JPAIR Multidisciplinary Research Volume 64 • March 2026
DOI: https://doi.org/10.7719/jpair.v64i1.986

Smart and Equitable Library Access: A Human-Centered Time-Tracking Policy for Congestion Management in a Cebu-Based Higher Education Institution

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Originality: 100% • Grammarly: 95% • Plagiarism: 0%

Article History

Received: 16 Jul 2025
Revised: 02 Feb 2026
Accepted: 23 Feb 2026
Published: 30 Mar 2026

Keywords— Human-Centered Design, Library Congestion, Mixed-Method Research, Sustainable Development Goals, Time-Tracking Policy

ABSTRACT

Library congestion is a persistent issue in many higher education institutions, limiting student access to study spaces and affecting overall academic productivity. This study explored the extent of congestion in the main library of a private higher education institution in Cebu City, Philippines, and examined student receptiveness to time-tracking policies as a potential solution. Specifically, it assessed patterns of library usage, seat occupancy behaviors, and perceptions of regulated stay durations through system-based interventions. A mixed-methods approach, guided by Human-Centered Design principles, was employed. Data collection included structured observations to

monitor space utilization and seat turnover, student surveys with Likert-scale and open-ended questions, and analysis of entry-exit logs to identify peak usage periods and average dwell times. Findings revealed that specific library zones, particularly individual study areas and group tables, consistently experienced high occupancy with low turnover, designating them as congestion hotspots. Survey results showed moderate support for time-tracking policies, especially when flexible rules are applied during high-demand periods such as examinations. System log data confirmed peak congestion during midterms and finals. The study concludes that a time-tracking policy, developed with student-centered considerations, could significantly improve seat circulation, reduce overcrowding, and promote more equitable access to library resources. By integrating digital infrastructure to optimize space management, the research aligns with Sustainable Development Goals 4 on Quality Education and 9 on Innovation and Infrastructure. It highlights the potential of technology-driven solutions in creating inclusive, efficient, and student-responsive learning environments.

INTRODUCTION

University libraries play a vital role in supporting academic success by providing access to information resources, facilitating collaborative learning, and serving as an environment conducive to focused study and research. As student enrollment increases and academic demands intensify, many higher education institutions face the persistent challenge of library congestion. Overcrowding diminishes students' ability to find suitable study spaces, creates distractions, and may contribute to academic stress. While limited research directly addresses library congestion, related literature on campus resource utilization, transportation management, and digital access offers valuable insights into strategies that can influence student traffic and space occupancy. Access to electronic resources has been shown to influence students' reliance on physical library spaces. At Kogi State University, students' awareness and utilization of digital resources significantly shaped their engagement with on-site library facilities, suggesting that improved online access may reduce unnecessary physical visits and mitigate congestion (Yemi-Peters et al., 2022). Universities also adopt policies that control or regulate access inside libraries. At Seattle University, certain equipment and resources are made available only to actively enrolled students and personnel, allowing the institution to manage occupancy more efficiently (Lemieux Library, n.d.).

Similarly, campus activities such as student orientations or move-in programs have been found to cause temporary surges in student volume,

prompting institutions to plan proactively for fluctuating library occupancy during peak periods (Jennings, 2025). Collectively, these strategies illustrate how access control, resource management, and campus movement influence student presence within library spaces. In one Cebu-based higher education institution, the main academic library remains central to student learning as it provides access to physical collections, electronic materials, and a variety of study environments.

However, increasing student population and the rising academic workloads have led to instances of overcrowding, especially during midterm and final examination periods. Students often occupy seats for prolonged periods even without actively engaging with library resources, limiting seat turnover and creating unequal access to study spaces. These behaviors contribute to extended seat reservation, noise, congestion in common areas, and inefficiencies in resource utilization, which ultimately hinder student productivity and well-being. Emerging research suggests that systematic space management, including time-based policies, can optimize library usage. Nichols and Philbin (2022) demonstrated that tracking user activity and involving patrons in space planning improved satisfaction and increased space utilization efficiency.

Trembach et al. (2020) further emphasized the importance of understanding behavioral patterns such as preference for quiet zones or technology-enabled areas to inform responsive space policies. Recent technological solutions, such as Wi-Fi–based Patron Counting and Analysis (PCA) systems, allow administrators to monitor real-time occupancy with low-cost and non-intrusive methods (Qu, 2024), supporting data-driven decision-making for library space allocation. Evidence also indicates that structured time management of study spaces promotes healthier study habits, improves turnover rates, and increases equitable access (Kane & Mahoney, 2020). Despite these developments, research remains limited regarding how such strategies may be adapted in Philippine educational contexts, where cultural study practices, available infrastructure, and student expectations differ from those of Western institutions.

Addressing this gap, the present study investigates the causes of library congestion in a Cebu-based higher education institution and examines the feasibility of implementing a time-tracking system for library seat usage. Grounded in both international literature and Philippine scholarship such as Navarro et al. (2023), this research seeks to propose context-sensitive, equitable, and technologically informed solutions that improve access while supporting student well-being. Ultimately, this study aims to contribute to the emerging discourse on academic library space management in the Philippines by offering empirical data and recommendations that support fair access, efficient resource use, and an enhanced learning environment for all library users.

METHODOLOGY

Research Design

This study employed a mixed-methods case study design guided by Human-Centered Design (HCD) principles. HCD was appropriate for addressing library congestion because it focused on understanding user behavior, identifying needs, and designing solutions aligned with real student experiences. Izmir Tunahan et al. (2025) demonstrated that analyzing seating patterns through data and AI revealed that congestion often resulted from inefficient layout rather than insufficient space. Magalhaes (2018) described HCD as a meaning-driven approach, emphasizing qualitative context and user motivations throughout the design process. The research was conducted in the library of a Cebu-based higher education institution, where data were collected to examine space usage patterns, seating behaviors, and student perceptions related to congestion. Three methods of data collection were employed: structured observations, a survey questionnaire, and library sign-in and sign-out logs. These methods were used concurrently to enable triangulation, ensuring both qualitative depth and quantitative accuracy. Structured observations were conducted within the library over a two-week period, encompassing both peak and off-peak hours. Observers adhered to a systematic and non-intrusive protocol, utilizing standardized observation templates to ensure consistency across designated zones and time intervals. The data collection focused on three key indicators: (1) average seat occupancy rate, (2) seat turnover rate, and (3) classification of student activities, distinguishing between academic and non-academic engagements. This approach enabled reliable comparisons across time slots and spatial zones, while minimizing observer bias and ensuring replicability of findings.

Table 1

Interpretation Guide for Average Seat Occupancy

Average Occupancy Rate	Category	Interpretation
0% – 49%	Low Occupancy	Many seats are unoccupied, which may indicate underutilization during that time.
50% – 79%	Moderate Occupancy	Balanced usage: space is being used but not yet overburdened.
80% – 100%	High Occupancy	The library is nearing or at full capacity; potential discomfort or congestion is likely.

Table 2

Interpretation Guide for Seat Turnover Rates

Seat Turnover Rate (per seat per hour)	Category	Interpretation
0–0.5 turnovers/hour	Low Turnover	Seats are rarely vacated; this may indicate long stay durations or potential hoarding.
0.6–1.5 turnovers/ hour	Moderate Turnover	Reasonable circulation: students are using and freeing up seats at a steady pace.
1.6 or more turnovers/hour	High Turnover	Frequent vacating and reoccupation; suggest efficient use or possible seat pressure.

Table 3

Average Occupancy Rate Legend for Heatmap Visualization

Legend	Average Occupancy Rate	Category
	80% - 100%	High Occupancy
	61% - 79%	Moderate Occupancy
	50% - 60%	Moderate Occupancy
	21% - 49%	Low Occupancy
	0% - 20%	Low Occupancy

An average occupancy of 50%–70% was considered moderate, consistent with Ju et al. (2023), who reported occupancy levels of 54.6% to 72% during regular academic semesters. This range was adjusted to fit the smaller scale of the study environment. The library floor layout was divided into functional observation zones (study tables, computer terminals, reading areas, and group study spaces). Congestion hotspots were identified in areas with consistently high occupancy and low turnover, indicating limited seat availability for incoming users. Heat-mapping techniques were used to visually represent the density and distribution of seat usage. Darker shades indicated higher congestion, following a five-range linear scale shown in Table 3. Dean (2023) emphasized that heat maps offer actionable insights into spatial preferences and crowding patterns, supporting the method used in this study. The survey collected quantitative and qualitative insights on (1) Student perceptions of library congestion, and (2) Openness to possible time-tracking or seat-management policies. The target population consisted of 16,925 enrolled college students for the Second Semester of Academic Year 2024–2025. The sample size was calculated using Slovin's formula at a 95% confidence level and 5% margin of error, which was

appropriate for large student populations. A stratified random sampling technique was employed to ensure representation across academic programs. The stratified sample distribution in Table 4 reflects proportional allocation based on program-level enrollment data. Within each stratum, respondents were randomly selected using a random number generator applied to official enrollment lists, ensuring both statistical rigor and equitable representation across academic programs.

Table 4

Stratified Sample Distribution by Program

Program	Population	% of Total	Sample Size
AB COMM	43	0.25%	1
AB-E	17	0.10%	0
AOAD	1	0.01%	0
BEED	71	0.42%	2
BMMA	612	3.62%	14
BPA	15	0.09%	0
BSA	239	1.41%	6
BSAIS	18	0.11%	0
BSARCH	2088	12.34%	48
BSBA-BA	7	0.04%	0
BSBA-BFM	238	1.41%	6
BSBA-GBM	74	0.44%	2
BSBA-HR	38	0.22%	1
BSBA-MKM	228	1.35%	5
BSBA-OM	21	0.12%	1
BSBA-QM	1	0.01%	0
BSBIO	57	0.34%	1
BSCE	3833	22.65%	89
BSCHE	286	1.69%	7
BSCPE	581	3.43%	13
BSCRIM	83	0.49%	2
BSCS	477	2.82%	11
BSECE	165	0.97%	4

BSED-E	61	0.36%	1
BSED-M	12	0.07%	0
BSED-S	10	0.06%	0
BSEE	610	3.60%	14
BSEM	117	0.69%	3
BSHM	361	2.13%	8
BSIE	215	1.27%	5
BSIT	1788	10.56%	41
BSMA	197	1.16%	5
BSMATH	11	0.06%	0
BSME	1022	6.04%	24
BSN	2088	12.34%	48
BSOAD	22	0.13%	1
BSPHARMA	230	1.36%	5
BSPSYCH	695	4.11%	16
BSTM	293	1.73%	7
Grand Total	16925	100.00%	391

Note: Sample sizes are rounded to the nearest whole number using proportional allocation. Programs with very small populations may round down to zero but can be included qualitatively if needed.

Instrumentation

The survey questionnaire consisted of multiple-choice, Likert-scale, and open-ended items designed to determine the frequency and purpose of library visits, perceived fairness of seat access, and student attitudes toward time-limiting or seat-management systems. Several close-ended items gathered information, including student ID number, college department, year level, and academic program. A five-point Likert scale was utilized in the survey to measure the level of agreement or disagreement with various statements related to library congestion. Responses were rated on a scale from 1 to 5, with 1 indicating Strongly Disagree and 5 indicating Strongly Agree. This format was selected because it allowed respondents to express varying degrees of perception without overwhelming them with too many response options. The use of the Likert scale followed the analytical framework discussed by Joshi et al. (2015), who explained that when individual response categories are combined into composite scores, the data

behave as interval in nature. This allowed the study to compute measures of central tendency (mean) and dispersion (standard deviation), making the five-point scale appropriate for both descriptive and inferential analyses. The Likert-scale items were grouped into two categories: (1) perceived causes and effects of library congestion, and (2) willingness to adopt seat time-tracking policies. Descriptive statistical techniques specifically frequency distribution and weighted mean were used to summarize student responses. To determine the statistical significance and precision of percentage-based results, the Confidence Interval with Finite Population Correction Equation 2 $h = 2 \bullet arcsin\left(\sqrt{p1}\right) - 2\, arcsin\left(\sqrt{p2}\right)$ and Cohen's h effect size Equation 3 $h = 2 \bullet arcsin\left(\sqrt{p1}\right) - 2\, arcsin\left(\sqrt{p2}\right)$ were applied. Prior to distribution, the questionnaire underwent expert validation. Three faculty evaluators, specialist in research for survey design and statistical validity, communication expert for clarity, readability, and ensuring the questions are understandable, and library personnel for content relevance related to library usage, student behavior, and academic context, reviewed the instrument to ensure clarity, appropriateness of wording, and alignment with the research objectives. Their feedback resulted in minor revisions, ensuring that the instrument achieved strong content and construct validity. After validation, a pilot test was administered, and the reliability of the Likert-scale items was assessed using Cronbach's alpha, which produced a coefficient of 0.89. This value surpassed the acceptable threshold of 0.70, indicating that the survey questionnaire demonstrated high internal consistency and reliability.

The third data-gathering technique employed in this study was the analysis of automated library system logs to capture real-time usage patterns within the library. This method provided a quantitative basis for validating observed student behaviors and traffic flow, complementing the structured observations and survey data. Data were sourced from the library's digital entry system, which records time-in and time-out stamps as students scan their IDs upon entering and exiting the facility. The dataset covered the period from January to May 2025 and was organized by hourly intervals and monthly aggregates. This structure enabled a granular analysis of library utilization across different times of day and phases of the academic calendar. Time-in records were used to calculate the frequency of entries per hour, revealing peak usage periods and traffic density. Time-out data were matched with corresponding time-in logs to determine the average duration of student visits. Monthly trends were also examined to identify patterns associated with academic milestones such as examinations, project deadlines, and enrollment cycles. The processed data were visualized through bar graphs illustrating hourly and monthly usage distributions. These visualizations provided actionable insights into consistently high-traffic time slots

and underutilized periods, informing recommendations for space optimization and time-tracking policies. Ultimately, the analysis served as an evidence-based foundation for enhancing fairness, efficiency, and accessibility in library space management. Ethical considerations were observed throughout the study. Participation was voluntary, informed consent was obtained from all respondents, personal identifiers were anonymized, and all data were handled confidentially to protect student privacy and comply with institutional research ethics standards.

RESULTS AND DISCUSSION

The findings were derived from multiple data-gathering techniques, including structured observations, system log analysis, and survey responses. These results provided a comprehensive understanding of student behavior, space utilization, and congestion patterns within the college library. Trends were analyzed with respect to time-of-day usage, activity types, and spatial distribution, offering evidence-based insights to inform library management and policy development. The observational data, presented in Table 5, demonstrated considerable temporal and spatial variation in library occupancy and user activities between 8:00 AM and 5:00 PM. Analysis of the data revealed that the highest overall occupancy consistently occurred between 11:00 AM and 1:00 PM, corresponding to the library's peak operational hours. These results suggested significant fluctuations in space utilization throughout the day, with implications for optimizing seating allocation and managing congestion during periods of maximum demand.

Table 5

Summary of Observed Library Zone Utilization and Student Activities by Time Period

Library Zone	Time Period	Average Occupancy Rate (%)	Seat Turnover Rate (per seat per hour)	Dominant Activity Observed
Study Tables	8:00 AM - 11:00 AM	60.03%	0.40	Studying, resting
	11:00 AM - 1:00 PM	85.14%	0.35	Studying, doing coursework
	1:00 PM - 5:00 PM	69.68%	0.50	Sleeping
Reading Areas	8:00 AM - 11:00 AM	50.08%	0.60	Casual reading
	11:00 AM - 1:00 PM	76.91%	0.45	Focused reading
	1:00 PM - 5:00 PM	60.89%	0.50	Sleeping

Discussion Rooms	8:00 AM - 11:00 AM	30.50%	0.70	Group discussions
	11:00 AM - 1:00 PM	69.41%	0.50	Active group discussions
	1:00 PM - 5:00 PM	59.79%	0.60	Socializing and discussions
Computer Terminal Zones	8:00 AM - 11:00 AM	39.11%	1.00	Research
	11:00 AM - 1:00 PM	71.19%	0.80	Document printing, coursework
	1:00 PM - 5:00 PM	67.61%	0.90	Browsing

Figure 1

Heatmap Visualization

		M	T	W	TH	F	S	AVERAGE OCCUPACY RATE (%)
STUDY TABLES	8:00 AM - 11:00 AM	63.25%	59.87%	61.04%	60.50%	62.91%	52.60%	60.03
	11:00 AM - 1:00 PM	92.60%	86.47%	89.73%	85.64%	93.87%	62.50%	85.14
	1:00 PM - 5:00	74.32%	67.45%	70.11%	69.77%	66.73%		69.68
READING AREAS	8:00 AM - 11:00 AM	47.60%	50.11%	48.65%	54.39%	49.13%	50.60%	50.08
	11:00 AM - 1:00 PM	77.48%	84.33%	79.22%	81.05%	82.39%	56.98%	76.91
	1:00 PM - 5:00	56.28%	63.85%	58.95%	61.26%	64.10%		60.89
DISCUSSION ROOMS	8:00 AM - 11:00 AM	34.15%	26.90%	33.88%	27.70%	30.65%	29.74%	30.50
	11:00 AM - 1:00 PM	66.10%	70.02%	78.15%	73.49%	69.02%	59.68%	69.41
	1:00 PM - 5:00	64.51%	52.71%	60.89%	58.83%	61.99%		59.79
COMPUTER TERMINAL ZONES	8:00 AM - 11:00 AM	36.78%	44.75%	42.26%	39.55%	43.80%	27.50%	39.11
	11:00 AM - 1:00 PM	81.13%	72.64%	74.67%	78.45%	77.31%	42.96%	71.19
	1:00 PM - 5:00	63.92%	70.55%	68.94%	66.42%	68.20%		67.61

The analysis of the heatmap visualization (Figure 1) provided granular insights into occupancy levels, turnover rates, and activity patterns across different library zones, forming the basis for the mean occupancy levels presented in Table 5. Study tables exhibited peak occupancy between 11:00 AM and 1:00 PM (85.14%), coinciding with intensive academic activities such as coursework and focused studying, while early morning (60.03%) and afternoon (69.68%) usage was lower, with resting and sleeping more prevalent, and turnover remained consistently low, indicating prolonged seat occupancy. Reading areas reached their highest utilization during the midday session (76.91%) for concentrated reading, with moderate turnover (0.45), whereas morning usage (50.08%) reflected perfunctory reading and afternoon usage (60.89%) suggested a shift toward resting. Discussion rooms showed the greatest variation, rising from 30.50% in the morning to 69.41% between 11:00 AM and 1:00 PM for active

group discussions, and remaining high in the afternoon (59.79%) as activities shifted toward social interactions, with turnover rates ranging from 0.5 to 0.7. Computer terminal zones displayed the highest turnover, particularly in the morning (39.11%) during short, task-oriented activities such as research, peaking at 71.19% occupancy in the late morning for printing and coursework, and maintaining substantial afternoon usage (67.61%) with slightly lower turnover (0.9), indicating longer browsing durations.

Overall, these data revealed substantial temporal and spatial variation in library usage, highlighting patterns of congestion, user behavior, and occupancy dynamics across functional zones. These findings were consistent with existing literature on student behavior in academic libraries. Prior studies had shown that library management, facility quality, and service provision significantly influenced student engagement and usage patterns (Fiqriansyah, 2021; Sukmaranti et al., 2021). Well-maintained facilities and accessible resources encouraged active participation and longer occupancy periods, aligning with the observed high usage of study tables during peak hours. Moreover, students' purposeful behaviors, such as concentrated reading or goal-oriented research, corresponded to findings by Jamaluddin and Tommeng (2021) and Dalitso (2023), which indicated that information-seeking activities drove library engagement and academic performance. Behavioral variation, such as resting or social interactions in the afternoon, was also influenced by factors including library anxiety, fatigue, and individual differences (Abdoh, 2021; Fatmawati & Zulaikha, 2022; Hasanah et al., 2024), suggesting that temporal fluctuations in occupancy reflected a combination of task-driven and comfort-seeking behaviors. The application of heatmaps as an analytical tool further contextualized these patterns. Heatmaps had been increasingly employed in academic libraries to visualize seating density, movement patterns, and space utilization, providing actionable insights for library management and policy development (Xiao et al., 2022; Adetayo et al., 2023).

By translating raw occupancy and turnover data into visual representations, heatmaps facilitated the identification of high-traffic zones, underutilized spaces, and temporal congestion peaks, enabling evidence-based interventions to optimize seating allocation and enhance user experience (Gyau et al., 2021; Xu, 2024). Beyond spatial analysis, heatmaps supported operational decision-making, from allocating staff and resources to improving digital infrastructure, such as WiFi accessibility, thus contributing to a responsive and student-centered library environment (Al-Khateeb, 2021). The results corroborated the literature indicating that student behaviors in libraries were shaped by a complex interplay of facility design, resource accessibility, academic demands, and psychosocial factors.

The integration of heatmap analytics provided both a descriptive and strategic lens to understand these behaviors, confirming its utility in monitoring library space utilization, addressing congestion, and informing evidence-based management decisions (Chang & Yeh, 2021). These insights underscored the importance of combining behavioral understanding with innovative visualization tools to foster efficient, equitable, and user-centered academic library environments.

Table 6

Descriptive Profile of Respondents (n = 391)

Variable	Category	Frequency (n)	Percentage (%)	Mean	Standard Deviation
Year Level	First Year	102	26.09		
	Second Year	231	59.08		
	Third Year	40	10.23		
	Fourth Year	18	4.60		
	Fifth Year	0	0.00		
College	College of Engineering and Architecture (CEA)	246	62.92		
	College of Management, Business & Accountancy (CMBA)	35	8.95		
	College of Arts, Sciences, & Education (CASE)	31	7.93		
	College of Nursing & Allied Health Sciences (CHAHS)	35	8.95		
	College of Computer Studies (CCS)	43	11.00		
	College of Criminal Justice (CCJ)	1	0.26		
Frequency of Library Visits	Daily	43	11.00	2.71	0.99
	Once a week	70	17.90		
	2-3 times a week	94	24.04		
	Rarely	184	47.06		
	Never	0	0.00		

Typical Visit Time	Morning (8:000 AM - 11:00 AM)	78	19.95	2.27	0.75
	Noon (11:00 AM - 1:00 PM)	129	32.99		
	Afternoon (1:00 PM - 5:00 PM)	184	47.06		
Duration of Stay	Less than 30 minutes	63	16.11	2.37	0.87
	30 minutes to 1 hour	168	42.97		
	1-2 hours	113	28.90		
	More than 2 hours	47	12.02		

The descriptive profile of the respondents revealed that the majority were Second Year students (59.08%), followed by First Year students (26.09%). Only a small proportion were in their Third (10.23%) and Fourth Year (4.60%), with no respondents from the Fifth-Year level. Most participants were enrolled in the College of Engineering and Architecture (62.92%), while the remaining respondents were distributed across other colleges, including Computer Studies (11.00%), Management, Business and Accountancy (8.95%), Nursing and Allied Health Sciences (8.95%), Arts, Sciences, and Education (7.93%), and Criminal Justice (0.26%). In terms of library usage, nearly half of the respondents (47.06%) reported visiting the library rarely, while 24.04% visited two to three times per week, and 17.90% visited once a week. Only 11.00% reported daily visits. The average frequency of visits was moderate (M = 2.71, SD = 0.99), indicating intermittent engagement with library services. Afternoon hours (1:00 PM to 5:00 PM) were the most preferred time for library visits (47.06%), followed by noon (32.99%) and morning (19.95%), with a mean visit time of M = 2.27 (SD = 0.75). Regarding duration of stay, most respondents remained in the library for 30 minutes to 1 hour (42.97%), while 28.90% stayed for 1 to 2 hours. Short visits of less than 30 minutes accounted for 16.11%, and extended stays beyond 2 hours were reported by 12.02% of respondents. The average duration of stay was M = 2.37 (SD = 0.87), suggesting that most students utilized the library for moderate periods. These findings provided a foundational understanding of student engagement patterns and informed subsequent analysis of congestion dynamics and policy preferences.

Figure 2

Reported Activities During Library Visits (Survey Results)

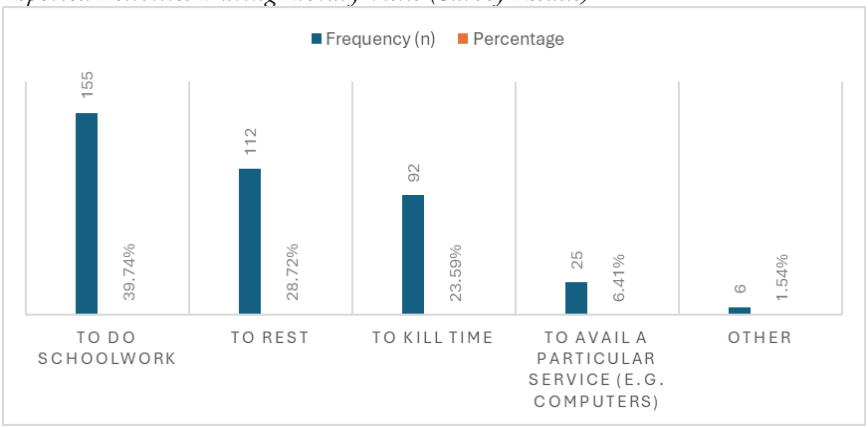


Table 7

Student Experience with Library Overcrowding and Willingness to Adhere to Time Limits, with Confidence Intervals and Effect Size Interpretation (n = 391)

Response Category	Response	Frequency (n)	Percentage (%)	Margin of Error (%)	Confidence Interval	Cohen's Comparison	Effect Size Interpretation
Experience in Over crowding	YES	356	91.05	±4.03	87.02% – 95.08%	Yes vs Neutral (0.50)	Large (h = 0.96)
	NO	23	5.88	±2.37	3.51% – 8.25%		
	MAYBE	12	3.07	±1.71	1.36% – 4.78%		
Willingness to Adhere to Time Limits	YES	305	78.01	±4.08	73.93% – 82.09%	Yes vs Neutral (0.50)	Medium to Large (h = 0.58)
	NO	86	21.99	±4.08	17.91% – 26.07%		

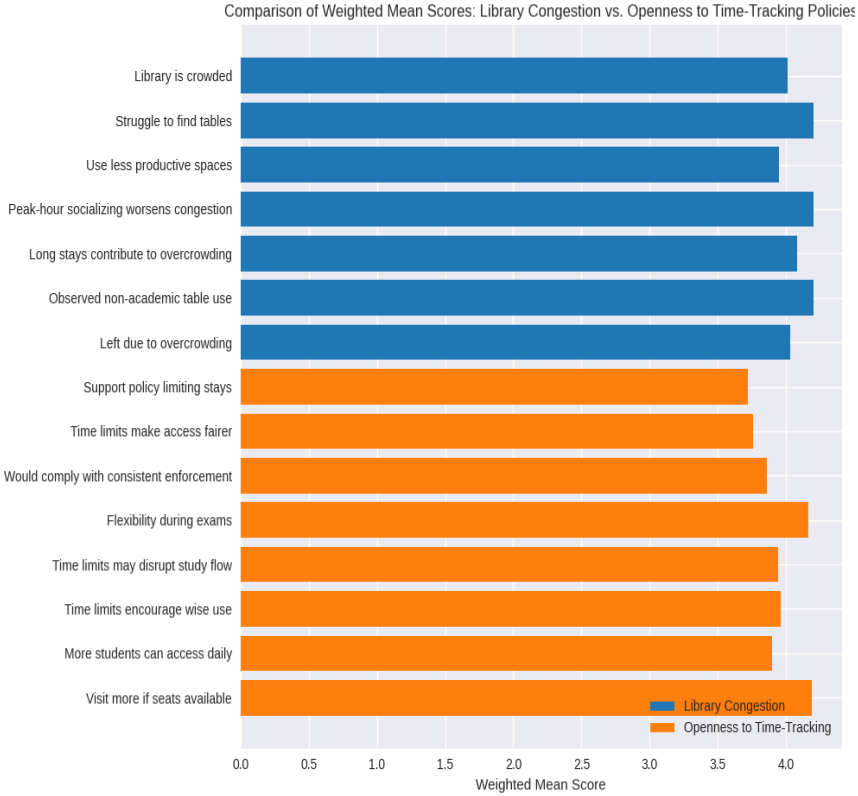
The survey results revealed a strong consensus among respondents regarding their experience with library overcrowding. As shown in the Table 7, 91.05% of students reported having experienced overcrowding, with a margin of error of ±4.03% and a 95% confidence interval ranging from 87.02% to 95.08%. This high proportion was statistically reinforced by a Cohen's h value of 0.96,

indicating a large effect size when compared to a neutral benchmark of 0.50. This suggests that the perception of overcrowding was not only widespread but also significantly deviated from neutrality, underscoring its relevance as a systemic concern. In contrast, only 5.88% of respondents reported no experience of overcrowding, while 3.07% were uncertain. These lower proportions, with narrower confidence intervals and smaller margins of error, further emphasize the dominance of the "Yes" response.

Complementing this finding, the data on willingness to adhere to time limits in designated library areas revealed that 78.01% of respondents expressed support for such measures. This response had a margin of error of ±4.08% and a confidence interval of 73.93% to 82.09%, indicating a statistically reliable majority. The corresponding Cohen's h value of 0.58 reflects a medium to large effect size, suggesting that students were not only aware of overcrowding but also receptive to behavioral interventions aimed at mitigating it. Taken together, these results demonstrate a clear alignment between the perceived problem of overcrowding and the willingness to adopt time-based solutions. The large effect size for overcrowding and the substantial support for time limits provide a strong empirical basis for implementing structured policies, such as time-tracking systems or designated study zones, to optimize library usage and enhance student experience.

Figure 3

Weighted Mean Ratings of Student Perceptions on Library Congestion and Time-Limit Policies



The clustered bar chart presents weighted mean scores from student responses to two thematic constructs: Library Congestion and Openness to Time-Tracking Policies. All statements received mean scores above 3.70, indicating general agreement across both domains. Students consistently agreed that the university library is overcrowded, particularly during peak hours. The highest-rated statements (mean = 4.20) reflected difficulty in finding tables, the impact of socializing on congestion, and the observation of prolonged table occupation without academic use. These findings suggest that students perceive the library as a contested space, where non-academic behaviors and prolonged stays exacerbate access issues.

The statement *"I've left the library due to overcrowding even when I needed to study"* (mean = 4.03) further underscores the functional disruption caused

by congestion. Responses also revealed substantial openness to time-based interventions. The statement *"I would visit the library more often if I knew seats were available"* received the highest agreement (mean = 4.19), suggesting that perceived seat availability directly influences usage behavior. Students supported time limits as a fairness mechanism (mean = 3.76) and expressed willingness to comply if policies were enforced consistently (mean = 3.86). Importantly, flexibility during exam periods (mean = 4.16) was emphasized, indicating that students value adaptive approaches over rigid enforcement. The convergence of high agreement on both overcrowding and openness to policy interventions suggests a readiness among students to embrace structured solutions. The data supports the implementation of time-tracking systems, flexible seat management, and behavioral guidelines to optimize library access. These measures could enhance equity, reduce congestion, and improve the overall study environment.

Figure 4

Hourly Sign-In and Sign-Out Frequencies in the University Library from January to May 2025

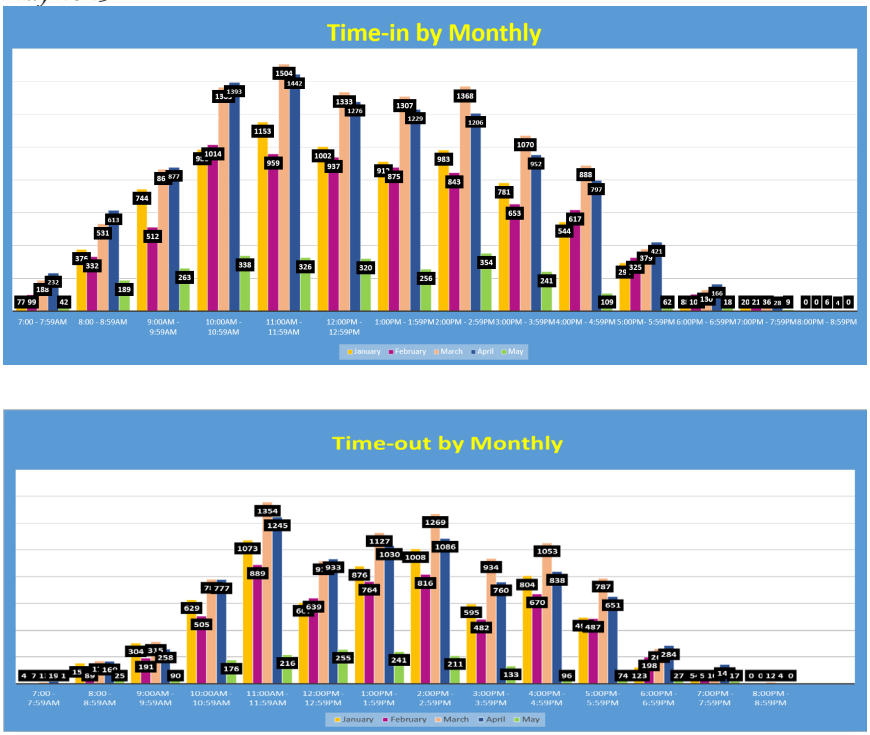


Table 8

Summary of Student Library Entry and Exit Logs by Hour and Month

Summary of Hourly Time-in/Time-out from January to May 2025										
TIME PERIOD	JANUARY		FEBRUARY		MARCH		APRIL		MAY	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT
7:00 - 7:59AM	77	4	99	7	188	13	232	19	42	1
8:00 - 8:59AM	376	152	332	89	531	172	613	169	189	25
9:00 - 9:59AM	744	304	512	191	864	315	877	258	263	90
10:00 - 10:59 AM	986	629	1014	505	1363	780	1393	777	338	176
11:00 - 11:59 AM	1153	1073	959	889	1504	1354	1442	1245	326	216
12:00 - 12:59 PM	1002	607	937	639	1333	917	1276	933	320	255
1:00 - 1:59 PM	912	876	875	764	1307	1127	1229	1030	256	241
2:00 - 2:59 PM	983	1008	843	816	1368	1269	1206	1086	354	211
3:00 - 3:59 PM	781	595	653	482	1070	934	952	760	241	133
4:00 - 4:59 PM	544	804	617	670	888	1053	797	838	109	96
5:00 - 5:59 PM	294	496	325	487	379	787	421	651	62	74
6:00 - 6:59 PM	88	123	103	198	130	262	166	284	18	27
7:00 - 7:59 PM	20	54	21	58	36	100	28	143	9	17
8:00 - 8:59 PM	0	0	0	0	6	12	4	4	0	0
TOTAL	7960	6725	7290	5795	10967	9095	10636	8197	2527	1562

The analysis of student sign-in and sign-out logs from January to May 2025 revealed consistent patterns in hourly library usage. As illustrated in Figure 4 and detailed in Table 8, the 11:00 AM to 11:59 AM time block consistently recorded the highest number of student entries and exits across all five months, followed closely by the 2:00 PM to 2:59 PM interval. These peak periods suggested that students predominantly accessed and exited the library during late morning and early afternoon, likely aligning with class breaks, mid-day academic routines, or designated study hours. The near symmetry between peak entry and exit times indicated that students tended to stay for short to moderate durations, typically ranging from one to two hours. This pattern reflected focused, task-oriented visits such as completing assignments, accessing resources, or preparing for assessments rather than extended study sessions.

Among the five months, March stood out as the busiest, with the highest total number of time-ins (10,967) and time-outs (9,095). This surge in activity likely

corresponded with midterm examinations, project deadlines, and other academic milestones, reinforcing the library's role as a vital academic support space during periods of heightened workload. April followed closely in usage volume, while May showed a marked decline, possibly due to the end of the semester or a shift in student priorities. In contrast, early morning (7:00–8:59 AM) and evening hours (6:00–8:59 PM) consistently registered the lowest activity, suggesting limited demand during off-peak periods. These insights provide a strong empirical basis for optimizing library operations, including staffing, space allocation, and the potential implementation of time-based access policies during peak hours to manage congestion and improve seat availability.

Table 9

Human-Centered Design Framework for Library Time-Tracking Policy

HCD Phase	Evidence Base	Student-Informed Insights	Design Implications
Inspiration	Survey results (Likert mean scores 3.90–4.20) Sign-in/out logs (Jan–May 2025) Peak congestion at 11 AM and 2 PM	Overcrowding disrupts study routines Students leave due to unavailable seats Openness to fair, flexible time limits	Target peak hours for intervention Design policies that prioritize fairness and access
Ideation	High support for seat availability (mean = 4.19) Flexibility preferred during exams (mean = 4.16)	Students prefer structured but adaptable systems Time limits are accepted if enforced consistently	Create time-limit zones (1–2 hours) Use digital sign-in/out tools Include feedback mechanisms
Implementation	March is the busiest month (10,967 time-ins) Consistent short-to-moderate stay durations	Students stay 1–2 hours per visit Off-peak hours show low demand	Pilot during high-demand months Monitor usage and feedback Adjust policies iteratively

Inspiration Phase

Based on the documented patterns of library congestion, student feedback on

time-limit policies, and hourly usage data, a human-centered design framework was developed to guide the implementation of a time-tracking system that is equitable, flexible, and responsive to student needs. The survey results and sign-in and out logs revealed consistent overcrowding during peak hours (11:00 AM and 2:00 PM). Students expressed frustration over the lack of available seating and showed openness to fair and flexible time limits. These findings reflected the complex and context-dependent nature of student library behavior, as emphasized by Hidayah et al. (2021), who found that students used library spaces for multiple purposes, including learning, leisure, and research, which necessitated policies that accommodated diverse intentions.

Husaini et al. (2022) introduced the concept of therapeutic landscapes and highlighted the library's role in supporting student well-being, particularly in post-pandemic contexts. This reinforced the need for time-tracking policies that not only managed congestion but also preserved the library's function as a restorative academic space. Nichols and Philbin (2022) stressed the importance of balanced space design to mitigate overcrowding and enhance user satisfaction, while Khaznadar and Ali (2025) underscored the influence of library location and layout on occupational efficiency. Vanderwerff and Herscovitch (2021) demonstrated that physical accessibility and spatial improvements shaped student engagement, suggesting that infrastructural and policy adjustments affected usage patterns. Technological factors also played a key role. Stephens et al. (2021) found that mobile-friendly platforms enhanced engagement with library services, while Doney and Kenyon (2022) explained how open-access perceptions affected resource utilization. Blocksidge and Primeau (2024) explored the emotional and psychological dimensions of library access and showed that addressing student anxieties and fostering positive beliefs about information improved perceptions of accessibility and support.

Ideation Phase

The survey results revealed strong student support for ensuring seat availability (mean = 4.19) and a preference for flexibility during examination periods (mean = 4.16), indicating that students favored structured systems that still adapted to academic demands. This aligned with institutional practices such as those at Westbank Libraries and the Georgia Tech Library, which implemented two-hour time limits for shared study spaces to promote equitable access and reduce disruptions. These examples reflected a widely accepted approach to managing shared resources through clear and enforceable time boundaries. Beyond structural design, the literature emphasized the importance of student engagement in policy development. Reflianto et al. (2021) and Goode et al. (2022) demonstrated

that active participation in digital learning environments enhanced academic outcomes, suggesting that engaged students were more likely to support and comply with well-communicated policies. Lee et al. (2023) further illustrated that student-led initiatives such as the SDG Alliance fostered ownership and influenced institutional decision-making, reinforcing the value of co-designed solutions. Technological integration also played a critical role. Qadeer (2025) and Richter et al. (2025) found that AI-driven feedback and chatbot interfaces positively influenced student engagement and self-directed learning, implying that digital tools such as sign-in and out systems and feedback mechanisms enhanced policy responsiveness and user experience. The technological landscape across ASEAN was rapidly transforming, with digitalization emerging as a key driver in improving resource management and service delivery. Initiatives such as the digital preservation of endangered cultural heritage in Southeast Asian cities underscored the growing emphasis on user-centered digital libraries and conservation strategies (Ocón, 2021). These developments illustrated how virtual access could complement traditional library functions, offering practical solutions to ease physical congestion—particularly in urban environments where demand for space was high.

Implementation Phase

The implementation phase was anchored in empirical evidence showing that March had the highest usage (10,967 time-ins) and that students typically stayed for 1–2 hours, with significantly lower activity during off-peak hours. These patterns supported the need for targeted piloting during high-demand periods, coupled with continuous monitoring and iterative policy refinement. Emerging technologies provided promising avenues for enhancing library operations. Jha (2023) reviewed the application of blockchain in smart libraries and highlighted its potential to enable secure, transparent, and efficient resource management, particularly for handling usage data to inform service delivery. Similarly, Barsha and Munshi (2024) discussed the integration of artificial intelligence (AI) in library systems and noted that AI-driven analytics supported personalized services, resource recommendations, and operational efficiency, although infrastructural challenges needed to be addressed, especially in developing contexts. Seat turnover management emerged as a critical component of optimizing space utilization. Izmir Tunahan et al. (2021) emphasized that environmental factors, such as daylight availability, influenced seat occupancy and therefore guided strategic space design. Davis (2023) and Sciforce (2025) expanded on this by advocating for real-time occupancy tracking and data analytics, drawing insights from hospitality settings to suggest that similar metrics could enhance user experience

and reduce congestion in libraries. Additionally, the Global Education Monitoring Report (2024) indicated that organizational and bureaucratic turnover affected resource management and service quality. This underscored the importance of consistent monitoring practices and adaptive policy mechanisms to maintain standards and respond to shifting institutional needs. Collectively, these studies reinforced the value of piloting time-tracking systems during peak months, using data-driven tools to monitor seat usage, and refining policies iteratively to ensure responsiveness, efficiency, and student-centered service delivery.

While the study provided valuable insights into library usage patterns and informed the design of equitable time-tracking policies, certain methodological constraints needed to be acknowledged. The relatively small sample size and reliance on self-reported survey responses might have limited the generalizability of the findings. In addition, the observation period was restricted to specific months, which might not have fully captured seasonal variations in student behavior. These constraints may have influenced the results and should be considered when interpreting the findings. Nonetheless, the study offered a useful foundation for policy development and highlighted areas for further investigation.

CONCLUSION

This study examined the feasibility of implementing a time-tracking policy as a strategic response to library overcrowding at CIT University. Through survey data, in-person observations, and analysis of time-in/time-out logs, the research identified persistent challenges related to seat availability, peak-hour congestion, and student frustration regarding study space accessibility. Survey results revealed that 91% of students acknowledged overcrowding as a recurring issue, and 84% reported that it negatively impacted their academic productivity. While 66% supported the idea of a time-tracking policy, some expressed concerns about potential stress and loss of autonomy, emphasizing the need for thoughtful and student-centered implementation. Observational findings further demonstrated that large study areas were often occupied for non-academic purposes, limiting access during high-demand hours. Time-log data confirmed that congestion consistently peaked between 11:00 AM–11:59 AM and 2:00 PM–2:59 PM, with March emerging as the busiest month, coinciding with midterm examinations. Despite generating strong insights, the study faced limitations. Administrative delays reduced the time allotted for survey distribution and data gathering, resulting in only 391 responses out of approximately 16,925 enrolled students, limiting generalizability. Although statistical measures supported data validity, a

larger and more diverse sample would strengthen reliability. Some open-ended responses were omitted for irrelevance, possibly excluding additional perspectives.

The study concludes that time-tracking mechanisms have potential as a partial solution to manage library congestion; however, they should not be adopted as stand-alone measures. Effective implementation requires integrating flexible policies with digital infrastructure, such as real-time seat monitoring and feedback systems, alongside improvements in spatial design and student engagement. Long-term sustainability will depend on continuous monitoring of usage data, with annual reviews of occupancy trends and policy effectiveness to ensure responsiveness to evolving student needs. To support adoption, training programs for both staff and students should be introduced, focusing on the use of digital tools, compliance with time-tracking protocols, and fostering a culture of shared responsibility. Quantitative benchmarks, such as reducing peak-hour congestion by 20% within the first year and improving average seat turnover rates by 15%, can serve as measurable indicators of success. By incorporating data-driven and technology-supported solutions to optimize space management, the proposed intervention aligns with Sustainable Development Goal 4 (Quality Education) by promoting equitable access to learning spaces, and SDG 9 (Innovation and Infrastructure) by encouraging the use of digital systems to enhance operational efficiency. The findings highlight how innovation can support inclusive, efficient, and student-responsive learning environments. Fundamentally, addressing library congestion requires a holistic approach, one that balances operational efficiency with empathy, inclusivity, and responsiveness to the evolving needs of the student body. Future research should adopt a longitudinal design to monitor the effectiveness of time-tracking policies post-implementation, capturing seasonal variations and evolving student behaviors. Integrating qualitative feedback, such as student narratives and focus group insights, will complement quantitative data and provide a richer understanding of user experience. Visual and tabular presentations of occupancy trends and survey responses will continue to be refined to ensure accessibility for diverse audiences. Finally, situating these findings more explicitly within the Philippine higher education context will strengthen their relevance and highlight opportunities for replication across local institutions.

TRANSLATIONAL RESEARCH

This translational research takes what students themselves experience every day - crowded library spaces, long waits for seats, and the struggle to find a quiet place to study, and turns those insights into a practical, student-friendly solution.

By observing real library usage, listening to student voices through surveys, and analyzing peak hours in entry logs, the study translates these patterns into a proposed time-tracking system designed not to restrict students, but to make the space fairer and easier for everyone to use. With features like flexible time limits, real-time seat updates, and digital tools that help manage busy hours, the proposed system aims to ease congestion while still respecting student comfort and autonomy. Grounded in human-centered design, this approach transforms data into an everyday improvement, one that supports students' learning, promotes equal access to study spaces, and reflects a campus environment that listens, adapts, and cares about the people who use it. This model also holds potential for replication in other higher education institutions, both nationally and internationally, particularly those facing similar challenges of overcrowding and limited study space. By adapting the framework to local contexts, universities can implement scalable policies that balance equity and efficiency. Furthermore, integration with digital learning initiatives, such as online reservation systems, mobile applications, and learning management platforms, can extend the utility of the library beyond its physical boundaries, enhancing accessibility and encouraging more strategic use of academic resources.

ACKNOWLEDGEMENT

The authors acknowledge the use of AI-assisted platforms such as Grammarly, Quillbot, and Elicit for grammar refinement, literature organization, and initial plagiarism checks. Reference management was supported by Mendeley and Zotero. All content, analysis, and interpretations remain the sole responsibility of the authors.

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