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Increasing the Productivity of Ribbed Smoked Sheet Manufacturing in Thailand

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Cost reduction from non-value added activities is one way to increase productivity and achieve the highest efficiency in reducing unnecessary production costs. The objectives of this research were to propose a cost reduction scheme from non-value added (NVA) activities in order to increase productivity in the manufacture of bales of ribbed smoked sheet (RSS) rubber. Data collected from a sample of 10 key informants was analysed using integration definition for function (IDEF0) techniques together with activity value analysis and activity-based costing. Results indicate that sorting and quality inspection activities, including rubber powdering activities during production, were NVA activities. Therefore, the management of farmer institutions should find solutions to reduce these costs by making improvements such as eliminating, integrating, rearranging and simplifying activities, in order to increase productivity during the manufacturing process.

Key words: *Cost reduction, Non-Value Added Activities, Increase Productivity, Process, Ribbed Smoked Sheet Rubber.*

Introduction

Lowering operational costs, which can be achieved by reducing non-value added (NVA) activities, is important in increasing productivity during production. This is especially true in the production of ribbed smoked sheets (RSS) rubber (Rubber Authority of Thailand, 2019), because reducing the cost of NVA activities can lead to the maximum utilisation of resources during production, thus increasing productivity. For this reason, the relevant government agency in the country, the Rubber Research Institute of the Department of Agriculture, tried to find solutions to reduce production costs. By accelerating the farmers' institutions, which were

created by groups of rubber farmers to produce bales of RSS rubber under good manufacturing standards (GMP), the authorities were able to reduce production costs which, in turn, increased productivity and efficiency as well as competitiveness in the international market, alongside such countries as China, Malaysia and Japan (Tassanakul et al., 2014; Ninkitsaranont & Sathapongpakdee, 2017).

However, a report found that some farmers' institutions, which have already been certified by GMP standards, still faced higher cost per unit of production, which led to their low productivity. Therefore, the institutions' management should find ways to reduce production costs and increase productivity.

Many past studies on the cost reduction of smoked rubber sheet production focused on cost and labour productivity (Chansungnoen, 2011); cost and profit analysis (Chanthawong, 2015; Khanchitchai, 2015; Sukrita Pumkaew et al., 2017), including cost, return and efficiency (Lalaeng, 2010; Souliman, Mamlouk & Eifert, 2016), raw material cost (Dunuwila, Rodrigo &Goto, 2018); and sinking costs (Min et al., 2018). However, rarely was cost-cutting from NVA activities investigated using activity-based costing (ABC) to increase productivity, especially during production. If NVA activities can be identified in the production process, by using ABC to analyse data, the authorities can reduce the cost of each activity and further increase productivity.

Due to the abovementioned reason, the current study aims to investigate the cost reduction from NVA activities in order to increase productivity of bales of RSS rubber. This was achieved by investigating GMP-certified farmers' institutions in the southern region of Thailand as the case study. The findings of this study can benefit the administrators of these institutions and provide insights that can assist the government in formulating policies and strategies for reducing costs resulting from NVA activities during production. As a result, GMP-certified farmers' institutions can increase their productivity and market competitiveness.

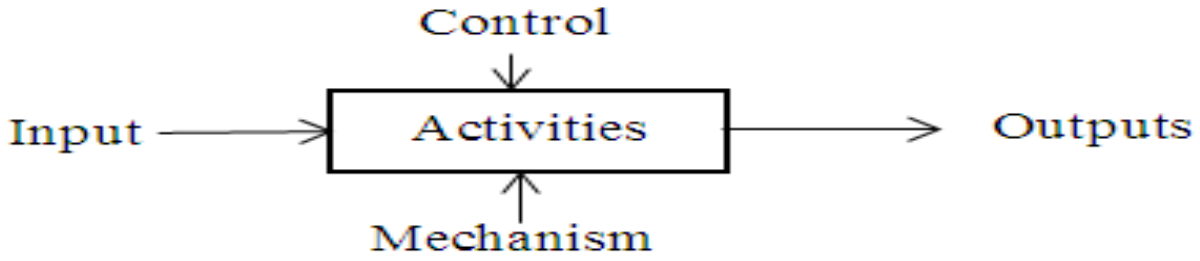
Materials and Methods

Integration Definition for Function (IDEF0)

Hunt (1996), Bouchlaghem et al. (2004) and Feldmann (2013) referred to IDEF0 as a business process mapping, which can provide the details of process activities, in order to analyse the flow of information in communication or coordination, including material and information flow. These are represented in the IDEF0 diagram format, which uses the symbols from the square representing various activities related to the operation, such as ordering raw materials, calibration, measurement and maintenance tools, and so on. The format includes the arrow symbol that enters the square, which consists of four parts from the input factor. These are related to the resources used, such as the raw materials or the required information to complete

the activity (e.g. quotations, purchase orders and documents, etc.). The diagram also includes the mechanisms that are accomplished by people who operate the machines, tools and computers. There is also a control section, which involves the activities related to the control guidelines, such as standard requirements, policies and orders. Meanwhile, the outputs are related to the completion of activities, such as purchase orders, goods orders and cash bills, among others (Figure 1). The components of this model are shown in many levels, from the overall to the sub levels. Such a hierarchical linkage (hierarchy) allows for the analysis, monitoring and evaluation of sub-activities at the desired level, including the pattern of activities, which can help set guidelines to further improve the process.

Figure 1. Integration definition for function



Source: Bouchlaghem et al. (2004)

The current study will use IDEF0 concepts to investigate the details of each activity and conduct the activity value analysis of the production of bales of RSS rubber.

Activity Value Analysis

According to Patel et al. (2013) and Sabet and Yazdani (2016), activity value analysis can be divided into two types: NVA and VA activities. NVA activities do not create operational value or meet the needs of customers. These have no effect on the quality of a service or product, but can unnecessarily increase business costs. Meanwhile, value-added (VA) activities are those that can increase the value of a product, can help meet customers' needs, or are activities that can be efficiently performed (Trisnasari, 2020). VA activities are business requirements (output), such as processing, packaging, etc., to meet the needs of customers. Mowen et al. (2016) mentioned that the analysis of activities can be applied in four ways in order to reduce costs occurring within the organisation:

1) Activity elimination - omitting unnecessary and useless activities, especially NVA activities. Eliminating these will not affect the operations of the organisation.
2) Activity reduction - the reduction of time and resources to lower the costs incurred and increase the efficiency of the necessary activities. Therefore, the productivity (output) can be increased by reducing such activities.

3) Activity sharing or combining - these are activities done together with high-cost activities to reduce the costs per unit.
4) Activity selection or rearrangement - these are considered new activities, which are not performed by an organisation at a certain time to achieve operational efficiency by choosing lowest cost activity.

From the abovementioned concepts, the researcher used activity value analysis together with ABC to find ways to reduce the costs incurred by NVA activities, in order to raise productivity levels during production.

Activity-Based Costing

Babad and Balachandran (1993), Hilton and Platt (2015), and Mahal and Hossain (2015) describe ABC as a method of costing in business units, which can create competitive advantage because it can be used to analyse the costs and resources used in each activity. ABC analyses activities in order to identify, explain, and evaluate each and every one of them (Wanjialin, 2004; Marshall et al., 2011;). Meanwhile, cost driver analysis is performed to determine the costs of all related activities. Hilton and Platt (2015) explained that the cost drivers obtained from the analysis of activities must have a strong relationship with the group or activity, and that activities can actually be measured (e.g., the resources and the time used). If properly analysed, these can reveal the cost driver for the cost of that activity. Analysing the cost drivers may involve observing or interviewing those involved in the activities, and the results can be used for the costing of the expenses or resources used in each activity.

From these concepts, the researcher will analyse data with ABC together with cost reduction from NVA activities, with the aim of increasing productivity in the manufacture of bales of RSS rubber.

Case Study

This research is a case study that employs a mixed-method approach using both qualitative and quantitative data. It studies in-depth the information from farmers' institutions that receive GMP standards and produced bales of RSS rubber in Thailand. The methods of conducting the research are discussed below.

Sampling Frame and Sample Selection

The sampling frame was determined from the list of farmers' institutions producing bales of RSS rubber. The location was restricted to the southern region of Thailand as it occupied the largest area dedicated to rubber plantation (60 percent of the country's total). Selective

purposive sampling was performed to identify the institutions registered with the Cooperative Auditing Office Department of Cooperative Auditing and the Rubber Authority of Thailand. A total of 10 groups from the GMP-certified organisations from the Rubber Authority of Thailand between the years 2015–2019 were identified. The researcher labelled these with codes to maintain confidentiality. They were representative of the farmer groups who received the GMP standard, had production capacities of all sizes: medium (300 tons per month) and mall capacity (150 tons per month) and were located in the provinces with the most planting and production area (11.29 percent), including Surat Thani, Trang, Satun, Phatthalung, Chumphon and Krabi (Table 1).

Table 1: Codes for farmer institutions with GMP certification

Code	Location	Capacity (ton/month)*	Labour numbers**	Farmer institute scale***
RB1	Surattanee	300	17	Medium scale
RB 2	Suratanee	150	24	Small scale
RB 3	Trang	300	17	Medium scale
RB 4	Trang	100	15	Small scale
RB 5	Trang	300	22	Medium scale
RB 6	Trang	150	15	Small scale
RB 7	Stul	200	7	Small scale
RB 8	Pattalung	500	24	Medium scale
RB 9	Chumpon	200	13	Small scale
RB 10	Krabi	200	11	Small scale

Sources: *The Rubber Authority of Thailand (2019). ** Based on a survey conducted by the research. *** Modified from references by the Cooperative Auditing Department (2019) in determining cooperative sizes and agricultural groups. If the production capacity is not more than 200 tons.

Data Collection

***Primary Data**:* The researcher conducted the participant observation and in-depth interviews with structured questions using the 5 W and 1 H concept (who, what, when, where, why and how), in order to gather information on various activities involved in the production process. Starting from importing raw materials to awaiting distribution, the cost of each activity was determined by interviewing key informants. These informants met the following inclusion criteria: an executive representative of a farmer institution that received GMP certification

(Table 1) and had at least three years of management experience in processes with medium production capacity (300 tons per month) or small production capacity (150 tons per month). Each interview, lasted for 1 hour. These interviews were audio-recorded, and photographs were taken in various activities to prevent data error.

Secondary Data: Relevant data was compiled from the database of farmer institutions that received GMP certification from the Rubber Authority of Thailand During the year 2012–2016 (5-year historical data), which was audited by the Cooperative Auditing Office Department of Cooperative Auditing. The data included those extracted from documents, websites, or research related to the smoked rubber sheet production process both locally and abroad. The data was prepared and compiled by various government agencies, such as the Rubber Authority of Thailand, the Department of Agriculture and the Office of Agricultural Economics, among others.

Data Analysis

The researcher collected various information from the participant observation and transcribed interviews for content analysis, together with the analysis of the production process activities of the GMP-certified farmers. From buying rubber to storing smoked rubber sheets, the activities required to produce bales of RSS rubber were identified, and the IDEF0 diagrams were applied to analyse the flow of activities involved in the process. The activity codes A1–A5 through the inputs, outputs, controls and mechanisms were specified, and the activities and resources used in the production process were also identified.

Then, the costs and accompanying details were identified by determining the resource drivers consisting of labour, materials, machine, equipment, facilities, electricity, energy, machine depreciation, equipment depreciation and building depreciation. These resource drivers and resource costs led to the mapping of resource costs and activities, which was used to analyse the costs and the cost proportion of each activity centre from A1–A5. Next, the NVA activities were identified for possible elimination via activity value analysis. These involved activities that use various resources, such as time, labour, machinery and space, but did not create value nor respond to the needs of customers. Either choosing to eliminate or not to act on these (e.g. error correction, warehouse storage, waiting for free time and delays, etc.) would have no effect on the quality of the product.

After analysing VA activities (i.e. activities done to change the shape of the raw material, create value and meet the needs of customers, such as welding or forming), the researcher analysed ABC from the resource drivers and activity drivers with basic statistics, including mean and percentage values for allocating activity costs, and then calculated the activity costs, in order to find ways to reduce costs resulting from NVA activities in the production process.

Verification of Data Reliability

The reliability of the qualitative data was verified by triangulating the data obtained through participatory interview observations and information from various document sources. The data accuracy of the quantitative data was verified, after which the editing was completed.

Results and Discussions

Research results supported the idea of cost reduction from NVA activities to increase productivity in the manufacture of bales of RSS rubber.

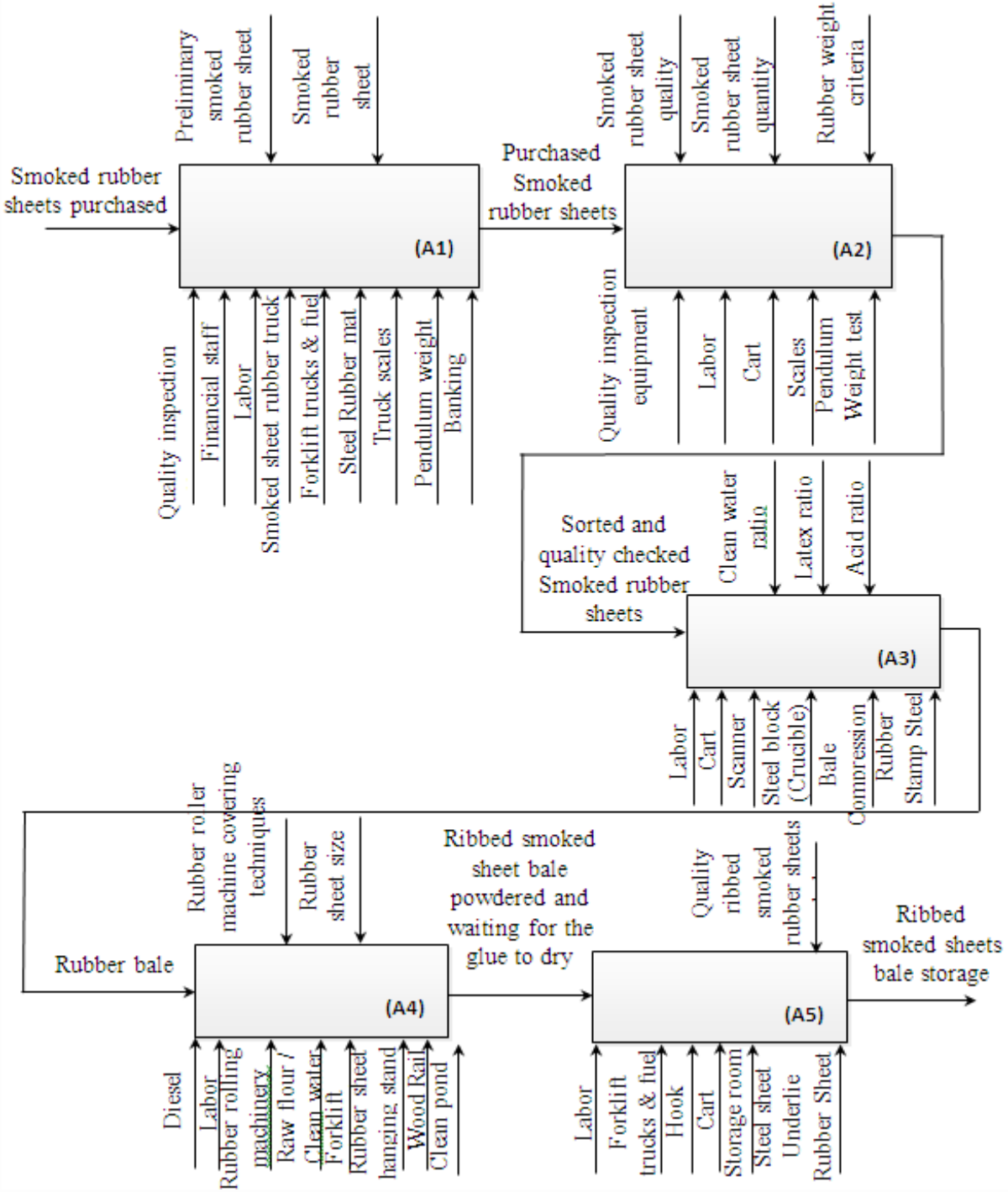
Identifying Activities Required to Complete the Production of Bales of RSS Rubber

Results from the participatory observation and the recording of still images and interviews with key informants indicated the following five main activities in the production, defined as activity centre: A1- buying the smoked rubber sheets, A2 - sorting and checking the quality of the sheets, A3 - pressing the rubber sheets, A4 - applying rubber powder and A5 - storing the smoked rubber sheets. These activities had a total of 31 sub-activities, in line with the research of Tassanakul et al. (2014), which investigated the overall process of producing bales of RSS rubber followed by GMP-standardised farmer institutions (Figure 2).

Figure 2. Key activities in the manufacture of bales of RSS rubber

From Figure 2, IDEF0 was applied to analyse the activity flow in the rubber sheet production process. The figure shows the details of resources used in various activities from A1–A5 (Figure 3).

Figure 3. Breakdown of activity flow during production of bales of RSS rubber with IDEF0



Identifying Costs and Collect Cost Details

From Figure 3, the researcher identified the costs and collected cost details in each activity of the production process. The cost elements were analysed by determining the resource drivers,

namely, labour, materials, machine, equipment, facilities, electricity, energy, machine depreciation, equipment depreciation and building depreciation. In accordance with Armstrong (2002), Gupta and Galloway (2003), Almeida and Cunha (2017), Carli and Grandi (2018), referred to the push of resources related to the purchase of raw materials, chemicals, equipment, consumption cost, fuel, wood fire, electricity, water, factory equipment repair, depreciation of machinery and equipment and depreciation of buildings and structures (Table 2).

Table 2: Resource drives of activities in the production of bales of RSS rubber

Cost element	Resource driver	Resource costs (Baht per kilogram)
Labours	Direct from production	0.9203
Materials	Direct from production	0.0138
Machine	Direct from production	0.0103
Equipment	Direct from production	0.0020
Facilities	Work area	0.0163
Electricity	Kilowatt hours consumption by activity	0.0323
Energy	Number of hours by activity	0.0267
Machine depreciation	Machine time by activity	0.0113
Equipment depreciation	Equipment time by activity	0.0106
Building depreciation	Work area	0.0123
Total		1.056

Mapping of Resource Costs of Activities

The results of the above analysis helped identify costs and collect cost details. The data regarding the resource drivers was used to map the resource costs of different activities in the production and to determine the cost allocation criteria. The activity costs were calculated by allocating costs from the cost centre or main activities into the sub-activities using arbitrary allocation. Results indicated that A2, A4 and A5 had the highest proportions of labour costs, materials and equipment. Among these, A2 had a proportion of as high as 67.8% for labour costs related to salaries and wages, whilst A4 had a proportion of 98.55% for the material costs associated with raw rubber. A5 had a cost ratio of up to 66.67% for the equipment related to hooks and steel briquettes. These findings are in accordance with Gosselin's research (2006), which applied the activity cost to help make decisions about cost management and other related activities (Table 3).

Table 3: Cost of producing bales of RSS rubber by activity centre

Cost element	Resource driver	Map resource costs to activities					Total
		A1	A2	A3	A4	A5	
Labours	Direct cost	0.0838 (9.10%)	0.6199 (67.35%)	0.1218 (13.24%)	0.0516 (5.61%)	0.0432 (4.69%)	0.9203 (100%)
Materials	Direct cost	0.0000 (0.00%)	0.0000 (0.00%)	0.0000 (0.00%)	0.0138 (100%)	0.0000 (0.00%)	0.0138 (100%)
Machines	Direct cost	0.0005 (4.99%)	0.0001 (0.66%)	0.0092 (88.95%)	0.0003 (2.43%)	0.0003 (2.97%)	0.0103 (100%)
Equipment	Direct cost	0.0003 (14.19%)	0.0004 (17.96%)	0.00006 (3.05%)	0.0001 (8.58%)	0.0012 (56.22%)	0.0020 (100%)
Facilities	Square feet of facility	0.0006 (4.06%)	0.0090 (54.60%	0.0023 (14.35%	0.0019 (11.52%)	0.0025 (15.47%)	0.0163 (100%)
Electricity	Kilowatt/hour consumption by activity	0.00008 (0.26%)	0.0000 (0.00%)	0.0315 (97.47%)	0.0007 (2.27%)	0.0000 (0.00%)	0.0323 (100%)
Energy	Hours spent on each activity	0.0016 (6.17%)	0.0003 (1.19%)	0.0000 (0.00%)	0.0234 (87.40%)	0.0014 (5.24%)	0.0267 (100%)
Machine depreciation	Machine time by activity	0.0006 (5.20%)	0.0001 (0.66%)	0.0101 (88.92%)	0.0003 (2.45%)	0.0003 (2.76%)	0.0113 (100%)
Equipment depreciation	Equipment time by activity	0.0002 (2.01%)	0.0067 (62.09%)	0.0004 (3.65%)	0.0005 (5.08%)	0.0028 (26.35%)	0.0106 (100%)
Building depreciation	Square feet of facility	0.0005 (4.25%)	0.0067 (54.49%)	0.0018 (14.31%)	0.0014 (11.51%)	0.0019 (15.44%)	0.0123 (100%)
Total (Baht per kilogram)		0.0881 (8.34%)	0.6432 (60.91%)	0.1772 (16.77%)	0.0940 (8.90%)	0.0536 (5.08%)	1.056 (100%)

Unit: Baht per kilogram

Next, the researcher compared the activity costs in the production of farmers' institutions with small and medium capacities by calculating the weights of the smoked rubber sheet (kg). Results showed that the average production cost of both groups was 0.73 Baht per kilogram. Institutions with small production capacity had higher activity costs, especially those linked to A2, A4 and A5, than the institutions with medium capacity. As a result, institutions with small production capacities had an average cost of 80 Baht per kilogram, which was higher than that of institutions with a medium capacity at 0.14 Baht per kilogram (Table 4).

Table 4: Comparison of the activity costs of farmers' institutions with small and medium production capacities in the manufacture of bales of RSS rubber

Activity centre	Cost per activity in the production of smoked rubber sheet bale			
	Farmers' institutions with medium production capacity	Farmers' institutions with small production capacity	Average	Lowest possible cost reduction
A1	0.09	0.04	0.06	0.04
A2	0.29	0.31	0.30	0.29
A3	0.18	0.16	0.17	0.16
A4	0.09	0.27	0.18	0.09
A5	0.01	0.02	0.02	0.01
Total	0.66	0.80	0.73	0.59

Remark: Cost driver is calculated as the weight of smoked rubber sheet (kg); Unit: Thai Baht (THB) per kilogram

Identifying the NVA Activities for Possible Elimination

From the analysis of all the above information, the research determines whether there are VA or NVA activities in each activity centre. Results indicated thatA1 was a VA activity, because it involved the purchase of smoked rubber sheets that required weighing procedures. To comply with the rules or regulations set; thus, the purchase of smoked rubber sheets resulted in a processing time of up to 73 minutes, accounting for 38.42% of the total time. Meanwhile, A3 was also a VA activity because of the compression moulding process, which can lead to deformation, resulting in a kind of value that could meet the needs of customers. However, the processing time used for the assembly, welding or formation of the product from smoked rubber sheets into bales, was just 13 minutes or 6.85% of the total time (Table 5).

Table 5: Activity value analysis and time rates of the activities of the production of bales of RSS rubber

Activity centre	Activity value analysis	Activity driver	Time rates (minutes)	Total percentage of time	Average cost per activity (Thai Baht per Kilogram)
A1	VA	Processing time	73	38.42	0.06
A2	NVA	Inspection time	40	21.05	0.30
A3	VA	Processing time	13	6.85	0.17
A4	NVA	Waiting time	56	29.47	0.18
A5	NVA	Transfer time	8	4.21	0.02
Total			**190**	**100.00**	**0.73**

Remarks: A1 (Activity 1): purchasing of smoked rubber sheets, A2 (Activity 2): sorting with quality checking, A3 (Activity 3): compressing the rubber bale, A4 (Activity 4): applying powder and A5 (Activity 5): storing the rubber sheets.

In identifying NVA activities for possible elimination results showed that A2, A4 and A5 were NVA activities. First, A2 was involved in quality checks or the correction of errors and used an inspection time of up to 40 minutes (21.05%), although it did not produce value during the production of smoked rubber sheet bales. Similarly, A4, which was involved in applying rubber powder to prevent moisture and humidity so that the rubber would not to stick together before moving, resulted in non-valuable waiting time, compressing up to 56 minutes or 29.47%. Meanwhile, A5, which was related to the transfer of materials to a storage area, used a bit of transferring time. Although it only took 8 minutes or 4.21% of the total, storage still involved waiting for distribution or delivery to customers, thus it did not help create value in the production process (Table 5).

Therefore, when considering all the research findings, the institutions should find a solution to reduce the costs of NVA activities in order to increase productivity in activities A2, A4 and A5. This can be achieved through work simplification by doing the following: eliminate activities, combine activities, rearrange activities and simplify activities. This is in accordance with Mowen et al. (2016), who proposed cost-cutting approaches to reduce NVA activities.

Eliminating Activities

Results showed that farmers' institutions with small and medium production capacities spent an average of 56 minutes of waiting time on A4 activities. Most of the time was spent in preparing the powder, glue and rubber and in moving the smoked rubber sheets to the powder points, resulting in longer waiting times for applying the rubber powder.

These unnecessary activities can be eliminated without affecting any customers. Doing so (i.e. eliminating the moving activities of the smoked rubber sheet bale to the powder point) can reduce the waiting time, resources and A4 activity costs. By changing the flow chart to reduce the moving time, the reduction of the time and costs spent for A4 activities can be reduced.

Combining Activities

Both types of farmers' institutions spent up to 40 minutes on A2 activities, following A1 activities. Most of the time spent on A2 activities were allocated to sorting and checking the quality of the rubber. However, the cost reduction of activities in A2 can be achieved by the integration of A1 and A2 and increasing the skills of workers to be able to perform many tasks from A1 and A2 at the same time.

Rearranging Activities

Results showed that both types of farmer institutions had similar activity sequences. However, A4, A2 and A5 activities took as much as 56, 40 and 8 minutes, respectively. These activities can be rearranged appropriately with the same result but with less time required, especially by reducing unnecessary waiting time or moving distance. For example, the researcher can alternate the waiting time in A4 activities by weighing the smoked rubber sheet bale, which is powdered in A5 sub activities, and preparing storage while waiting for the rubber powder, smoking the sheets, pressing the sheets until they are dry, etc. These may result in the reduction of time and costs in activities A4 and A5.

Simplifying Activities

Both types of institutions used average activity costs of A2 of up to 0.30 Baht per kilogram. The farmer institutions with small production capacity had higher activity cost of A2 at 0.31 Baht per kilogram than those with medium production capacity, which had a cost of 0.29 Baht per kilogram. Most of the cost of A2 activity came from labour costs for people responsible for sorting and checking the quality of rubber. Cusanelli & Trevallion (2020) mentioned that if possible, technology or machines can be used to accomplish the tasks of sorting and checking the quality which, in turn, may lower the labour costs in A2 activities.

Conclusion and suggestions

Conclusion

The findings showed that the process of smoked rubber sheet bale production consisted of 5 main activities and 31 sub-activities. When comparing the activity costs in the process production, both types of farmers' institutions had an average production cost of 0.73 Baht per kilogram. The institutions with small production capacity had higher production costs than those with medium production capacity at 0.14 Baht per kilogram. However, both institutions had costs arising from the NVA activities. Therefore, the management of farmers' institutions should find ways to reduce the cost of the NVA activities, especially the sorting and inspection of rubber quality activities, including rubber powdering activities. The researcher proposed a reduction of the costs arising from NVA activities in order to increase productivity by eliminating, combining, rearranging and simplifying activities.

The results of this research provide useful information to help the administrators of farmers' institutions understand all cost behaviour processes occurring within the organisation and identify the factors that decrease or increase production costs. By specifying activities, activity costs and cost drivers, the cost of production can be calculated, and the information can be used as guidelines to develop cost efficiency, especially the costs arising from NVA activities.

Suggestions

Suggestions for Future Research

The results of this research are beneficial to the farmers' institutions in terms of reducing activities, the time requirement and the cost of activities involved in the production of smoked rubber sheets. The management should also pay attention to the reduction of time spent on NVA activities during production. Meanwhile, the government should provide funds to help farmers use modern technology or machinery, such as sorting and quality inspection machines, to help reduce time and activity costs during production.

Suggestions for Further Studies

Future studies should investigate the cost allocation to activity drivers, which may be determined by the production times spent by farmers' institutions with small and medium production capacities. The entire picture of the production of smoked rubber sheets should also be obtained (both non-compressed and compressed) from upstream, midstream and downstream in order to find ways to reduce activities and time spent as well as increase productivity from the use of inputs or resources during the production of smoked rubber sheet bales.

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