

## Evaluation of Laboratory Utilization at the Department of Civil Engineering, Andalas University in Enhancing Educational Services for External Parties

Uci Mardiani<sup>1✉</sup>, Sabril Haris HG<sup>2</sup>, Refni Herman<sup>3</sup>, Muhammad Al Hasbi Ashrief<sup>4</sup>

Universitas Andalas, Indonesia<sup>1,2,3,4</sup>

### ABSTRACT

**Purpose** – This study aims to evaluate the utilization level of the Civil Engineering Department (DTS) laboratories at Universitas Andalas for educational and research activities, both internally and externally, as well as their implications for enhancing educational service offerings to external parties.

**Design/methods/approach** – The research focused on four out of eight DTS laboratories that regularly conduct undergraduate practicum and research activities: the Materials and Structures Laboratory (LMS), the Transportation and Highway Pavement Laboratory (LTJR), the Soil Mechanics Laboratory (Mektan), and the Fluid Mechanics and Hydraulics Laboratory (LMH). A descriptive qualitative approach was employed. Primary data were obtained through interviews during benchmarking visits to the Civil Engineering laboratories at Gadjah Mada University and Bandung Institute of Technology, and through interviews with internal users of the DTS laboratories. Secondary data consisted of laboratory usage schedules for internal and external undergraduate practicums. NVivo 15 software was used to analyze qualitative data, while laboratory utilization was calculated by comparing the actual usage time against the available operational time.

**Findings** – Benchmarking results indicate that external services can be provided as long as laboratories are adequately equipped and their use does not interfere with internal activities. The utilization analysis revealed varying levels: 66.54% (LMS), 33.09% (LTJR), 80.46% (Mektan), and 85.71% (LMH). Three laboratories showed optimal usage, while LTJR exhibited significantly lower utilization.

**Research implications/limitations** – The findings can serve as a reference for managing DTS laboratories, particularly in scheduling for internal and external users and in improving infrastructure. However, the study's limitations include an uneven distribution of laboratory usage throughout the year and extended durations required for certain research activities, especially in test specimen preparation.

**Originality/value** – The study provides a foundation for developing strategic plans to enhance the DTS laboratories' capacity to deliver educational services to external institutions.

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**CONTACT:** ✉ [ucimardiani@adm.unand.ac.id](mailto:ucimardiani@adm.unand.ac.id)

## Introduction

Andalas University is one of the State Higher Education Institutions with a Legal Entity (Perguruan Tinggi Negeri Badan Hukum/PTN-BH) in Indonesia, as regulated by Government Regulation of the Republic of Indonesia No. 95 of 2021. As a PTN-BH, Andalas University has autonomous authority in managing its resources and finances. This autonomy requires the optimization of various institutional assets, not only to support the achievement of academic goals but also to serve as alternative sources of funding for the institution. One of the university's strategic assets is its laboratories, which have the potential to be developed to support educational services not only for internal academic communities but also for external parties.

A laboratory, according to Indrawan et al. (2020), is a facility designed to carry out scientific research activities, experiments, measurements, and scientific training tailored to specific disciplines and conducted under controlled conditions. Based on Ministerial Regulation of Administrative and Bureaucratic Reform (Permen PANRB) No. 7 of 2019, an Educational Laboratory is defined as an academic support unit within an educational institution, either enclosed or open, permanent or mobile, that is systematically managed to conduct testing, calibration, or limited-scale production. These activities are carried out using specific tools and materials based on scientific methods in support of education, research, and community service.

Within higher education institutions, laboratories play a vital role in implementing the Tri Dharma of Higher Education. In the field of engineering, as an applied discipline, the existence of laboratories is particularly important, as practical and experimental activities are integral components of the engineering learning process. Feisel and Rosa (2005) stated that laboratories in engineering education serve to strengthen conceptual understanding, develop work skills, and enable the direct application of classroom theory.

The Department of Civil Engineering is one of the departments under the Faculty of Engineering at Andalas University. Currently, the department manages eight laboratories: the Materials and Structures Laboratory, the Transportation and Highway Pavement Laboratory, the Soil Mechanics Laboratory, the Fluid Mechanics and Hydraulics Laboratory, the Surveying and GIS Laboratory, the Construction Engineering Management Laboratory, the Computer Laboratory, and the Material Technology and Modeling Laboratory. These laboratories play an essential role in supporting undergraduate practical sessions, research conducted by lecturers and students, as well as community service, all of which are integral components of the Tri Dharma of Higher Education.

As one of the largest state universities in the central region of Sumatra, Andalas University holds both the responsibility and the opportunity to establish academic collaborations, particularly in the field of engineering education. The Department of Civil Engineering has become a strategic partner for several private universities in West Sumatra and Jambi in facilitating undergraduate practical activities. These collaborations were initiated in response to the limited laboratory infrastructure at newly established private institutions. As a result, practical sessions that cannot be independently conducted at those institutions are instead carried out at the laboratories of Andalas University through educational cooperation schemes.

Furthermore, a collaborative network has now been established among Civil Engineering study programs from various universities in West Sumatra, Riau, Jambi, and Bengkulu. This network is focused on supporting the continuity of undergraduate practical activities, particularly those requiring complete and standardized laboratory infrastructure.

This condition provides a significant opportunity for Andalas University to optimize the use of its laboratories as part of its educational service offerings to external parties.

According to the Online Dictionary of the Indonesian Language (KBBI, 2024), *utility* refers to benefit, usefulness, or advantage. In the context of laboratories, utilization can be defined as the effective and efficient use of laboratory resources for various academic and non-academic activities. Optimizing laboratory utilization will have a direct impact on institutional productivity, both academically and financially. However, achieving optimal utilization requires laboratories to be managed professionally.

Good laboratory management includes the organization of spatial layout, equipment, infrastructure, administration, human resources, regulations, and the types of activities conducted (Hamdani in Indrawan et al., 2020). Nuryani (1991) in Indrawan et al. (2020) emphasized that laboratory management is the process of mobilizing human resources, finances, equipment, and facilities in an effective, efficient, and optimal manner to achieve predetermined goals. Fred and Ellington (1984) in Indrawan et al. (2020) further explained that educational laboratory management involves the systematic implementation of the management functions of planning, organizing, implementation, supervision, and reporting to support the teaching and learning process and to develop the competencies of both students and educators.

In the context of PTN-BH universities such as Andalas University, laboratories are also expected to be developed as supporting units for institutional financial independence. This can be achieved through the provision of educational services to external parties on a commercial basis. Laboratories possess strong potential as commercial units due to the specialized nature of their activities, which are based on specific expertise and cannot be easily substituted by other facilities. However, because the primary function of laboratories is to support the Tri Dharma, their use for commercial purposes must be carefully designed so as not to interfere with the university's core academic functions.

Therefore, it is necessary to conduct an evaluation of the utilization of laboratories in the Department of Civil Engineering at Andalas University, particularly in relation to the enhancement of educational services for external parties. This evaluation is essential, as it can provide an objective overview of laboratory usage and serve as a foundation for formulating future development strategies.

Several previous studies have examined laboratory utilization from various perspectives. Richardson and Blair (2015) evaluated Civil Engineering student engagement in laboratory practicals and its relation to the improvement of future employability skills. Neji and Nuoha (2015) analyzed the relationship between laboratory facility utilization and the academic performance of chemistry students in Calabar, Nigeria, and found that laboratory utilization was still suboptimal. Suherly et al. (2022) assessed the level of need for physics laboratories in secondary schools to support students' conceptual understanding. Meanwhile, Fitri and Wahyu (2023) evaluated the utilization of biology laboratories in senior high schools and reported relatively good usage levels.

Other studies have offered strategic insights. Riswanto et al. (2025) proposed a Total Quality Management (TQM)-based management framework for optimizing the use of physics laboratories in schools. Handayani (2018) compared laboratory utilization in senior high schools that had and had not implemented the 2013 Curriculum. Nurhasanah and Deliani (2013) developed strategic plans for the development of industrial engineering laboratories based on internal and external environmental analysis. Natsir (2017) initiated

the development of a laboratory service unit in engineering as a preparatory step toward becoming a Public Service Agency. Ikhsan and Lingga (2024) assessed user satisfaction in nursing education laboratories. Sintiya and Putranta (2024) examined the impact of modern physics practicums on students' science process skills. Susanti et al. (2023) developed a big-data-based information system for borrowing laboratory equipment. Finally, Sultanni et al. (2023) investigated the manipulative aspect of students' psychomotor skills in practicum-based learning.

However, most of these studies have focused on laboratory utilization from an internal perspective and have not yet incorporated external service utilization as a key variable of inquiry. Therefore, this study aims to fill that gap by evaluating laboratory utilization comprehensively—from both internal and external dimensions—and by analyzing its implications for enhancing the provision of educational services.

This study seeks to measure the utilization of four laboratories in the Department of Civil Engineering at Andalas University that are used for undergraduate practical activities and research conducted by both faculty and students from internal and external institutions. The laboratories are: the Materials and Structures Laboratory, the Transportation and Highway Pavement Laboratory, the Soil Mechanics Laboratory, and the Fluid Mechanics and Hydraulics Laboratory. The focus of the research includes laboratory usage for internal and external undergraduate practicals, as well as research activities involving students and faculty at the undergraduate, master's, and doctoral levels.

## Methods

### 1. Type and Research Approach

This study employed a descriptive qualitative approach (Creswell & Creswell, 2018). This approach was chosen to provide an in-depth description of the utilization level of laboratories in the Department of Civil Engineering at Andalas University in supporting educational and research activities, both for internal and external purposes. Quantitative data were used as supporting data to numerically calculate the laboratory utilization rate, thereby strengthening the interpretation of the qualitative data.

### 2. Research Location and Subjects

The research was conducted in four laboratories under the Department of Civil Engineering at Andalas University, namely: (1) Materials and Structures Laboratory (LMS), (2) Transportation and Highway Pavement Laboratory (LTJR), (3) Soil Mechanics Laboratory (Mektan), and (4) Fluid Mechanics and Hydraulics Laboratory (LMH).

These laboratories were selected due to their active implementation of undergraduate practicum activities and research by both lecturers and students, as well as their involvement in collaborative services with external institutions.

### 3. Data Collection Technique

Data were collected from two types of sources:

3.1. **Primary data**, obtained through: (1) In-depth interviews with laboratory managers and users (lecturers, students, and external partners), (2) Benchmarking visits to two state universities with legal entity status located on Java Island, namely Gadjah Mada University (UGM) and Bandung Institute of Technology (ITB), to gain insights into standardized and professional laboratory management systems.

3.2. **Secondary data**, which included: (1) Laboratory usage schedules for practicum and research activities, (2) Archives of laboratory usage for external collaboration, and (3) Activity reports and laboratory administrative documentation.

The interviews were conducted face-to-face and documented in the form of field notes and audio recordings to facilitate qualitative data analysis.

#### 4. Data Analysis Technique

Data analysis was conducted using two approaches:

4.1. **Qualitative Analysis:** Interview and observation data were analyzed thematically using NVivo 15 software (Rahadi, 2020). This analysis aimed to identify key themes related to laboratory management, utilization, and the challenges faced in achieving optimal usage. The data analysis process using NVivo 15 was carried out in several systematic stages: (1) Data collection and preparation (ensuring data format compatibility with NVivo 15), (2) Creating a "New Project" and assigning a project name, (3) Importing the prepared data files into the new project, (4) Organizing the data using "Cases" and "Attributes", (5) Coding the data into relevant "Codes", (6) Analyzing and exploring coded data, (7) Visualizing the data analysis results, and (8) Verifying and validating the results of the analysis.

4.2. **Quantitative Analysis:** The laboratory utilization rate was calculated by comparing the total actual usage time with the total available operational time, measured in hours per week. The calculation stages were as follows:

##### (1) Determining Available Time

Available time refers to the total number of operational days in a year. At the Civil Engineering laboratories, activities are conducted six days per week. The calculation is based on 365 days per year, subtracting the number of holidays. The assumed holidays include: 52 Sundays, 30 days for Ramadan, 10 days for Eid holidays, and 7 days for year-end holidays. Therefore, the available time is:

$$\text{Available Time} = 365 - (52 + 30 + 10 + 7) = 266 \text{ days/year (Eq.1)}$$

##### (2) Determining Used Time

Used time refers to the duration the laboratory was actively utilized for activities. This includes practicum sessions for internal and external undergraduate students, as well as research conducted by faculty members and students at undergraduate, master's, and doctoral levels.

##### (3) Utilization Calculation

To calculate laboratory utilization, the study refers to Pratama et al. (2017), using the following formula:

$$\text{Utilization (\%)} = \left( \frac{\text{Used Time}}{\text{Available Time}} \right) \times 100\% \text{ (Eq.2)}$$

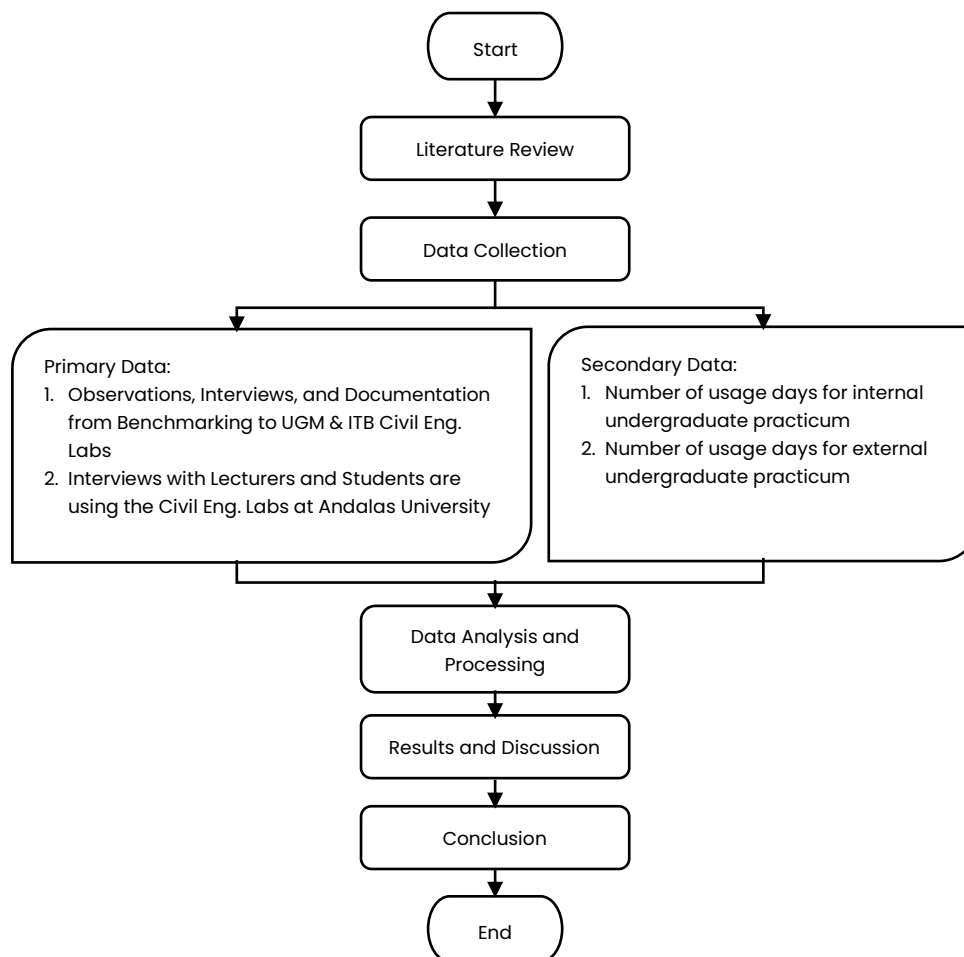
#### 5. Data Validation Technique

Data validation was carried out through triangulation of sources and methods (Fadli, 2021; Fitri & Wahyu, 2023; Sidiq & Choiri, 2019; Solikin, 2022; and Rahadi, 2020). Source triangulation was conducted by comparing information obtained from various

stakeholders: laboratory coordinators, faculty users, students, and external partners. Method triangulation was performed by combining the results of interviews, direct observations, supporting documents, and quantitative utilization analysis. This triangulation approach ensured the accuracy, consistency, and depth of data, thereby strengthening the validity of the research findings.

**Figure 1**

*Flowchart of the Research Methodology*



The stages in this research include: Literature Review, Data Collection (Primary and Secondary Data), Data Analysis and Processing, Results and Discussion, and Conclusion. The literature review was conducted by collecting various references relevant to the research, such as regulations, theories, data analysis methods, problem-solving models, and related publications.

Data collection was grouped into three categories: direct observation methods, question-based methods, and special methods (Nazir, 2009). These methods were used to obtain data to be analyzed, consisting of primary and secondary data.

Data analysis and processing were divided into two parts: analysis of benchmarking data and analysis of laboratory utilization. The results of these analyses were presented in the results and discussion section. The final stage of this research was to draw conclusions based on the findings.

## Result

### 1. Results of the Benchmarking Visits to Gadjah Mada University and Bandung Institute of Technology

The benchmarking activities were conducted by two researchers, each assigned to visit the Civil Engineering Laboratory at Gadjah Mada University and Bandung Institute of Technology, respectively. Each benchmarking visit was carried out for one full day on different scheduled dates. At Gadjah Mada University, five Civil Engineering laboratories were visited, and likewise, five laboratories were visited at Bandung Institute of Technology.

The activities during the benchmarking included direct observation and documentation of the facilities, infrastructure, and other supporting equipment available in the laboratories. In addition, interviews were conducted with laboratory personnel (laboratory technicians and engineers) regarding internal laboratory activities and external service operations, the condition of laboratory facilities, and the number of technical staff available.

Further interviews were held with cooperation management staff at the Department of Civil and Environmental Engineering, Gadjah Mada university, and with administrative staff in each laboratory at Bandung Institute of Technology. These discussions focused on the types of services provided, procedures and regulations for external laboratory services, laboratory profiles, scheduling systems, and laboratory administration management systems.

The list of laboratories involved in the benchmarking study and documentation of the benchmarking activities are presented in Table 1, Figure 2, and Figure 3 below:

**Table 1**

#### *List of Benchmarking Respondents*

No	University	Laboratory Name	Respondent ID
1	Gadjah Mada University (UGM)	Transportation	UGM_Transportation
		Structural	UGM_Structural
		Hydraulics	UGM_Hydraulics
		Soil Mechanics	UGM_SoilMechanics
		Building Materials	UGM_BuildingMaterials
2	Bandung Institute of Technology (ITB)	Structural Engineering	ITB_StructuralEngineering
		Soil Mechanics	ITB_SoilMechanics
		Road and Traffic Engineering	ITB_RoadTrafficEngineering
		Fluid Mechanics	ITB_FluidMechanics
		Hydraulics	ITB_Hydraulics



**Figure 2**

*Documentation of Benchmarking Activities to Gadjah Mada University*



**Figure 3**

*Documentation of Benchmarking Activities to Bandung Institute of Technology*



The data obtained from interviews, observations, and document analysis during the benchmarking activities were subsequently processed using NVivo 15 software, with the following detailed aspects analyzed:

1. Availability of undergraduate (Bachelor's level) practicum services;
2. Availability of research services for lecturers and students (Bachelor's, Master's, and Doctoral levels);
3. Availability of external service activities;

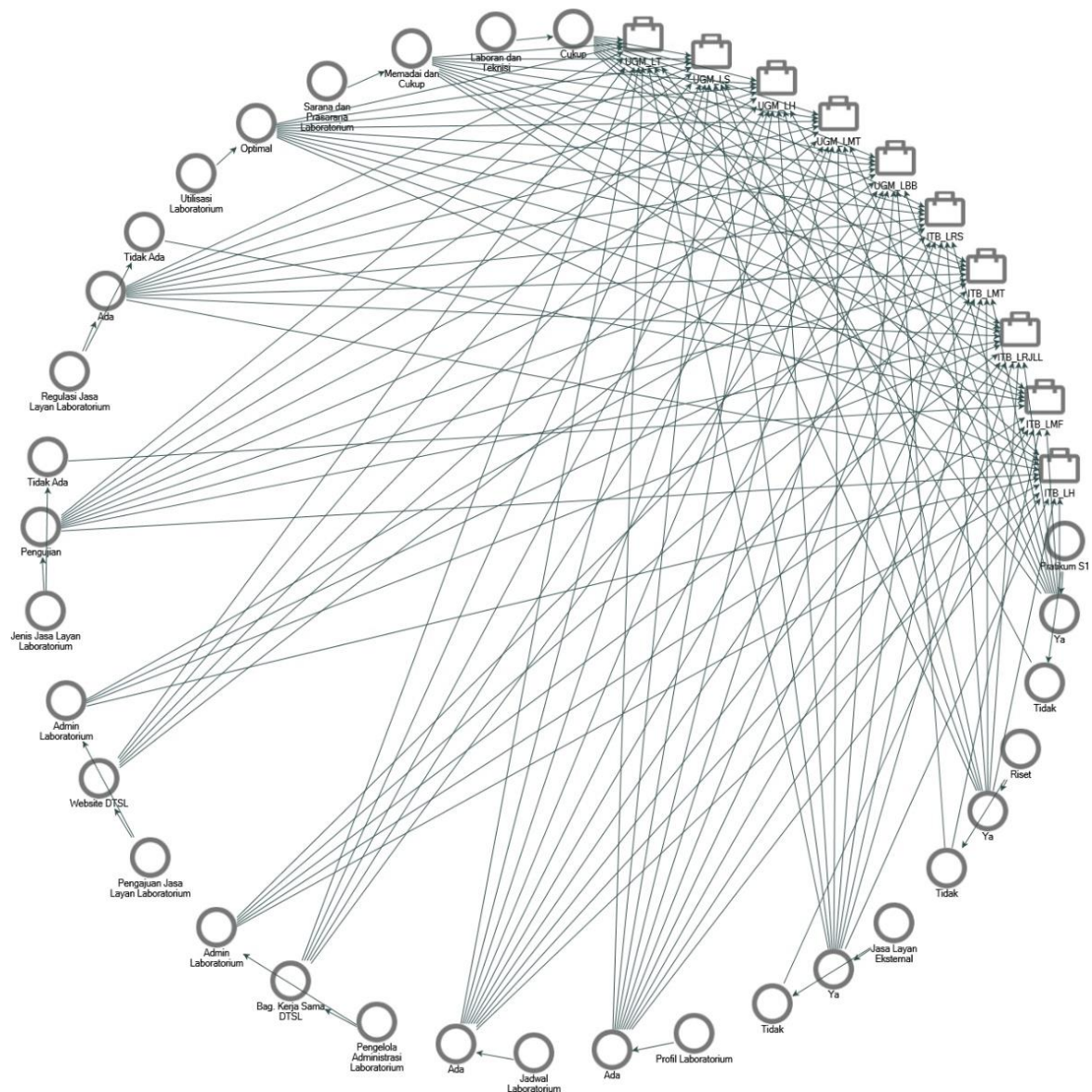


4. Availability of laboratory profiles;
5. Availability of laboratory usage scheduling systems;
6. Laboratory administrative management systems;
7. Procedures for submitting external service activity requests;
8. Types of external service activities provided by the laboratory;
9. Availability of regulations governing external laboratory services;
10. Optimization of laboratory utilization;
11. Adequacy and condition of laboratory facilities and infrastructure; and
12. Adequacy of the number of laboratory technicians and staff.

Visualization of the Relationship between the management and services of each laboratory are presented in Figure 4, Figure 5, and Table 2 below.

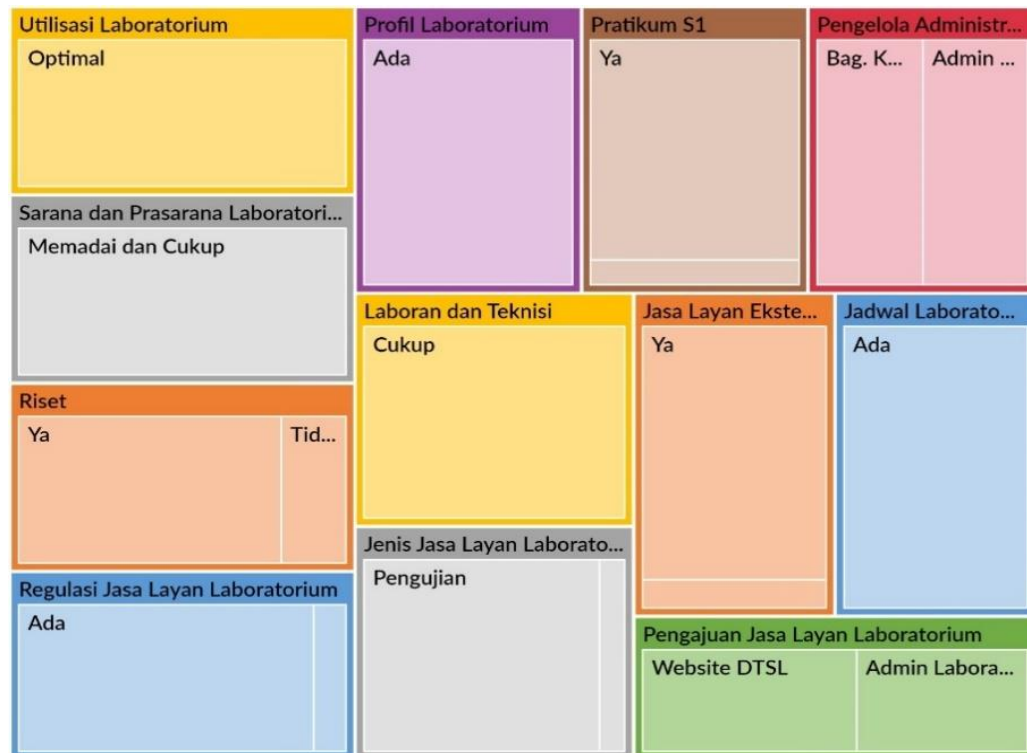
**Figure 4**

*Visualization of the Relationship between the Management Aspects and Laboratory Services Using NVivo 15 Software*



**Figure 5**

*Hierarchy Chart Aspects of Laboratory Management and Services Using NVivo 15 Software*



**Table 2**

*Description of Laboratory Management and Service Aspects*

No	Question	UGM					ITB				
		Transportation	Structural	Hydraulics	Soil Mechanics	Building Materials	Structural Engineering	Soil Mechanics	Road & Traffic Engineering	Fluid Mechanics	Hydraulics
1	Does the laboratory provide undergraduate practicum services?	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	Does the laboratory support research activities (BSc, MSc, PhD)?	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes
3	Does the laboratory accept external service activities?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
4	Is a laboratory profile available?	Available	Available	Available	Available	Available	Available	Available	Available	Available	Available
5	Is there a system for managing lab usage schedules?	Available	Available	Available	Available	Available	Available	Available	Available	Available	Available
6	How is the laboratory administration managed?	DTSL Cooperation Unit	DTSL Cooperation Unit	DTSL Cooperation Unit	DTSL Cooperation Unit	DTSL Cooperation Unit	Laboratory Administration	Laboratory Administration	Laboratory Administration	Laboratory Administration	Laboratory Administration
7	How are external service requests submitted?	DTSL Website	DTSL Website	DTSL Website	DTSL Website	DTSL Website	Laboratory Administration	Laboratory Administration	Laboratory Administration	Not Available	Laboratory Administration

No	Question	UGM					ITB				
		Transportation	Structural	Hydraulics	Soil Mechanics	Building Materials	Structural Engineering	Soil Mechanics	Road & Traffic Engineering	Fluid Mechanics	Hydraulics
8	What types of external services are provided?	Testing	Testing	Testing	Testing	Testing	Testing	Testing	Testing	Not Available	Testing
9	Are there regulations governing external services?	Available	Available	Available	Available	Available	Available	Available	Available	Not Available	Available
10	Is the laboratory utilization considered optimal?	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
11	Are the laboratory facilities and infrastructure adequate?	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate
12	Are the number of technicians and staff sufficient?	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient

Based on Table 2, the aspects of laboratory management and services at Gadjah Mada University and Bandung Institute of Technology can be described as follows:

1. Undergraduate Practicum Services

In general, all laboratories provide undergraduate practicum services, except for the Structural Laboratory at Gadjah Mada University, which does not serve undergraduate practicals as it is designated specifically for research activities (Bachelor's, Master's, and Doctoral levels) and external testing services.

2. Research Services for Lecturers and Students (BSc, MSc, PhD)

Laboratories that do not provide research services for lecturers and students include the Building Materials Laboratory at Gadjah Mada University and the Fluid Mechanics Laboratory at Bandung Institute of Technology. These laboratories only accommodate undergraduate practical sessions and materials testing activities.

3. External Service Activities

All laboratories provide external laboratory services, except for the Fluid Mechanics Laboratory at Bandung Institute of Technology, which only offers undergraduate practicum services.

4. Laboratory Profile

Each laboratory has a profile containing general laboratory information, available infrastructure and equipment, and activities provided. These profiles are accessible via the respective Department's website.

5. Laboratory Usage Scheduling System

At Gadjah Mada University, laboratory scheduling is managed by the Cooperation Unit of the Department of Civil and Environmental Engineering in coordination with each laboratory manager. Booking requests are submitted via a dedicated link available on the department's website. In contrast, at Bandung Institute of Technology, scheduling is managed independently by administrative staff in each laboratory.

6. Laboratory Administrative Management System

The administrative management of laboratories at Gadjah Mada University is handled by the Cooperation Unit of the Department of Civil and Environmental

Engineering in coordination with laboratory managers. Meanwhile, at Bandung Institute of Technology, each laboratory has its own administrative staff responsible for managing laboratory administration.

7. Submission of External Service Requests

At Gadjah Mada University, external service requests are submitted by completing a request form available on the department's website. At Bandung Institute of Technology, requests are submitted by directly contacting the laboratory's administrative staff.

8. Types of External Laboratory Services

In general, the types of external services provided by the laboratories include material or sample testing, either in the laboratory or in the field.

9. Regulations for External Services

Both Gadjah Mada University and Bandung Institute of Technology have Rector's Regulations that govern the procedures and service fees for external laboratory services.

10. Optimization of Laboratory Utilization

With the available facilities, infrastructure, human resources, and existing systems, the laboratories are considered to have achieved a fairly optimal level of utilization.

11. Laboratory Facilities and Infrastructure

The laboratories at both institutions are equipped with adequate and sufficient facilities and infrastructure to support internal activities and external services.

12. Laboratory Technicians and Staff

Each laboratory has a sufficient number of laboratory technicians and staff (at least two or more personnel), who are capable of handling both internal activities and external service requests.

## 2. Laboratory Utilization Calculation Results at the Department of Civil Engineering, Andalas University

### 2.1. Utilization of the Materials and Structures Laboratory

The utilization calculation results for the Materials and Structures Laboratory are presented as follows:

**Table 3**

*Utilization Calculation Results of the Materials and Structures Laboratory*

No	Activity Description	Number of Groups or Research Projects	Days per Group/ Project	Usage Time (days)	Available Time (days)	Utilization per Year (%)
a	b	c	d	e = c * d	f	g = (f/e) x 100%
1	Undergraduate Practicum – Internal (Odd Semester)	13	4	52	266	19.55
2	Undergraduate Practicum –					

No	Activity Description	Number of Groups or Research Projects	Days per Group/ Project	Usage Time (days)	Available Time (days)	Utilization per Year (%)
a	b	c	d	e = c * d	f	g = (f/e) x 100%
	External (Even Semester)					
	1) University of Muaro Bungo	2	4	8	266	3.01
3	Internal Research (Lecturer and/or Students – BSc, MSc, PhD) (Odd & Even Semesters)					
	1) Concrete Materials & Structures Research	2	48	96	266	36.09
	2) Steel Structures Research	3	7	21	266	7.89
<b>Total</b>						<b>66.54</b>

Based on Table 3, the total utilization rate of the Materials and Structures Laboratory is 66.54%. This result indicates that the use of the Materials and Structures Laboratory is relatively optimal. Currently, the laboratory is predominantly used for internal purposes, particularly for research activities conducted by lecturers and/or students. Furthermore, the use of the laboratory throughout the year is not evenly distributed, with most activities concentrated in the odd semester. This is due to the scheduling of internal undergraduate practicums, which are held during the odd semester, as well as the implementation of lecturer research activities, which usually take place from the middle of the odd semester to the beginning of the even semester, following the disbursement of research grant funds, which generally occurs mid-year.

Regarding external use, the Materials and Structures Laboratory currently only accommodates undergraduate practicum activities from one other university. As for collaborative research and external testing, these activities are still limited and not yet conducted regularly.

## 2.2. Utilization of the Transportation and Highway Pavement Laboratory

The utilization calculation results for the Transportation and Highway Pavement Laboratory are presented as follows:



**Table 4**

*Utilization Calculation Results of the Transportation and Highway Pavement Laboratory*

No	Activity Description	Number of Groups or Research Projects	Days per Group/ Project	Usage Time (days)	Available Time (days)	Utilization per Year (%)
a	b	c	d	e = c * d	f	g = (f/e) x 100%
1	Undergraduate Practicum – Internal (Even Semester)	12	4	48	266	18.05
2	Undergraduate Practicum – External (Odd Semester)					
	1) University of Muaro Bungo	2	4	8	266	3.01
	2) Dharma Andalas University	2	4	8	266	3.01
3	Internal Research (Lecturers/Students – BSc only, Odd Semester)	1	24	24	266	9.02
<b>Total</b>						<b>33.09</b>

Based on Table 4, the total utilization rate of the Transportation and Highway Pavement Laboratory is 33.09%. This result indicates that the laboratory's usage is still suboptimal. Currently, the laboratory only supports internal undergraduate practicum activities and research conducted by undergraduate students and/or lecturers. Research activities by Master's and Doctoral students are not conducted in this laboratory due to limited equipment availability.

In terms of external usage, the laboratory currently serves undergraduate practicum activities from two external universities. However, the scheduling of activities has been well-managed, with external activities scheduled at different times from internal ones.

### 2.3. Utilization of the Soil Mechanics Laboratory

The utilization calculation results for the Soil Mechanics Laboratory are presented as follows:

**Table 5**

*Utilization Calculation Results of the Soil Mechanics Laboratory*

No	Activity Description	Number of Groups or Research Projects	Days per Group/ Project	Usage Time (days)	Available Time (days)	Utilization per Year (%)
a	b	c	d	e = c * d	f	g = (f/e) x 100%
1	Undergraduate Practicum – Internal (Odd Semester)	10	3	30	266	11.28
2	Undergraduate Practicum – External (Even Semester)					
	1) University of Muaro Bungo	2	4	8	266	3.01
	2) Dharma Andalas University	2	4	8	266	3.01
3	Internal Research (Lecturers/Students – BSc, MSc, PhD) (Odd & Even Semesters)					
	1) Research by Undergraduate and Master's Students	1	24	24	266	9.02
	2) Research by PhD Students and Lecturers	1	144	144	266	54.14
<b>Total</b>						<b>80.46</b>

Based on Table 5, the total utilization of the Soil Mechanics Laboratory is 80.46%, which indicates that the laboratory is being used optimally. Research activities involving doctoral students and/or lecturers typically require extended durations—sometimes lasting more than one semester. Therefore, the scheduling of laboratory usage, particularly for specific testing equipment, must be carefully managed to avoid conflicts.

For external activities, the laboratory currently serves practicum sessions for students from two external universities.

#### 2.4. Utilization of the Fluid Mechanics and Hydraulics Laboratory

The utilization calculation results for the Fluid Mechanics and Hydraulics Laboratory are presented as follows:

**Table 6**

*Utilization Calculation Results of the Fluid Mechanics and Hydraulics Laboratory*

No	Activity Description	Number of Groups or Research Projects	Days per Group/ Project	Usage Time (days)	Available Time (days)	Utilization per Year (%)
a	b	c	d	$e = c * d$	f	$g = (f/e) \times 100\%$
1	Undergraduate Practicum – Internal (Even and Odd Semesters)					
	1) Fluid Mechanics Practicum (Even Semester)	11	1	11	266	4.14
	2) Hydraulics Practicum (Odd Semester)	17	1	17	266	6.39
2	Undergraduate Practicum – External (Odd Semester)					
	1) University of Muaro Bungo					
	• Fluid Mechanics Practicum	2	1	2	266	0.75
	• Hydraulics Practicum	2	1	2	266	0.75
	2) Dharma Andalas University					
	• Fluid Mechanics Practicum	2	1	2	266	0.75
	• Hydraulics Practicum	2	1	2	266	0.75
3	Internal Research (Lecturers/Students – BSc and MSc) (Odd & Even Semesters)	2	96	192	266	72.18
<b>Total</b>						<b>85.71</b>

For the Fluid Mechanics and Hydraulics Laboratory, the total utilization rate is 85.71%, which indicates optimal usage. However, the utilization values across activities vary significantly. The highest utilization comes from internal research activities, while the undergraduate practicum activities contribute very little to overall utilization.

Thus, the scheduling of undergraduate practicum activities should be better aligned with the schedules of other laboratories so that students participating in more than one practicum session can manage their time more efficiently. Additionally, as the laboratory currently accommodates only four external practicum sessions from two partner universities, there is still a wide opportunity to expand collaboration for external undergraduate practicum sessions. This is particularly feasible because the equipment used for undergraduate practicums and research activities are different.

## Discussion

### 1. Discussion of the Benchmarking Results at Gadjah Mada University and Bandung Institute of Technology

Based on the benchmarking results conducted at the Civil Engineering Laboratories of Gadjah Mada University and Bandung Institute of Technology, it was found that the laboratory utilization at both universities has reached an optimal level. The Civil Engineering Laboratories at both institutions have implemented sound educational laboratory management practices, which include the execution of core management functions: planning, organizing, implementing, monitoring, and reporting.

This success is supported by the presence of adequate and well-equipped facilities and infrastructure that accommodate both internal and external activities. Furthermore, the management systems in place are well-structured, and the human resources—comprising laboratory technicians, engineers, and administrative staff—are sufficient to support the operational needs of the laboratories.

In terms of external service activities, the laboratories at Gadjah Mada University and Bandung Institute of Technology provide services for both educational and commercial purposes. Educational services typically involve research testing conducted by lecturers and students at the undergraduate, master's, and doctoral levels, either individually or collaboratively. However, undergraduate practicum services are not provided to external institutions, as there has been no demand from other universities—public or private—to conduct such activities at the Civil Engineering laboratories of these institutions.

Meanwhile, commercial services include sample testing in laboratories and field testing using laboratory equipment. For these services, both Gadjah Mada University and Bandung Institute of Technology have established formal regulations, namely Rector's Decrees, governing the fees and procedures for educational and commercial external laboratory services.

### 2. Discussion of Laboratory Utilization Calculation Results at the Department of Civil Engineering, Andalas University

From the utilization calculations conducted across the four laboratories within the Department of Civil Engineering at Andalas University—namely the Materials and Structures Laboratory, the Transportation and Highway Pavement Laboratory, the Soil Mechanics Laboratory, and the Fluid Mechanics and Hydraulics Laboratory—varied results were obtained. Three laboratories demonstrated relatively optimal utilization, namely: (1) Materials and Structures Laboratory, (2) Soil Mechanics Laboratory, and (3) Fluid Mechanics and Hydraulics Laboratory.

However, the Transportation and Highway Pavement Laboratory showed a relatively low utilization rate.

It is important to note that these utilization figures do not fully represent comprehensive laboratory usage. Higher utilization rates were largely influenced by research activities, which often require extended periods of laboratory use—particularly for sample preparation and observation phases of the research. In contrast, undergraduate practicum activities generally contributed to low utilization rates across the laboratories.

Therefore, there is considerable potential to further utilize the Civil Engineering laboratories at Andalas University for external educational services, particularly for undergraduate practicum sessions. However, this would require proper scheduling to prevent overlap and ensure effective use of resources. Additionally, laboratories must be equipped with the appropriate facilities and infrastructure to support both types of activities.

It is also essential to establish an appropriate laboratory layout configuration to ensure that external undergraduate practicum activities do not disrupt internal operations, especially ongoing research. The findings of this study are expected to provide valuable input for laboratory managers and departmental leadership in formulating improved policies and strategies for managing educational laboratories at the Department of Civil Engineering, Andalas University.

## Conclusion

The benchmarking visits conducted at Gadjah Mada University and Bandung Institute of Technology revealed that laboratory utilization at these institutions has reached an optimal level. This achievement is primarily due to well-organized laboratory management practices that are already integrated with information technology systems. The available resources are highly adequate, including comprehensive facilities and infrastructure, sufficient human resources such as laboratory technicians, engineers, and administrative staff who manage the laboratory's operations.

Laboratory utilization for external services, both educational and commercial, is also optimal at these institutions. This is supported by proper management by either the laboratories themselves or the department's cooperation unit, along with the presence of clear regulatory frameworks.

Meanwhile, the utilization calculations for laboratories within the Department of Civil Engineering at Andalas University indicate that three laboratories—namely the Materials and Structures Laboratory, Soil Mechanics Laboratory, and Fluid Mechanics and Hydraulics Laboratory—have achieved relatively optimal utilization rates. On the other hand, the Transportation and Highway Pavement Laboratory recorded a relatively low utilization rate. This discrepancy is largely due to the concentration of research activities involving lecturers and students at the undergraduate, master's, and doctoral levels in the first three laboratories, where research activities generally require longer periods of laboratory usage.

The findings of this study suggest that to increase the utilization of Civil Engineering laboratories—particularly for external educational services—it is necessary to implement appropriate educational laboratory management practices. Such management will ensure that both internal and external educational activities can be conducted effectively and harmoniously within the laboratory environment.



Looking forward, it is essential to develop strategic programs to support the expansion of laboratory utilization for external educational services. Building on the results of this study, the next stage of research will focus on formulating a development strategy for the Civil Engineering laboratories at Andalas University. This will involve identifying the key factors that influence laboratory development and planning a strategic framework for expanding the department's laboratory services to external academic partners.

## Declarations

### Author contribution statement

In this study, the first and second authors contributed as the originators of the research idea, data analysts, and were responsible for the preparation of the report and its publication. The third and fourth authors contributed to data collection and data processing.

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### Data availability statement

The data supporting the findings of this study are available upon request by contacting the following email address: [ucimardiani@adm.universitasandalas.ac.id](mailto:ucimardiani@adm.universitasandalas.ac.id).

### Declaration of interests statement

The authors declare that there are no competing financial interests or personal relationships that could have appeared to influence the work reported in this study.

### Additional information

Feedback and suggestions regarding this study may be directed to the following email address: [ucimardiani@adm.universitasandalas.ac.id](mailto:ucimardiani@adm.universitasandalas.ac.id).

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