ISSN 1693-9220 (Print) | 2987-8713 (Online), Volume 20, No. 1 (2026), pp. 1-8

International Journal of Enterprise Modelling

Published by: International Enterprise Integration Association

Dynamic Modeling of Service Quality Improvement through Feedback-Based Governance

Wildan Alrasyid, Galih Prakoso Rizky A, Budi Arif Dermawan, Rasenda

[1,2,3,4] Faculty of Computer Science, Universitas Pembangunan Nasional Veteran Jakarta, Jakarta, Indonesia

Abstract

This study aims to design a dynamic system model that aims to improve service quality while reducing the significant gap between expectations and actual satisfaction levels. This study focuses on analyzing the relationship between key factors such as human resources (HR), information and communication technology (ICT), and evaluation systems that operate within a feedback-based service framework. The approach used is system dynamics, which includes the creation of cause-and-effect loop models and stock-flow models. These models are tested through simulations over a 12-month period to predict the impact of strengthening human resources, optimizing information and communication technology, and improving evaluation mechanisms on service quality. The simulation data included performance indicators, public satisfaction levels, and reactions to internal dynamics. The simulation results showed that improving human resource capabilities, optimizing the use of information and communication technology, and implementing evaluations focused on continuous feedback can significantly improve service quality. These improvements contribute directly to higher levels of public satisfaction and reduce the gap between target and actual results. Public response acts as a key driver that accelerates performance improvement through reinforced feedback. The presentation of data in graphs and tables supports positive trends and the system's ability to adapt to internal changes. This study reveals that the application of dynamic system models can be a useful approach for policymakers in managing complex public service systems. Feedback-based models provide policy analysis before implementation in real life, thereby reducing the possibility of policy failure.

Article Info

Article history:

Received : Aug 14, 2025
Revised : Oct 24, 2025
Accepted : Jan 20 ,2026

Keywords:

Community Satisfaction;
Dynamic Simulation;
Feedback Loop;
Public Service;
Service Quality.

Corresponding Author:

Wildan Alrasyid,
Faculty of Computer Science,
Universitas Pembangunan Nasional Veteran Jakarta,
Jl. RS Fatmawati Raya, No. 1, Jakarta Selatan, DKI Jakarta, 12450, Indonesia
wildanalrasyid@upnvj.ac.id.

Introduction

Improving the quality of public services remains a significant challenge for governments, including in Indonesia, despite various measures such as digital service transformation, workforce capacity building, and bureaucratic reform (Ingsih et al., 2024). However, implementation in the field often falls short of public expectations. Recent research reveals that structural barriers such as a lack of integration between strategic leadership, effective budget management, and user-input-oriented evaluation systems remain a major source of problems (Salomo & Rahmayanti, 2023). The lack of alignment between policy and implementation widens the gap in service quality, especially in the context of a complex and dynamic public sector (Ningrum et al., 2024).

With the increasing complexity of issues in the field of public services, a systemic approach is needed, namely an approach that is capable of capturing the patterns of interaction between interrelated variables. The system dynamics approach is considered appropriate because it provides an analytical framework for understanding the structure of cause and effect, feedback, and the long-term impact of a policy (Crielaard et al., 2025). This method facilitates the determination of complex relationship patterns between elements such as the dedication of leaders, distribution of funds, human resource capabilities, use of information and communication technology, service evaluation systems, and public perceptions of the quality of services they receive (Armenia et al., 2021).

This model is applied to explain how these elements interact with each other in two main conditions: ideal (objective function) and actual (problem function), in order to identify gaps and opportunities for improving the quality of public services in a more measurable and sustainable manner. By assuming that the influencing factors are on an interval scale and that the relationship between these factors is fairly linear, a linear formula can provide estimates that are easy to understand and useful for decision makers to analyze the influence of each element (Yenni et al., 2025). A method is needed that can map the dynamics of the relationship between variables in a sustainable and comprehensive manner. In this case, the system dynamics method is considered appropriate for describing the interrelationships between leadership commitment, finance, human resources, information and communication technology, evaluation mechanisms, and public perceptions of the services received. In this study, two main models were developed: an objective function (ideal conditions) and a problem function (actual conditions) to analyze the differences in results in the service quality improvement process.

The objectives of this research include creating mathematical models and simulations that represent improvement processes in public services and determining strategic points for policy intervention. This research also analyzes the effects of intervention in various situations and provides recommendations based on data.

Conceptually, this study is based on a theoretical framework of performance management for the modern public sector, a systems dynamics approach, and the principle of feedback in an organizational system. This theoretical basis is supported by the latest literature on dynamic systems modeling approaches applied to assess the relationship between human resources, information technology, and feedback-based assessment mechanisms that affect the quality of public services (Andika, 2019). Consistent with the results revealed by (Andika, 2019), The application of dynamic systems allows researchers to simulate policy scenarios that combine empirical data and theoretical assumptions, thereby providing a more comprehensive analysis of the effects of policy interventions on public satisfaction. Other recent literature also highlights the importance of systemic understanding in designing sustainable public policy interventions (Sardi & Sorano, 2019). The input-process-output-outcome approach is applied to describe the system flow, in which elements such as leadership commitment, budget capacity, and human resource quality are considered inputs; the process includes the use of information and communication technology and service assessment mechanisms; while the output is reflected in service quality and community satisfaction levels. The interrelationship between these elements reveals the existence of feedback that reinforces and balances, which dynamically affects the effectiveness of the system over time (Chang et al., 2022). The contributions of this research are expected to have value in both practice and theory. In practical terms, the results of the simulation can be used by decision makers to analyze the effects of various interventions. From an academic perspective, this research expands the use of the system dynamics approach in public management in Indonesia. The model designed can also serve as a reference for evidence-based policy development.

Methods

This study applies a numerical approach based on dynamic simulation to examine the patterns of interaction between variables in public service systems. This method was chosen because it is capable of reflecting the complexity of the system by involving feedback cycles, delays, and the collection of variable characteristics over time related to public services (Naugle et al., 2024).

The selection of system dynamics is also important for assessing the effects of policies in the medium and long term comprehensively, so that the indirect impacts of certain policies can be predicted (Crosland et al., 2024). Support for this approach was also obtained from a study conducted by (Mansoor & Williams, 2024) who revealed his success in improving service quality in the public sector (Mansoor & Williams, 2024).

Two categories of models have been designed, namely the ideal model (objective function), which assumes that resources are unlimited, and the practical model (problem function), which considers various constraints such as fund allocation and human resource capabilities. These models were developed with reference to a system dynamics framework that has been proven valid through various studies in the field of public policy (Merrill et al., 2013).

Information gathering was conducted in several ways, namely: literature studies from journals, policy reports, and institutional documents; as well as the utilization of existing data from official reports of ministries or institutions related to budgets, public satisfaction, and human resource performance (Rezagama et al., 2025). The parameters of this model were obtained from the average values found in the literature and adjusted through a repeated calibration process.

The stages in model formation consist of: (a) Identify variables including: leadership, budget, human resources, information and communication technology (ICT), evaluation, and public satisfaction. (b) Development of Cause and Effect Circle Diagrams (CCD): illustrates the cause-and-effect relationships between variables, including feedback loops. (c) Mathematical model development: creating causal relationships between variables. (d) Simulation models were created: implemented in Excel and simulation software such as Vensim and Python. (f) Calibration and sensitivity testing: verifying that the model fits the behavior of past data and testing the effects of changes in inputs. (g) Scenario simulation: comparing optimal situations, limited situations, and policy impacts.

The measurement of results focuses on key outputs such as service quality and community satisfaction levels. The validity of this model is tested using behavioral replication methods and assessed by comparing results from various policy situations(Chapela-Campa et al., 2023).

Results and Discussion

This section describes the results of the simulation model that has been created. This study formulates two main scenarios to evaluate improvements in public service quality (SQ) and their impact on community satisfaction (CS).

The first scenario is the target function, which shows the ideal situation where resource allocation takes place without disruption. In this situation, all important elements, including management, financing, labor, technology systems, and assessment methods, work optimally(Chen & Wu, 2024).

In contrast, another scenario is known as the problem function, which reflects real-world situations that face many constraints, including lack of funds, limited human resources, and low efficiency of the assessment system. These constraints lead to a decline in the quality of public services (Tanantong et al., 2022).

Within the framework of the objective function, which is used to describe the most desirable conditions, there are a number of key variables that are included, namely:

SQ	= Service Quality	E	= Evaluation & Improvement
HR	= Human Resources	B	= Budget Support
ICT	=Information and Communication Technology	L	= Leadership Commitment
CF	= Community Feedback	CS	= Community Satisfaction

The model applied is a linear model with the following function equation:
Budget support is influenced by leadership:

$$B(t) = \alpha_1 L(t) \quad (1)$$

HR & Training and Infrastructure depend on the Budget:

$$HR(t) = \alpha_2 B(t) \quad (2)$$

$$ICT(t) = \alpha_3 B(t) \quad (3)$$

Service Quality is influenced by HR, ICT, and Evaluation:

$$SQ(t) = \beta_1 . HR(t) + \beta_2 . ICT(t) + \beta_3 . E(t) \quad (4)$$

Community Satisfaction comes from Service Quality:

$$CS(t) = \gamma_1 SQ(t) \quad (5)$$

Feedback comes from Satisfaction:

$$CF(t) = \delta_1 CS(t) \quad (6)$$

$$CF(t) = \delta_1 CS(t) \quad (7)$$

Evaluation comes from Feedback:

$$E(t) = \epsilon_1 CF(t) \quad (8)$$

A continuous feedback loop occurs, where evaluation improves SQ → CS → CF → E → back to SQ. The objective of this numerical model is to improve service quality (SQ).

A mathematical model for the problem function was created to show how various constraints can hinder the process of improving service quality (Caicedo-Rolon et al., 2024). In this situation, a number of elements that significantly hinder the efficiency of the system play a role (Leino et al., 2024), including:

B_{lim}	= limitations in budget support	HR_{cap}	= limited human resource capacity
L_{low}	= weak leadership commitment	E_{ineff}	= low evaluation effectiveness

Limited budget:

$$B(t) = \max(0, \alpha_1 . L(t) - B_{lim}) \quad (9)$$

Human resources do not develop due to limitations:

$$HR(t) = \min(HR(t), HR_{cap}) \quad (10)$$

Ineffective evaluation:

$$E(t) = \epsilon_1 . (CF(t) - E_{ineff}) \quad (11)$$

Service quality is hindered:

$$SQ(t) = \beta_1 . HR(t) + \beta_2 . ICT(t) + \beta_3 . E(t) \quad (12)$$

With the following parameter assumptions:

Table 1. Assumed Value Parameter

Parameter	Assumed Value	Reason
α_1	0.8	Leadership strongly influences the budget
β_1	0.5	Human resources (HR) are considered the most influential factor
β_2	0.3	ICT is important but not the main priority
ϵ_1	0.7	Evaluation is not always used to its fullest potential

In dynamic modeling methods, systems are built to consider elements such as duration, delay, and speed of response to input modifications (Wu et al., 2010). The calculation of these simulation results is based on a dynamic model of the system that has been created, considering several key variables: Leadership (L), Budget (B), Human Resources (HR), ICT, Evaluation (E), Service Quality (SQ), Community Satisfaction (CS), and Feedback Loop (CF).
Based on the results obtained, the dynamic model of the system is as follows:

$$SQ(t) = SQ(t-1) + \alpha\,.(HR(t) + ICT(t) + E(t)) - \beta.SQ(t-1) \qquad (13)$$

And:

$$CS(t) = CS(t-1) + \gamma_1.SQ(t) \qquad (14)$$

Table 2. Simulation Results of the Goal Function and Problem Function

Month	HR	*ICT*	*Evaluation*	*Service Quality*	*Community Satisfaction*	*Feedback*	*Gap (problem)*
1	0.2000	*0.2000*	*0.2000*	*0.1800*	*0.1080*	*0.0648*	*0.392*
2	0.2900	*0.2720*	*0.2242*	*0.3302*	*0.1981*	*0.1188*	*0.3603*
3	0.3610	*0.3276*	*0.2573*	*0.4269*	*0.2561*	*0.1537*	*0.3151*
4	0.4170	*0.3705*	*0.2974*	*0.4922*	*0.2953*	*0.1772*	*0.2585*
5	0.4602	*0.4036*	*0.3422*	*0.5369*	*0.3222*	*0.1933*	*0.1923*
6	0.4932	*0.4298*	*0.3895*	*0.5674*	*0.3404*	*0.2043*	*0.1182*
7	0.5185	*0.4503*	*0.4373*	*0.5886*	*0.3531*	*0.2118*	*0.0375*
8	0.5376	*0.4663*	*0.4839*	*0.6033*	*0.3620*	*0.2172*	*0.0485*
9	0.5520	*0.4784*	*0.5282*	*0.6134*	*0.3680*	*0.2208*	*0.1386*
10	0.5627	*0.4877*	*0.5696*	*0.6202*	*0.3721*	*0.2233*	*0.232*
11	0.5707	*0.4948*	*0.6077*	*0.6246*	*0.3748*	*0.2249*	*0.3277*
12	0.5766	*0.5003*	*0.6424*	*0.6273*	*0.3764*	*0.2258*	*0.4252*

The data in the table shows that the objective function model is able to drive improvements in service quality and public satisfaction more quickly and consistently than the problem function model, which is hampered by various implementation constraints. The increase in HR value from 0.20 to 0.57 over a 12-month period contributed significantly to the improvement in Service Quality, which increased from 0.18 to 0.63. The gradual decrease in the gap (problem) value each month shows that the system is getting closer to the target level of public satisfaction. In addition, by examining the evaluation column, monitoring activities play an important role in strengthening the overall performance of the system.

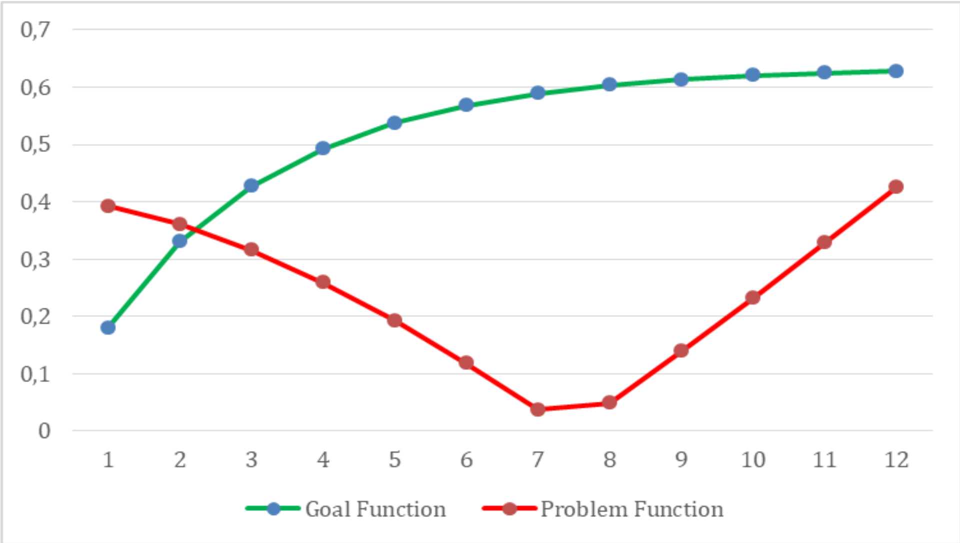

Figure 2. Simulation Curve of the Goal Function vs. the Problem Function

The curve shown in Figure 2 indicates that, in the context of the objective function, there was a significant increase in service quality (SQ) and community satisfaction (CS) over the 12-month period. This situation shows that, in the absence of major obstacles such as budget constraints, lack of human resource capacity, or weaknesses in the assessment process, the actions taken by leaders can produce optimal results in improving the service system. (Sfantou et al., 2017).

Conversely, in the context of problem functions, progress in SQ and CS occurs at a slower pace. This is due to various constraints such as limited budgets (B_{lim}), limited human resource capacity (HR_{cap}), and low level of evaluation effectiveness (E_{ineff}). Although leadership has improved, its impact on services has not yet been fully realized due to implementation challenges in the field.

The simulation results in this study show that the system dynamics method can effectively reflect the complexity and interaction patterns among elements in the public service system. This model provides the ability to recognize nonlinear cause-and-effect relationships and incorporate feedback loops and capacity constraints that affect overall service outcomes. These findings are consistent with recent studies, such as those conducted by (OECD, 2022; Zolak Poljašević et al., 2025), which emphasizes that the success of public policy is greatly influenced by the integration of human resources, budget management, and a continuous evaluation system. In this context, elements such as service quality, efficient fund management, and the adaptability of the monitoring system are very important for improving the responsiveness and transparency of public services.

Furthermore, these results are in line with recent studies on adaptive management ideas, which reveal that progress in public services depends not only on effective policy design, but also on the system's ability to gain insights from experience, adapt, and respond to ever-changing situations in the field (Sørensen et al., 2021). The striking contrast between the desired and actual situations highlights the need to develop policies that take into account human resource potential, financial management agility, and the implementation of a sustainable data-driven assessment system (Brandl et al., 2022).

In general, the findings of this study offer a few significant consequences, including that dynamic system models can be applied to model policies before they are implemented in real-world situations. Problem function models are also useful in determining critical points or obstacles in public service systems. Therefore, policies should place greater emphasis on improving human resource capabilities, refining budgeting procedures to be more responsive, and developing assessment systems that utilize input from the community.

Conclusion

This study successfully designed and tested a simulation of a mathematical model to assess the quality of public services (Service Quality/SQ) and the level of public satisfaction (Customer Satisfaction/CS) through two key approaches: an objective model, which describes the ideal situation, and a problem model, which reflects the situation with resource constraints. The results of this simulation indicate significant differences in performance between the two scenarios, emphasizing the importance of utilizing internal factors such as human resources (HR), information and communication technology (ICT), and evaluation systems as the main drivers for improving public service quality. From a theoretical perspective, this study contributes to the field of public service evaluation through the application of a system dynamics approach, which provides a deeper understanding of service changes over time. This method has advantages over static regression techniques because it can capture the effects of time lags and feedback cycle interactions in complex systems. From a practical perspective, simulation outputs provide strategic insights for policymakers and service providers in identifying ways to strengthen internal capacities, particularly in terms of human resources, information and communication technology infrastructure, and evaluation systems, which can be optimized to improve public satisfaction. The model also serves as a decision-making tool to assess various policy options virtually before they are implemented in the real world.

However, this study faces several limitations, one of which is the use of parameter assumptions that have not been tested and validated with empirical data from the field. In addition, this model also does not consider external variables such as political dynamics, community behavior, and budget fluctuations, each of which can have a significant impact on service outcomes.

For future research, it is recommended that this dynamic system be combined with factual data through statistical calibration using regression methods and expanded to include external elements such as citizen engagement, state finances, and changes in institutions. Modeling methods that involve participation are also recommended to strengthen the validity and suitability of the model in the actual policy context.

References

Andika, L. R. (2019). 1242-3198-1-Pb. *Jurnal Ekonomi & Kebijakan Publik*, *10*(1), 74–83.

Armenia, S., Casalino, N., Gnan, L., & Flamini, G. (2021). A systems approach to the digital transformation of public administration. *Perspectives in Organization*, *14*, 1–20.

Brandl, J., Keegan, A., & Kozica, A. (2022). When less is more: HRM implementation, legitimacy and decoupling. *Human Resource Management Journal*, *32*(1), 247–260. https://doi.org/10.1111/1748-8583.12388

Caicedo-Rolon, A. J., Cely-Calixto, N. J., & Moreno-Gamboa, F. (2024). Design of a Mathematical Model for Staff Planning in an Emergency Department. *EUREKA, Physics and Engineering*, *2024*(2), 170–177. https://doi.org/10.21303/2461-4262.2024.003265

Chang, C., Makahaube, J., Raheem, A., Smith, E., & Mahnaz, S. (2022). Using System Dynamics Method to Measure Project Management Performance of Local Government Agencies. *Businesses*, *2*, 376–395. https://doi.org/10.3390/businesses2040024

Chapela-Campa, D., Benchekroun, I., Baron, O., Dumas, M., Krass, D., & Senderovich, A. (2023). *Can I Trust My Simulation Model? Measuring the Quality of Business Process Simulation Models BT - Business Process Management* (C. Di Francescomarino, A. Burattin, C. Janiesch, & S. Sadiq (eds.); pp. 20–37). Springer Nature Switzerland.

Chen, R., & Wu, L. (2024). Calculation and analysis of the efficiency of resource allocation for technological innovation in China. *PLoS ONE*, *19*(8), 1–20. https://doi.org/10.1371/journal.pone.0308960

Crielaard, L., Nicolaou, M., Brown, A. D., Dijkstra, S. C., ter Ellen, F., Elsenburg, L. K., Luna Pinzon, A., Waterlander, W. E., & Stronks, K. (2025). Systems approaches in public health: beyond mapping the causes. *International Journal of Behavioral Nutrition and Physical Activity* , *22*(1), 1–14. https://doi.org/10.1186/s12966-025-01766-z

Crosland, P., Marshall, D. A., Hosseini, S. H., Ho, N., Vacher, C., Skinner, A., Nguyen, K. H., Iorfino, F., Rosenberg, S., Song, Y. J. C., Tsiachristas, A., Tran, K., Occhipinti, J. A., & Hickie, I. B. (2024). Incorporating Complexity and System Dynamics into Economic Modelling for Mental Health Policy and Planning. *PharmacoEconomics*, *42*(12), 1301–1315. https://doi.org/10.1007/s40273-024-01434-3

Ingsih, K., Astuti, S., & Riyanto, F. (2024). The role of digital competence in improving service quality and employee performance. *SA Journal of Human Resource Management*, *22*. https://doi.org/10.4102/sajhrm.v22i0.2689

Leino, H. M., Davey, J., & Johns, R. (2024). Service system resilience under resource scarcity: from vulnerability to balanced centricity. *Journal of Services Marketing*, *38*(1), 113–130. https://doi.org/10.1108/JSM-01-2023-0024

Mansoor, Z., & Williams, M. J. (2024). Systems approaches to public service delivery: Methods and frameworks. *Journal of Public Policy*, *44*(2), 258–283. https://doi.org/10.1017/S0143814X23000405

Merrill, J. A., Deegan, M., Wilson, R. V, Kaushal, R., & Fredericks, K. (2013). A system dynamics evaluation model: implementation of health information exchange for public health reporting. *Journal of the American Medical Informatics Association*, *20*(e1), e131–e138.

Naugle, A., Langarudi, S., & Clancy, T. (2024). What is (quantitative) system dynamics modeling? Defining characteristics and the opportunities they create. *System Dynamics Review*, *40*. https://doi.org/10.1002/sdr.1762

Ningrum, S., Dwiputri, D. A., Agus, R., Fazarani, F., & Roseline, H. (2024). Policy Harmony or Dissonance? Investigating Alignment in Indonesia's Multi-Level Governance System. *Journal of Ecohumanism*, *3*(8), 2406–2425. https://doi.org/10.62754/joe.v3i8.5741

OECD. (2022). *Innovative capacity of governments : A systemic framework ǀ OECD Working Papers on Public Governance ǀ OECD iLibrary*. *51*. https://www.oecd-ilibrary.org/governance/innovative-capacity-of-governments_52389006-en

Rezagama, A., Hartono, D. M., Soesilo, T. E. B., & Hasibuan, H. S. (2025). Developing A System Dynamics Model for Water Resource Management in Urban Coastal Areas: A Case Study of Semarang City, Indonesia. *International Journal of Sustainable Development and Planning*, *20*(5), 2029–2043. https://doi.org/10.18280/ijsdp.200520

Salomo, R. V., & Rahmayanti, K. P. (2023). Progress and Institutional Challenges on Local Governments Performance Accountability System Reform in Indonesia. *SAGE Open*, *13*(4), 1–14. https://doi.org/10.1177/21582440231196659

Sardi, A., & Sorano, E. (2019). Dynamic performance management: An approach for managing the common goods. *Sustainability (Switzerland)*, *11*(22), 1–22. https://doi.org/10.3390/su11226435

Sfantou, D. F., Laliotis, A., Patelarou, A. E., Sifaki-Pistolla, D., Matalliotakis, M., & Patelarou, E. (2017). Importance of leadership style towards quality of care measures in healthcare settings: A systematic review. *Healthcare (Switzerland)*, *5*(4). https://doi.org/10.3390/healthcare5040073

Sørensen, E., Bryson, J., & Crosby, B. (2021). How public leaders can promote public value through co-creation. *Policy & Politics*, *49*. https://doi.org/10.1332/030557321X16119271739728

Tanantong, T., Pannakkong, W., & Chemkomnerd, N. (2022). Resource management framework using simulation modeling and multi-objective optimization: a case study of a front-end department of a public hospital in Thailand. *BMC Medical Informatics and Decision Making*, *22*(1), 1–21. https://doi.org/10.1186/s12911-022-01750-8

Wu, W. H., Wang, F. S., & Chang, M. S. (2010). Sensitivity analysis of dynamic biological systems with time-delays. *BMC Bioinformatics*, *11*(SUPPL. 7). https://doi.org/10.1186/1471-2105-11-S7-S12

Yenni, A., Fauziah, A., Luciana, M., & Destria, D. (2025). *Analysis of Determinants of Public Service Quality at Public Service Malls in Bukittinggi City*. *08*(08), 4742–4754. https://doi.org/10.47191/ijmra/v8-i08-44

Zolak Poljašević, B., Gričnik, A. M., & Šarotar Žižek, S. (2025). Human Resource Management in Public Administration: The Ongoing Tension Between Reform Requirements and Resistance to Change. *Administrative Sciences*, *15*(3). https://doi.org/10.3390/admsci15030094