

## Unit Cost Analysis for Health Academic and Operational Purposes

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**Background:** Unit cost estimation is one of the key planning tasks of organisation in order to allocate resources to each activity properly. Therefore, this study was conducted applying top-down costing approach, for academic unit cost estimation.

**Objective:** To estimate the unit costs using top-down allocation costing approach for academic and operational purposes of the Department of Clinical Epidemiology and Biostatistics (CEB) at Faculty of Medicine, Ramathibodi Hospital, Mahidol University.

**Methods:** A cross-sectional study of the cost of CEB in fiscal year 2018 was retrieved. Direct and indirect costs were allocated to CEB based on 3 main missions (education, research, and academic services) considering staffs' activities and time spent for each mission. Three cost per unit of measures (cost per student, cost per publication, and cost per research consultation) were estimated accordingly to these 3 main missions.

**Results:** In the fiscal year 2018, direct and indirect costs were ฿15 178 761 and ฿737 496, respectively. As for staffs' time spent for each mission activity, CEB mission costs were ฿6 807 282 for education (฿3 914 187 and ฿2 893 095 for MSc and PhD, respectively), ฿5 912 895 for research, and ฿2 186 280 for academic services.

**Conclusions:** Unit cost should be estimated properly to minimise and optimally allocate resources to each activity. This study should be useful for other departments as a guideline for their cost management and resource planning.

**Keywords:** Unit cost, Academic, Top-down, Cost allocation

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## Introduction

Finance system is very important for development, operation, and maintenance of the quality of academic department. Proper unit cost estimation has been used as one of the keys in planning for operations and resource management. Evaluation of the operation and management should be performed regularly in order to minimise cost and human resource workload. Re-adjustment of the budget and human resource may be required, so they can be properly allocated.

Unit cost analysis should be performed considering all costs for producing the required quantity of goods or services, which aims to calculate expenses effectively to get an accurate number of the needed resources for the institution. For instance, a unit cost per student can be calculated by dividing the total expenditure by the total number of students.<sup>1</sup> The operating costs are usually money payments to acquire the resources needed to operate the institutions. Cost elements should be categorised considering both direct and indirect cost in order to get the precise estimation. Direct cost is the cost in the production process to directly produce a unit of output which includes raw material and direct labor, whereas indirect cost is the overhead cost such as rent, tax, repair, maintenance and insurance, and others, which is not involved with the production process.<sup>2</sup> Direct cost of the Department of Clinical Epidemiology and Biostatistics (CEB), under the Faculty of Medicine Ramathibodi Hospital, Mahidol University, for the academic purpose can be incurred for salary wage and benefit (SWB), material cost, general expenses, and asset depreciation. The indirect cost can be incurred for faculty's building depreciation, electricity, and water.

Various methods have been used to compute the unit cost for academic and operational purposes. One is activity-based costing (ABC),<sup>3</sup> which assigns direct costs to service based on each activity involved in the process or service, while indirect cost is allocated to the related activity based on the cost driver (a number of academic hours). However, various types of academic programs may result in different unit costs for the organisation.<sup>4</sup> Franklin<sup>5</sup> suggested that ABC

approach is the determination of product cost charge to products or services based on resource consumption caused by the activity. Later, Atkinson et al<sup>6</sup> stated that ABC is an activity-based cost accounting system that connects the resources used by organisations with products or services produced or received by customers. In 2010 - 2011, the University of Washington launched the activity-based financial systems and compared ABC with the traditional method. The outcomes showed that cost from traditional model was higher than ABC.<sup>7</sup>

Other 2 approaches, but less in academic purpose, are traditional bottom-up allocation costing, which is for the ones that could not measure accurate time or resource used for each activity<sup>8</sup> and top-down allocation costing, which is for the ones that have no available cost data on individual unit of measure level.<sup>9</sup> Each approach has pros and cons. The administrators need to choose the method based on their available cost data, timeframe and objectives to make better judgments about their programs. Generally, ABC requires more granular information and because of its complexity, it takes more time than other two, but the results are potentially more accurate.

In Thailand, unit cost per curriculum was estimated for Master of Science (MSc) and Doctor of Philosophy (PhD) students in Business Administration and Humanities and Social Sciences who graduated from Rajamangala University of Technology Thanyaburi in 2014.<sup>10</sup> The estimated cost was obtained by the total of indirect and direct cost divided by full-time equivalent (FTE) student. They noticed that the unit cost was varied due to student FTEs at each year. However, there is no study in Thailand assessed the cost of international programs.

The CEB department has been established since 1989, which was firstly named as Clinical Epidemiology Unit and was expanded to be the CEB section in 2010, and to be the CEB department in 2019. The CEB department has 3 main responsibilities including education, research, and academic services. For education, 4 international programs (MSc in Medical Epidemiology, PhD in Clinical Epidemiology, and MSc and PhD in Data

Science for Health Care) have been developed complying with Mahidol University and the Faculty's visions and missions of becoming a world class university and excellence in health sciences and leader in the national health advocacy. These programs are under regulation of the Office of the Higher Education Commission, Ministry of Higher Education Commission, Science, Research and Innovation, in which one regulation is a requirement of program revisions every 5 years. For research, the CEB department has conducted research and produced various studies in both communicable and non-communicable diseases. For academic services, the CEB has setup a consultation clinic, which can help and support the Faculty's members in conducting research. In order to comply with the Faculty's and the University's missions, CEB has missions as follows: 1) to create the new graduates for education mission; 2) to produce the international peer review research for research mission; and 3) to facilitate the Faculty's members and academic staffs in doing research for consultation service mission.

In order to achieve these missions, the present study aimed to estimate unit cost, planning, and management of budget and human resource properly used the CEB department as a case study to estimate the direct and indirect costs for running post-graduate programs. In addition, the cost per production of both MSc and PhD students and academic services was estimated using the concept of unit cost analysis. This method should be the guideline for the cost management planning and allocating the budget effectively, for the Faculty.

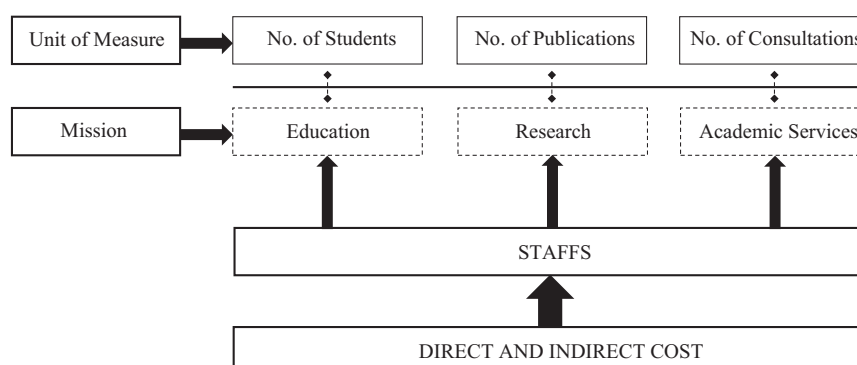
## Methods

The study design used a cross-sectional top-down allocation costing approach. The cost of the CEB department for 2018 fiscal year (October 1, 2017, to September 30, 2018) was retrieved from the central finance system of the Faculty of Medicine Ramathibodi Hospital, Mahidol University. The cost consisted of direct and indirect costs. Direct cost included SWB, material cost, general expense, and asset depreciation. Indirect cost was the allocated expenses from the centre such as the faculty's building depreciation, electricity, and water. This study did not apply for the ethics approval as the study does not involved with patient's data.

## Cost Allocation

Total cost per year was calculated as a summation of direct and indirect costs, then deducted incentive cost which is an academic allowance for lecturer's position (professor, associate professor or assistant professor). The cost was allocated to 3 CEB missions including education, research, and academic services (Figure 1) according to each staff's activity and time spent for each mission stated in their performance agreement. A table containing a list of activities such as administrative or supporting tasks would be divided by 3 and equally allocated to each mission. Up to September 2018, the CEB department had 22 staffs including 9 academic staffs, 4 biostatisticians, 4 administrative officers, 4 education officers, and 1 information technology officer.

**Figure 1. Allocation of Direct and Indirect Cost to the 3 Missions**



## Units of Measurement

Units of measurement of education, research, and academic services missions were number of students, publications, and consultations, respectively. The number of students derived from an average of year 2017 and 2018 students of 4 postgraduate programs (MSc in Medical Epidemiology, PhD in Clinical Epidemiology, and MSc and PhD in Data Science for Healthcare).

Number of publications were accounted from manuscripts produced by academic staffs and published in international peer-reviewed journals indexed in PubMed, Web of Science, or Scopus databases up to 2017. Number of research consultations provided by CEB staffs during the year 2017 were recorded. Clients of research consultation were residents, clinical fellows, lecturers, and hospital staffs.

As for cost allocation and unit of measurement, 3 costs per unit of measurement were estimated according to 3 main missions (cost per student, cost per publication, and cost per consultation), calculated by divided each cost allocation with its unit of measurement. Cost per student was separately estimated by MSc and PhD programs. Average numbers of 2017 and 2018 students of 2 MSc and 2 PhD programs were used as proportions to absorb annual education cost for conducting PhD and MSc program. Then, cost per student per year was respectively multiplied by approximate duration of study (2 and 3 for MSc and PhD, respectively). Cost per publication and cost per consultation were directly calculated by dividing cost spent for research and academic services missions by number of publications and consultations, respectively.

## Results

In the fiscal year 2018, direct and indirect costs were ฿15 178 761 and ฿737 496, respectively. The highest cost was spent for staff salary at ฿9 864 163, followed by benefit and general expenses of ฿3 644 906 and ฿1 146 530, respectively (Table 1). Under the SWB, cost of ฿1 009 800 was for academic position allowance. After deducting

this cost, the total cost for allocation was ฿14 906 457.

As for staff's performance agreements, the ratio of percent time spent for education: research: academic services mission was collected for each staff and then averaged, which yielded an actual average ratio of 37:31:6, and the remaining 26% was accounted for administrative and supporting tasks, which supported all 3 missions. By equally dividing administrative jobs to the main 3 missions, the adjusted allocation ratio was 45.7:39.7:14.6. Then, a total cost for 2018 fiscal year was re-allocated proportional to the adjusted ratio.

As a result, CEB mission costs were ฿6 807 282 for education (฿2 893 095 and ฿3 914 187 for MSc and PhD, respectively), ฿5 912 895 for research, and ฿2 186 280 for academic services, each cost obtained from total cost multiplied by the adjusted allocation ratio for that mission. The yearly productivity of CEB consisted of 20 students (11.5 MSc and 8.5 PhD students), 44 publications in international peer-reviewed journals, and 1069 consultations. Therefore, the costs per MSc and PhD students produced were ฿680 728 ( $[3\ 914\ 187 \times 2]/11.5$ ) and ฿1 021 092 ( $[2\ 893\ 095 \times 3]/8.5$ ), respectively, whereas cost per publication and cost per consultation were ฿134 384 ( $5\ 912\ 895/44$ ) and ฿2045 ( $2\ 186\ 280/1069$ ), respectively (Table 2).

**Table 1. Department of Clinical Epidemiology and Biostatistics Cost by Functional Accounting**

Functional Accounting	Fiscal Year 2018, ฿
Total cost	15 916 257
Direct cost	15 178 761
Salary	9 864 163
Wage	69 520
Benefit	3 644 906
Material cost	371 092
General expense	1 146 530
Asset depreciation	82 550
Indirect cost	737 496

**Table 2. Description of Cost Allocations According to Unit of Measures and Missions**

Cost Allocations	Education	Research	Academic Services
Allocation ratio, %	45.7	39.7	14.6
Allocated cost, ฿	6 807 282	5 912 895	2 186 280
Unit of measure	11.5 MSc students 8.5 PhD students	44 publications	1069 consultations
Cost per unit of measure, ฿	680 728/MSc student 1 021 092/PhD student	134 384/publication	2045/consultation

## Discussion

This present study estimated costs for conducting education, research, and academic service of CEB indicated that the total cost for 4 postgraduate programs (MSc in Medical Epidemiology, PhD in Clinical Epidemiology, and MSc and PhD in Data Science for Healthcare) in the 2018 fiscal year was ฿15 916 257. Direct cost was the main contribution (฿15 178 761), in which about 65% went to staff's salary.

As for staffs' performance agreement, the actual ratio of percent time spent for the 3 missions of education: research: consultation was 37:31:6. In order to achieve the 3 missions, the adjusted ratio was re-estimated as 45.7:39.7:14.6. This suggested a gap of 8.7% for each mission, which required costs of ฿6 807 282, ฿5 912 895, and ฿2 186 280 for education, research, and academic services, respectively.

By estimating cost per unit of measurement, CEB mission costs were ฿680 728 and ฿1 021 092 per MSc and PhD students, respectively, ฿134 384 per publication, and ฿2045 per consultation. The incomes from running MSc and PhD programs were ฿408 500 and ฿668 700 per student, respectively. As a result, either fee for these programs (tuition, thesis, research) or number of students need to be increased to reach to break-even point. For instance, this may need a total of 32 students (15 MSc in Medical Epidemiology, 8 PhD in Clinical Epidemiology, 4 MSc in Data Science for Health Care, and 5 PhD in Data Science for Health Care).

Previous study was conducted to estimate cost per MSc and PhD students in Business Administration and Humanities and Social Sciences who graduated from Rajamangala University

of Technology Thanyaburi, respectively.<sup>10</sup> They found that costs for these corresponding programs were ฿213 437 and ฿157 576 whereas cost per publication was at ฿163 141. However, their postgraduate programs are not international programs; therefore, their costs may be lower than costs at the CEB department of the present study.

This present study performed actual unit cost estimation for conducting international postgraduate programs in Thailand. This reflects the real cost in operating the programs to support Thai higher education for more efficiently way to allocate financial and human resources for each program. The method can be applied in a case where resource spent on individual unit of measure could not directly be measured. This should be useful for other departments as a guideline for their cost management and resource planning.

Some limitations of this present study included ABC did not perform as other institutes, but alternatively, applying performance agreement of staff activities to allocate time and resource used for top-down unit cost estimation. The result due to the chosen method may be less accurate than ABC since resource use was indirectly allocated from aggregate data.

## Conclusions

Costs for conducting postgraduate programs should be properly estimated to minimize cost, human resources and also to allocate of resources. This will likely lead to achieve missions of the institutions.

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## การวิเคราะห์ต้นทุนต่อหน่วยของหน่วยงานทางการศึกษาด้านสุขภาพ

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**บทนำ:** การประมาณราคาต้นทุนต่อหน่วยเป็นหนึ่งในปัจจัยหลักในการวางแผน เพื่อดำเนินการจัดสรรทรัพยากรให้กับกิจกรรมแต่ละประเภทได้อย่างเหมาะสม ซึ่งการคิดต้นทุนฐานกิจกรรมโดยการประมาณราคานั้นสามารถนำไปใช้เพื่อ วัตถุประสงค์ทางวิชาการในสำนักงานได้เป็นอย่างดี

**วัตถุประสงค์:** เพื่อศึกษาต้นทุนต่อหน่วยให้ตรงตามวัตถุประสงค์ทางวิชาการ ของภาควิชาระบาดวิทยาคลินิกและชีวสถิติ คณะแพทยศาสตร์ โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล

**วิธีการศึกษา:** การศึกษาการจัดสรรต้นทุนจากบนลงล่างของภาควิชาระบาดวิทยา คลินิกและชีวสถิติในปีงบประมาณ พ.ศ. 2561 ที่ได้รับจัดสรรเป็นค่าใช้จ่ายทางตรง และทางอ้อม ซึ่งถูกจัดสรรให้กับ 3 พันธกิจหลัก (การศึกษา การวิจัย และการบริการ) จำแนกตามกิจกรรมและเวลาที่ใชของพนักงานแต่ละคนในแต่ละพันธกิจ โดยค่าใช้จ่าย ต่อหน่วยของการวัดจะถูกประเมินตาม 3 พันธกิจ (ค่าใช้จ่ายต่อนักศึกษา ค่าใช้จ่าย ต่อผลงานการตีพิมพ์ และค่าใช้จ่ายต่อการให้คำปรึกษา)

**ผลการศึกษา:** ในปีงบประมาณ พ.ศ. 2561 ต้นทุนทางตรงและทางอ้อมเท่ากับ 15,178,761 บาท และ 737,496 บาท ตามลำดับ สำหรับเวลาที่พนักงานใช้ในแต่ละ พันธกิจของภาควิชาระบาดวิทยาคลินิกและชีวสถิติ แบ่งเป็น ค่าใช้จ่ายด้านการศึกษา เท่ากับ 6,807,282 บาท (ปริญญาโท 3,914,187 บาท และ ปริญญาเอก 2,893,095 บาท) ด้านการวิจัย เท่ากับ 5,912,895 บาท และด้านการบริการ เท่ากับ 2,186,280 บาท

**สรุป:** การประเมินต้นทุนต่อหน่วยสามารถลดต้นทุนและจัดสรรทรัพยากร ให้แต่ละกิจกรรมได้อย่างเหมาะสม ซึ่งจะเป็นประโยชน์และเป็นแนวทางสำหรับ ภาควิชาอื่นๆ ในการวางแผนและบริหารจัดการต้นทุนของหน่วยงานต่อไป

**คำสำคัญ:** ต้นทุนต่อหน่วย วิชาการ ต้นทุนจากบนลงล่าง การจัดสรรต้นทุน

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