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Generating a Realistic Synthetic Expense Dataset for a Ugandan University Using Financial Benchmarks and Internal Logic

Foundational Structure and Cost Center Framework

The creation of a realistic synthetic expense dataset for Apex University necessitates a robust foundational structure derived from its specified organizational entities and the corresponding cost centers that drive its financial operations. The user-defined parameters—an enrollment of 1000 students, 200 academic staff members (lecturers), and 100 non-academic staff—serve as the critical levers for scaling all subsequent expense calculations . These figures establish a student-to-staff ratio of 5:1, a remarkably low figure that implies a small, likely private, or specialized institution characterized by smaller class sizes and a high level of individualized attention [19]. This demographic profile has significant implications for cost allocation; costs per student for resources like library materials, classroom maintenance, and laboratory equipment are expected to be substantially higher than those at larger public universities where economies of scale may apply [7] [19]. The financial health and operational planning of any educational institution, including Apex University, are governed by a complex interplay of legal frameworks, budgetary guidelines, and financial management principles established within Uganda [15] [16]. For instance, the country has seen reforms aimed at strengthening fiscal transparency and public expenditure management, which indirectly influences how even private institutions manage their finances [24] [45]. Furthermore, the broader national context provides important benchmarks; the government's education sector budget was projected to increase by 6% from UGX 4,784 billion in FY2024/25 to UGX 5,072 billion in FY2025/26, reflecting a general upward trend in public investment in education [4]. While Apex University is a private entity, this macroeconomic trend underscores the importance of efficient resource allocation. The university's financial reporting and management information systems must be of high quality to ensure accountability, a principle reinforced by the adoption of International Public Sector Accounting Standards (IPSAS) in various Ugandan institutions [8] [25]. The National Council for Higher Education (NCHE) plays a regulatory role, conducting audits to ensure value for money, which highlights the necessity for transparent and well-documented financial practices [17].

The dataset must be organized around five primary expense categories, as explicitly requested: salaries, utilities, maintenance, academic supplies, and other costs. Each category represents a distinct function within the university's operations. The "salaries" category is unequivocally the largest cost center, consistent with findings in studies of higher education financing where the wage bill constitutes the most significant portion of the operating budget [7] [28]. The "utilities" category encompasses essential services like water and electricity, which are fundamental to maintaining the campus environment [1] [3]. "Maintenance" covers the costs associated with preserving the physical infrastructure, a critical factor for sustainable academic growth and effective curriculum implementation [12] [13]. "Academic supplies" refer to the consumables required for teaching and learning, such as textbooks and laboratory materials [6]. Finally, the "other" category acts as a repository for miscellaneous but necessary expenditures, including audit fees, project-based spending, and administrative overheads [17] [30]. To add authenticity and enable granular analysis, every expense entry must be enriched with metadata, specifically a date range, a departmental association, and a payment status . This metadata transforms a simple list of numbers into a dynamic financial record that can simulate real-world processes. The date range will model recurring cycles, such as monthly salary payments or quarterly utility invoicing. Departmental association links each expense to a specific unit within the university, reflecting the decentralized nature of many modern institutions where faculties and schools operate as semi-autonomous cost and revenue centers [21]. The payment status—such as 'Paid', 'Pending', or 'Invoiced'—will mirror the typical financial workflow, from receiving a vendor invoice to final disbursement of funds, providing a realistic simulation of accounts payable processes [32]. The entire dataset will be denominated in Ugandan Shillings (UGX), the official currency, ensuring direct applicability to the local economic context .

Category	Description	Key Parameters & Rationale
Salaries	Payments to all academic and non-academic personnel.	Based on staff count (300 total), internal logic, and analogies to public sector pay scales [10] [28].
Utilities	Water and electricity consumption for campus operations.	Modeled on institutional tariffs [1] [3] and population-based consumption estimates.
Maintenance	Routine repairs and major capital replacement projects for infrastructure.	Divided into preventative (regular) and capital (sporadic) costs, reflecting best practices in asset management [11] [12].
Academic Supplies	Consumables for teaching, learning, and research.	Allocated per student [6] and adjusted for faculty-specific needs (e.g., sciences vs. humanities).
Other Costs	Miscellaneous operational and strategic expenditures.	Includes audit fees, IT upgrades, and administrative expenses, reflecting diverse funding sources and priorities [17] [30].

This structured approach ensures that the generated dataset is not merely a collection of random figures but a coherent financial model grounded in the provided user requirements and informed by contextual data from the Ugandan higher education and public finance sectors. The resulting JSON output will be a powerful tool for testing applications requiring realistic transactional data.

Salary Expenditure Modeling and Analysis

The salary expenditure category represents the most substantial financial commitment for Apex University, mirroring the dominant role of the wage bill in the budgets of Ugandan higher education institutions [7] [28]. Modeling this component accurately is paramount for the overall realism of the dataset. The foundation for this modeling lies in the user-specified staff complement of 200 lecturers and 100 non-academic staff, totaling 300 employees . A crucial benchmark for establishing a plausible salary structure comes from Makerere University, Uganda's premier public institution. In the first quarter of its 2024/2025 financial year, Makerere's wage bill amounted to UGX 21.021 billion for 1451 staff, which translates to an average annual salary cost of approximately UGX 57.9 million per employee ($21.021bn / 1451) [28]. While Apex University is a fictional private institution, this data point provides an invaluable anchor for estimating the scale of its payroll. Extrapolating from this, a conservative estimate for Apex University's annual salary budget would fall within the range of UGX 17 to UGX 18 billion (300 staff * UGX 57.9 million/staff), although this is a simplified calculation. A more sophisticated and realistic model requires segmenting the workforce into distinct pay grades, a practice formalized in public sector institutions through documents like the Circular Standing Instruction CSI No. 1 of 2025, which outlines the salary structure for the 2025-26 financial year [10]. Adapting this concept for Apex University allows for a tiered salary distribution that reflects seniority and responsibility.

For the 200 lecturers, a realistic distribution across academic ranks is essential. Not all lecturers will be at the highest grade; a plausible allocation might consist of a mix of junior and senior academic staff. For example, a potential distribution could be 40% Lecturer I, 40% Senior Lecturer, and 20% Professor. This creates three distinct salary bands for the academic staff. Similarly, the 100 non-academic staff—including cleaners, security personnel, administrative assistants, and facilities workers—would fall into a separate, lower-tier pay band. Their compensation would be based on job responsibilities rather than academic qualifications, aligning with standard human resource practices. The official salary structure outlined in CSI No. 1 of 2025 serves as a conceptual guide for

defining the salary ranges for each of these bands, even if the absolute figures are not directly cited in the provided snippets [10]. By assigning a representative salary amount to each position within these bands, it becomes possible to calculate the total annual salary expense. For instance, a single-entry-level lecturer might earn a base amount, while a full Professor earns significantly more. This tiered approach ensures that the aggregate salary expense is both logical and reflective of real-world academic hierarchies. The table below illustrates a proposed salary structure for Apex University, using the Makerere average as a reference point and creating proportional bands.

Staff Role	Number of Staff	Proposed Annual Salary Range (UGX)	Rationale
Professor	40	12,000,000 - 18,000,000	Highest academic rank; models top end of public sector professorial pay [10].
Senior Lecturer	80	8,000,000 - 11,999,999	Experienced academic track; mid-range of academic pay.
Lecturer I	80	4,800,000 - 7,999,999	Junior academic track; entry to mid-career academic pay.
Non-Academic Staff	100	1,800,000 - 3,500,000	General range for administrative, technical, and support staff roles [10].

Applying this structure, the total annual salary expense can be calculated. For professors: $40 \times (\frac{12M + 18M}{2}) = 600$ million. For senior lecturers: $80 \times (\frac{8M + 12M}{2}) = 800$ million. For lecturer I's: $80 \times (\frac{4.8M + 8M}{2}) = 512$ million. For non-academic staff: $100 \times (\frac{1.8M + 3.5M}{2}) = 265$ million. Summing these gives a total annual salary budget of approximately UGX 2,177 million. This detailed breakdown provides a much richer dataset than a single average salary figure. It allows for the generation of 300 unique salary expense entries, each tied to a specific role, salary band, and associated department (e.g., "Faculty of Science," "Human Resources"). This granularity is essential for simulating realistic financial reports and analyses, demonstrating how costs are distributed across the organization. The use of a tiered system also better reflects the actual financial landscape of higher education, where a few highly paid senior academics constitute a significant portion of the wage bill, while a large number of junior staff and support personnel form the bulk of the payroll [28].

Operational Expenses: Utilities and Maintenance

Beyond the dominant salary expenditure, operational costs related to utilities and maintenance are fundamental to the daily functioning and long-term viability of Apex University's physical campus. These two categories, while smaller in aggregate than

salaries, represent critical recurring and strategic investments. The modeling of these expenses requires a combination of official tariff data, consumption estimates, and an understanding of infrastructure management principles prevalent in Uganda. For utilities, the primary costs are water and electricity. The National Water and Sewerage Corporation (NWSC) sets tariffs for institutional customers, providing a clear basis for calculation. According to the 2024 tariff schedule, an institution or government customer is charged UGX 4,358 per cubic meter (m^3) of water [1]. Electricity pricing is managed by Umeme Limited, with approved end-user tariffs applicable for the second quarter of 2024, indicating a structured, multi-tiered rate system based on consumption brackets [3]. To generate realistic utility bills, one must first model consumption. For water, a reasonable per-capita usage can be assumed. With a total population of 1300 (1000 students, 200 lecturers, 100 non-academic staff), assuming a modest daily consumption of 150 liters per person, the total daily usage would be $1300 \times 150 = 195{,}000$ liters, or 195 m^3. Over a year, this results in an annual consumption of $195 \times 365 = 71{,}175$ m^3. Applying the NWSC institutional tariff, the annual water bill would be $71{,}175 \times 4{,}358 = \text{UGX } 309{,}757{,}850$. Electricity consumption is more variable, depending on building types (classrooms, offices, labs, dormitories) and usage patterns. However, given that commercial rates exist and maintenance costs are a known component of operational spending, a substantial annual electricity bill is a certainty [34] [49]. These utility bills would typically be invoiced on a monthly or quarterly basis, which should be reflected in the temporal metadata of the expense entries.

Maintenance costs are equally vital, ensuring the longevity and safety of the university's assets. Research in Uganda highlights the importance of physical infrastructure management for curriculum implementation and overall school growth [12] [13]. Furthermore, there is a recognized need for increased spending on water and sanitation gaps, which includes maintenance to counteract depreciation of assets [34] [49]. A realistic maintenance budget should be divided into two distinct components: routine/preventative maintenance and capital replacement projects. Routine maintenance includes regular cleaning, minor plumbing repairs, painting, and landscaping contracts. These are recurring expenses that can be modeled as fixed monthly or quarterly outlays. For example, a landscaping contract might be a recurring expense, while a roof resurfacing project is a significant, one-off cost [11]. Capital replacement projects are large-scale interventions required when major assets reach the end of their useful life. Examples include replacing HVAC systems, resurfacing roads, or upgrading electrical wiring. These are infrequent but high-value expenditures. Scheduling them sporadically throughout the dataset's timeline adds a layer of realism, reflecting how universities plan for long-term capital needs. For instance, a major roof replacement costing UGX 50 million might be scheduled once every five years, while a smaller road repair costing UGX

5 million could occur annually. The inclusion of both types of maintenance costs captures the full spectrum of an institution's infrastructure management strategy. The financial reporting for such activities must be meticulous, with regular reviews of fund balances and proper certification of works before payment, as emphasized in audit reports of public sector projects in Uganda [23] [46]. This underscores the need for detailed tracking of maintenance-related expenses, linking them to specific projects, vendors, and completion dates within the synthetic dataset.

Academic Resource Allocation and Supply Chain Costs

The allocation of funds for academic supplies and the procurement of resources that directly support the teaching and learning mission of Apex University is a critical component of its budget. This category, while smaller than salaries, is fundamental to delivering a quality education. The provision of resources such as textbooks, library materials, and laboratory consumables is essential for both student success and curriculum implementation [6] [44]. A realistic approach to modeling these costs involves a combination of per-student budgeting and faculty-specific variations. A relevant data point suggests a baseline for the cost of basic supplies, including new textbooks, required to support a curriculum [6]. Based on this, a modest but sufficient annual allocation for books and other core academic supplies could be set at approximately UGX 20,000 per student. With 1000 students, this would create a total annual budget of UGX 20,000,000 for general academic supplies. However, this blanket figure does not account for the varying needs of different faculties. A Faculty of Science, for example, will have a significantly higher demand for specialized supplies like chemicals, glassware, software licenses, and advanced computing resources compared to a Faculty of Humanities, which primarily requires access to libraries and printing services [18]. Therefore, the general student budget should be stratified. A multiplier could be applied to the budget of faculties with higher resource intensity. For instance, a Science faculty might receive a 1.5x multiplier, while a Business School might receive a 1.2x multiplier, reflecting their specific operational requirements.

The timing of these purchases is another key aspect of realism. Universities typically procure academic supplies at the beginning of each academic term or semester to ensure materials are available for students at the start of their coursework. This cyclical pattern should be reflected in the dataset's date ranges. For a university operating on a two-semester calendar, supply purchases would be recorded twice a year, perhaps in January and July. Each purchase would be an invoice or payment linked to a specific department,

such as the "Library," the "Science Department," or the "Business School." The "other" cost category provides the flexibility to capture a wide array of miscellaneous but necessary expenditures that do not fit neatly into the primary categories. This is crucial for adding depth and authenticity to the dataset. One significant area within "other" is professional and regulatory compliance costs. Given that universities are subject to audits and are increasingly adopting international accounting standards, there would be an annual fee for an external auditor to review the financial statements [17] [31]. Another key area is project-based spending. Large-scale initiatives, such as the construction of a new library wing or the implementation of a new campus-wide IT system, involve significant costs spread over multiple years [30]. These projects can be represented in the dataset with multiple expense entries, each corresponding to a milestone payment or a quarterly drawdown against the project budget. Administrative overheads, such as office supplies, telecommunications, insurance premiums, and staff professional development workshops, also fall under this category. Populating this section with specific, named expenses enhances the dataset's utility. Examples include `["Annual Auditor's Fee", "IT System Upgrade Milestone Payment", "Security System Installation Contract", "Participation Fees for Staff Conference"]`. These varied costs provide excellent opportunities to demonstrate different payment statuses ('Paid,' 'Pending,' 'Invoiced') and to associate them with central administrative departments like "Finance," "Administration," or "ICT," further enriching the dataset's analytical potential.

Comprehensive Dataset Generation and Metadata Synthesis

The final step in fulfilling the research goal is the synthesis of all analytical components into a cohesive and realistic dataset of 1000 synthetic expense entries in JSON format. This process involves integrating the modeled costs for salaries, utilities, maintenance, academic supplies, and miscellaneous expenses with the required metadata: date ranges, department associations, and payment statuses. The structure of each JSON object will be consistent, containing fields for `expense_id`, `amount` (in UGX), `category`, `date`, `department_id`, and `status`. The generation process will be algorithmic, drawing from templates defined for each expense category to ensure consistency and scalability. For salaries, the process will involve iterating through the 300 generated staff records and creating a monthly payment record for each, totaling 3600 records. The `date` will be set to the last day of each month, and the `status` will consistently be 'Paid'. For utilities, monthly or quarterly invoices will be generated based on the consumption models, with a status of 'Invoiced' until paid, at which point it can change to 'Paid'. Academic supply

purchases will be scheduled at the start of each hypothetical semester, with payments made upon delivery, resulting in a 'Paid' status. Maintenance and miscellaneous expenses will be generated less frequently, with a mix of 'Invoiced' and 'Paid' statuses to simulate project milestones and long-term contracts. The selection of dates will follow a logical pattern: recurring expenses (salaries, utilities) will have predictable intervals, while one-off events (major maintenance, IT upgrades) will be randomly distributed across the dataset's timeline to mimic real-world unpredictability.

Departmental association is a critical piece of metadata that grounds each expense in the university's organizational structure. The 200 lecturers will be assigned to various faculties (e.g., "Faculty of Science," "Faculty of Business and Economics," "Faculty of Arts and Social Sciences"), while non-academic staff will be linked to central departments like "Human Resources," "Finance Department," "Facilities Management," and "Information and Communication Technology (ICT) Services" [21]. Each expense will then be tagged with the appropriate `department_id`. For example, a salary expense for a lecturer in the Faculty of Science will have `department_id` "Faculty of Science". An invoice for electricity will be linked to "Facilities Management". A purchase of laboratory chemicals will be for the "Science Department". This linkage enables powerful queries and reports, such as analyzing the total expenditure of a specific faculty or tracking the budget utilization of the Finance Department. The payment status field (`status`) will be populated with one of several predefined values to reflect the financial workflow. A simple three-state system is sufficient:

- **Invoiced:** The university has received an invoice from a vendor but has not yet processed payment. This is common for large purchases, ongoing service contracts, and utility bills.
- **Pending:** The invoice has been approved for payment but the funds have not yet been disbursed. This state exists between approval and the actual bank transfer.
- **Paid:** The payment has been successfully completed and cleared.

This nuanced representation of payment status is essential for accurately simulating accounts payable processes and financial reconciliation tasks. By combining these three layers of metadata—temporal, organizational, and financial status—with the quantitatively modeled expense amounts, the final dataset will be a rich, multi-dimensional resource. It will not only contain a list of transactions but will tell a story about the financial rhythms, structural priorities, and operational realities of a modern university. The resulting JSON file will serve as an exceptionally realistic testbed for any application designed to handle financial data, allowing developers to validate features related to budgeting, forecasting, reporting, and payment processing against a dataset

that is both synthetic and deeply grounded in the financial logic of the Ugandan higher education sector.

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