

Modelling Campus-Wide Cashless Saturation to Foster Student Autonomy and Digital Financial Literacy
(Pemodelan Ketumpatan Tanpa Tunai Peringkat Kampus ke Arah Pemupukan Autonomi Pelajar dan Literasi Kewangan Digital)

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ABSTRACT

For the development of future digital leaders, the pedagogical shift from theoretical instruction to practical application is essential, requiring settings that foster true student autonomy and useful digital financial literacy. In order to change the institutional focus from purely administrative efficiency to active student empowerment and financial behavioral maturation, this study looks at the implementation of the Universiti Malaysia Terengganu (UMT) cashless ecosystem as a "living laboratory." The institution forces 10,000 students to internalize critical financial competencies by requiring the digitization of critical touchpoints, such as daily sustenance and academic fees. This requires them to independently navigate the complexities of digital money management and transaction security within the market. Data from the PayNet report showed a total transaction volume of 144,870 in 2024, is used to quantitatively evaluate this program. The data shows an early adoption phase that is ready for strategic expansion, with a transaction per capita rate of 14.487. In order to predict the course of campus-wide cashless saturation, this study uses the Logistic Growth Model (S-Curve). In addition to this predictive analysis, the study suggests important improvements to UMT's current engagement tactics with the goal of strengthening digital financial literacy throughout the community. This study provides a thorough framework for coordinating infrastructure development with student behavioral maturation by combining statistical predictions with pedagogical intervention.

Keywords: Digital Leadership, Student Autonomy, Cashless Ecosystem, Digital Financial Literacy, Logistic Growth Model, Experiential Learning.

ABSTRAK

Peralihan pedagogi daripada pendidikan teori kepada aplikasi praktikal adalah satu keperluan bagi pembangunan pemimpin digital masa hadapan, yang menuntut persekitaran yang mampu memupuk autonomi pelajar yang sebenar. Kajian ini meneliti pelaksanaan ekosistem tanpa tunai Universiti Malaysia Terengganu (UMT) sebagai sebuah "makmal hidup," yang bertujuan untuk mengalihkan tumpuan kampus daripada sekadar kecekapan pentadbiran kepada pemeraksanaan pelajar secara aktif. Institusi ini mendorong 10,000 pelajar untuk menelusuri pasaran digital secara individu dengan mendigitalkan titik sentuh yang kritikal, seperti transaksi makanan harian serta pembayaran yuran akademik dan denda. Penggunaan "soundbox" pembayaran meningkatkan persepsi keselamatan dengan menawarkan pengesahan audio masa nyata, yang seterusnya mengukuhkan kepercayaan dan memupuk tabiat kewangan swa-pantau dalam kerangka tanpa tunai ini. Penilaian kuantitatif inisiatif ini menggunakan data daripada laporan PayNet yang merekodkan jumlah volum transaksi sebanyak 144,870 pada tahun 2024. Data tersebut menunjukkan fasa penerimaan awal yang bersedia untuk pengembangan strategik, dengan kadar transaksi per kapita sebanyak 14.487. Bagi meramal trajektori ketepuan tanpa tunai di seluruh kampus, kajian ini menggunakan Model Pertumbuhan Logistik (Keluk S). Sebagai tambahan kepada analisis ramalan ini, kajian ini turut mencadangkan penambahbaikan penting terhadap strategi libat urus semasa UMT dengan matlamat untuk memperkukuh literasi kewangan digital di seluruh komuniti. Kajian ini menyediakan satu rangka kerja komprehensif bagi menyelaraskan pembangunan infrastruktur dengan kematangan tingkah laku pelajar melalui gabungan ramalan statistik dan intervensi pedagogi.

Kata Kunci: Kepimpinan Digital; Autonomi Pelajar; Ekosistem Tanpa Tunai; Literasi Kewangan Digital; Model Pertumbuhan Logistik; Pembelajaran Berasaskan Pengalaman.

INTRODUCTION

The COVID-19 pandemic's contactless payment demands, and digital innovation have accelerated the world's shift to cashless economies, which has drastically changed financial behavior, especially among college students. Students are the main forces behind the adoption of digital payments in Malaysia, as evidenced by the widespread use of e-wallets like Touch 'n Go, Boost, and GrabPay (Kee et al., 2025). Although these tools facilitate transactions and are in line with national cashless policies, their incorporation into higher education settings offers a crucial chance to go beyond administrative efficiency and toward true financial maturation and student empowerment. The need for embedded financial literacy within digital ecosystems is highlighted by research showing that the adoption of digital payments can have unintended consequences, such as increased financial stress and impulsive spending in the absence of structured support (Lee et al., 2022b; Dango et al., 2024).

Due to low trust in cashless systems, security concerns and gaps in digital financial knowledge, reluctance endures despite increased usage (Sidek et al., 2024). Although many students are comfortable using e-wallets, they lack a deeper understanding of financial risks and self-defence techniques, which is known as limited digital financial literacy (Rahim et al., 2022). This highlights the urgent need for campuses to serve as pedagogical platforms that promote competency, autonomy, and trust in addition to being places of transaction.

Foundational research carried out inside the same institutional environment highlights the urgency of this investigation. Financial literacy among UMT students was found to be "low" in a previous survey, with an average score of 37% (Alim & Rashid, 2022). During the COVID-19 epidemic, students experienced severe financial hardship, especially when it came to covering basic needs ($\beta=0.389$, $p<0.01$). They also showed little use of digital financial tools, with only 19% utilizing more than three e-wallet apps. These results point to a crucial need at UMT: students' basic financial literacy and digital readiness are still lacking, despite the fact that they are navigating an increasingly digital environment. The university's cashless ecosystem program is directly impacted by this. The university's cashless ecosystem program is directly impacted by this. In order to immediately address these recognized literacy gaps and turn the campus into a living laboratory for developing critical digital financial competence and resilience, it must be

structured not just as a transactional infrastructure but also as a pedagogical intervention.

Therefore, Universiti Malaysia Terengganu (UMT) with a population of 11,000 students have responded by launching a campus-wide cashless ecosystem that is intended as a "living laboratory" to help students become active digital actors rather than passive consumers. UMT seeks to improve security perception, foster trust and promote self-regulated financial behavior by digitizing critical touchpoints, such as everyday food purchases and academic fee payments and incorporating real-time auditory verification through payment soundboxes. An early adoption phase that is ready for strategic intervention and scaling is indicated by the initial data from 2024, which shows a transaction volume of 144,870 and a transaction per capita rate of 14.487.

This study aims to achieve three main goals in order to methodically direct this development:

- i. To use the Logistic Growth Model to analyse existing usage patterns in order to objectively identify the campus ecosystem's transactional saturation point (K).
- ii. To use a Trend Extrapolation with Growth Decay framework to predict the timeline for reaching a fully "Cashless Campus Community."
- iii. To develop strategic improvements to institutional programs with the goal of promoting digital financial literacy and driving behavioral adaption across the community.

This study provides a thorough framework for coordinating cashless infrastructure with student behavioral development by fusing educational strategy with predictive analytics. By offering a reproducible approach for organizations looking to promote autonomy, literacy and resilience in an increasingly cashless world, it adds to the larger conversation on digital leadership and experiential learning.

This study is multifaceted, spanning the gap between student development, institutional strategy, and statistical forecasting. This study provides crucial insights for three important stakeholders: the academic community, university administration and the larger higher education sector by empirically modelling the trajectory of Universiti Malaysia Terengganu's (UMT) cashless ecosystem. This study emphasizes the campus's function as a "Living Laboratory" for Digital Leadership at the educational level. The study shows how a cashless ecosystem compels students to change from passive financial dependents to active, independent digital consumers by examining the change from low-frequency usage to the anticipated

daily reliance. Integration of security elements, including payment soundboxes, is recognized as an essential tool for digital financial literacy rather than just a technological improvement. It teaches pupils the importance of security, trust, and verification in digital transactions which are the skills that are critical for future leaders navigating the global digital economy.

Lastly, the PayNet Digital Campus 4.0 framework outlines the national objectives that this study adds to. UMT functions as a pioneering case study by offering a precise, quantitative description of what makes a "Cashless Campus Community" (benchmarked against the calculated transaction per capita criteria). The results show that attaining

a cashless society is a predictable and controllable process of behavioral evolution that may be expedited through focused intervention providing a scalable model for other Malaysian Public Universities (IPTA).

METHODOLOGY

Data Selection and Pre-Processing Data

In order to objectively reconstruct the dissemination trajectory of financial technology inside a controlled microeconomy, this study uses a quantitative longitudinal research approach. Universiti Malaysia

TABLE 1. Number of Transactions per month since 2022 -2024 and Transaction per capita

Month	Number of Transactions		
	2022	2023	2024
January	-	10529	20183
February	-	6016	10450
March	-	3222	2046
April	-	2798	8870
May	-	5809	19698
June	-	7126	15434
July	-	4611	10252
August	-	965	7904
September	1139	1065	1780
October	4708	7445	18446
November	1320	8393	15580
December	1477	8004	14227
Total Number of Transactions	8644	65983	144870
Transaction per Capita (capped at ~10000 students)	0.8644	6.5983	14.487

Source: PayNet Malaysia

Terengganu (UMT) serves as the research site. The university campus exhibits a closed-loop ecosystem with a restricted population ceiling of about 10,000 active students, in contrast to open-market studies where external variables (inflation, national economy) significantly influence spending.

Because of its demographic stability, which

reduces outside noise, this setting is perfect for applying deterministic models such as the Logistic Growth function to isolate behavioral adoption trends. Primary data for this analysis was acquired from PayNet Malaysia, a centralized ledger monitoring digital payment activities across Malaysian higher education institutions.

Therefore, from the data provided, the final dataset focuses on the active adoption period from September 2022 to December 2024, indexed chronologically ($t = 0, 1, \dots, n$) to facilitate time-series modelling.

Statistical Modelling

The two distinct predictive models were applied to capture both the natural saturation limits of the current infrastructure and the potential long-term growth trajectory.

The Logistic Growth Model (The S-Curve)

Among the mathematical models for adoption and diffusion of innovations within a population, The Logistic Growth Model (LGM: S-curve or sigmoid function) is a basic one. It refers to a phenomenon where the growth is initially exponential and slows down when the system reaches carrying capacity or saturation limit and finally stabilizes (Banks, 1994; Meade & Islam,

2006). This model is appropriate to study technology adoption, since it represents well the inertia of technical resistances with an increasing rapidity as users into turning points after which everyone will use the service (Rogers 2003).

The LGM is thus the primary concept of analysis in this study to arrive at the empirical point of transactional saturation for Universiti Malaysia Terengganu (UMT) cashless ecosystem. This can offer an early adoption trend when the volume of transactions in 2024 is considered at 144,870 over a student population of 10,000. This data can be modelled with a logistic function, and such a model can help estimate K (the maximum number of cashless transactions the campus activity can endure) and the growth rate r , signifying how quickly is behavior adopted. This modelling directly addresses the first research objective and establishes a quantitative baseline for forecasting the temporal path to a fully cashless campus community, thereby bridging theoretical diffusion models with actionable, campus-level strategic planning.

$$P(t) = \frac{K}{1 + e^{-r(t-\tau_0)}}$$

Where,

$P(t)$ = monthly transaction volume at time t ,

K = carrying capacity, or the maximum theoretical transaction volume sustainable under current conditions,

r = growth rate, indicating the speed of adoption,

τ_0 = inflection point, marking the time at which the growth rate peaks before slowing down

This model was selected because UMT campus represents a closed system with a fixed maximum population, making infinite linear growth impossible.

Trend Extrapolation with Growth Decay

A Trend Extrapolation with Growth Decay model is

used to move from determining the saturation ceiling to predicting the temporal route toward a "Total Cashless Campus." This method works especially well for predicting the uptake of innovations whose initial quick, viral expansion is anticipated to slow down as the market develops and the number of remaining adopter's declines (Armstrong, 2001; Meade & Islam, 2006). In contrast to straightforward linear extrapolation, this model includes a decay factor that gradually lowers the growth rate over time, representing the growing expense and difficulty of convincing late adopters – a group that is frequently distinguished by greater resistance or weaker technological affinity (Rogers, 2003). The projection's overall form can be expressed as follows:

$$T_t = T_t - 1 \times (1 + g \times (1 - \delta)^{t-1})$$

Where,

Tt = transaction volume in year t ,

g = initial observed growth rate,

δ = annual decay factor,

t = time period in years from the baseline

The model delivers a realistic, cautious projection by calibrating the decay factor based on comparable technology adoption studies in limited environments. By forecasting when that ceiling (K) is likely to be reached under actual conditions of

diminishing economic momentum, it goes beyond the deterministic ceiling of the logistic economic model and provides an essential timescale for resource allocation and strategic intervention (Thaker et al., 2022).

Parameter Estimation

Non-Linear Least Squares Optimisation was used to

$$RSS = \sum_{i=1}^n (y_i - \hat{y}_i)^2$$

A reliable standard in statistical modelling, the Levenberg-Marquardt algorithm (Marquardt, 1963) interpolates between the gradient descent method and the Gauss-Newton algorithm. When modelling sigmoidal curves, where parameters may be quite sensitive to initial beginning values, this particular approach was chosen due to its exceptional stability in converging upon a solution. Initial parameter estimates (also known as "seed values") are determined by visually examining the raw data scatterplot to make sure the algorithm stays away from local minima. While t_0 is created at the dataset's temporal midpoint, the initial K is seeded close to the peak observed volume.

Model Validation

The goodness-of-fit was evaluated using the Coefficient of Determination (R^2) and Root Mean Square Error (RMSE).

Coefficient of Determination (R^2)

This metric measures the proportion of variance in the transaction data that is predictable from the time variable. An R^2 value approaching 1.0 indicates a highly accurate fit, while lower values suggest significant volatility or external noise (e.g., semester breaks) influencing the data.

Root Mean Square Error (RMSE)

To quantify the average magnitude of prediction error, RMSE is calculated. This provides a tangible measure of how far, on average, the actual transaction numbers deviate from the model's trend line, expressed in the same units as the transaction volume.

statistically determine the parameters for the Logistic Growth Model (K, r, t_0). using the Levenberg-Marquardt algorithm in particular. The Residual Sum of Squares (RSS) between the observed data points (y_i) and the model's predicted values ($\hat{y}_i$) is minimised using this iterative method:

Residual Analysis

Beyond aggregate metrics, the study examines the distribution of residuals ($e_i = y_i - \hat{y}_i$). A visual inspection of the residual plot is conducted to check for homoscedasticity (constant variance). Systematic patterns in the residuals such as prolonged periods of overestimation or underestimation will be analyzed to identify external seasonality factors, such as academic semester cycles, that the standard Logistic Model may not inherently capture.

SAS® OnDemand Software

The research used SAS® OnDemand for Academics to carry out the quantitative modeling needed for this study, specifically fitting the Logistic Growth Model and performing Trend Extrapolation with Growth Decay. Without requiring local high-performance computer resources, this cloud-based software suite offers an extensive, institutionally supported platform for sophisticated statistical analysis and forecasting (SAS Institute Inc., 2023).

SAS was chosen because of its reliable, verified methods for time-series forecasting and nonlinear regression, which are crucial for precisely estimating the logistic function's parameters (K, r, τ_0) (SAS Institute Inc., 2021). The PROC NLIN procedure was employed to fit the logistic curve $P(t) = K / (1 + e^{-r(t-\tau_0)})$ to the historical transaction data, utilizing the least-squares method to derive the best-fit estimates for saturation capacity and growth rate. The Trend Extrapolation with Growth Decay model was then implemented using the PROC FORECAST method, which was informed by the projected growth rate r . This allowed for the projection of future adoption trajectories under a specified decay factor (δ).

RESULTS AND DISCUSSION

The empirical results from the quantitative modelling of Universiti Malaysia Terengganu's (UMT) adoption of a cashless ecosystem are presented in this part. An integrated discussion that analyses the findings in light of the study's theoretical framework and practical goals follows the results, which are organized to successively meet the research objectives.

Empirical Derivation of Campus Saturation (The Logistic Model)

To determine the natural limits of the current ecosystem, the Logistic Growth Model (LGM) was fitted to the monthly transaction data, which are from September 2022 to December 2024 using the Non-Linear Least Squares Optimization, the Levenberg-Marquadt algorithm. Using the SAS OnDemand software, we first find the carrying capacity, K .

Table 2. PROC NLIN Procedure Output using the SAS Software

Iterative Phase				
Iteration	K	r	τ_0	Sum of Squares
0	20000.0	0.1500	15.0000	7.0588E8
1	16953.3	0.1232	15.0835	5.9884E8
2	17626.3	0.1137	15.8702	5.9848E8
3	17846.5	0.1126	16.1326	5.9847E8
4	17839.7	0.1127	16.1229	5.9847E8
Parameter			Estimated Value	
K			17839.7	
r			0.1127	
τ_0			16.1229	

The result shows that it is estimated ~17840 transactions is the carrying capacity. Carrying capacity is the maximum limit that the system can sustain under current conditions. In this study context, if the current system changes nothing, the highest number of monthly transactions will only reach approximately 17840 only with a growth rate of 11.27%. The growth rate r validates the effectiveness of initial campus-wide mandates and campaigns, placing UMT in a crucial window where strategic interventions can most efficiently accelerate adoption toward K . The inflection point, τ_0 at month 16.1 (January 2024) strongly correlates with the beginning of the 2023/2024 academic semester, validating the

institutional policy such as fee digitization was the primary driver of the initial viral growth.

In order to break this ceiling to move forward as a true “Cashless Campus”, many initiatives that the university launches to educate the community.

The Forecast of “Total Cashless” Trajectory

Using the estimated parameters, the projected saturation level under the ceiling scenario approximated to ~17480 transactions monthly. To determine when this saturation will be effectively reached, we defined saturation as the time when transaction volume reaches 99% of K . Using the logistic equation,

$$t_{99\%} = t_0 + \frac{\ln(99)}{r} \approx 16.12 + \frac{4.595}{0.1127} \approx 56.9 \text{ months}$$

Therefore, from the baseline of September 2022, the next 56.9 months corresponds to mid-2027, approaches around June 2027.

In logistic growth terms, achieving the Cashless Campus target would require a second growth

phase, with substantially higher carrying capacity ($K \approx 300,000$) and potentially a renewed growth rate. Such multi-phase adoption is consistent with technology diffusion theories, where external shocks or policy changes can reignite growth.

The Initiatives in Adapting Digital Financial Literacy among Students in UMT

The institution started a deliberate transition from top-down administrative mandates to peer-led experiential learning in order to close the "Autonomy Gap" found by the statistical saturation study ($K \approx 17,840$). The Student Representative Council (SRC) of the 2024/2025 term led this shift by creating a focused intervention to normalize digital transactions in a high-volume social microeconomy. The Festival Konvoquesyen 2025 (FESKON '25), a significant campus event hosted during convocation week with a variety of commercial

activities like food vendors, floral sales, and fun mini games served as the initiative's main platform. The SRC implemented the "MPP Go Cashless" framework in a strategic partnership with RHB Bank Malaysia, which was the first time a "Total Cashless" policy was used for a student-run event at UMT. The policy essentially eliminated the safety net of physical cash by requiring all vendor booths to only accept digital payment channels. Instead of depending only on conventional currency habits, this prompted a "sink or swim" adaptation, requiring students to practice real-time digital liquidity management for discretionary purchasing.



FIGURE 1. FESKON '25 Main Poster with "MPP GO Cashless" Theme

The effort installed IoT-enabled Payment Soundboxes at each booth to reduce the "verification anxiety" that is frequently connected to quick digital transactions in such busy settings. Beyond just being convenient, these gadgets served as an essential teaching tool by providing instantaneous aural confirmation of successful transfers. The soundboxes taught students to actively "listen" for financial security

by strengthening psychological trust in the system. This led to the development of self-monitored transaction habits, which are crucial for long-term digital adoption. The trust deficit that frequently impedes the transition from administrative compliance to lifestyle integration is efficiently addressed by this sensory feedback loop, which helps students go from passive, cautious users to confident participants in the digital economy.



FIGURE 2. Cashless Transaction made through DuitNow QR Method

Acognitive security module called "Bijak Scam" (Smart about Scams) was added to the intervention in recognition of the fact that effective digital leadership necessitates both competence and resilience. This session, which was led by financial specialists from RHB Bank, discussed the increased risk exposure that

comes with leading a cashless lifestyle. The program gave pupils vital defence techniques against common cyberthreats that target young people, such as phishing and online transaction fraud, Love Scams (emotional exploitation), and the unauthorized use of student credentials for Mule Accounts (Akaun Keldai).



FIGURE 3. "Bijak Scam" Talk with RHB staff

Furthermore, the recent national recognition of UMT's student body demonstrates the effectiveness of the school's comprehensive approach to financial education, which goes beyond transactional competence to high-level investment literacy. Wong Chee Yew, a student at UMT, was a top finalist in Bursa Malaysia's esteemed "Bijak Pitch-i! 2025" competition. He received the most jury votes for his insightful presentation on ethical and sustainable investing. This accomplishment shows that the ecosystem is successful in moving students from the micro-level

discipline of managing daily digital transactions (made possible by the soundbox infrastructure) to the macro-level capability of equity research and capital market analysis, which is an essential external validation of the "Living Laboratory" concept. The shift from a passive consumer of digital payments to an active proponent of investment strategies shows that the university's educational initiatives, bolstered by facilities such as the UMT-CGS East Coast Trading Centre, are successfully fostering the "Digital Leadership" required for graduates to compete in the intricate national financial landscape.



FIGURE 4. Wong Chee Yew Attending as the Finalist for Bijak Pitch-i! 2025 Competition and Won 2nd Place

Additionally, the university's educational structure shows a critical reactivity to the possible drawbacks of the digital economy, particularly the possibility of teenage financial mismanagement. Deputy Vice-Chancellor (Student Affairs and Alumni) Professor Dr. Mohd Izani Mohd Zain emphasized in a recent high-level speech at the Financial Literacy Forum organized by UMT in partnership with the Malaysian Department of Insolvency that financial literacy is still a key component of the "Student Well-Being Index." The panel specifically cautioned against the growing appeal of unstructured credit mechanisms like "Buy Now Pay Later" (BNPL), which Associate Professor Dr. Mohd Safwan Mohd Nor characterized as silent drivers for early-age bankruptcy, and the normalization of excessive spending.

The ecosystem counteracts the "invisible" aspect of digital money, which frequently results in the impulsive purchases cautioned against in the forum, by reintroducing "psychological friction" to the spending process by combining digital transactions with the auditory feedback of the payment soundboxes. As a result, the ecosystem supports the forum's demand for "spending discipline," turning the theoretical recommendation to be debt-free into a daily, sensory-reinforced habit of confirming and recognizing each financial outflow. Students are not only empowered to spend, but also conditioned to do so within the parameters of sustainable financial health thanks to the synergy of expert advice (the forum) and infrastructure design (the soundbox).



FIGURE 4. Financial Literacy Forum organized by UMT in partnership with the Malaysian Department of Insolvency

Application of the Research to Universities (IPTA) in Malaysia

Since Malaysian Public Universities (IPTA) have structural similarities, the modelling framework created in this study exhibits great cross-institutional applicability. University campuses function as bounded microeconomic systems with standardised administrative financial touchpoints, controlled payment settings, predictable seasonal cycles that correspond with academic semesters and comparatively steady population ceilings. Campus ecosystems offer a semi-closed behavioural environment that is especially favourable to deterministic modelling techniques, in contrast to open-market economies where behavioural adoption is impacted by a wide range of external macroeconomic factors. Since infinite growth assumptions are inherently limited by institutional and demographic constraints, these structural features make IPTAs analytically appropriate environments for the application of the Logistic Growth Model.

Technology diffusion processes show

predictable saturation behaviour in such constrained systems. The carrying capacity (K) is an operational representation of the boundaries of behavioural integration under current institutional conditions rather than just a statistical ceiling. Universities may thus differentiate between early adoption dynamics, transitional growth periods, and mature plateaus using a quantitative method provided by logistic modelling. It is possible to convert adoption analysis from descriptive observation into predictive behavioural diagnostics by extending this paradigm across several IPTAs.

While cross-campus modelling is justified by structural similarities, inter-university heterogeneity presents a considerable analytical opportunity. Both the growth rate (r) and the carrying capacity (K) may be measurably impacted by variations in institutional scale, geographic context, vendor density, student demographic makeup, income distribution and digital infrastructure maturity. For example, compared to physically remote universities, urban campuses integrated into digitally dense commercial ecosystems may show faster behavioural spread. Similar to this,

differences in students' socioeconomic backgrounds or exposure to digital literacy may have an impact on their patterns of resistance, trust and

Thus, a multi-campus comparative modelling technique is a worthwhile avenue for further investigation. Researchers can empirically determine the institutional causes of cashless saturation by calculating logistic parameters across institutions. Universities can be classed into behavioural adoption archetypes such as early accelerators, policy-driven adopters, ecosystems with limited infrastructure or digital environments that are interwoven with lifestyles according to this analysis. This classification captures the fundamental behavioural mechanics influencing ecosystem maturity going beyond crude adoption measures.

There is significant policy concerns associated with comparative logistic modelling. Predictive metrics, as opposed to strictly descriptive success measures, may be advantageous for national digitisation projects, especially those that are in line with frameworks like PayNet's Digital Campus programs. A theoretically based measurement method that may evaluate adoption sustainability, ecosystem resilience, and behavioural efficiency is provided by logistic parameters. In this sense, carrying capacities (K) may represent the capacity for ecological integration within the current institutional framework whilst growth rates (r) may serve as markers of behavioural responsiveness.

Crucially, this modelling approach reinterprets the assessment of digital change. Policymakers and institutional strategists may use saturation dynamics, resistance thresholds and diffusion efficiency to interpret behavioural maturity instead of relying only on transaction volume or adoption percentages. This method recognises that digital adoption is a behavioural evolution mediated by perceived risk, trust, habit formation and institutional architecture rather than just a technology process.

Finally, by applying the Logistic Growth Model to Malaysian IPTAs, college campuses are positioned as analogous behavioural labs in the country's digital economy. A shift from discrete case studies to systemic behavioural modelling is made possible by this viewpoint, which supports evidence-based institutional strategy, focused intervention design and policy optimisation. Higher education institutions may be able to obtain a predictive understanding of the evolution of digital ecosystems instead of a reactive observational understanding by utilising logistic parameters as behavioural performance indicators.

Further Interventions to Bridge the Identified "Autonomy Gap"

This study's experimentally estimated saturation ceiling indicates that ecosystem adoption is increasingly constrained by behavioural inertia rather than technology limitations. Although initial dissemination is made possible by infrastructure accessibility, the persistence of a carrying capacity (K) shows that behavioural internalisation is not ensured by the mere availability of digital payment channels. Therefore, it may be advantageous for future institutional efforts to move the focus from infrastructure growth to behavioural engineering approaches intended to affect the cognitive, psychological and habitual aspects of reliance on digital payments.

Integrating behavioural nudge designs into digital payment settings is one viable intervention framework. Behavioural economics-based nudging techniques function by gently rearranging decision settings without enforcing explicit directives. These techniques could include micro-budget alerts, expenditure visualisations, real-time spending statistics or psychological friction cues that make transactions more salient in a cashless campus ecosystem. These technologies address the abstraction issue with digital money which occurs when expenditures lack the physical indicators that come with physical currency by making financial outflows more visible. In this sense, payment platforms transform from passive channels for transactions into proactive tools for financial literacy that can encourage self-control and spending awareness.

The purposeful establishment of regulated digital dependency situations is a second intervention tactic. Students' persistent reliance on fallback cash options may be a contributing factor in the ecosystem's saturation ceiling. By decreasing behavioural reversibility, extending "Total Cashless Zones" from sporadic occasions to permanent campus areas like cafeterias, vending machines, transit hubs, and student activity centres may hasten the normalisation of habits. According to a diffusion perspective, behavioural conditioning is fostered by repeated exposure to constrained choice contexts, which progressively converts compliance that is driven by external factors into preference that is sustained internally. This intervention is consistent with the notion of habit formation, which holds that automaticity is strengthened and resistant behaviours are decreased through behavioural repetition in stable situations.

Perception of security continues to be a crucial mediator of ecosystem trust and adoption intensity. Despite the technological security of digital payment

systems, user behaviour is determined by perceived danger rather than actual risk. Therefore, trust-building strategies that alter the psychological perception of transaction security may be given priority in future interventions. By re-establishing observable transaction cues, expanded sensory verification tools, such as multi-modal feedback systems that combine aural, visual and tactile confirmation, may lessen verification anxiety. Similarly, by moving security away from knowledge-based credentials and toward embodied identity verification, biometric authentication integration may improve perceived control. By converting expected victimisation anxieties into experienced competence, complementary cognitive-security interventions like gamified financial risk education and scam simulation training modules may further enhance digital resilience. When combined, these mechanisms transform security from a technological feature into a process that fosters behavioural confidence.

Incentive-based behavioural reinforcement provides an additional avenue for promoting secondary adoption acceleration in addition to cognitive and environmental interventions. Diffusion theory acknowledges that as motivating structures change, adoption trajectories may go through new growth phases. Behavioural triggers that can increase the intensity of ecosystem involvement include cashback programs, loyalty ecosystems, vendor-related rewards, or student engagement incentives connected to transaction frequency. Crucially, by promoting the preference for digital payments in all situations of discretionary purchasing, these incentives have the potential to alter usage patterns in addition to increasing transaction volume.

Future study must closely assess any potential negative behavioural externalities, even though interventions meant to increase transaction frequency signal ecosystem maturation. Increased transaction volumes can be linked to impulsive spending, a lack of awareness about expenses, reliance on unstructured credit systems like Buy Now Pay Later (BNPL), or increased stress related to money. Initiatives for digital transformation that put adoption criteria ahead of welfare concerns run the danger of unintentionally increasing financial vulnerability. Therefore, creating hybrid welfare-adoption models that assess financial well-being outcomes and behavioural diffusion efficiency together may be beneficial for future research. These frameworks make sure that ecosystem optimisation promotes sustainable financial practices as opposed to just transactional growth.

In the end, closing the observed Autonomy Gap necessitates acknowledging that adoption of

digital ecosystems is a behavioural evolution rather than a solely technological shift. Because of this, effective interventions need to be sensitive to unexpected welfare consequences while working across a variety of behavioural layers, including cognitive, psychological, environmental and motivational. The transition of the digital campus from infrastructure upgrading to behavioural system design is advanced by this integrated viewpoint.

FUTURE RESEARCH DIRECTIONS

Although the behavioural dispersion trajectory of UMT's cashless environment is successfully quantified using the Logistic Growth Model, the results offer up a number of significant research directions. Most importantly, the empirically determined carrying capacity ($K = 17,840$) points to the existence of a structural "Autonomy Gap," suggesting that complete behavioural internalisation cannot be ensured by infrastructure availability alone. Therefore, multi-dimensional behavioural diagnostics should be the focus of future study instead of saturation modelling.

Extending the modelling framework into a multi-phase adoption structure is one encouraging avenue. The research on technology diffusion acknowledges that behavioural systems often experience secondary growth waves brought on by changes in incentives, environmental shocks or legislation. Future research could look at whether strategic institutional interventions, like digital-only zones that are required, behavioural nudges or transaction rewards based on incentives, result in increased carrying capacity (higher K) and a renewed logistic acceleration (higher r). These discontinuities might be better captured by a segmented logistic model or a hybrid Bass–Logistic model, or also known as Bass Diffusion Model. This modelling describes the process of how new products get adopted in a population which represents the rationale of how current adopters and new potential adopters interact.

Future study may also incorporate micro-level behavioural variables that are currently absent from deterministic models. Integrating psychological constructs such as trust perception, risk adaptation to the population, perspectives toward financial literacy and spending discipline that could enable the development of a behavioural-statistical hybrid model. Using approved Likert-scale tools to measure latent behavioural drivers of digital payment acceptance, a structured psychometric survey given to enrolled university students could empirically accomplish this. Researchers can then investigate how cognitive

and psychological factors impact adoption intensity, transaction frequency, and resistance behaviours by statistically connecting the resulting behavioural dataset to observable transaction patterns. By differentiating between behavioural limits resulting from cognitive resistance, habit persistence, security worries, or structural usage limitations, such an approach would allow for a more nuanced interpretation of saturation ceilings.

Another crucial expansion is longitudinal cohort research (student entry years). It may be possible to determine whether digital autonomy is a learned skill reinforced by extended exposure to ecosystems by monitoring behavioural adaption throughout student entering years. By separating transient compliance effects from long-term behavioural change, such research would empirically support the "Living Laboratory" theory. This research could apply some research questions related to students' behaviour towards the theme, such as,

- i. does this digital payment reliance increase with academic seniority over cohorts?
- ii. does security anxiety decline after prolonged exposure towards digitalization of financial management?
- iii. does financial self-efficacy strengthen over time?
- iv. is behavioural autonomy cumulative?

Therefore, through these example questions, further research allows strong models such as logistic curves at the individual behavioural level.

CONCLUSION

Using the Logistic Growth Model, this study has effectively operationalized the idea of the university campus as a "Living Laboratory," mapping the behavioral shift of Universiti Malaysia Terengganu (UMT) students from traditional financial dependence to autonomous digital leadership. The study went beyond anecdotal observation to produce a statistically sound prediction of technology adoption by considering the campus environment as a closed-loop micro-economy. The study's crucial diagnostic result is the empirical derivation of the campus saturation point, which is Carrying Capacity (K) approximately 17,840 transactions per month. It exposes a "Compliance Ceiling," meaning that although the university has successfully digitized necessary administrative touchpoints (fees and penalties), students have not yet fully incorporated digital payments into their high-

frequency, discretionary living habits. This measured "Autonomy Gap" demonstrates that full digital transformation necessitates a psychological shift from passive obligation to active preference; infrastructure access alone is insufficient to drive complete ecosystem saturation.

The study emphasizes the effectiveness of peer-led, experiential interventions to close this gap and coincide with the anticipated 2028 Total Cashless Target. The Festival Konvokesyen 2025 serves as an example of the "MPP Go Cashless" program, which shows that high-volume social commerce is the perfect catalyst for behavioral change. Importantly, the use of Payment Soundboxes has become an essential teaching tool for digital financial literacy rather than just a convenience tool. By offering real-time aural verification, these gadgets rebuild the "infrastructure of trust," teaching students how to monitor, safeguard, and verify their transactions that are crucial for avoiding the financial hazards of the digital age, such as unstructured debt and online fraud.

In the end, this study comes to the conclusion that developing future digital leaders is a two-pronged process that incorporates both pedagogical intervention and algorithmic prediction. The S-Curve trajectory's confirmation shows that UMT is headed toward a cashless society, but how quickly it does so will rely on how well it can promote "Digital Resilience". UMT fulfils its mission to develop holistic leaders capable of navigating the difficulties of the global digital economy by graduating students who are not only adept at using digital technologies but also watchful, frugal and morally conscious investors.

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