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# Revisiting a Funding Model for University-led Dental Clinics: The Case of Complete Denture Fabrication

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# Revisiting a Funding Model for University-led Dental Clinics: The Case of Complete Denture Fabrication

## Cover Page Footnote

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***ORIGINAL ARTICLE***

# Revisiting a Funding Model for University-led Dental Clinics: The Case of Complete Denture Fabrication

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## ABSTRACT

**Objectives:** University-led dental clinics are rarely seen as core to the national healthcare system. Thus, when publicly funded universities experience a decline in government support, dental clinic services operated by students are confronted by a potentially inadequate operating budget. Prompted by the need for strategic resource allocation, this study seeks to quantify the resources consumed in the construction of complete dentures by undergraduate students in an effort to identify opportunities for cost-cutting measures. **Methods:** Clinical cases were retrieved from the logbooks of graduating students of Class 2015, and patient records were reviewed to identify and quantify all clinical and laboratory procedures involved in constructing a set of complete dentures. Cost estimation was carried out using the activity-based method on the basis of direct medical costs. **Results:** A total of 83 patient records were reviewed. The average number of visits required to fabricate a set of complete dentures was 10 (range, 6–20 visits) with an average total cost of MYR2131±538 (€450±114). The number of visits contributed substantially to the total cost, and procedures requiring multiple visits included secondary impression and jaw relation recording. The major cost components were dental equipment (44%), laboratory costs (28%), dental consumables (17%), salaries (7%), and dental instruments (3%). **Conclusion:** The operating cost for training students in denture fabrication is substantial. Schools should formulate strategies to reduce the number of patient visits by ensuring that students optimize the time spent per visit. A financially sustainable model to fund dental training is necessary to ensure that quality of care is not compromised in university-led clinics.

**Key words:** complete denture, cost analysis, activity-based costing

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## INTRODUCTION

Public higher education worldwide has experienced a decline in government support, especially since the turn of the century, as the global financial crisis and its aftermath put pressure on government funds. In the Malaysian context, the government reduced funding for higher education by 20% from MYR7.57 billion in 2016 to MYR6.12 billion (€1.29 billion) in 2017 in an effort to reduce the country's financial deficit.[1] This reduction in funding has challenged public universities to devise ways to meet their overheads and acutely impacted professional schools such as dentistry schools, where operating expenditures are relatively higher compared with those of other faculties offering nonprofessional courses.[2]

Malaysia currently has 13 dental schools, six of which are government-funded. University-led clinics are not seen as core to the national healthcare system because of the pervasive belief that such establishments are merely for teaching and research. However, university-led clinics also provide dental treatment direct to the public at lower out-of-pocket prices when compared with private dental clinics. Moreover, dental education providers must ensure adherence to strict accreditation requirements. As such, university-led clinics provide quality dental care to those who are unable to afford

private care. The treatment provided at lower cost is the direct result of subsidies from the federal government. This practice has worked well for the past 30 years as the government has fully supported dental education to overcome the shortage of dentists in the country, especially in under-served rural areas. However, in the context of a fluid economic climate, the practice of subsidy is no longer fiscally sustainable.

Dental schools must now formulate strategies to either trim their operating expenditures or reduce their need for a community subsidy scheme to provide dental treatment. Either of these options must be seriously considered, especially in view of the fact that public universities do not have the autonomy to increase tuition fees to sustain their operating costs.

An economic analysis of the provision of dental treatment by dental students under senior supervision has not been conducted in Malaysia. Basic economic principles in an area of great impact led our team to focus on the fabrication of complete dentures. Complete dentures are among the most costly items of dental care as their fabrication involves laboratory costs, the use of several major pieces of equipment, and multiple clinic visits. In addition, complete denture treatment follows a standard procedure for every patient and therefore, simplify cost analysis as compared to fixed or removable partial dentures which varies in complexity from patient to patient depending on the number of teeth replaced. Although complete denture may be fabricated by either conventional or simplified methods, most dental schools teach students using the former, which can be resource-intensive.

General dentists typically use the simplified method to reduce the number of patient visits and time required to construct the prostheses. Several reports have questioned the real need for such complex procedures, and some clinical studies have shown that simplified methods can produce complete dentures without compromising quality and patient satisfaction. The demand for complete denture treatment remains high on account of the increasing proportion of elderly Malaysians; therefore, the need for dental students to be taught appropriate methods of denture fabrication is relevant. [3,4,5,6,7,8,9.]

The current global economic situation highlights the need to explore the use of simplified technique as a possible cost-cutting solution. Thus, the present study aims to quantify actual dental clinic visits and laboratory procedures involved in constructing a set of complete dentures and calculate the cost of the same as performed by dental students in a university-led clinic environment. The findings of this analysis will help dental school administrators carry out evidence-based decision-making on whether to focus efforts on reducing operational costs or shift them toward revisiting the funding model (for example, by introducing patient charges).

## METHODS

Ethical approval was obtained from Universiti Teknologi MARA, Malaysia Research Ethics Committee (600-IRMI (5/1/6), REC/244/16). This study was conducted within a year beginning August 2016 and executed in two phases. Phase 1 included a retrospective review of patient case notes, and Phase 2 included cost estimation and analysis. Identification of prosthodontic complete denture cases was conducted in Phase 1. All clinical cases were retrieved from the logbooks of a cohort of graduating students of Class 2015. The inclusion criterion was completed cases requiring maxillary and mandibular complete dentures; patients were excluded from this study if they required any pre-prosthetic procedure.

In Phase 2, cost estimation for constructing a set of complete dentures was conducted from the perspective of the provider using the activity-based costing (ABC) approach as adapted from the methods described by Mohd–Dom et al.[10,11] ABC is a method of allocating costs to products and services by assigning costs to all activities related to performing each treatment procedure. Items costed in this study were direct medical/dental costs, namely, labor costs, equipment costing less than MYR500 per unit, and consumables used for each procedure. The total cost per procedure (for each patient) was calculated by adding all costs related to resource consumption as estimated using the ABC approach. The total cost of all patients in this study was then averaged to estimate the cost of fabricating one set of complete dentures. Specifically, calculations comprised: (1) the clinical component (equipment, instruments, and consumable materials), (2) the laboratory component (equipment, instruments, and consumable materials), and (3) dental personnel salaries. These data were collected from patient case notes, inventory price lists, and resource persons. All costs in the analysis are presented in Malaysian Ringgit (MYR) and converted to Euro on the basis of the rate in May 2017 (€1 = MYR4.74).

The costs of clinical equipment and instruments of MYR500 (€105) and above were considered at a lifespan of 9 and 2 years (because they were purchased in 2007 and 2014, respectively) with an annual discount rate of 5% (annualization factor, 7.108 and 1.859, respectively)[12] apportioned by the number of clinical sessions per year (total, 324) and prosthodontic sessions per year (total, 101) to estimate their frequency of use. These prosthodontic sessions are meant for both complete and removable partial denture work to fulfill the minimal clinical requirements of two sets of complete dentures and two units of removable partial

dentures before graduation. Clinical equipment costing MYR500 (€105) and above included dental chairs, work stations (cubicle), autoclave, sealing machine, OPG machine, a Mixstar impression mixer, facebow, straight handpiece, wax heater, hot air blower, and water bath. The instruments used in the clinic costing less than MYR500 (€105) included examination sets, kidney dishes, metal rulers, stock trays, spatulas, bowls, acrylic burs, fox planes, scrapers, scalpel blades, blade holders, and wax knives. The cost of these items was calculated on the basis of their purchase price and divided by the number of prosthodontic sessions in a year.

The cost of laboratory equipment and instruments of RM500 (€105) and above was taken at a lifespan of 9 years with an annual discount rate of 5% (annualization factor, 7.108) apportioned by the number of prosthodontic laboratory usages per year, which is 6 days for every week in a year for both morning and afternoon sessions (total, 624). The cost of the articulator was apportioned by the number of prosthodontic cases required for every student, which is 15 cases. The cost of other instruments used in the laboratory, such as plaster knives, bowls, and spatulas, were calculated on the basis of their purchase price and divided by the number of laboratory usages per year, which is 624.

The materials and other consumables used in the clinic included saliva ejectors, sterilization bags, wipes, disinfectant, compounds, alginate, greenstick, indelible pencils, impression materials, modeling wax, base plate wax, face tape (3M tape), floss, wooden spatulas, bite registration materials, pressure indicating paste, and articulating paper. Materials used for standard infection control, such as disposable gloves, face mask, bibs, and barrier films, were also considered. The cost of these materials was calculated on the basis of their purchase price and divided by the number of units used or the weight of the approximate amount of material used each time a procedure was undertaken. Materials used in the laboratory, such as plaster, stones, and waxes, were also quantified and weighted accordingly. The amount of materials used for each procedure was calculated according to the assumption that each clinical and laboratory procedure was carried out only once because the number of times these procedures were done or repeated in the clinic or laboratory was not recorded.

Emolument costs included the salaries and allowances of dental health personnel involved in each activity within the scope of the study; here, the salaries and allowances of the lecturer (prosthodontic specialist), dental technologist, dental student operator, and assistant were considered. Emolument costs were calculated on the basis of the time ratio allotted to each activity. The total gross income of an individual supervisor (prosthodontic specialist) was divided by 176 hours to arrive at an emolument cost per hour on the basis of the assumptions that the total number of work days per month is 22 and that the individual worked 8 hours per day. The supervisor's salary was divided by 5 to reflect the individual cost of supervising five pairs of students during each prosthodontic clinical session. A prosthodontic specialist was assumed to receive a gross salary of approximately MYR12,000 (€2531) per month under the DUG54 grade as most lecturers in the Restorative Department are of this government salary scheme.

The student operator and assistant were assumed to receive a salary in the amount of the scholarship received per semester. The total gross income of individual student operators and assistants was divided by 990 hours to arrive at an emolument cost per hour on the basis of the assumptions that the total number of work days per semester is 90 and that an individual works 11 hours per day for 18 weeks in a semester. The technician salary taken into consideration was the overtime allowance, which is approximately MYR10 (€2.11) per hour. This cost was divided by 30 on the assumption that approximately 30 students used the prosthodontic laboratory at any one time from 5:00–7:00 pm on weekdays and 9:00 am–1:00 pm on weekends.

## RESULTS

A total of 83 patient records with complete documentation were reviewed. On average, students took a total of 10 clinical visits (range, 6–20 visits) to complete all prescribed steps to construct complete dentures for a patient. The clinical procedure requiring the most number of visits was the making of secondary impressions. Many students required nearly two visits to complete border molding and another two to three visits to complete the final impressions. Another procedure that typically requires multiple visits (average, approximately three visits) was the recording of jaw relations (Table 1).

The average cost for constructing a set of complete dentures over 10 clinical visits was MYR2131±538 (€450±114). The highest cost recorded was MYR4018 (€848) for a total of 20 visits, and the lowest was MYR1264 (€267) for 6 visits. The higher the number of visits, the greater the cost incurred. The distribution of total cost by component is clinical equipment (44%), laboratory fees (28%), clinical consumables (17%), salaries (7%), and clinical instruments (3%) (Figure 1).

The cost of each clinical procedure included two components: a fixed cost and a recurrent cost. Fixed costs included the use of equipment, such as dental chairs, cubicles, and autoclaves; clinical instruments, such as handpieces and basic examination sets; and dental personnel salaries. Recurrent costs included the cost of dental materials/consumables, such as

**Table 1.** Average number of visits required for each step of fabricating a set of complete dentures

| Procedure | Mean number of visits | SD |
|---|---|---|
| E & D | 1.1 | 0.3 |
| Primary Impression | 1.4 | 0.65 |
| Secondary Impression | 4.5 | 0.61 |
| Jaw Relations Record | 2.9 | 0.56 |
| Try in | 1.7 | 0.65 |
| Issue | 1.1 | 0.52 |
| Review | 0.9 | 0.51 |

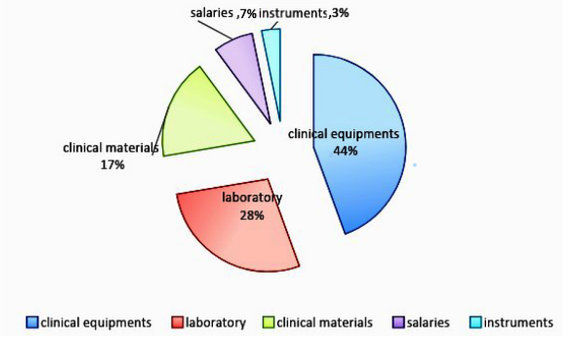


**Figure 1.** Distribution of costs for fabricating a set of complete dentures.

**Table 2.** Cost of each clinical procedure

| Procedure | Cost[MYR(€)] |
|---|---|
| Examination and Diagnosis | |
| Examination and Diagnosis | 149 (31) |
| Radiograph (OPG) | 35 (7) |
| Primary impression | |
| Primary impression (compound) | 192 (40) |
| Primary impression (compound + alginate wash) | 195 (41) |
| Primary impression (alginate) | 157 (33) |
| Secondary Impression | |
| Border molding | 192 (40) |
| Secondary impression (ZnOE) | 186 (39) |
| Secondary impression (silicone) | 193 (41) |
| Jaw relationship | |
| Maxillomandibular relationship | 174 (37) |
| Bite registration and facebow | 157 (33) |
| Try in | 159 (34) |
| Issue | 152 (32) |
| Review | 152 (32) |

impression materials, cements, and waxes, and personal protective equipment, such as disposable gowns, gloves and masks. Fixed costs accounted for the bulk of the cost of each procedure (equipment 44% + salaries 7% + instruments 3%), and materials/consumables accounted for only 18% (Table 2).

**Table 3.** Cost of each laboratory procedure

| Procedure | Cost [MYR(€)] |
|---|---|
| Study cast and special tray | 15 (3) |
| Beading, boxing and master cast | 22 (5) |
| Base plate with occlusal rim | 71 (15) |
| Mounting on articulator | 39 (8) |
| Teeth set up and wax up | 63 (13) |
| Investing and selective grinding | 54 (11) |
| Denture polishing | 5 (1) |

**Table 4.** Salaries of dental personnel.

| Dental personnel | Salary per hour [MYR(€)] |
|---|---|
| Supervisor (Lecturer) | 14 (3) |
| Student (Operator/assistant) | 5 (1) |
| Dental technician (Overtime pay only) | 0.33 (0.07) |

For example, the procedure required to obtain a primary impression with compound costs MYR192 (€40). The distribution of this cost is as follows: MYR75 (€16) for equipment, MYR 72 (€15) for salaries, MYR14 (€3) for instruments, and MYR30 (€6) for compound materials (Tables 3 and 4).

## DISCUSSION

In this study, we analyzed the direct medical (dental) cost for 83 patients who received complete prosthodontic treatment provided by undergraduate students in Universiti Teknologi MARA Dental Center. Non-dental direct costs, such as utility bills, building rental, or patients' expenses, were not included in this analysis because we had no access to this information. Indirect costs comprising loss of productivity of the patients resulting from their having to leave work for treatment were also not considered because this factor would require an interview with the patients, which is beyond the scope of this study. Hence, the true total cost of fabricating a set of complete dentures in this study may actually be underestimated. Nonetheless, the average cost calculated, i.e., MYR2131 (€450), is consistent with the recommended scale of fees in the private sector[13] and the estimated true cost of the government sector (at 95% subsidy).[14] In the current university setting, patients do not pay for fees for dental treatment provided by undergraduate students.

The average number of visits required to fabricate a set of complete dentures (10 visits) is greater than

what may be considered optimal. Ideally, a student should be able to deliver a complete set of dentures within seven visits. Among the procedures involved in denture-making, border molding and jaw relation recording required the most time to complete, averaging between four and five and up to three visits each, respectively. These procedures require high manual dexterity and are very demanding for novice clinical students. The patient folders indicated that the clinical dexterity of students improves as they progress to senior clinical years, resulting in a decline in the number of visits required to achieve these procedures. Clinical supervisors should monitor junior students closely and employ a hands-on approach during chair-side teaching to reduce the number of visits required for these initial clinical encounters. Changes in the curriculum to adopt a simplified approach by reducing the number of steps required for denture construction should also be considered to reduce the amount of resources consumed.[7]

The equipment, instruments, and personnel salaries represent the fixed cost and account for the bulk of the total cost of fabricating complete dentures. Each dental chair in student clinics is utilized an average of nine times per week only. When a dental chair is not utilized, the cost per unit increases. In established private/ government clinics, fixed costs are often low because these establishments have higher patient volumes on a daily basis. To increase the efficiency of student clinics, students should treat more patients in one clinic session. However, this solution may not be feasible because students in teaching institutions have diverse learning needs. Nonetheless, effort should be consciously made to discourage no-show or late patients by imposing the corresponding penalties accordingly.

Materials or consumables represent the recurrent cost and account for only 18% of the total cost of fabricating dentures. Thus, except during primary-impression making, the cost of each procedure of the denture-making process is fairly similar (Table 1). The cost of making a primary impression is low when the impression is made with alginate instead of impression compounds. We propose that the effectiveness of using compounds for primary impression be evaluated by auditing the outcome of the procedures, such as the quality of the trays made from these impressions and the effects of compounds versus alginate. If the outcomes are similar, the use of alginate may be considered to reduce costs without affecting quality.

To estimate laboratory procedures, we assumed that each procedure was done only once because we found no record of repeated procedures or the amount of materials actually consumed. In this aspect, we may have underestimated the cost of each laboratory procedure. Students working in the laboratory should be closely monitored to optimize the time taken to complete each procedure and prevent repetitions and material wastage. Such usage should also be recorded.

An important quality indicator worth analyzing when studying treatment costs is the treatment outcome. Outcome measures provide an indication of the quality of care provided by any institution; this information may be used to evaluate the cost-effectiveness of treatment provided to a patient. In the present study, most of the patients treated were discharged from the waiting list after completion of their dentures. As yearly recalls are not part of our standard care pathway, we have no knowledge of the success or failure rates of our complete dentures. We thus recommend the implementation of a recall system for prosthodontic patients and periodic monitoring of outcome measures as an important performance indicator.

Government support for universities is unlikely to increase. Ultimately, dental school management must aspire to convince top university management that inadequate funding for dental school operations will inevitably impact the standard of dental education because dental students provide direct treatment to the community at large and, thus, perform a visible role in healthcare delivery. The scenario of complete denture fabrication presented in this study is only one aspect of the clinical requirements necessary to ensure the competency of a dental student. Higher dental school operating budgets from the university may be combined with a number of cost-cutting measures. University administrators may consider reducing subsidies for select dental treatments to help recover the cost of clinic consumables; they may also consider imposing minimal charges to patients to recoup some of their operating costs, ensure the financial sustainability of the dental school faculty, and, ultimately, maintain a high standard of dental services rendered by students. For example, recurrent costs, especially the cost of consumables, which accounts for approximately 18% of the total cost, could be passed on to patients.

## CONCLUSION

This study analyzed the direct cost of fabricating a set of complete dentures by undergraduate students and identified the major contributions to fixed and recurrent costs. Because the cost of fabricating dentures significantly increases with the number of patient visits, efforts should be made by all parties involved to reduce the number of visits required to make the dentures. Treatment provided by dental students in a university environment should be recognized as an important aspect of the national healthcare delivery system leading to a revision of the current funding model to reduce subsidy for select dental procedures with high recurrent costs, such as the fabrication of full dentures.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest in this study.

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