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MATRIX EQUATIONS IN RECIPROCAL COST ALLOCATION: AN APPLICATION IN THE TAKAFUL INDUSTRY IN MALAYSIA

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Abstract: *Shared and outsourced services have been generally allowed by the regulator (Bank Negara Malaysia, BNM) for commercial expediency and enhanced competitiveness of takaful companies in Malaysia. The different departments usually have a system of transferring the costs to each function; however the reciprocal method is rarely chosen. This study aims to analyze some of the methods of cost allocation through linear equations which will allow a large number of departmental cost transfers on Microsoft Excel. The study shows some relevant findings towards takaful operators' decision on which method to adopt. The findings illustrates how the excel solver efficiently simplifies the calculation of reciprocal method of allocation which are generally avoided due to its complex computations.*

Keywords: *Linear equations, matrices, cost allocation, takaful operators*

Introduction

Cost allocation methodologies have been discussed in various literatures and widely taught in text books and universities. In general, cost allocation is applied in businesses to transfer expenses that are usually indirect and cannot be identified specific to an activity (KLR, 2012). The components that are concerned with indirect costs usually involve general expenses and administration (Tan et. al, 2009). Most organizations spend enormous amounts of investment to cater the cost allocation strategies when in fact, there are much cheaper alternatives that could result in the company saving a huge bulk of cost and resources. Literature specific on the cost allocation methodologies in Malaysian companies are very rare and limited. One such example is in the financial industry relating to insurance and takaful providers where takaful as a young industry still needs to outsource or share some functions with its conventional parent company. This paper therefore aims to contribute to the gap in this field and will focus on the *takaful* business.

The main objective of this paper is to propose the reciprocal method for allocating costs in companies that share certain functions or services.

Literature review

Conceptual Foundations of Takaful and Shared/Outsourced Services

Takaful is an Islamic insurance that originates from the word '*kafala'* which means to take care of one another. The philosophy behind the concept of *takaful* is very unique from its conventional counterpart through its mutual cooperation in undergoing certain events in which one person would not be able to handle by oneself. With the act of tabarru' which is to donate an amount of money as contribution (known as premium in conventional insurance), everyone who contributes to the pool of fund will have a mutual protection over events that few of them may encounter.

Takaful business in Malaysia generally started off from either banks offering *takaful* services or conventional insurance counterpart as their parent companies. This led to the formation of the structure of these organizations to be dependent upon shared or outsourced services that may cater for a number of activities. These shared or outsourced services are also known as support centers which include activities such as accounting, billing, customer support, telecommunications, training, programming and health care. The basic reason for such centers have been about optimizing people, capital, time and resources (Bergeron, 2003). Although the shared services structure in insurance companies only initiated in 2013, the model quickly moved from only basic activities to operations such as claims, billing and underwriting. Soon, insurance companies realized that these support centers were not only helping them to cut cost, but also to aid them to be more organized and curb challenges involving compliance. This was due to the previous systems that had more constraints to insurer's compliance efforts which resulted in inefficiencies in cost management (Malaysian *Takaful* Association and Ernst & Young Report, 2014).

The earliest capture of shared services was in the late 1980s, when large corporations started to combine some of their back-office functions, including the accounting unit. (Redman, Snape, Wass & Hamilton, 2007). Then, in the 1990s the European and Asian firms adopted the shared services initiatives from managers in the US firms. In the early days, shared services only involved areas such as accounting and finance, but more recently have been extended to other units like IT, human resources, customer service, procurement, and public administration. (Paagman, Tate, Furtmueller & Bloom, 2015)

Both shared and outsourced services are sourcing activities and have many overlapping elements that make it difficult to distinguish between the two (Marciniak, 2013). While the former is considered an in-sourcing activity (having resources from internal sectors), the latter is more towards having certain functions' resources from outside (Truocâ & Bodislav, 2012). Another perspective to show the differences is that shared services are usually placed under large multinational companies while outsourcing are arranged by small to large companies for reasons including reduction in cost and staff efficiency. Outsourcing involves the same functions but may include other forms of services such as contact centers and data entry (Iqbal & Munir Dad, 2013)

It was only in 2013 that the insurance industry started to talk about shared services, although banks, manufacturers, and companies have already aggressively ventured on this journey to change (Malaysian *Takaful* Association and Ernst & Young, 2014). The different functions of *takaful* operators as mentioned in Alhabshi et al (2012), Htay et al. (2013), Lahsasna (2014)

and Onagun (2014) include but not limited to finance, marketing, operations, human resources and information technology. These functions have been seen to work under the shared services or outsourcing activities of both insurance and *takaful* companies.

A typical manufacturing company would have its cost different to those offering services such as the insurance industry. The company would buy raw materials through which they will incur costs and sell the final product at a price after having added value to the product. The said price should be able to cover all costs incurred plus a profit margin (Young, 1990). On the other

hand, an insurance company would have its revenue through premiums and investment income to cover its expenses. These expenses include management expenses, claims and commissions. According to Young (1990), these expenses are normally allocated based on the percentage on premiums which are as follows:

Claims	– typically 65-80 percent of premiums
Commissions	– typically 14-19 percent of premiums
Management expenses	– typically 12-18 percent of premiums

The cost allocation is particularly important since insurance companies function based on their services provided to customers usually only when an unwanted event occurs. This is also crucial not only in order to remain competitive in the market, but also helps in the process of management control and decision making. It becomes even more critical when it comes to newer organizations such as *takaful* companies, which still have room for penetration and to gain trust from customers.

With increasing costs in catering the business, *takaful* companies depend on their conventional insurance counterparts especially with functions involving specific expertise that the conventional insurance already had for decades. *Takaful* was not able to operate under window-operated services due to the Shariah compliance restrictions (Frenz, Tobias & Soualhi, 2010), therefore they resorted to shared and outsourced services. However, the cost allocation methods used are still vague and some have outsourced this function to other companies therefore costs may turn to be higher than if it was done in-house.

The Cost Allocation Methods

Caplan (2007) and most textbooks have discussed the three types of allocation of services department cost which are direct method, the step down (sequential) method, and the reciprocal method. The direct method is considered the simplest method as it allocates costs based on operating departments while the interaction between support departments are ignored. It is also one of the widely used methods as it is practically easy to apply. The sequential method allocates costs to other service departments but once these are allocated, there are no costs allocated back to the initial department. This is different from the more accurate reciprocal method which actually takes into account all the costs involved including the mutual costs between support departments. The complicated nature of the reciprocal method usually results in companies not opting for such method (Togo, 2013). However, with Microsoft Excel Solver, the matrix equations of different costs can be allocated easily.

A simple typical example to show the cost allocation in an insurance company is as follows[1]:

[1] Adapted from Blocher, Blout & Cokins (2009)

ABC Insurance company has two service departments (underwriting and premium rating) and two production departments (advertising and sales). The following table shows the distribution of each department's usage on the other departments.

Table 1: Percentage Allocation from department to department

	To			
From	**Underwriting**	**Premium Rating**	**Advertising**	**Sales**
Underwriting	---	80%	10%	10%
Premium Rating	20%	---	20%	60%

Source: Adapted from Blocher, Blout & Cokins (2009)

Each department is assumed to have the following costs:

Underwriting RM 80,000
Premium rating RM 15,000
Advertising RM 60,000
Sales RM 40,000

For the direct cost method, since advertising and sales both add up to 20% from the underwriting department, we only calculate based on this percentage.

Advertising share is 10% from 20% = 0.5
Sales department share is also 10% from 20% = 0.5

The same calculation is applied to the premium rating department where the total percentage is 80%.

These are summarized in the following table:

Table 2: Direct Method for Cost Allocation

	Advertising	**Sales**
Underwriting	0.5 × 80,000 = 40,000	0.5 × 80,000 = 40,000
Premium rating	0.25 × 15,000 = 3,750	0.75 × 15,000 = 11,250
Initial Production department cost	60,000	40,000
Total cost for each production department	103,750	91,250

Source: Adapted from Blocher, Blout & Cokins (2009)

While for the sequential method, we need to choose the department that provides the most services to other departments. In this case, from table 1 we find that the underwriting department provides the greatest service. Therefore, the underwriting department is chosen first as shown in table 3.

Table 3: Sequential Method for Cost Allocation

	Premium	Advertising	Sales
Underwriting	0.8 × 80,000 = 64,000	0.1 × 80,000 = 8,000	0.1 × 80,000 = 8,000
Premium rating		0.25 × (64,000 + 15,000) = 19,750	0.75 × (64,000 + 15,000) = 59,250
Initial cost		60,000	40,000
Total cost		87,750	107,250

Source: Adapted from Blocher, Blout & Cokins (2009)

The reciprocal method requires solving simultaneous equations. Therefore, we define some variables to represent the departments:

U = Underwriting
P = Premium

U = 80,000 + 0.2P
P = 15,000 + 0.8U

Solving for these simultaneous equations, we arrive at

U = 80,000 + 0.2 (15,000 + 0.8U)
U = 98.809.5 ≈ 98,810

Therefore,

P = 15,000 + 0.8 (98,810)
= 94,048

Now that we have both U and P, we allocate the costs to the advertising and sales department.

Table 4: Reciprocal Method for Cost Allocation

	Advertising	Sales
Underwriting	0.1 × 98,810 = 9,881	0.1 × 98,810 = 9,881
Premium rating	0.25 × 94,048 = 18,809.60	0.75 × 94,408 = 56,428.80
Initial cost	60,000	40,000
Total cost	88,690.60	106,309.80

Source: Adapted from Blocher, Blout & Cokins (2009)

The example shown involves only two equations since there are only two service departments involved. Additionally, the example only caters for one entity that share these departments. Therefore, the current study will show the allocation of costs based on more than two departments involving two entities, which are insurance and *takaful* companies.

Methodology and Data

This study is designed based on both qualitative and quantitative data. The qualitative data was needed in order to understand the allocation of costs in the insurance and *takaful* industry where this depended upon content analysis through literature review and also interviews from several

takaful companies to confirm on the functions that are being shared or outsourced. The quantitative data were taken from selected companies' annual reports and Microsoft Excel Solver is used to show the reciprocal method for cost allocation can be done with only a few steps.

Theoretically, the reciprocal method for cost allocation will have a number of equations, depending on the number of support departments in the company. This paper assumes that the number of support departments are three, which are key management persons, finance and marketing. Therefore, the number of equations will also be three. The calculations will be based on the following assumptions:

The total cost for shared services is RM80,000,000 and the breakdown is as follows:

a. RM 40,000,000 for key management positions
b. RM 21,000,000 for finance
c. RM 19,000,000 for marketing

The proportion of each department to another is based on table 5.

Table 5: Proportion of Allocation among Departments and *Takaful* Operator

Total Cost (RM '000)	**Service Department**	**HR (KMP)**	**Finance**	**Marketing**	***Takaful***
40,000	HR (KMP)	--	5%	5%	45%
21,000	Finance	15%	--	15%	35%
19,000	Marketing	20%	10%	--	40%
80,000					

Therefore, we have three simultaneous equations below:

+1.00K – 0.15F – 0.2M = RM 40,000,000
–0.05K +1.00F – 0.1M = RM 21,000,000
– 0.05K –0.15F + 1.00M = RM 19,000,000

Where K = Key management positions
F = Finance
M= Marketing

The equation solving through Microsoft Excel will involve two processes as follows:

1. Solving reciprocated costs using matrix functions:

$|S|$ x $|X|$ = $|K|$, where

$$|S| = \begin{vmatrix} +1 & -0.15 & -0.2 \\ -0.05 & +1 & -0.1 \\ -0.05 & -0.15 & +1 \end{vmatrix}$$

$|X|$ represents the allocated costs for each department =

$$\begin{vmatrix} K \\ F \\ M \end{vmatrix}$$

And $|K|$ is the matrix representing the cost before allocation =

$$\begin{vmatrix} 40{,}000{,}000 \\ 21{,}000{,}000 \\ 19{,}000{,}000 \end{vmatrix}$$

To solve for X, the formula involves the inverse of S, $|X| = |S^{-1}|\, x\, |K|$. This is done by typing mmult(minverse(S, K)) in Excel.

2. Allocating the reciprocated costs using matrix functions:

$|D|$ x $|P| = |A|$

Where D = $\begin{vmatrix} K & 0 & 0 \\ 0 & F & 0 \\ 0 & 0 & M \end{vmatrix}$

P = $\begin{vmatrix} -1 & 0.05 & 0.05 & 0.45 & 0.45 \\ 0.15 & -1 & 0.15 & 0.35 & 0.35 \\ 0.2 & 0.1 & -1 & 0.4 & 0.3 \end{vmatrix}$

Solving for A in this equation will allocate the costs for each department and to both sectors sharing the service. This is done by using the *mmult* function in Excel to produce a 3x5 matrix for the allocated costs.

Results

When using the reciprocal method, all departments costs are also taken into account, therefore in this case three simultaneous equations must be solved:

+1.00K – 0.15F – 0.2M = RM 40,000,000
–0.05K +1.00F – 0.1M = RM 21,000,000
–0.05K –0.15F + 1.00M = RM 19,000,000

This can be solved through cancelling one equation and reducing the three equations into two and solving for the three unknowns. However, with Microsoft Excel, this can be calculated using the mmult and minverse functions, which utilizes the matrix function.

1. Solving reciprocated costs through matrix functions:

This solves the matrix problem $|S|$ x $|X| = |K|$ where

$|S|$ is $\begin{vmatrix} +1 & -0.15 & -0.2 \\ -0.05 & +1 & -0.1 \\ -0.05 & -0.15 & +1 \end{vmatrix}$

$|X|$ represents the allocated costs for each department =

$$\begin{vmatrix} K \\ F \\ M \end{vmatrix}$$

And $|K|$ is the matrix representing the cost before allocation=

$$\begin{vmatrix} 40{,}000{,}000 \\ 21{,}000{,}000 \\ 19{,}000{,}000 \end{vmatrix}$$

Solving for $|X|$, the formula is
$|X| = |S^{-1}|\ x\ |K|$ which uses the mmult and minverse functions in Excel as described above. This arrives at the following figures

where $|X| = \begin{vmatrix} 48{,}966{,}589 \\ 25{,}829{,}906 \\ 25{,}345{,}765 \end{vmatrix}$

2. Allocating the reciprocated costs using matrix function

$|D|$ x $|P| = |A|$

Where

$$D = \begin{vmatrix} 48{,}966{,}589 & 0 & 0 \\ 0 & 25{,}829{,}906 & 0 \\ 0 & 0 & 25{,}345{,}765 \end{vmatrix}$$

$$P = \begin{vmatrix} -1 & 0.05 & 0.05 & 0.45 & 0.45 \\ 0.15 & -1 & 0.15 & 0.35 & 0.35 \\ 0.2 & 0.1 & -1 & 0.4 & 0.3 \end{vmatrix}$$

Once the reciprocated costs are solved, the matrix functions can then be used to allocate the costs to the departments and the *takaful* and insurance sectors using only the mmult function. This arrives at the figures summarized in table 6:

Table 6: Allocation of costs using reciprocal method

Allocation	**KMP**	**Finance**	**Marketing**	***Takaful***
Costs (RM'000)	40,000	21,000	19,000	0
Allocation of KMP	-48,966	2,448	2,448	22,035
Allocation of Finance	3,897	-25,983	3,897	9,094
Allocation of Marketing	5,069	2,535	-25,345	10,138
	0	0	0	41,267

Conclusion

The paper has shown that the application of reciprocal method for allocating costs is not a very complicated process. It requires the basic components where the weights are assigned to each support department then the costs are quite easily allocated to the different entities sharing the support functions. In this paper, it is shown that the initial costs from each of the three departments are first reciprocated among the support departments and then are allocated accordingly among departments and entities, in this case the *takaful* and insurance sectors.

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