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An application of activity-based costing in the chicken processing industry: a case of joint products

RESEARCH ARTICLE

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Abstract

A great deal of research has been presented on the application of activity-based costing (ABC) in the manufacturing and service industries. In the field of agribusiness, which focuses uniquely on joint products, few studies exist that illustrate applications of ABC. This research has therefore applied ABC to a food company, concentrating on fresh and frozen chicken processing production. The basic process of ABC, based upon five steps, was applied and demonstrated the difficulties in applying cost data collection, identifying activity and cost drivers, as well as collecting driver data. The results also revealed significant differences in unit costs derived by ABC and the company's existing cost system, particularly within frozen food products. This may suggest the possibility of distorted cost allocations within the company's current costing system.

Keywords: process manufacturing, activity-based costing, ABC, agribusiness, food company
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1. Introduction

Cooper and Kaplan (1988) introduced activity-based costing (ABC) which allocates overheads to end products or services based on the activities required for their production. Since its introduction, ABC has moved from concept to implementation (Tsai, 1996). Many researchers have discussed how to employ ABC in general and/or conceptual models (Carli and Canavali, 2013; Gunasekaran and Sarhadi, 1998; Roztocki *et al.*, 2004; Schulze *et al.*, 2011; Spedding and Sun, 1999), while others explored the use of ABC as case studies in manufacturing firms (Hughes, 2005; Jongprasithpron *et al.*, 2006; Liu and Pan, 2007; Ong, 1995; Rezaie *et al.*, 2008; Salehi *et al.*, 2010; Tsai *et al.*, 2012) and service businesses (Baykasoğlu and Kaplanoğlu, 2008; Themido *et al.*, 2000; Vaughn *et al.*, 2010).

In the agricultural industry, Koutouzidou *et al.* (2015) reviewed studies on the application of ABC to several agricultural production systems; including fishing, winemaking, ornamental plant cultivating, sawmilling, and dairy farming, and concluded that there were limited applications within this industry, because its production methods have several unique characteristics that are not found in other industries. Of the research reviewed by Koutouzidou *et al.*, (2015) González-Gómez and Morini (2006) applied ABC to winemaking processes that had no fixed operational procedures and in which the specific knowledge of the winemaker was crucial. In 2009, the same authors examined the application of ABC in multi-production of ornamental plants. However, current research has yet to catch up with the unique characteristics of joint processes, which are typically found in the food industry.

The food industry produces a multitude of products from one or more primary materials through its manufacturing processes. That is, that joint products are simultaneously produced using a common or series of processes (Tsai, 1996). As such, this unique characteristic makes food companies an interesting case study for applying ABC. Tsai (1996) outlined a framework for applying ABC to joint products, but this concept has not been applied in practice. Therefore, this research applies ABC to a specific food company, and investigates whether ABC generates different product costs from the current cost system that is frequently used by many food manufacturing companies.

This case study focuses on a food company in Thailand, as Thailand is an agricultural country with a high rate of food export, and a broad range of agricultural businesses. The Thai food industry has developed significantly and large manufacturing facilities have established many advanced technologies, in which production processes have become increasingly complicated. As a result, the indirect-cost proportion of the processes increases and must be accounted for in the unit cost calculation. Thailand also represents a developing country where ABC, as an advanced management accounting tool, has rarely been employed (Majid and Sulaiman, 2008).

2. The concept of ABC for joint products and an applied approach

ABC is a costing system based on production activities. It assigns all overhead costs to activities with the assistance of resource drivers. Activity costs are then assigned to products according to activity drivers (Vazakidis *et al.*, 2010). However, because of the unique characteristics of the joint production process in the food industry, there developed a need to modify standard ABC concepts. Tsai (1996) suggested that some joint products must pass through specific production process while others may be manufactured through an entire process. Thus, the second stage of cost allocation should be directed to each process, and then the costs of each process assigned to the joint products. According to the ABC framework and Tsai's suggestion, this study follows the approach in Figure 1.

The first step identifies resource costs and activities. Resource costs refer to the ingredients required in a production process, such as labor and materials, which cannot be directly assigned to particular products, and are often described as overhead (OH). Oliver (2000) defines activities as a description of the work necessary to produce a product in a company; which uses people, technology, materials, processes, and the

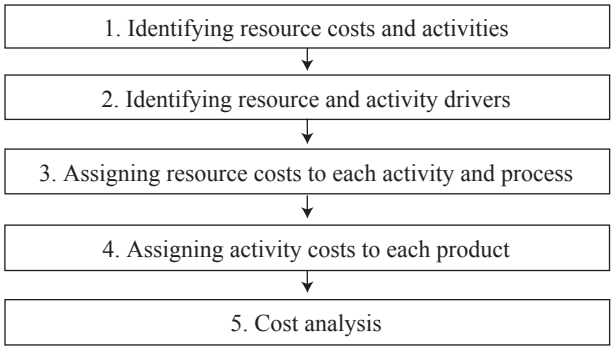

Figure 1. The ABC approach (adapted from Baykasoğlu and Kaplanoğlu, 2008; Nachtmann and Al-Rifai, 2004; Tsai, 1996). ABC = activity-based costing

environment. This information can be obtained by reviewing the documentation of work flow, observing the actual production process, and interviewing employees (Baykasoğlu and Kaplanoğlu, 2008).

The second step indicates resource and activity drivers, both of which are generally selected based on three criteria: (1) they are easy to identify, simple to use, and uncomplicated; (2) they have a direct relationship to indirect costs; and (3) they generate an advantage for understanding the behavior of costs, and influence the changing of cost (Gary and Sorinel, 2010). Several approaches were employed to identify the drivers; such as brainstorming, meetings, interviews, questionnaires, observations and/or combinations of approaches (Baykasoğlu and Kaplanoğlu, 2008; Themido *et al.*, 2000; Tornberg *et al.*, 2002).

In the third step, resource costs are allocated according to the resource consumption coefficients of the resource drivers, and are calculated in proportions (in which the sum of the proportion in each driver=1). Several researchers (e.g. Baykasoğlu and Kaplanoğlu, 2008; Salehi *et al.*, 2010) utilized the expense activity dependence (EAD) matrix to assign OH costs to specific activities. Due to joint process characteristics, the activities' costs are then assigned to the processes.

The fourth step involves allocating the process costs to the product. Similar to the method employed in the third step; the consumption coefficients are calculated and the activity product dependence matrix may be used when there are a wide range of processes and products.

The final step compares the product cost based on ABC with that initially calculated by the company through other means, and analyzes similarities and/or differences.

3. Company background

This case study[1] is on a food corporation in Thailand that runs a complete supply chain of poultry and swine integration for both domestic and international markets. Its operations were classified into six types of business; regional and feed, poultry integration, swine integration, food integration, animal health, and other. For this study, the poultry integration business was chosen as the case because it is successful and creates the main revenue for the company.

The poultry integration business encompasses chicken feed mills, breeder farms, hatcheries, broiler farms, contract farms, fresh and frozen chicken processing, cooked chicken products, and chicken meatballs and sausages. The products from fresh and frozen chicken processing represent our main focus, as their production processes are complex and justify the application of ABC.

[1] The company name is anonymous in order to prevent a potential competitive disadvantage.

The company's fresh and frozen chicken products

The products derived from fresh and frozen chicken processing are structured and outlined in Figure 2. There are six main parts: the carcass, fillet, bone-in leg, breast bone, wing, and whole chicken. Four of these chicken parts (bone-in leg, breast bone, fillet, and wing) can be further processed into several product variations. For example, the breast bone can be categorized into breast-bone meat and a skinless breast-bone meat. Each of these products can be further allotted to three sub-products: domestic, frozen and raw material. The other three primary parts can be separated into the products presented in Figure 2. Each product has three sub-products, except for the drumstick, which has two sub-products: domestic and raw material. Therefore, there are six primary parts, separated into 15 products, and further processed into 38 sub-products. These sub-products were grouped from 136 total products manufactured by the company.

The production area and process

The company has two production factories: the slaughter house and the cooked-food house. The former is in focus, for its processing of the fresh and frozen chicken products. The slaughter house area is divided into eight zones, illustrated in Figure 3:

1. 'Live birds zone' receives and weighs live chickens, and conducts a quality control procedure, an ante-mortem inspection. The chickens are then unloaded and transported on a conveyor belt that leads to the slaughter zone.
2. 'Slaughter zone' is for slaughtering chickens. This is gently performed by skilled employees. There are six steps in this zone: hanging and stunning, slaughtering, scalding, de-feathering, washing, and head and feet removal. The whole chicken is prepared for production, and the blood, head, feet, and feathers become by-products.
3. 'Evisceration zone' includes two machine-operated processes: (1) evisceration and post-mortem inspection – the chickens are eviscerated by the auto-eviscerating machine and veterinarians perform the post-mortem inspection; and (2) inside and outside washing – in which the whole chicken is placed in a washing machine.
4. 'Chiller zone' contains the chiller and sorting machines, which freezes and sorts chickens by weight. A whole chicken is passed through the chiller machine at 4 °C to preserve the freshness of the chicken.
5. 'Primary cut-up zone' cuts the chicken into five main parts: fillet, leg bone, breast bone, wing, and carcass. Four parts are sent to the secondary cut and special product separation zone. The carcass is sent to the storage process (Zone 8).

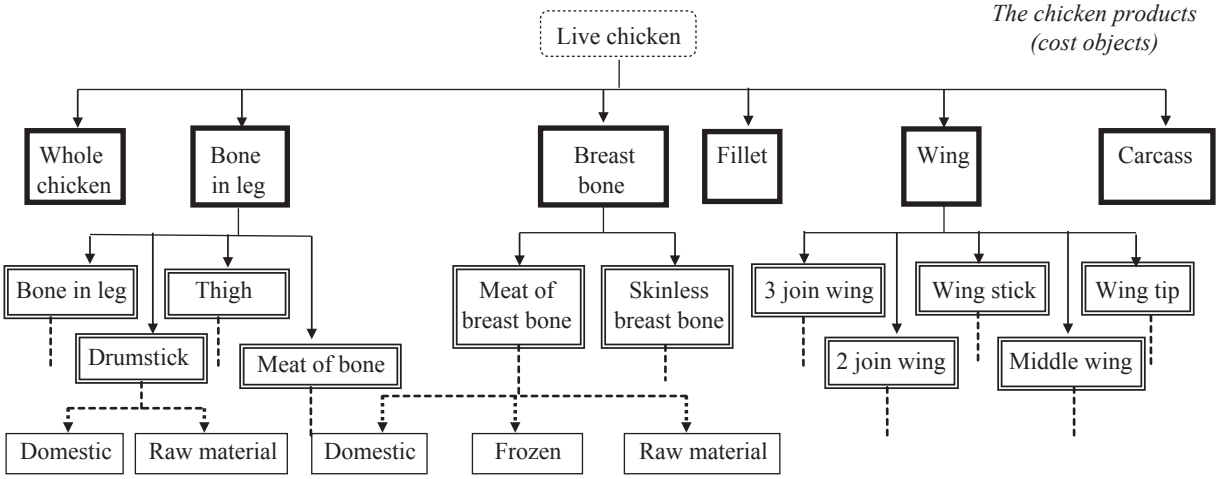

Figure 2. Fresh and frozen chicken products (information obtained from the interviews and company documents).

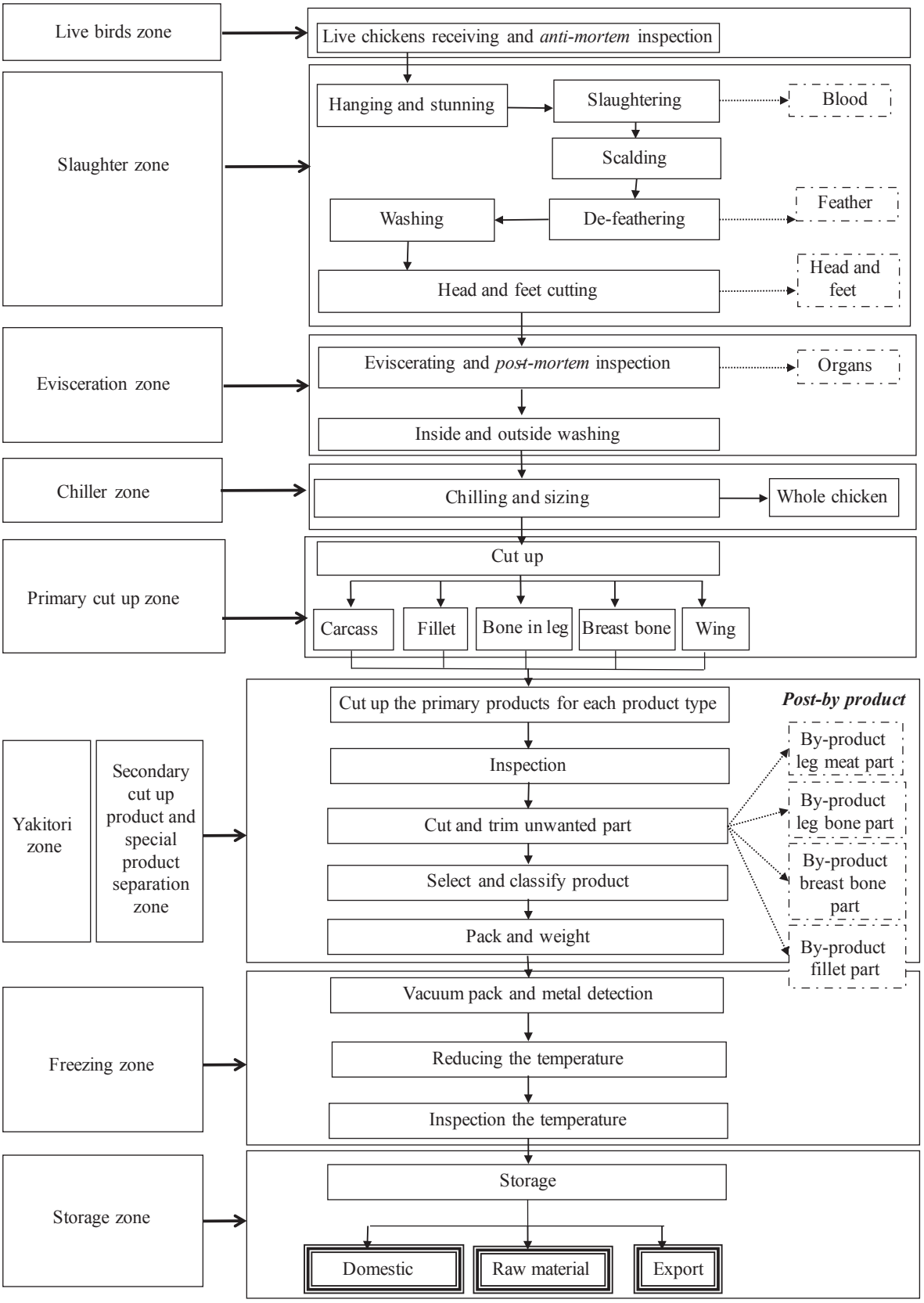

Figure 3. Production zones in the slaughter house (information obtained from the interviews and company documents).

6. 'Secondary cut-up and special product separation zone' include five processes:
   6.1 Secondary cut: four parts from the primary cut-up zone are separated into sub-products by skilled laborers.
   6.2 Inspection: laborers check the products by sampling whether the meat will satisfy customer quality requirements. If not, the meat is sent to the cut-and-trim process.
   6.3 Cutting and trimming the unwanted parts: laborers cut and trim the unwanted parts, such as bruised skin, bones, blood, or scrap. These are by-products and sold in domestic markets.
   6.4 Selection and classification: laborers sort the chicken into three groups: domestic, export, and raw material; based on features, such as weight and shape. Each group is transferred to its product-line process.
   6.5 Pack and weight: laborers pack and send the products to the appropriate departments. Domestic products are sent to an exposing department in the storage zone, raw materials are transferred to the chilling room, and exported products are delivered to the freezing zone.
7. 'Freezing zone' consists of three processes:
   7.1 Vacuum packing and metal detection: meat is packed and sealed with a vacuum packing machine and inspected by the metal detection machine.
   7.2 Freezing process: sealed packages are transferred to the freezing room and are immediately frozen at -18 °C to preserve their quality.
   7.3 Quality control process: frozen products are randomly sampled to check whether their temperature is appropriate.
8. 'Storage zone' is for storing products in a different way. Domestic products are kept in a domestic warehouse, while raw material products are transported by trolley to a chilled room. Frozen products are transported to a warehouse that maintains a specific temperature.

The company's current cost allocation method

The company currently uses the absorption costing method, which accumulates costs throughout the production process and allocates these costs to an individual product (Figure 4). It also employs the sales value at the split-off-point to allocate joint costs to joint products and by-products. However, the absorption costing method was not directly connected to the corporate accounting system. If the company wished to connect it, significant costs would be incurred. Therefore, production costs were calculated in an offline system. Cost data was gathered from the accounting system, and calculated as follows:

1. In the primary cut processes, the total joint costs consisted of all costs associated with four units: live bird, de-feathering, evisceration, and primary cut; which typically comprised of direct costs, production overhead, and service overhead. Some overhead costs were directly incurred in the unit, such as the unit manager's salary; but other unidentified-unit costs, such as electrical expenses and the plant manager's salary, were allocated to each unit based on selected drivers.
2. In each unit, when by-products were generated, the total joint costs were allocated to each by-product at the split-off point, based on its marketable value. The net total joint costs were then assigned to the six primary parts, based on their proportion of the total marketable value. The overall cost allocation process is presented in Figure 4.
3. After the primary cut processes, the allocated joint costs of the four main parts (bone-in leg, breast bone, fillet, and wing) were assigned to 136 sub-products. Each sub-product also absorbed its own additional production costs, such as the freezing expenses incurred by the frozen sub-products. The cost allocation for the secondary cut processes, seen in Figure 4, uses the fillet products as an example.

In sum, the company's cost allocation method allows by-products to absorb production costs according to their marketable value. Consequently, a by-product with a high marketable value would have higher joint costs, while one with a low marketable value would be assigned a low cost. This may not distort the production costs of each product if the by-products have a low market price and if they represent a small proportion of

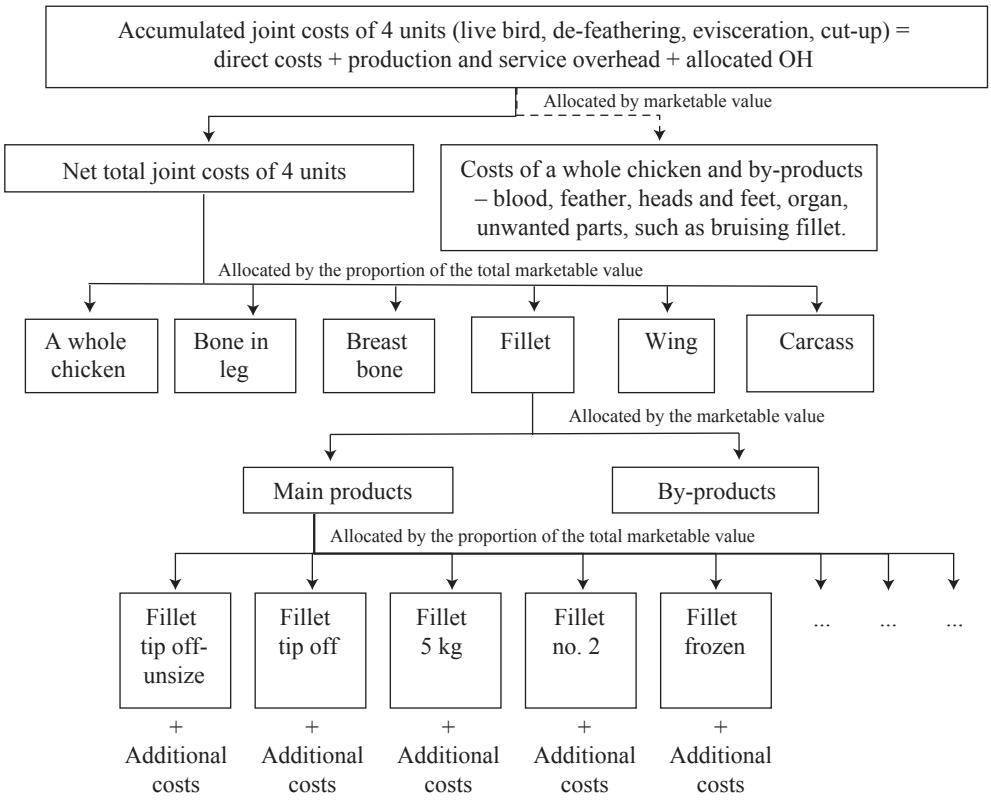

Figure 4. The current cost allocation method that the company applied (information obtained from the interviews and company documents). OH = overhead.

the company's total production; otherwise, management could misunderstand the production costs, which could lead to unintended mistakes or decisions.

Similarly, the current method allowed the joint costs assigned to each sub-product based on its proportion of total marketable value, which suggests that a sub-product with high marketable value could have high allocated joint costs, and vice versa. Therefore, it is possible that a product with uncomplicated production processes could have higher costs than those with complicated processes.

4. Results

The results of the applied ABC approach are explained below.

Identifying resource costs and activities

We observed the production processes and conducted initial interviews with management from three departments: cost accounting, slaughter house, and cooked products. The company's documents were reviewed, including the work flow of the slaughtering process, a list of products, and the chart of accounts.

Eighty-eight accounts of resource costs were identified but due to their diversity, they were grouped into 26 overhead categories based on their similarities (Baykasoğlu and Kaplanoğlu, 2008). Work flows were analyzed and drafted for each type of product. The flow illustrated the process of production, previously presented in Figure 3. Each process consisted of various complicated activities; some of which could not be clearly identified. The research therefore identified activities according to their manufacturing processes.

A second interview was conducted with the company's managers to confirm expense categories and activities. Some expenses were determined whether they should be allocated to production. After thoroughly consulting with the accounting department, some were classified as 'non-allocated' expenses because the transactions' direct relation to production was unclear. All expense categories are shown in Supplementary Table S1. In deriving the activities, the production manager clarified the work flow of the production process in detail and suggested improvements, so that the activities were well-defined. As a result, 16 activities were identified, and are presented in Table 1.

Identifying resource and activity drivers

A discussion with management and consultation with the work flow document were conducted to indicate the resource and activity drivers, based on criteria outlined by Gary and Sorinel (2010). To allocate some expenses, more than one resource drivers could be employed. For example, the training expenses could be allocated to activities according to either the number of staff or the number of training courses. In this case, management suggested that most of the training courses were organized for all staff, and were not specific to particular departments. Therefore, the staff number was considered a more suitable resource driver of the training cost allocation than the number of training courses. The problem of alternative drivers for allocating costs also appeared when the activity drivers were identified. Therefore, at this step, drivers were identified strictly on the condition that they satisfied the criteria of Gary and Sorinel (2010) and management reviewed and approved them. The resource and activity drivers are outlined in the above tables.

Assigning resource costs to each activity/process

This step is to allocate OH to activities and then activity costs to processes. Because the research identified activities according to the manufacturing processes, cost allocation to processes was not needed. Supplementary Table S2 reports the consumption rates and costs of each activity in the EAD matrix, and demonstrates how much production cost each activity consumed.

Before assigning costs to activities, the research collected data on the resource costs and drivers. Cost data was obtained from the accounting system, which primarily records transactions for financial reporting purposes; thus, some expenses included both direct and indirect costs, such as staff expenses, including the salaries of staff who work in a particular process (direct costs), as well as on various procedures (indirect costs). It is necessary to accurately identify the indirect costs when applying ABC. The company addresses this problem through the use of subaccounts to indicate indirect costs, and then manually collects those subaccounts for cost management. Our study relied upon this cost data. Resource-driver data were primarily collected from the slaughter house department; however, portions of the required data were not available, as the company had no data collection system. Therefore, other possible drivers were determined, and obtained within the second step: identifying resource and activity drivers.

After obtaining the cost and driver data, consumption rates for each activity were calculated by dividing the amount of resources consumed by each activity with the total amount of resource consumption. For example, for vehicle expenses (No. 6 in Supplementary Table S2), the resource driver was the number of times a vehicle was used, which was 10,872 times. This total number contributed to four activities: marketing and selling (691 times), administration and support (10,062 times), waste water treatment (107 times), and customer service (12 times). As a result, the consumption rate for marketing and selling was 0.0636 (691/10,872). Administration and support consumed the most vehicle expense, as its consumption rate was 0.9255. Customer service and the waste water treatment activities consumed rates 0.0098 and 0.0011, respectively. Consumption rates for other activities were calculated in the same way.

According to the consumption rates, the total amount of each expense was allocated to each activity. Continuing from the vehicle expense example above, the total vehicle expense of $460,476 was distributed to four activities, according to their consumption rates. Therefore, the marketing and selling activity accounted

Table 1. Details of the activities and activity drivers.

Activities/process	Explanation	Activity drivers	Measurement unit
1. Marketing and selling	A set of activities performed to obtain orders from customers.	no. of customers	person
2. Ordering and planning	A set of activities that uses the process of receiving an order from customers and scheduling a production plan according to the orders.	no. of product types	type
3. Slaughtering	Activities of preparing a whole chicken to be ready to cut that includes receiving live chickens, stunning, slaughtering, scalding, de-feathering, washing, eviscerating and sizing the whole chickens.	product quantity	kilogram
4. Primary cut	A group of activities that involve cutting. Chickens are put in the loop of head conveyor and passed through the breast bone, wing, leg bone, and fillet stations for cutting. The carcass is the last main part received.	amount of time used in cutting	second
5. Secondary cut	A set of activities that include detail cutting and trimming the breast bone, wing, leg bone and fillet.	amount of time used in cutting	second
6. Checker weigh	A set of activities that record skilled laborers' performance in cutting and trimming particular products. Their performance depends on the weight of chickens that are recorded to a card or machine and then sent to the administration.	product quantity	kilogram
7. Packing and weighting	A group of activities that includes selecting the shaped parts of chicken, their weight, and their quality, according to customers' specifications, and the packing.	product quantity	kilogram
8. Vacuum packing and metal detection	Two main activities: (1) vacuum packing, to pack selected parts of the chicken with a special technique that is performed by a machine to keep the meat from spoiling; and (2) metal detection, the machine detects unwanted pieces in the packages.	product quantity	kilogram
9. Chilling activity	The activity is to maintain the products at a temperature of 0-4 °C.	product quantity	kilogram
10. Freezing	The activity is to freeze the product by quickly lowering its temperature to the appropriate degree.	product quantity	kilogram
11. Storage	An activity for storing the finished frozen products before transferring them to customers or sending them to be a ready-to-eat product.	product quantity	kilogram
12. Domestic products	A group of activities that prepare products that are sold to domestic customers.	product quantity	kilogram
13. Delivery-out	A group of activities for shipping frozen products to overseas customers by hiring a third party.	product quantity	kilogram
14. Administration and support	A set of activities that exist to support and facilitate staff and laborers who work in manufacturing.	no. of product types	type
15. Waste water treatment	An activity for converting waste water to clean water before released.	product quantity	kilogram
16. Customer services	A series of activities designed to enhance the level of customer satisfaction.	no. of customers	person

for $29,286.27 (460,476 × 0.0636); administration and support activity received $426,170.54 (460,476 × 0.9255); waste water treatment and customer service activities received $506.52 (460,476 × 0.0011) and $4,512.66 (460,476 × 0.0098), respectively. Allocations of other expenses were calculated in the same way. Supplementary Table S2 provides the consumption rates and costs allocated to each activity.

After allocating all costs, we summed the total costs for all activities. The slaughtering activity costs were the highest, at approximately 8.5 million dollars, and customer service activity costs were the lowest, at approximately $71,180.

Assigning activity costs to each product

At this stage, the total cost for each activity was allocated to the 38 product types. Supplementary Table S3 shows the activities associated to each product and several of their consumption rates. Wingtip-frozen and skinless breast-bone-frozen products consumed 14 activities in the production procedures whereas the whole chicken product consumed only five activities.

To calculate the total OH cost for each product, its activity consumption was multiplied by the activity rate (Supplementary Table S2). Due to the many types of products, and to clearly present the differences between the current cost system and ABC, this paper exemplified the OH cost calculation of the fillet products, as illustrated in Supplementary Table S4.

Product cost analysis

Comparisons between the current cost system and ABC are presented in Table 2. In both the company's current system and the proposed ABC concept, the frozen fillet products had the highest costs. However, in comparing these costs, the ABC cost was higher than that of the current system about $2.17 and $2.21 per kilogram. This difference suggests that the current cost system possibly has not allocated all associated OH costs to frozen fillets regarding their production activities.

Table 2. A comparison of the product costs.[1]

No.	Product types	ABC			The case study	Diff.
		OH per unit ($/kg)	Direct costs per unit ($/kg)	Total costs per unit ($/kg)	Total costs per unit ($/kg)	
1	domestic fillet					
	fillet	0.3299	1.0294	1.3594	1.9011	-0.5418
	fillet No. 2	0.3299	1.0294	1.3594	1.8826	-0.5232
	bruising fillet	0.3299	1.0294	1.3594	1.7206	-0.3612
	fillet 1	0.3299	1.0294	1.3594	1.8143	-0.4549
	fillet 5	0.3299	1.0294	1.3594	1.8689	-0.5095
	fillet (BF)	0.3299	1.0294	1.3594	1.9174	-0.5581
	fillet BFS	0.3299	1.0294	1.3594	1.7431	-0.3838
2	frozen fillet					
	fillet frozen	3.13	1.0294	4.16	1.9580	2.21
	fillet frozen 2	3.13	1.0294	4.16	1.9891	2.17
3	raw material fillet					
	fillet unsize	0.3257	1.0294	1.3551	1.8969	-0.5417
	fillet	0.3257	1.0294	1.3551	1.8880	-0.5329
	fillet ML	0.3257	1.0294	1.3551	1.8894	-0.5343

[1] ABC = activity-based costing; OH = overhead.

The product costs for the two other types of fillet products based on the ABC were lower than those from the company. This is consistent with the frozen fillet products, as the company may be allocating more OH costs to the other fillet product types rather than to the frozen products. Therefore, the two types of fillet products would have lower costs if their overhead costs were ABC based.

Differences in production cost methods (company's existing system and ABC) were found in other product types, sharing a similar explanation: frozen products have higher costs than other types of products, as a result of their assigned consumption activities.

5. Conclusions and recommendations

The purpose of the study was to apply ABC in a food production company that had the uniqueness of joint processes. The Thai company operating a fresh and frozen chicken processing production was selected as the case study to achieve this objective. Its production generates more than one hundred products, assigned to 38 product groups. It was currently using an absorption cost system and the selling value split-off point method for its production costs.

The study employed the five steps of ABC application, interviews, documentation, observation, and consultation for data collection and analysis; as well as an EAD matrix and an activity-product-dependence matrix, given the wide range of processes and product variations. The results from the applied ABC provided several conclusions. First, that identifying activities can be challenging, as the food industry's manufacturing process is complicated and consists of many related activities. We addressed this difficulty by identifying activities according to production procedures, and consulting with various production managers.

Additionally, there are problems with cost and activity data availability. Because most food manufacturing companies apply a process cost system, cost data is primarily accumulated through the flow of production. Some data had not been clearly indicated as either direct or indirect costs, such as staff salary. Any application of ABC would therefore require a separation of direct and indirect costs. Shigaev (2015) suggested that at least two groups of accounts should be created for recording related costs when applying ABC. And, for activity data, data collection should be modified if it is not available in the company's system.

Another consideration of importance in applying ABC to the food industry is the determination of resource and activity drivers. Some activities may be found to have more than one appropriate driver, which fairly allocate overhead costs; whereas other activities may be found to have no suitable cost drivers at all. Selection criteria must be precise and practical. Another concern in ABC application is that certain costs cannot be allocated to a particular activity (Spedding and Sun, 1999) and, thus the costs may be classified as non-allocated expenses. The difficulties in allocating resources to activities, and from activities to individual products were also presented by Zakić and Borović (2013).

Although the research results demonstrated the benefits of ABC compared to the company's existing cost system, this should be interpreted with caution, as the accuracy of product costs based on ABC depends upon numerous random factors, such as the selection of activities and cost drivers (Spedding and Sun, 1999). The ABC application presented in this paper sheds light on the possibility of distorted cost allocations within the industry's current costing methods. Current methods are typically used in several food manufacturing companies for cost allocation; yet may not fully realize the production activities that each product passes through in the cost allocation procedure. The ABC approach could address this possible distortion and provide more accurate cost information for company management.

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Supplementary material

Supplementary material can be found online at https://doi.org/10.22434/IFAMR2016.0017.

Table S1. The details for the 26 expense categories and resource drivers.
Table S2. Assigning resource costs to the activities that are presented in the EAD matrix.
Table S3. The activity product dependence matrix showing the amount of activity consumed by some products.
Table S4. An example of the overhead cost calculation for the fillet products.

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