to maintain and to improve industry's competitiveness in both domestic and international markets, science and technology are key factors. Besides hard sciences and technologies, modern industrial engineering concepts such as Just in Time (JIT) Total Quality Management (TQM), Quick Response (QR), Supply Chain Management (SCM) and Lean can be very effective to support to increase efficiency and effectiveness of these agricultural products on world stage. Onion is one of Thailand's major export products which bring back national incomes. But, it is also facing challenges in many ways. This paper focused its interests in onion packing process and its related activities such as storage and shipment from one of major packing plant and storage in Mae Wang District, Chiang Mai, Thailand, by applying Toyota Production System (TPS) or Lean concepts, to improve process capability throughout the entire packing and distribution process which will be profitable for the whole onion supply chain. And it will be beneficial to other related agricultural products in Thailand and other ASEAN countries.

**Keywords**—Lean Concepts, Lean in Agro-industries Activities, Packing Process, Toyota Production System (TPS), Waste Reduction.

## I. INTRODUCTION

AGRICULTURAL product sector used to be a major economic player in Thailand and other Asian countries. Exporting rice and other agricultural products, such as tapioca, corn and sugar-cane, were once on the national top ten ranking before getting behind export and tourism industries. After the Thai government has focused its development policies on improving national competitiveness through encouraging industries for exporting goods, such as textile and garments, automotive, electronics, computer hardware, chemical and plastics [1]. Agricultural export has declined its relative values, but agricultural sector stills be part of Thai life styles, traditions and cultures, especially local people and communities who are the majority and sensitive group of Thai people so agro-industry has still strong impact on national economic incomes, growth, stability and sustainable development. Moreover, this industry also has strong

influences on social, cultural and political issues. The national government needs to provide support for agro-industry to be part of national heritage, assets and its political stability. Furthermore, this industry, as producing primary and secondary products, is facing challenges from such diverse factors such as demand inconsistency, intense international competition, technological advancements and new competitors so supporting, maintaining and improving to Thai agricultural products on the world stage is crucial and important and how to enhance the industry's competitiveness in both domestic and international markets from any knowledge such as science, engineering, technology and management is necessary.

Onion is not a local plant in Southeast Asia, as we may recognize from many local dishes, but it has been widely accepted by many Southeast Asian consumers. Onion plantation has been promoted in Thailand many decades ago for both local consumption and exporting. This is because the appropriate climate and cultivation factors. Now, it is one of major agricultural export products of the country which brings back national incomes. But, it is also facing challenges in many ways [2]. Onions grown from Thailand are also export to other countries such as Japan, South Korea and other ASEAN neighbors. But, similar to other agricultural products, onion is difficult to preserve, store and transports [3]. And these, countries have set strong regulations and standards for importing fruits and vegetables from other countries. If ones can improve onion packing storage and transportation techniques, it will help every player in onion supply chain ranging from farmers to exporter.

On the other hand, there are a large amount of onions imported to Thailand both legally and illegally especially from China and their prices are quite lower than domestic onions [4]. So how reduce any waste in any stage of domestic onion supply chain such as cultivation, crop, dried, packing process, storage, distribution, transportation etc. is necessary to reduce cost, build value-added, increase product quality and strengthen Thai onion's competitiveness.

Applying modern industrial engineering and management (IE&M) principles such as Just in Time (JIT), Total Quality Management (TQM), and Quick Respond (QR) can be beneficial to solve problems for onion supply chain, but, onion packing plant is different from other factories, especially ones in major industries such as automotive, electronics and computer hardware. Plant managers have to manage it with understanding of agricultural product in order to bring the best

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out from all resources ranging from materials, men, machines, methods and money. The researchers adapt Toyota Production System (TPS) or Lean Production concepts to identify wastes for entire supply chain before recommending possible solutions. This will help improving onion packing, storage and transportation which will make the Thai agriculture product more competitive in the world market.

## II. OBJECTIVE

- To study the entire activities of the onion packing process by researchers' participant observation on plant in order to find the real condition and relationship in the existing process to identify the found problems, faults and relevant wastes from production persons working and brainstorming.
- To determine the methods of working that reduce wastes found and how to improve onion packing, storage and transportation process efficiency which will provide product quality and customer satisfaction by applying TPS to reduce wastes found.

## III. RELATED LITERATURE

Exporting agricultural products are producing a great amount of income to Thailand. First 5 countries that import agricultural product from Thailand include China, Japan, the USA, Malaysia, and South Korea. When considering Thailand's total export of fresh vegetable, onion was exported as the fifth vegetable of the country both fresh and refrigerated. The main market of onion is in ASEAN countries which have 77.7% of export value, Japan 15.1% of export value, and the USA 1.5% of export value, respectively [5].

Onion packaging process in Thailand can be divided into 3 types: fresh, refrigerated, and frozen. These 3 types of process have similar procedures, including purchasing onions, selecting specific size, cleaning, reducing temperature, packaging, and storing in cold storage. However, some procedures are different. Refrigerated onions' temperature need to be decreased before being cleaned. After that, select onions with standard size, and then take them to packaging procedure. On the other hand, frozen onions need to be cleaned by blowing. After that, clean them with water and decrease their temperature before freezing them. Take them to packaging procedure, and then distribute them domestically, however, they need to be stored in a cold storage if they are going to be exported to other countries.

Onion, similar to many agriculture products, has moderate moisture content and spoilage. They can be stored for certain duration, about 1-2 weeks. Onions spoilages are caused by 2 major sources; 1. Mechanical damage such as impacted during cultivation and transportation. 2. Chemical caused such as scratch wound. Moreover, improper packaging and handling can cause damage and bacterial infection to the products [6].

Mae Wang district, Chiang Mai, Thailand, has played strong roles in supplying onion for both domestic consumption and exporting. There are about 10 onion packing plants in the area. These plants operate from 4 to 8 months due to 2 sources

of products supply from their own region and other related areas. Among all these plants, there are 2 major players: Premier-agro and Thaworn Karnkaset Agriculture. They both supply their products to domestic and exporting markets.

Toyota Production System (TPS) is a manufacturing technique and philosophy that observed and developed by Toyota executives many decades ago. Anyhow, after their long studied and development, TPS, or what many people known as "Lean Manufacturing", aims to use production method which is reasonable and corresponds to the concept of eliminating waste. According to the literature, there are two types of waste in activities of production – value added (NVA) and non-value added (VA), including over production; over processing; conveyance; inventory; motion; waiting; defect and rework [7]; and underutilized people or unused employee creativity. According to the eight non-value added activities, it is estimated that 95% of duration that productions are inside factory come from wasting activities but the primary of waste is over production that causes other wastes in production.

TABLE I  
SUMMARIZES THE 8 WASTES OF LEAN

Type of waste	Means
Over Production	Processing too soon or too much than required
Over Processing	Processing more than required wherein a simple approach would have done
Conveyance	Movement of items more than required resulting in wasted efforts and energy and adding to cost
Inventory	Holding inventory (material and information) more than required
Motion	Processing too soon or too much than required
Defect	Errors, mistakes and rework
Waiting	Waiting for the previous step in the process to complete.
Underutilized People	Employees not leveraged to their own potential

Toyota Production System and Lean Manufacturing may have different definition in someone eyes, but they are similar in many perspectives. Importantly the concept of TPS and Lean can be applied, not only in industrial setting, but also to different enterprises. Agro-industries can also get benefits from these concepts. It can be used to improve quality and find new ways to solve problems which will enhance competitiveness [8].

Dr. Jeffrey K. Liker who has studied in Toyota Production System for many years explained TPS as the revolution after Mass Production System and has been applied to many companies in various industries around the world. It has been acknowledged as Lean Production. Although it system would influence to a large number of companies, most of them are usually implemented in process level such as 5S, Just in Time (JIT). TPS has to apply not only by managerial and technical tools but also by absorbing TPS culture. Liker's concept on TPS consists from (1) philosophy as long term thinking, (2) process by eliminating waste concerning continuous flow production concept, using TPS concepts and tools such as pull system to avoid over production, Heijunka, Jidoka or automation, standardized task, visual control, and reliable technology, (3) people/partner to be respected and challenged

and (4) problem solving with continuous improvement and learning respectively as 4Ps of the Toyota Way [9]. This is showed in Fig. 1.

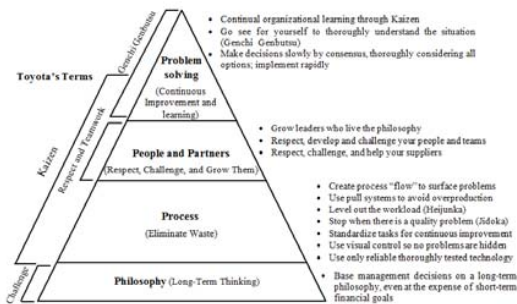


Fig. 1 A "4Ps" of the Toyota Way

These 4Ps concepts are linked to 4 principles as Genchi Genbutsu, Kaizen, Respect and Teamwork, and Challenge.

Genchi Genbutsu is one of TPS principles that real workers deeply work and examine close to the work in order to keep an eye on any waste or activity that required improvement and Kaizen is the other principle as maintaining the good and improving the defect continuously that come from finding out the root of the problem and decide the solution to solve the found problems by either large revolution or detail improvement. In order to succeed the above target, respect to teamwork is quite important. These principles have to be challenged to do and to be idea for philosophy.

#### IV. METHODOLOGY

This study is an action research, concerning making objective results, which can be shortly described as:

1. Researchers survey and observe onions packing process from different plants in Mae Wang District, Chiang Mai, Thailand.
2. Researchers choose Thaworn Karnkaset as a study unit because this plant operates year long. And, the owner wants to improve its efficiency for future competition. The period of study is out of onion season between April to November 2014 that almost product is delivered to Central Market close to Bangkok for domestic consumers so few preserving activities as reducing temperature and cleaning are waived because packed onion is rapidly delivered to Central Market after packing process every day.
3. Researchers study packing plant to identify problems and relevant wastes in its entire packing and storage process by using Caused and Effect Diagram or Fishbone Diagram with brainstorming and evaluating the information of any major and root causes to problems and relevant wastes found.
4. Researchers use TPS or Lean Production concepts and other IE&M tools such as techniques of principle of 5W 1H and ECRS (Eliminate, Combine, Rearrange and Simplify) together with Relationship Diagram and

Process layout to solve problems and enhance process capability. The proposed improvement methods and controls are sent to the plant owner of Thaworn Karnkaset to make decision to implement.

#### V. RESULTS AND DISCUSSION

Onion factory layout of Thaworn Karnkaset plant was established and started the production in 2012 and never has any obvious production improvement up to now. This study how to improve the production packing process by using TPS was required by the plant owner. By preliminary observation by the researchers found that this plant designed by following process as process layout or planning by following functions that similar activities are located close together in the same area. According to the study, there are 8 major activities in the onion packaging process and flow onion packaging process chart is shown in Fig. 2.

1. Transfer purchased onion to conveyor belt
2. Onion screening
3. Size selection
4. Onion packing
5. Package weighted
6. Package seal
7. Storage
8. Loading and transportation

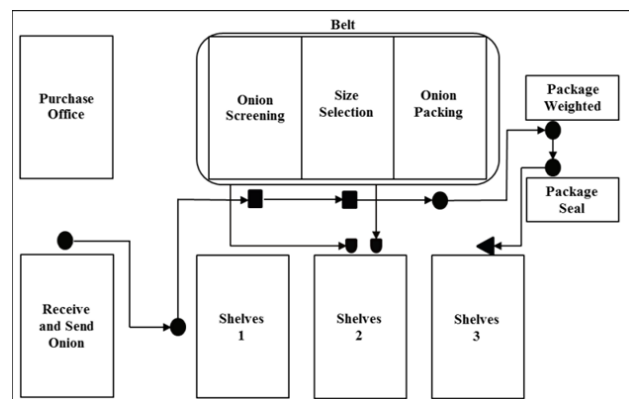


Fig. 2 Flow onion packaging process chart

The internal logistic is using forklift to lift and transfer the purchased onion to the conveyor belt system. This conveyor belt transfers the onion from onion screening to size selection and onion packing activities continuously as similar as "milk runs". The onion transported from onion packing, package weighted to package seal is moved by man-power. Then the forklift transfers the onion finished goods to shelf No.3 for transportation to buyer. The forklift also transfers the onion that is not select for the certain standard sizes to vestibule shelf No. 2 for next production cycle as similar to "taxi" system [10] waiting for the next new size screening cycle. The cycle will be repeated depend on each 4 standard size (size No. 0, 1, 2, and 3) for 3 cycles more.

This study also observes the entire process on plant in order to identify the existing numbers of workers working in each

activity as shown in Table II. The three workers who work in onion packing and package weighted are work together within these 2 station areas.

TABLE II  
NUMBERS OF WORKERS IN EACH ACTIVITY

Activities	numbers
Purchasing and delivering from vender	2
Carrying purchased onion to conveyor belt	3
Laying purchased onion on conveyor belt	1
Onion Screening	2
Size selection	3
Onion packing	3
Package weighted	3
Package seal	1
Total	15

The researchers analyze the problems and wastes occurred in the packing process by setting up brainstorming from all persons concern in the process consisting of the owner, plant manager, production manager for onion, and workers and record step by step of each major and minor root cause in cause and effect diagram shown in Fig. 3. The 4 major causes are found consisting of (1) working step in purchasing activity, size selection and improper working station layout, (2) lack of equipment in package weighted and damage from binding drawstring, (3) workers that neglect to use the rings selecting sizes of onion, and (4) some of onion quality is rotten, bruised and smaller than required standard sizes.

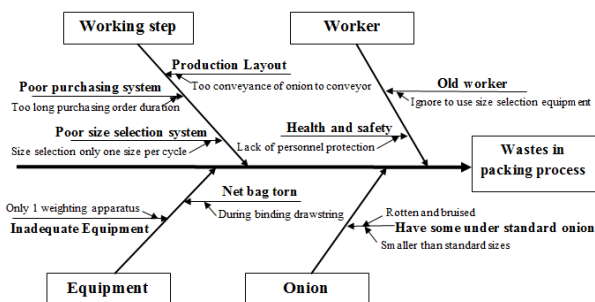


Fig. 3 Analyze the problems in cause and effect diagram

During analyzing problems in onion packaging process by recording in the cause and effect diagram above, researchers used flow process chart as major analysis tools. After that, researchers consider the wastes in accordance with studied problems and their causes and find that there are 4 types of waste in the process as follows:

1. Over Processing occurs from producing as customers ordered, thus the same process is repeated over and over.
2. Waiting occurs from irrelevance between purchasing onions and customers' orders due to duration of customer's order is too long until 14:00 hrs., thus the production schedule is not planned and constant so production flow may be not continuous.
3. Conveyance occurs from the irrelevance between the number of personnel and the number of equipment in the process or there are too long distance between activities

such as between onion packing and package weighted as well as between the package weighting activity and package seal, thus transferring products is redundant.

4. Defect and rework occur from purchasing onions because some onions are rotten, bruised, or smaller than required standard sizes. Furthermore, the bags are sometimes torn during binding their drawstring.

The researchers, the owner, plant manager, production manager for onion and workers set a meeting and analyze data together by adjusting activities, equipment, and the number of personnel in the process to be relevant with each other. The improvement was done by using the following techniques:

A. Relationship Diagram

Relationship diagram is drawing activity relationship diagram by organizing groups of activities with the same type of function. Activity relationship chart was used for calculating relationship of function, in order to be used as basis for considering plant layout improvement as shown in Fig. 4. The relationships include code A refers to absolutely important, E refers to especially important, I refers to important, O refers to okay, U refers to unimportant, and X refers to undesirable. Factory re-planning is started by drawing activity relationship diagram as shown in Fig. 5. It is a diagram that helps seeing activity relationship clearer by using data from the activity relationship diagram. In the diagram, lines are used to show level of relationship as follows: 4 lines refer to relationship A, 3 lines refer to relationship E, 2 lines refer to relationship I, 1 line refers to relationship O, no line refers to relationship U, and wavy line refers to relationship X.

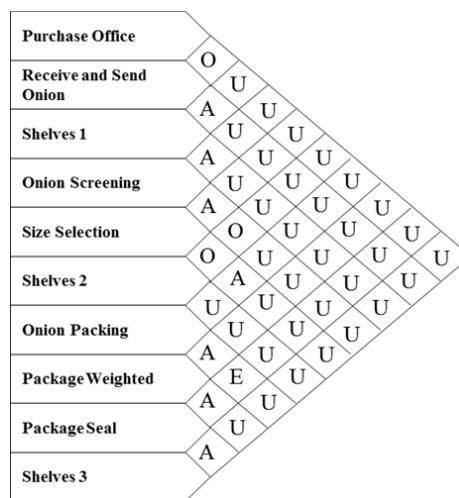


Fig. 4 Analyze relationship among activities

According to the activity relationship diagram, the researchers design a plant layout that each location of activity corresponds to relationship in the activity relationship diagram. By this technique, parking spot of purchased onion trucks and onion shelves No. 1 are moved to the same side with Onion screening activity of the conveyor belt, in order to reduce waste from too long conveyance. The amended plant layout is shown Fig. 6.

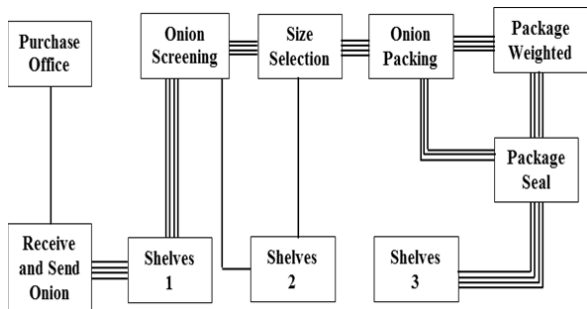


Fig. 5 Activity relationship in existing process layout

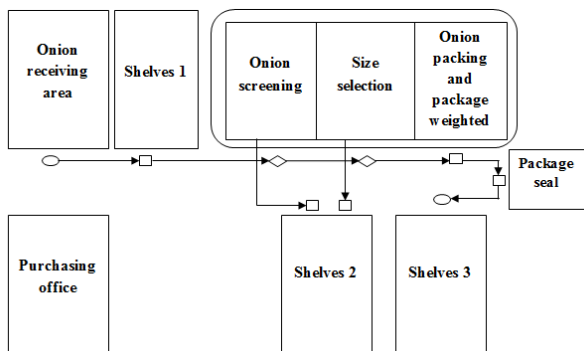


Fig. 6 Flow onion packaging process chart after improvement

**B. Continuous Flow Processing**

Production process of the packing plant is not continuous or producing as customers order, thus it is improved by using the TPS technique as follows:

**Material:** Onions purchasing must be at certain time and they need to investigate customers' needs instead of waiting for customers' orders, in order to reducing waste from waiting.

**Process:** It is changed to be parallel production that used to be producing with only one size as customers ordered. The new process sorts out 2 sizes, in order to reduce waste from over processing and conveyance.

**Personnel and equipment:** They need to be relevant in each activity. It is found that the procedure of packing onions into net bags with 3 personnel. After that, they are weighed with only one scale, and then tying the bags with one personnel. The improvement is done by reducing the number of personnel for packing onions into net bags to 2 persons, adding one more weighting scale, and adds one more person for tying bags. The improvement could reduce waste from waiting and conveyance.

TABLE III  
NUMBERS OF WORKERS IN EACH ACTIVITY AFTER IMPROVEMENT

Activities	After	Before
Purchasing and delivering from vender	1	2
Carrying purchased onion to conveyor belt	3	3
Laying purchased onion on conveyor belt	1	1
Onion Screening	2	2
Size selection	4	3
Package weighted	2	3
Package seal	2	1
Total	15	15

**C. Working Manual**

Creating a working manual as a tool for monitoring efficiency of production by using as a guideline for personnel and work checking for administrators as follows:

1. Rationale: to explain personnel to know importance and necessity of this manual.
2. Objective: to explain personnel to know the purpose of this working manual.
3. Scope: to explain readers or personnel to know the scope of process in the manual in terms of procedure, agency, person, place, and time.
4. Onion Standard Criteria: to explain quality of onion, size of onion, packing, and packaging, so as to be used as a guideline for administrators' consideration.
5. Process Rode Sign: designing onion packaging process that covers all procedures-purchasing onions, sorting out rotten or too small onions, selecting onion size, and packaging; in order to reduce wastes in the process by drawing a process diagram.
6. Documenting Procedure: writing procedure of packaging onions in details for mutual understanding of operation in each procedure and to make anyone can work in someone else position.
7. Proper Appearance: Personnel's clothe must be able to protect them from dangerous chemicals and safe while working.
8. Regulation: explains regulation for purchasing onions, sorting out rotten or too small onions, selecting size of onions, and packaging.
9. Record: analyzing waste in onion packing process and recording onion packing process in terms of distance, time, number, and personnel in each procedure.

**D. Techniques of TPS to Reduce Wastes in Study of This Onion Packing Process**

To improve plants as the above packing process is considered production techniques of TPS to reduce wastes in the process as follows

1. In the purchasing fresh onion, it has over processing and unnecessary transport or conveyance so this study amends the daily onion purchasing duration by buying and receiving the purchased onion in the morning between 06:00 to 09:00 hrs. of the production day in order to determine the daily production schedule prior to the production. This production is depended on customers' orders that also determine the produced and delivered date. The onion package produced in that production day will be certainly delivered to customers who order before 09:00 hrs. These customer orders will be input in that day production schedule so the onion production manager is able to decide how much onion purchase and when the production start and finish. This system also simplifies the flexible and continuous production in accordance with TPS flow concept that is in the JIT principle. The flow of onion in the process is continuous and smooth until the entire amount of purchased onion in that day is over. This amended system will be implemented together with the

rearrangement of receiving area and shelves No. 1 to be close to and located at the same side of the conveyor belt in the production. This amended layout is able to reduce waste of unnecessary transport or conveyance, over processing and waiting from reducing distance and cycle time of onion transport in the process in accordance with TPS concept by using Kaizen. This simple amendment is able to lead to much more return in reducing wastes and cost in long term. Furthermore, this improvement also causes the forklift to work less movement and able to use it in other work such as to move the onion in and out of shelves No.2 that is the vestibule shelves for work in process onion to the next cycles of onion size selection in the process and move the under standard size onion. This amendment help less forklift working and able to reduce worker and move in size selection activity that is improved to select 2 sizes per production cycle instead of only one size per cycle before.

This amendment is preliminarily assessed the betterment by measuring less distance and production time between before and after amendment. In the beginning of purchasing, the onion may be move from the vendor truck that delivers close to the start area of the conveyor belt assisting workers who carrying the purchased onion to conveyor belt that reduces the workers' stress from overburden or Muri and also reduce inconsistency or Mura that are the TPS basic targets.

2. In the process of onion size selection, the production process is undertaken in accordance with customers' orders so the process usually operates one production cycle for only one selected size. This is observed in the process study that causes the repeated more production cycles and over processing waste so this existing size selection has to be amended to select 2 sizes per one production cycle instead to eliminate waste according to JIT principle in TPS concept. This reduces unnecessary repeated production cycles and numbers of set up times from stoppage for changing required size of onion. The plant has limitation of conveyor belt length so this size selection method that selecting sizes of onion by passing control rings is maximum 2 sizes selected per time.

To reduce numbers of production cycles by amending working method from existing one size selection that has at least 4 production cycles to amended 2 size selection that has less production cycles to 2 cycles. The amended cycles is specified to select onion size No. 0 and 2 in order to receive size No. 0 that is the premium biggest size first with size No. 2 to protect error of the slightly different between onion sizes in the same cycle selection. This amendment also helps the workers to fill size different selected onion into the net bag easily by arranging size selection activity into 2 production lines (parallel line) worked by 2 groups of workers with 2 workers each. The one additional worker is come from purchasing activities. After first cycle size selection, Rest of onion will be transport to start the production process at size selection without passing the prior activities such as onion screening. So the 2 workers who work in onion screening of rotten or bruised and smaller than standard required size onion

are work over and able to transfer to work other activities such as assisting in carrying onion in and out of shelves No. 2 for the next production cycle to size selection of size No. 1 and 3 or implementing quality activity such as 5S to providing the working area convenience for working. This improvement is in accordance with change of working method that is determined to implement as Kaizen in TPS technique.

How to apply the reliable technology using in production activity is also the Kaizen to change the working method for betterment. In this study, there is the idea to change the size selection method by using size selection device installed within limited area and length of conveyor belt to replace the present size selection by control rings. This device will select all required size of ordered onion and is able to reduce the production cycle to only one cycle. This proposed working method is discussed in this study and will be considered by the plant owner. It is very crucial and much beneficial for the production plant to reduce cycle time, lead time, cost and to increase work quality, standard product, value-added and to strengthen stable competitiveness. This has to be invested in the present time but it makes the long term benefit that complies with TPS Philosophy from Liker's point of view.

3. It has combined activities between size-selected onion packing by filling in the net bags and package weighted in the same area. And improving continuous working by locating the filling onion in net bag as close as possible to the weighting apparatus and increase another 1 weighing apparatus installed in 2 parallel lines conform to size selection that also has 2 production lines. This is in accordance with Kaizen in TPS to solve the problem and improve the work method by considering the package weighted activity as bottle neck that required to be amended crucially by increasing one more weighting apparatus to correct it. Its result is the production flow continuously and smoothly (eliminate inconsistent or Mura and Overburden to weighting or Muri). This also conforms to TPS's concept to keep an eye on any defect or inefficiency thing in the production process as Genchi Genbutsu. It finds that the workers wait intermittently during the weighting is working continuously and there are some of net bags are still waiting to weight. This is the waiting waste required to amend in JIT principle. To increase one more weighting apparatus, this problem is solved not only by parallel line production but also by pull system in package weighted to call the onion in prior activity as onion packing in net bags. Leveling of the production line is considered by making the balance of work load between 2 parallel lines firstly determined by size of selected onion. (Between size No. 0 and 2 in first production cycle and size No. 1 and 3 in second production cycle) as line balancing. This should be re-considered according to daily actual production. The amended and improved method is Heijunka as TPS's tool to reduce waste of waiting that is able to reduce cycle time, make the production flow and reduce the workers in these activities from 3 to 2 persons.

The reduction of distance between onion packing and package weighted is certainly reduced the unnecessary transportation and worker movement and eliminate the overburden stressing to worker who weights the onion package according to TPS concept.

4. The activity for binding drawstring to onion package is located as close as possible to package weighted and determined as last checking point in the packing process before onion package is transported to shelves No. 3 prior to deliver to the customers after 18:00 hrs. By observing these activities, the researchers find that there is over or unnecessary transportation as well as assessed high significant relation between these two activities similar to the relation of prior activities. So the study arranges the closer distance between these two activities and increases one worker from 1 to 2 workers with 2 production lines for reducing cycle time of this activity. This is also the pull system from the binding drawstring activity.

The amendment of the onion packing to the binding drawstring for finished goods in packing process is aligned as U-shape production line to turn around to the storage area (Shelves No. 2 and 3) that is convenience to providing continuous production flow from accommodating the other line for storage. This arrangement reduces cycle time and makes the environment easy to visual control the production in each activity according to TPS tool. The production manager is able to supervise and the workers can keep an eye on the details of the entire working by arranging tidy and convenience workplace.

5. To improve the personnel and partner is essential as one of the components of TPS success. TPS is as corporate culture that is necessary for organization. This study is the initial of this plant improvement due to the plant owner requirement. However improvement in TPS consists of not only production but also people and partner. Liker's concept as shown in Fig. 1 is the development from the process prior to people and partner. This is true but it does not finish the process to eliminate any found waste before the improvement of people and partner starts. The practical way is to improve the process together to develop the people and partner in order to solve any problem with continuous improvement and knowledge learning. One of analyzed problem is quality of purchased onion bought from suppliers or process partner. Asking the key informants in this studied plant by 5W 1H and ECRS principles, the plant is not able to control the whole purchased onion quality because the fresh onion purchased sometimes is not seen the rotten or bruised. They think that is unmanageable. The further plant execution should consider the supply chain management by building the relation of both supply from supplier and deliver depended on customers' requirement in accordance with marketing concept in amount, kind, size, qualification such as taste, smell etc. quality, and price. The plant should be collected and analyzed the information by asking customers during purchase ordering then the plant will determine the measurements

of quality, standard, and procedure for buying the onion and setting up the collaboration and promotion programs with the suppliers like the network for kind of onion and cultivation control such as selecting young plant or seed, soil preparation, water and fertilizer supply, pests control, the onion cultivation, air-dried process, look after onion moisture until delivering fresh onion to packing plant.

To enhance the personnel in the organization is the fundamental component in TPS in order to create continuous knowledge learning and work improvement. This has to be implemented together with Kaizen, Genchi Genbutsu, challenge, respect to people and teamwork under supporting, pay attention to, open the opportunity, and assisting them. The plant has to build new challenge in working and provides the training both course and on the job. To create good workers' attitude in working is also important. This study that is the initial of improvement in Thaworn karnkaset is a good practice to stimulate the workers developing themselves together with the ongoing improvement continuously.

## VI. CONCLUSION

To improve the onion packaging process by using Toyota production system and lean production concept, the relationship between concept and tool of the study can be explained as:

1. Study of production process of the plant. In the study, flow process chart that shows structure and relationship of procedures in production process are used, and wastes in the process are analyzed by using Caused and Effect Diagram which is an important part for finding causes of problems and wastes in production process.
2. Plant re-planning by using the techniques of principle of 5W 1H and ECRS together with relationship diagram and process layout. Activities that relate to each other were moved close together, since people's motion, material, and equipment affect efficiency of production significantly and they help the process flows continuously. It is the basis of Toyota production that reduces conveyance and waiting in the process.
3. Establishing working standard. The researchers and administrators of the company worked together to make working manual for onion packaging, so as to have reference for working standard and following such standard. Thus operation and outcome can be monitored constantly such as waste analysis and work assessment. Moreover, it also helps communicate with personnel more easily.

All of the concepts and tools mentioned are relevant to each other. For improving efficiency of onion packaging process, all process must be studied, wastes must be analyzed and improved, and working standard must be created. It needs tools for collecting data, analysis, and operation planning. However, improving efficiency of production process must be on the basis that entrepreneurs or administrators are ready and be able to change.

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