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# PER STUDENT COST CALCULATION AND AUTOMATIZATION IN HIGHER EDUCATION

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This article examines the methodology and automation of calculating the full economic cost per student in higher education, distinguishing it from tuition fees. It emphasizes that tuition fees represent the price students are charged, while the per-unit cost reflects the actual expenses incurred by the university to educate a student for a specific period, typically one academic year. The problem addressed is accurately determining these costs, considering the allocation of direct and indirect expenses, student mobility, the Student-to-Academic-Staff Ratio (SASR), the complexity of overhead allocation, joint teaching and research responsibilities, and data availability. The methodology proposed involves identifying direct costs such as faculty salaries, teaching materials, laboratories, stipends, and other program-specific expenses, as well as allocating indirect costs including administrative salaries, facilities, utilities, IT infrastructure, library resources, student services, and depreciation. Calculations are based on Full-Time Equivalent (FTE) students, adjusted for mobility such as entrants, leavers, and temporary leaves. The algorithm provided allows automated computation of per-student costs by aggregating direct and indirect costs, adjusting for student numbers, and applying appropriate allocation bases. Special attention is given to SASR, particularly for engineering universities where hands-on, resource-intensive education requires small group supervision and specialized instruction. Benchmarking of SASR helps assess educational quality, program accreditation compliance, and financial sustainability. The study demonstrates that precise calculation and automation of per-unit costs support strategic decision-making in resource allocation, staffing, program planning, and tuition management, ensuring transparency and efficiency in higher education institutions.

***Keywords***: per unit cost, higher education, direct costs, indirect costs, automation, SASR, engineering universities.

***Introduction.*** The concept of per-student cost, or self-cost, in higher education represents the total economic resources a university allocates to educate a single student over a defined period, typically one academic year. Unlike tuition fees, which reflect the amount charged to students, the per-student cost captures the actual expenses borne by the institution, including both direct costs such as faculty salaries, teaching materials, laboratory use, and stipends, and indirect costs like administrative support, facilities, IT infrastructure, and depreciation. Accurate calculation of this cost also requires consideration of student mobility, including new entrants, graduates, transfers, and temporary leaves, as well as factors such as the student-to-academic-staff ratio (SASR), which significantly impacts resource allocation and teaching quality. Understanding and analyzing per-student costs is crucial for universities to plan budgets effectively, allocate resources efficiently, maintain educational standards, ensure program sustainability, and make informed strategic decisions regarding tuition levels, staffing, and program development.

***Problem statement.*** The problem is to accurately determine the per-student cost in higher education, taking into account the allocation of direct and indirect costs, adjustments for student mobility, the impact of the Student-to-Academic-Staff Ratio (SASR), the complexity of overhead allocation, the division of faculty time between teaching and research, and the availability of reliable financial and operational data.

***Solution / Methodology.*** The Key Principles of the Calculation are:

- Direct and Indirect Costs: we must allocate both costs that can be directly transferred to a student group and a fair share of overheads [1].
- Full Cost Absorption: The goal is to have the sum of all student tuition in a group absorb 100% of the costs for that group [2].
- Group Definition: The "group" must be clearly defined (in NPUA they are defined ciliary, you can guess the faculty, the year the student study easily).

Step-by-Step Calculation Methodology is based on the following formula:

$$Per\ student\ Cost\ =\ (Total\ Direct\ Costs\ +Allocated\ Indirect\ Costs)/\ Number\ of\ Students\ in\ the\ Group\ [3]$$

Total direct costs attributable to a specific student cohort encompass expenditures that can be distinctly allocated without ambiguity, encompassing allocations from faculty and instructor remuneration—namely, the prorated portions of compensation for professors, lecturers, and teaching assistants dedicated predominantly or exclusively to instructional delivery within that cohort; remuneration for ancillary academic personnel, such as laboratory assistants, tutors, and administrators tailored to programmatic needs; outlays for pedagogical resources and consumables, including laboratory apparatus, chemical reagents, artistic materials, bespoke software licensing, and customized instructional compilations utilized forthwith by cohort participants; operational and upkeep expenses for dedicated instructional venues, such as lecture halls and laboratories employed chiefly by the cohort (e.g., a bespoke engineering fabrication facility); and disbursements for pecuniary assistance mechanisms, comprising stipends, merit-based scholarships, and tuition reimbursements sourced exclusively from state or institutional endowments—precluding exogenous philanthropic inputs—extended to qualifying students therein, wherein such mechanisms invariably conform to statutory imperatives delineated in educational legislation and intramural university ordinances, with quantum determinations rendered by the convocation of the academic senate.

The allocation of indirect costs, commonly referred to as overheads, represents one of the most intricate aspects of cost calculation, as the choice of allocation base can substantially affect the distribution of expenses across per-unit costs. In higher education institutions, central university expenditures that ensure the functioning of all academic and administrative processes must be apportioned fairly among different student groups. To achieve this, widely applied methodologies include allocation according to the amount of space utilized, measured in square meters, or as a percentage relative to direct costs. Indirect costs encompass a wide range of components. These include portions of salaries for central administrative staff, such as those employed in the registrar's office, finance, human resources, and IT support divisions. They also cover expenditures related to facilities and utilities, which consist of heating, cooling, electricity, cleaning, and the maintenance of general-purpose buildings like libraries, administrative blocks, and shared spaces, often distributed based on the square footage attributed to each group. Additionally, library resources form part of these costs, incorporating subscriptions to journals and databases, as well as the salaries of library staff. IT infrastructure also plays a crucial role, including university-wide networks, central servers, and helpdesk services that support both staff and students. Furthermore, indirect costs extend to student services such as career centers, counseling, and health services, which contribute to the holistic support of the academic community. Finally, depreciation must be considered, as it reflects the gradual allocation of the value of capital assets, including buildings and major equipment, over their expected useful life [1].

The survey is based in the data collected from National Polytechnic University of Armenia, NPUA, which is the only Engineering University in Armenia, educating students in Yerevan, Gyumri, Vanadzor and Kapan cities.

*Table 1*

*The direct and indirect cost structures in National Polytechnic University of Armenia*

| Total_Direct_Costs | Indirect Costs (Overheads) |
|---|---|
| Faculty & Instructor Salaries - 52% | Administrative Salaries -14% |
| Academic Support Staff - 5% | Facilities & Utilities - 9% |
| Teaching Materials & Supplies - 5% | Library Resources - 1% |
| Classroom & Lab Costs - 4% | IT Infrastructure - 3% |
| Stipends & Scholarships - 2% | Student Services - 3% |
| | Depreciation - 2% |

At the initial stage of cost calculation, it is necessary to gather accurate data and perform several preparatory computations, one of the most essential of which is determining the correct number of students. For this purpose, the internationally accepted measure is the Full-Time Equivalent (FTE) student indicator. According to this standard, a full-time student is counted as 1.0 FTE, while several part-time students can be combined to form one FTE; for example, two students each completing half of a full course load are considered together as 1.0 FTE. In addition to this basic definition, it is crucial to account for the average number of students per academic year, considering various forms of student mobility. Such mobility may include student entrance and graduation, temporary withdrawals, transfers, academic leave, or compulsory military service. Therefore, to ensure the accuracy of cost calculations, comprehensive data on all student mobilities within a given year must be collected and analyzed in order to determine the medium or average number of students enrolled during the period under review [4].

Now let's try to give the algorithm of automatic calculation. The algorithm for calculating the full economic cost per student involves collecting and using several categories of input data. These include the total direct costs for the student group, such as faculty salaries, teaching materials, facilities, and stipends; the total indirect costs or overheads, including administrative salaries, utilities, and library resources; the number of students in the group measured on a Full-Time Equivalent (FTE) basis; adjustment data reflecting student mobility, such as entrants, leavers, and graduates; and the selected bases for cost allocation, for example square meters of space or percentages of direct costs, to ensure a fair distribution of expenses across all students.

Steps for Calculating Cost per Student The process of calculating the full economic cost per student involves several sequential steps. First, all necessary data must be collected. This includes gathering all direct costs associated with the student group, compiling all indirect costs while determining the appropriate allocation bases, and obtaining the number of Full-Time Equivalent (FTE) students for the period, taking into account adjustments for student mobility. Next, total direct costs are calculated by summing all direct cost categories:

$$Total\_Direct\_Costs \; = \; Sum\ of\ all\ direct\ cost\ categories.$$

Indirect costs are then allocated based on a selected method, such as space used, percentage of direct costs, or other fair allocation bases. The allocated indirect costs for the group are computed as:

$$Allocated\_Indirect\_Costs = Total\_Indirect\_Costs * (Group's\ Allocation\ Base\ /\ Total\ Allocation\ Base).$$

The total costs for the group are obtained by summing the total direct costs and the allocated indirect costs:

$$Total\_Costs\_Group = Total\_Direct\_Costs + Allocated\_Indirect\_Costs.$$

Adjustments for student mobility are made by collecting data on new entrants, graduates, withdrawals, and other relevant movements. The average number of FTE students over the period is calculated as:

$$Adjusted\_FTE\_Students = Initial\_FTE + Entrants\_FTE - Leavers\_FTE.$$

Finally, the cost per student is determined:

$$Cost\_Per\_Student = Total\_Costs\_Group\ /\ Adjusted\_FTE\_Students.$$

**Pseudo Code:**

```
INPUT:
direct_costs[]
indirect_costs
allocation_base_group
```

```
total_allocation_base
total_students_FTE
mobility_data (entrants, leavers, duration)
PROCESS:
sum_direct_costs = sum(direct_costs)
allocated_indirect = indirect_costs * (allocation_base_group /
total_allocation_base)
total_group_cost = sum_direct_costs + allocated_indirect
adjust_students_for_mobility:
total_students = initial_FTE + entrants_FTE - leavers_FTE
// or use average FTE over period
cost_per_student = total_group_cost / total_students
OUTPUT:
cost_per_student
```

Now let's begin to automize the collection of data. The collection of direct costs, while seemingly straightforward, is complex in an educational setting. It is necessary to isolate costs specifically for a student group. Data from the Educational and Methodological Department reflects the complex teaching load of academic staff. Each department (chair) must provide the hours dedicated to the group. The medium cost per hour in each chair is calculated and then allocated to the group.

***An algorithm for gathering and allocating direct costs based on teaching load.*** To calculate direct costs for a student group, it is necessary to collect data on teaching loads, staff salary rates, department costs, and group-specific information such as course enrollments and section sizes. Each staff member involved in teaching the group is identified, and the hours they spend on the group's courses are recorded. The total teaching hours for the group are then summed:

$$Staff\_Hours\_Group = \sum \text{hours spent teaching the group's courses.}$$

$$Total\_Group\_Hours = \sum Staff\_Hours\_Group \text{ for all staff involved.}$$

Next, the average cost per hour for each department is calculated based on the total annual salaries and working hours of the staff:

$$Department\_Total\_Salary\_Cost = \sum \text{salaries for staff in the department.}$$

$$Department\_Total\_Working\_Hours = \sum \text{annual working hours for staff.}$$

$$Cost\_Per\_Hour\_Chair = Department\_Total\_Salary\_Cost / Department\_Total\_Working\_Hours.$$

$$Staff\_Cost = Staff\_Hours\_Group * Cost\_Per\_Hour\_Chair.$$

$$Total\_Direct\_Cost\_Group = \sum Staff\_Cost \text{ for all involved staff.}$$

This approach ensures that costs are fairly allocated according to actual teaching workload, providing a precise reflection of resource consumption [2].

Gathering and allocating indirect costs is an essential process to ensure fair distribution of institutional or departmental overheads among student groups. The first step in this process is to identify all relevant indirect cost categories, which typically include administrative salaries, facilities and utilities, library resources, IT infrastructure, student services, and depreciation. Once these categories are established, it is necessary to determine an appropriate allocation base. Possible bases for allocation include total direct costs, total student FTEs, the square meters of space used, the number of courses offered, or the total course hours. Finally, allocation ratios are calculated for each category, and the indirect costs are distributed to student groups according to the chosen allocation base. This approach allows universities to reflect the actual use of resources by each group and ensures that overheads are allocated in a transparent and equitable manner:

$$\boldsymbol{A}llocated\_Indirect\_Cost = Total\_Indirect\_Cost \ast Allocation\_Ratio.$$

Collecting and calculating student FTE begins with gathering monthly or periodic data on student enrollment. This includes recording the number of new students entering at the start of the period, the number of students leaving due to withdrawals or graduation, the number of returning students if applicable, and the number of students on academic leave or pauses. Each month, student counts are converted to FTE using the formulas:

$$FTE\_month = (Number\ of\ Part - Time\ Students \ast Part - \\ - Time\ Fraction) + (Number\ of\ Full - Time\ Students \ast 1).$$

If data is based on course loads, the proportion of a full load, for example 50 percent, is calculated as 0.5 FTE and the students' contribution is adjusted accordingly. The average FTE over the period is calculated by summing all monthly or periodic FTEs as

$$Total\_FTE = Sum\ of\ FTEs\ over\ all\ periods\ (months).$$
$$Average\_FTE = Total\_FTE\ /\ Number\ of\ months.$$

Alternatively, if student numbers are provided at specific points, a time-weighted average is used based on the periods with different counts. Adjustments for student mobility are incorporated including entrants who join during the period, leavers who exit the program, returnees resuming after leave, and expelled students who fail during the period. The net change is calculated and the initial student count is updated accordingly. The final FTE count is obtained as

$$Adjusted_{FTE} = Initial_{FTE} + Entrants_{FTE} during\ period - \\ - Leavers\_FTE\ during\ period.$$

Alternatively, the period-based average FTE can be refined with mobility adjustments. In Armenia, the Ministry of Education, Science, Sports and Culture defines the yearly FTE formula as

$$FTE\ year = The\ number\ of\ FTE\ for\ the\ beginning\ of\ the\ year + \\ + Entrants\ during\ \frac{period}{3} - Graduaters\ during\ \frac{period}{2} + \\ + \frac{Number\ of\ Returnees - Number\ Leavers}{3} - Expelledsx60\% - \\ - Result\ of\ rotation/3.$$

*Table 2*

*The National Polytechnic University of Armenia FTE Schedule*

| | |
|---|---|
| The number of students for the beginning of the year | 2150 |
| Entrants | 846 |
| Leavers | 206 |
| Rotation | -50 |
| Expelled | 495 |
| Returnees | 275 |
| Graduators | 348 |
| The number of students for the end of the year | 2172 |

*In National Polytechnic University of Armenia, the data about Students mobility is collected in the schedule above. So, the Calculation of FTE for 2024 will be as follows:*

*FTE year=2150+846/3-348/2+(275-206)*0.6-495*0.6-50/3=2000.*

Accurate calculation of FTE is essential for pricing and tuition setting. It helps ensure that tuition fees remain both competitive and sustainable. FTE analysis is also important for program viability, as it identifies which programs are financially sustainable and which ones generate losses. The results are used in budgeting and resource allocation, allowing funds, staff, and space to be distributed more efficiently across departments and faculties. In addition, FTE provides a basis for strategic planning by modeling the financial impact of launching new programs or changing student intake numbers. It also strengthens reporting and transparency when presenting data to government bodies, boards of trustees, and accrediting agencies. Finally, FTE calculation supports subsidy identification, helping institutions understand how profitable programs subsidize more expensive ones, such as science laboratories or humanities libraries [3].

***Challenges in Calculation.*** Calculating the self-cost per student presents several challenges. The allocation of overheads is complex, as there is no single "perfect" method, and the chosen approach can significantly influence results [1]. Joint costs are also difficult to assign, particularly for professors teaching both undergraduate and postgraduate courses [2]. Separating teaching and research costs for academic staff is another classic challenge in university costing [3], and the availability of detailed financial and operational data is essential [5]. Overall, this process is a critical management accounting exercise that goes beyond bookkeeping, providing insights into the financial health and operational efficiency of university programs [6]. Universities should pay attention to the Student-to-Academic-Staff Ratio (SASR), which measures the number of students relative to the academic staff available to teach and support them [5]. This ratio is especially important for engineering programs, where hands-on, resource-intensive learning is common. Engineering education relies heavily on laboratories, design projects, workshops, and technical software, all of which require small-group supervision and specialized instruction.

Accreditation bodies, such as ABET or their equivalents, scrutinize SASR. A very high ratio can indicate insufficient faculty-student contact, affecting program quality. Conversely, a lower ratio generally suggests more small-class teaching, better accessibility of professors, detailed feedback, and stronger mentorship [2]. Maintaining a low ratio also increases costs, so universities must balance educational quality with financial sustainability.

A meaningful analysis of SASR goes beyond a single university-wide figure. Ratios should be considered by faculty or college, by student level (undergraduate vs. postgraduate), and by program type. Staff composition—permanent versus contract and teaching-focused versus research-focused—also affects the ratio [5].

Benchmarking provides context: top-tier research universities often aim for ratios between 10:1 and 15:1, comprehensive universities between 15:1 and 20:1, and teaching-focused polytechnics may operate closer to 20:1 to 25:1, often supported by more lecture-based teaching. The best benchmark is always peer-based [2]. Despite its importance, SASR has limitations. It does not measure the teaching quality directly, as staff motivation and effectiveness are critical. Technology can slightly adjust the optimal ratio in online or hybrid formats. The ratio also ignores the contributions of support staff, such as lab technicians and teaching assistants, who significantly affect student learning outcomes [5].

***Conclusion.*** For an engineering university, the Student-to-Academic-Staff Ratio is a vital sign. It is a powerful, quantifiable metric that sits at the intersection of:

- Educational Quality
- Program Accreditation
- Financial Sustainability

By calculating the per unit cost for education carefully, breaking it down by program and level, and benchmarking it against appropriate peers, university leadership can make informed decisions about hiring, student intake, and strategic investment.

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## ՄԵԿ ՈՒՍԱՆՈՂԻ ՀԱՇՎՈՎ ԾԱԽՍԵՐԻ ՀԱՇՎԱՐԿԸ ԵՎ ԱՎՏՈՄԱՏԱՑՈՒՄԸ ԲԱՐՁՐԱԳՈՒՅՆ ԿՐԹԱԿԱՆ ՀԱՄԱԿԱՐԳՈՒՄ

**Կ.Մ. Խաչատրյան, Լ.Դ. Բարաղամյան**

Ներկայացվում են բարձրագույն կրթության ոլորտում մեկ ուսանողի հաշվով ամբողջական ինքնարժեքի հաշվարկման մեթոդաբանությունն ու դրա ավտոմատացման հնարավորությունները: Ուսման վճարներն ուսանողի կողմից վճարվող գումարն են, մինչդեռ ինքնարժեքն արտացոլում է բուհի իրական ծախսերը, որոնք անհրաժեշտ են ուսանողի կրթության ապահովման համար: Խնդիրն է ճշգրիտ հաշվարկել մեկ ուսանողի ուսման ինքնարժեքը՝ հաշվի առնելով ուղղակի և անուղղակի ծախսերի բաշխումը, ուսանողների շարժունությունը, ուսանող-ակադեմիական անձնակազմի հարաբերակցությունը (SASR), դասավանդման և հետազոտական աշխատանքների համատեղ ծախսերը, ինչպես նաև ֆինանսական ու գործառնական տվյալների հասանելիությունը: Հաշվարկների մեթոդաբանությունն ընդգրկում է ուսուցանող անձնակազմի աշխատավարձերի, լաբորատոր սարքավորումների, տեխնիկական ծրագրային ապահովման և ուսանողական խրախուսումների ուղղակի ծախսերի հավաքագրումը, ինչպես նաև վարչարարության, կոմունալ ծառայությունների, IT ենթակառուցվածքի, գրադարանային ռեսուրսների և ամորտիզացիայի անուղղակի ծախսերի արդար բաշխումը: Ուսանողների թիվը գնահատվում է FTE չափանիշով՝ հաշվի առնելով ուսանողների շարժունության բոլոր դեպքերը՝ նորեկներ, ավարտողներ, դուրս եկողներ և ընդմիջում ունեցող ուսանողներ: Ինժեներական կրթության համար Ուսանող-ակադեմիական անձնակազմ հարաբերակցությունը (SASR) կարևոր ցուցիչ է, քանի որ ուսուցումը պահանջում է փոքր խմբերով ինտենսիվ հսկողություն, անհատական խորհրդատվություն և մասնագիտական ուղեցույց: Հաշվարկների ավտոմատացումը հնարավորություն է տալիս բուհերին՝ կրճատելու մարդկային սխալները, արդար և թափանցիկ բաշխում ապահովելու, ինչպես նաև կայուն ֆինանսական պլանավորում ու ռազմավարական որոշումներ ընդունել: Այս մեթոդը մեծացնում է ծրագրերի ֆինանսական վերահսկելիությունը, նպաստում է ռեսուրսների արդյունավետ կառավարմանը, ապահովում կրթության որակը, հստակեցնում կրթական ծրագրերի ինքնարժեքը և թույլ է տալիս բուհերի ղեկավարությանը ընդունել հիմնավորված որոշումներ ուսուցման, աշխատակազմի և ներդրումների ոլորտում:

***Առանցքային բառեր.*** ինքնարժեքի հաշվարկ, բարձրագույն կրթություն, ուղղակի ծախսեր, անուղղակի ծախսեր, ավտոմատացում, SASR, ինժեներական համալսարաններ:

## РАСЧЕТ И АВТОМАТИЗАЦИЯ ЗАТРАТ НА ОДНОГО СТУДЕНТА В ВЫСШЕМ ОБРАЗОВАНИИ

**К.М. Хачатрян, Л.Д. Барагамян**

Рассматриваются методология расчета полной себестоимости обучения одного студента в высшем учебном заведении и возможности ее автоматизации. Обучение для студента оплачивается через плату за обучение, тогда как себестоимость отражает реальные расходы университета на предоставление образовательных услуг. Проблема заключается в точном определении себестоимости на студента с учетом распределения прямых и косвенных затрат, подвижности студентов, соотношения ˝студент – преподаватель˝ (SASR), совместного учета преподавательской деятельности между обучением и исследованиями, а также доступности надежных финансовых и операционных данных. Методология расчета включает сбор данных о зарплатах преподавателей, расходах на лабораторное оборудование, программное обеспечение, учебные материалы и студенческие поощрения, а также справедливое распределение административных, коммунальных, IT и библиотечных расходов и амортизации. Численность студентов определяется по показателю эквивалента полной занятости (FTE) с учетом всех форм подвижности студентов: поступления, выпуск, уход и академические перерывы. Для инженерного образования SASR является критическим показателем, так как обучение требует интенсивного контроля в малых группах, индивидуальных консультаций и специализированного наставничества. Автоматизация расчетов позволяет минимизировать человеческие ошибки, обеспечить прозрачное распределение затрат, повысить финансовую устойчивость и стратегическое планирование. Применение предложенной методики способствует финансовой управляемости образовательных программ, эффективному использованию ресурсов, поддержанию качества образования и точному определению себестоимости программ. Это дает руководству университета возможность принимать обоснованные решения в отношении набора студентов, управления персоналом и стратегических инвестиций.

***Ключевые слова***: расчет себестоимости на единицу, высшее образование, прямые затраты, косвенные затраты, автоматизация, SASR, инженерные университеты.