Developing a Computerized Simulation Model through a System Dynamics Approach: A Case Study on the Digitalization among the Business Community in Kedah State, Malaysia.

Ahmad Afif Ahmarofi[1]*, Noor Zahirah Mohd Sidek[2], Muhammad Hanif Othman[3], Azyyati Anuar[4], Mohd Zhafri Mohd Zukhi[5]

[1]*Simulation and Visualization (i-SiVi) Research Interest Group, Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA (UiTM) Kedah, 08400 Malaysia.

[2,3,4]Faculty of Business and Management, Universiti Teknologi MARA (UiTM) Kedah, 08400 Merbok Kedah Malaysia.

[5]Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA (UiTM) Kedah, 08400 Malaysia.

***Corresponding Author**

DOI: https://dx.doi.org/10.47772/IJRISS.2025.9010407

Received: 09 October 2024; Revised: 22 October 2024; Accepted: 01 December 2024; Published: 02 January 2025

ABSTRACT

Digitalization in the economic sector of the Kedah state, Malaysia needs to be strengthened to ensure the development goals in 2035 can be achieved. The launch of the Kedah Cashless campaign by the state government in 2020 is the beginning of the digitalization policy in the Kedah economic sector. However, the cashless payment method in the state is still at a low level which is around 10 percent among the business community. In this regard, this study aims to evaluate the effectiveness of the cashless payment by the business community in Kedah state through a computerized simulation model. Accordingly, a survey among 631 merchants was conducted around the state. Findings from the research such as cost, sales price, percentage of customers who buy goods, and profit rate are simulated using computer aid through the system dynamics approach. System dynamics is a computer-aided simulation method based on mathematical modeling. Two scenarios on different cashless implementation rates among merchants were developed. When comparing the two scenarios, a 90 percent cashless payment rate reflects a difference of 2.46 percent profit in the twelfth week of operation. Consequently, the implementation of cashless payments is expected to increase state revenue as well. By implementing a high cashless transaction policy among the business community, the target to improve the state's revenue is achievable. Subsequently, the findings of the study will be used to develop a cashless roadmap policy in the Kedah state.

Keywords: business, digitalization, computer simulation, system dynamics, policy

INTRODUCTION

The 2035 Structural Plan aims to make the Kedah state in the north of Peninsular Malaysia a resilient state (BPEN, 2022). To achieve this goal, five development cores have been developed towards making Kedah a developed state in Malaysia. To fulfill the mission, digitalization is one of the latest initiatives designed by the Kedah State Finance and Treasury Office as a catalyst to achieve economic prosperity.

Initially, a digital cashless payment platform known as iBAYAQ was launched in 2020 (Bernama, 2022). This platform manages online payment transactions covering land tax services, housing rent, and education loans,

to name a few. However, in 2022, the use of cashless payments in the state, especially among the business community, was found to be still as low as 10 percent. This is because this group is more comfortable using cash payment transactions with less technical hassles (Chang, Chen, & Hashimoto, 2022).

In this regard, the objective of this study is to evaluate the effectiveness of digital cashless payments among the business community in the Kedah state through a computerized simulation model. For that purpose, a simulation model was developed using a system dynamics (SD) approach. SD is known as a computer-aided simulation method based on mathematical modeling for better decision-making in a complex environment (Ahmarofi et al., 2021). It was considered a simulation tool in this study since SD can mimic the real situation and operation by considering related causes and effects (Ahmarofi, Zainal Abidin, & Mahadzir, 2022; Basil, Tamyez, Zahari, Yao, & Ahmarofi, 2023). The next section describes some computer simulation methods for evaluating the operation performance. Subsequently, the next section elaborates on the research methodology using the SD approach. Results and discussion are described in the following section. Finally, the conclusion of this study is stated in the last section.

LITERATURE REVIEW

A study conducted between 2022 and early 2024 reveals substantial advancements in Malaysia's transition towards a cashless society. This progress is attributed to technological innovations, evolving consumer behaviors, and favorable governmental policies. Nevertheless, challenges persist, notably in bridging the digital divide and ensuring robust security measures. Table 1 highlights the recent research related to the implementation of cashless in Malaysia.

Table 1 Recent research in cashless implementation in Malaysia

Year	Author(s)	Focus Area	Key Findings
2022	Ahmad et al.	Contactless Payments	Sharp rise in contactless card payments due to pandemic-induced behavior changes and increased merchant acceptance.
2022	Lee et al.	Security Concerns	Perceived security risks, particularly regarding data privacy and fraud prevention, remain key concerns for many Malaysians.
2023	Zain et al.	Regulatory Framework	Bank Negara Malaysia's,(BNM) evolving regulatory approach aims to balance innovation with consumer protection.
2023	Tan and Wong	Merchant Adoption	Improvements in merchant adoption rates, credited to government incentives and changing consumer preferences.
2023	Lim et al.	Future Technologies	Potential integration of cashless payments with IoT and blockchain to enhance security and efficiency.
2024	Hamid and Aziz	Central Bank Digital Currency	Explored Bank Negara Malaysia's ongoing research into a potential CBDC and its impact on the cashless ecosystem

Furthermore, when real-world problems are difficult to understand, simulation and visualization provide valuable solutions for decision-making by giving clear insights (Mahadzir et al., 2021). The simulation technique is a process of designing a model that resembles a real system in a graphical appearance and provides risk-free experimentation without any interruption of the actual system (Applanaidu, Abidin, Ahmarofi, Abdullahi, & Viandrito, 2022).

Variants of simulation techniques had been studied earlier. These variant techniques that are implemented to evaluate the operation performance are agent-based simulation (ABS), discrete event simulation (DES), and system dynamics (SD) (Ahmarofi et al., 2022). However, the ABS technique, which is an individual-centric model is not flexible in terms of explaining the performance of production as many functions need to be assigned to the agents to reflect their behavioral rules (Mansur et al., 2022). In addition, the DES technique, which models the operation of a system as an isolated time of a selected event model, is less concerned with cause-effect relationships and feedback (Ahmarofi et al., 2022).

On the other hand, the SD technique which is known as a thinking system over time function model can understand the complexity of an actual operation. Furthermore, it is a superior approach to improve the operation policy by integrating the relevant cause-effect relationships of various factors in a dynamic behavior (Phan, Bertone, & Stewart, 2021). The effectiveness of the SD approach in improving operational policies has been proven through several previous studies such as sustainable mobility policies (Fontoura, Radzicki, & Ribeiro, 2024), carbon emission mitigation (Ige, Von Kallon, & Desai, 2024), sustainable performance of research (Núñez- Acosta & Sánchez-García, 2024), and road pricing policy (Ahmarofi et al., 2021).

In this regard, the SD approach offers a step-by-step guide for developing a simulation model that can be applied across areas such as the management sector, manufacturing, social science, healthcare, and many more (Darabi & Hosseinichimeh, 2021). Hence, the SD is potentially useful in the development of a simulation model for evaluating the performance of cashless operations among the business community in Kedah state.

METHODOLOGY

A simulation model for the adoption of cashless transactions in the state of Kedah was created using a stock and flow diagram (SFD), a version of the Decision Support System (DSS) software. This simulation model incorporates the variables listed in Table 1, along with their respective parameters, which are inputted into the model.

Table 2 Variables and parameters in the simulation model

Variable	Parameter/Formula	Data Source
Birth rate	0.341	Department of Statistics, Malaysia
Birth	Population x Birth rate	Stock and Flow Diagram
Death rate	0.136	Department of Statistics, Malaysia
Death	Population x Death rate	Stock and Flow Diagram
Population	2,172, 415	Department of Statistics, Malaysia
Estimated customer	Population x Percentage of customer	Stock and Flow Diagram
Percentage of customer	0.0001	Qualitative Questionnaires
Cashless rate	0.4 and 0.9	Qualitative Questionnaires
Cashless implementation	Cashless rate	Stock and Flow Diagram
Increase in sales	0.5	Qualitative Questionnaires
Actual increase in sales	Function MIN (1, Increase in Sales)	Ventana System Incorporation
Income	Sales × Actual Increase in Sales × Estimated Customers × Price of Product	Stock and Flow Diagram
Cost	RM10	Average value
Price	RM12	Average value
Profit	Price - cost	Stock and Flow Diagram
Expenditure	Quantity of Product × Cost × Estimated Customer	Stock and Flow Diagram
Sales	Quantity of Product	Stock and Flow Diagram
Quantity of product	1	Stock and Flow Diagram

The parameter values presented in Table 1 are collected from a qualitative questionnaire conducted during the initial stages of this research. The 631 merchants were selected through purposive sampling. The purposeful

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue I January 2025

sampling ensures that the chosen participants are well-versed in the core phenomenon, i.e., cashless transaction policy among the business community.

Furthermore, demographic data on the population of Kedah, and birth and death rates have been obtained from the Department of Statistics Malaysia. For parameters lacking specific data sources, mathematical equations have been formulated based on the SFD which is designed for simulation purposes.

The actual increment in sales is determined by a mathematical function, aimed at optimizing cashless payment adoption to a level of 0.9, equivalent to a 90 percent utilization rate among merchants. The remaining 10 percent accounts for cash transactions in certain scenarios, such as those involving senior citizens without smartphones or situations where smartphones have run out of battery.

Subsequently, the time frame established in this simulation model spans 12 weeks, equivalent to a three-month duration. This three-month interval was selected as it aligns with the evaluation of the organization's operational dynamics during this specific timeframe.

RESULTS AND DISCUSSION

The results are divided into two sections. The first section discusses the findings based on the first scenario simulation for businesses, i.e., 40 percent implementation of cashless. Subsequently, the second section elaborates on the findings based on the second scenario for businesses, i.e., 90 percent implementation of cashless. The simulation model for introducing cashless transactions in Kedah is illustrated in Figure 1.

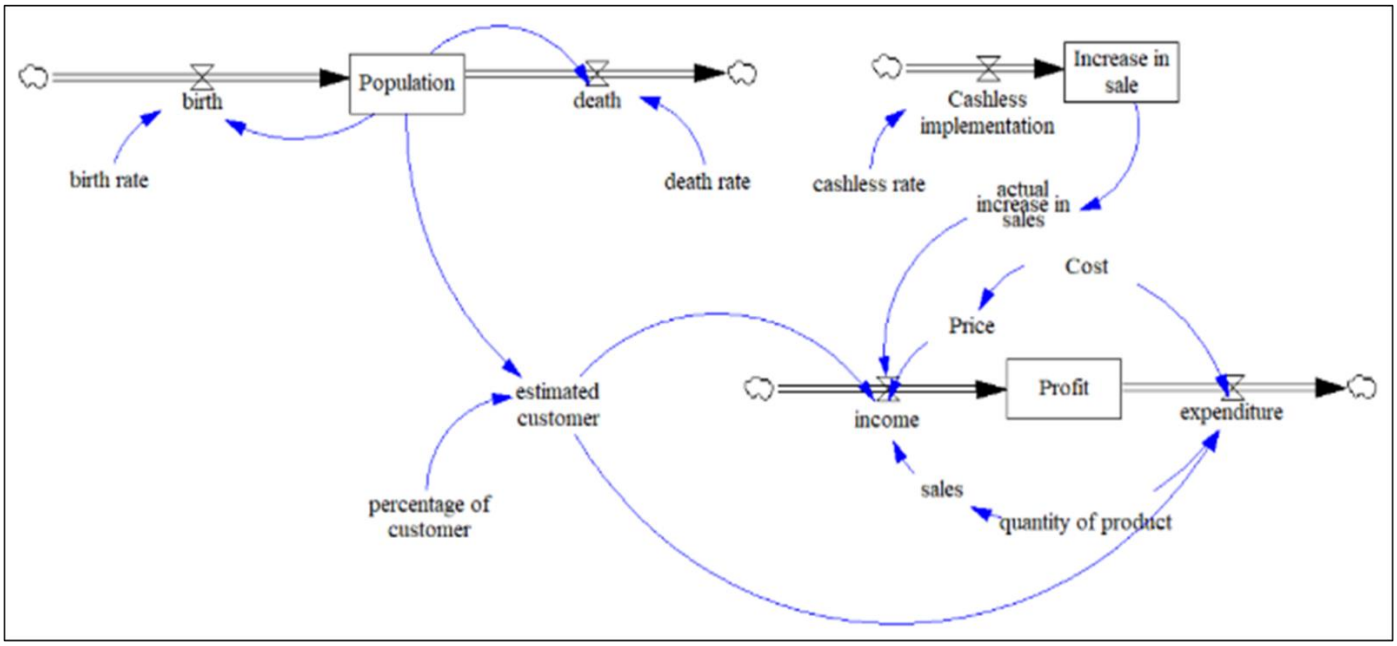

Figure 1: A simulation model for the business community in Kedah state

Utilizing this simulation model, two distinct scenarios, i.e., 40 percent and 90 percent implementation of cashless, were conducted for businesses in Kedah selling products priced at RM12. The product's cost stands at RM10, with the assumption that the number of customers amounts to 0.0001 of the total population, equating to approximately 217 customers purchasing the product every week.

In the first scenario, the cashless payment adoption rate is established at 0.4, equivalent to 40%. This percentage is derived from the outcomes of a qualitative survey, which revealed that, on average, 40% of transactions in the business of buying and selling products were conducted using cashless methods. The outcomes of the 12-week business profit simulation are visually presented in Figure 2 and summarized in Table 3.

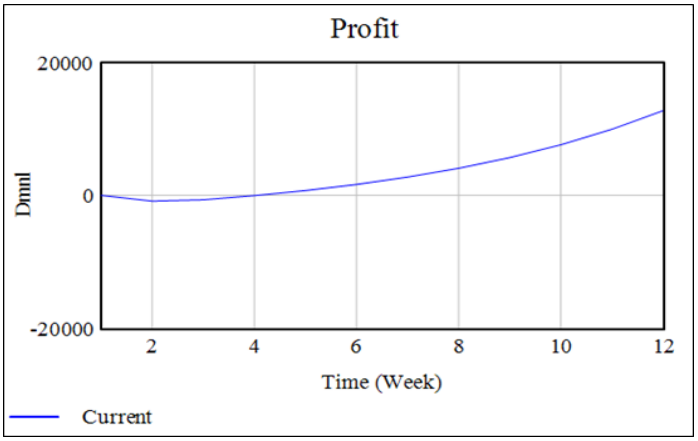

Figure 2: Business profit for 12 weeks based on a 40 percent cashless rate

Table 3: Business profit for 12 weeks based on a 40 percent cashless rate

Week	Business profit (RM)
1	0
2	-863.96
3	-654.54
4	-23.66
5	736.55
6	1652.60
7	2756.45
8	4086.58
9	5689.39
10	7620.78
11	9948.10
12	12752.50

Subsequently, the cashless rate is set to 0.9 (90%) in the scenario 2. The value is the target of cashless transactions by optimizing cashless payment adoption to a level of 90 percent utilization rate among merchants. The remaining 10 percent accounts for cash transactions in certain scenarios, such as those involving senior citizens without smartphones or situations where smartphones. The results of the simulation of the business profit for 12 weeks are shown in Figure 3 and Table 4.

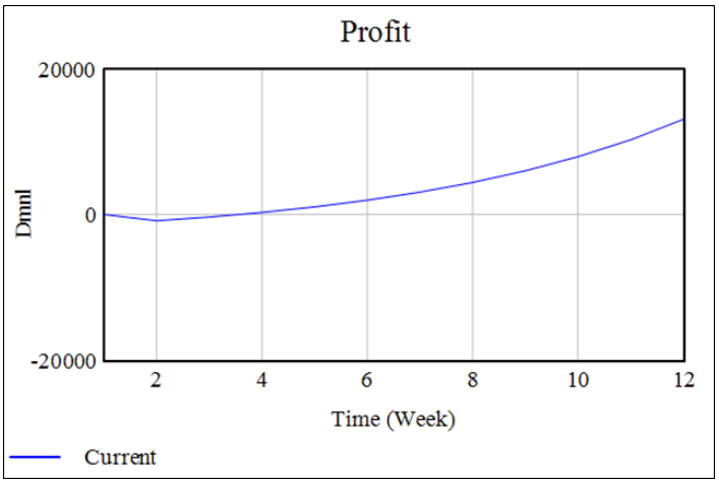

Figure 3: Business profit for 12 weeks based on a 90 percent cashless rate

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue I January 2025

Table 4: Business profit for 12 weeks based on 90 percent cashless rate

Week	Business profit (RM)
1	0
2	-863.96
3	-340.41
4	290.46
5	1,050.68
6	1,966.73
7	3,030.58
8	4,400.71
9	6,003.52
10	7,934.91
11	10,262.20
12	13,066.60

Based on Figure 3 and Table 4, after deducting the cost of expenses, the business profit will start to profit in the fourth week with the implementation of a 90 percent cashless rate. The profit obtained in the fourth week was as much as RM290.466 while the 12th week was as much as RM13,066.60.

Furthermore, the profit registered in the twelfth week for the 90% cashless payment rate amounted to RM13,066.60, surpassing the RM12,752.50 recorded for the 40% cashless payment rate. This results in a profit difference of RM314.10, equivalent to a 2.46% increase.

Therefore, by implementing a higher cashless payment rate among traders engaged in the buying and selling of their products, it is anticipated that business profits can be accelerated, resulting in a reduction of 30 days or one month in the timeline. Moreover, this improvement in cashless transactions in product sales is expected to yield a 2.46% increase in profit values by the twelfth week.

CONCLUSIONS

Digitization greatly facilitates business transactions through cashless payments. However, the success rate is still unclear as shown by a case study that took place in the state of Kedah, Malaysia involving traders. In this regard, a computerized simulation model is necessary to measure the level of effectiveness of cashless payment implementation by considering several factors. Based on the development of a simulation model using the concept of system dynamics, it was found that a 90 percent cashless payment rate reflects a difference of 2.46 percent profit in the twelfth week, i.e., equivalent to RM314.10 of operation compared to 40 percent implementation. With this achievement, a policy related to the implementation rate of cashless payments will be proposed to the state government. The development of a simulation model in this study provides insight for researchers to evaluate the cashless implementation capabilities of the business community. As a result, stakeholders can take proactive steps to achieve developed state status in 2035 by reviewing its current policy. Furthermore, the significant benefit of the development of a simulation model in this research for academia and industry is the ability to study the financial behavior, economic patterns, and societal impacts of cashless policy implementation. Moreover, in terms of analytics and innovation, this research could enrich transaction data for business intelligence and improve customer behavior analysis.

ACKNOWLEDGMENT

This study was funded by a Kedah Cashless Grant under the Kedah State government, Malaysia (100-TNCPI/GOV 16/6/2 006/2023). Besides, special thanks to UiTM Kedah for the opportunity to conduct this research.

REFERENCES

1. Ahmad, S., Yusof, M., & Lim, T. (2022). The rise of contactless payments in Malaysia: A longitudinal analysis. Journal of Payment Systems, 15(3), 245-260.
2. Ahmarofi, A. A., Abidin, N. Z., & Ramli, R. (2017). Effect of manpower factor on semiautomatic production line completion time: A system dynamics approach. Journal of Mechanical Engineering and Sciences, 11(2), 2567-2580.
3. Ahmarofi, A. A., Kamaruzzaman, Z. A., Rahman, H. A., Masri, K. A., Rahim, N. A., Shariff, S. S. R., ... & Ahmad, A. B. (2021, December). Development of A Computer Simulation on Road Pricing Strategy to Reduce Congestion and Carbon Dioxide Emission: A System Dynamics Approach. In 2021 6th IEEE International Conference on Recent Advances and Innovations in Engineering (ICRAIE) (Vol. 6, pp. 1-5). IEEE.
4. Ahmarofi, A. A., Zainal Abidin, N., & Mahadzir, N. H. (2022). Simulating the Cycle Time Based on a Manpower Performance Through a System Dynamics Model: A Case Company in the Automotive Sector. In Human-Centered Technology for a Better Tomorrow: Proceedings of HUMENS 2021 (pp. 515-523). Springer Singapore.
5. Applanaidu, S. D., Abidin, N. Z., Ahmarofi, A. A., Abdullahi, M. B., & Viandrito, J. (2022). How Enhancement in Agricultural Education Affects the Employment Opportunities in the Oil Palm Plantation Sector in Malaysia?. Journal of Positive School Psychology, 6(3), 9700-9723.
6. Bahagian Perancang Ekonomi Negeri Kedah Darul Aman, Pelan Pembangunan Kedah 2035 (BPEN), 2022, https://kedah2035.com/files/BUKUKEDAH2035VER2.pdf.
7. Basil, F. F. A., Tamyez, P. F. M., Zahari, A. R., Yao, L., & Ahmarofi, A. A. (2023). Packaging waste generation by households: a mixed method study. International Journal of Environmental Studies, 80(4), 964-977.
8. Bernama, I-Bayaq permudah rakyat Kedah bayar cukai, sewa, dan pinjaman pendidikan, January 2022, https://bernama.com/ bm/am/news.php?id=1922289.
9. Chang, W. L., Chen, L. M., & Hashimoto, T. (2022). Cashless Japan: Unlocking influential risk on mobile payment service. Information Systems Frontiers, 24(5), 1515-1528.
10. Darabi, N., & Hosseinichimeh, N. (2020). System dynamics modeling in health and medicine: a systematic literature review. System Dynamics Review, 36(1), 29-73.
11. Fontoura, W. B., Radzicki, M. J., & Ribeiro, G. M. (2024). Using system dynamics to understand long-term impact of new mobility services and sustainable mobility policies: an analysis pre-and post-COVID-19 pandemic in Rio de Janeiro, Brazil. Transportation Letters, 16(7), 751-763.
12. Hamid, N., & Aziz, F. (2024). Exploring the potential of Central Bank Digital Currency in Malaysia. Bank Negara Malaysia Research Bulletin, 12(1), 1-15.
13. Ige, O. E., Von Kallon, D. V., & Desai, D. (2024). Carbon emissions mitigation methods for cement industry using a systems dynamics model. Clean Technologies and Environmental Policy, 26(3), 579-597.
14. Lee, S. Y., Tan, K. L., & Wong, C. M. (2022). Security concerns in cashless transactions: A Malaysian perspective. Cybersecurity Journal, 18(4), 420-435.
15. Lim, J. T., Ng, S. C., & Yap, K. H. (2023). Integration of cashless payments with IoT and blockchain: Opportunities and challenges. Journal of Financial Technology, 7(2), 180-195.
16. Mahadzir, N. H. B., Ismail, S. N. B., Razak, N. H. B. A., Ahmarofi, A. A. B., Ahmad, J. I. B., & Ahmad, A. B. (2021, December). EDU_INSIGHTS: The Analytic Tools to Assess Students' Satisfaction Level in Open and Distance Learning (ODL). In 2021 6th IEEE International Conference on Recent Advances and Innovations in Engineering (ICRAIE) (Vol. 6, pp. 1-6). IEEE.
17. Mansur, M., Kamaruzzaman, Z. A., Ahmarofi, A. A., Cheng, J. K., Rahman, H. A., Masri, K. A., ... & Shariff, S. S. R. (2022). Linking integrity with road pricing cause-and-effect model: A system dynamics simulation approach. Journal of Governance and Integrity, 5(3), 370-381.
18. Núñez-Acosta, A., & Sánchez-García, J. Y. (2024). Leadership in Private Universities for the Sustainable Performance of Research: A System Dynamics Approach. Administrative Sciences, 14(8), 166.

19. Phan, T. D., Bertone, E., & Stewart, R. A. (2021). Critical review of system dynamics modelling applications for water resources planning and management. Cleaner Environmental Systems, 2, 100031.
20. Tan, J. L., & Wong, S. M. (2023). Merchant adoption of cashless payments: Progress and challenges. Asian Journal of Business and Accounting, 16(1), 78-95.
21. Zain, R. M., Abdullah, N., & Hassan, R. (2023). Regulatory approaches to digital payments in Malaysia: Balancing innovation and consumer protection. Journal of Financial Regulation and Compliance, 31(2), 156-172.