Enhancing Inventory Management in Dental Clinics through Agile Methodology: A Practical Approach

Denny Jean Cross Sihombing
Information System Study Program, Atma Jaya Catholic University of Indonesia

Article Info	ABSTRACT
Keywords: Inventory Management, Agile Methodology, Dental Clinics.	This research investigates complex inventory management issues in dental clinic settings, including lack of transparency in stock monitoring, challenges in timely procurement planning, and the risk of losing information about expiration dates or item conditions. The methods employed include initial analysis of existing inventory management processes, stakeholder interviews within dental clinics, and functional testing and user acceptance analysis of the developed inventory system. The research findings demonstrate that developing inventory systems using Agile methodology can address various challenges in dental clinic inventory management, yielding satisfactory results in functional testing and high user acceptance rates. The contribution of this research lies in providing practical concepts and guidelines for dental clinics to manage inventories more efficiently and adaptively, as well as laying a solid foundation for developing inventory systems responsive to changing needs and fast-paced market dynamics.
	Corresponding Author: Denny Jean Cross Sihombing Atma Jaya Catholic University of Indonesia Jakarta, Indonesia denny.jean@atmajaya.ac.id

INTRODUCTION

Dental clinics, as healthcare institutions focusing on oral and dental healthcare, inherently possess a diverse inventory, including medications, medical equipment, disposable materials, and clinic supplies. However, the complexity of this inventory often becomes a vulnerable point in dental clinic management. Issues that arise include more transparency in stock monitoring, difficulties in timely procurement planning, and the risk of losing information regarding expiration dates or item conditions. Amid the constantly changing dynamics of healthcare services and diverse patient needs, efficient inventory management is crucial(Bhat et al., 2023; Das et al., 2021). This not only relates to the operational and financial aspects of the clinic but also impacts the quality of care that can be provided to patients. Well-organized inventory enables dental clinics to avoid sudden stock shortages, optimize resource utilization more effectively, reduce the risk of waste or losses due to unused items, and improve service process efficiency. Therefore, a profound understanding of the importance of efficient inventory management in dental clinics is a strong foundation for developing a responsive, integrated, and sustainable system to support smooth operations and quality services(Al-Hassan & AlQahtani, 2019; Birant et al., 2023; Chau et al., 2024;

Enhancing Inventory Management in Dental Clinics through Agile Methodology: A Practical Approach–Denny Jean Cross Sihombing

25 | P a g e

Cheng et al., 2023; Montoya et al., 2023; Shu et al., 2024; Song et al., 2024; Y. L. Wang et al., 2024).

The problem statement faced in inventory management at dental clinics encompasses several complex challenges(Alsaleh et al., 2024; Bhat et al., 2023; Cao et al., 2023; Hossain et al., 2023; Joda et al., 2020; Mahdi et al., 2023; Pourhajibagher et al., 2023; C. Wang et al., 2021). One of the main challenges is the need for integrated and responsive systems to change. Dental clinics often need help to monitor stock accurately, plan timely purchases, and manage comprehensive and reliable inventory information. This can hurt operational smoothness, resource utilization efficiency, and the quality of services provided to patients. Additionally, the limitation of systems needing to be more responsive to changes also emerges as a recurring issue, where dental clinics find it challenging to quickly adjust inventory management processes to changing needs or dynamic market conditions.

Appropriate and innovative solutions in inventory management at dental clinics are required to address these challenges. Information technology and integrated inventory management systems are two solutions expected to help optimize this process. Implementing a system capable of automating stock monitoring, providing notifications for items nearing depletion, and offering accurate and real-time inventory reports will facilitate more efficient and responsive inventory management. Consequently, dental clinics can enhance their operational effectiveness, reduce the risk of stock shortages or wastage, and improve patient satisfaction through more coordinated and quality services.

The objectives of this research encompass two interrelated aspects, namely enhancing efficiency and responsiveness in dental clinic inventory management and implementing Agile methods in inventory system development. With a focus on efficiency, this research aims to identify and address obstacles in inventory management that can hinder clinic operational smoothness, such as difficulties in stock monitoring, lack of inventory information transparency, and challenges in timely procurement planning. On the other hand, implementing Agile methods is a critical strategy in developing an inventory system that is responsive and adaptive to changes, including changes in patient needs, technological advancements, and rapid market dynamics(Almeida et al., 2022; Al-Saqqa et al., 2020; Bomström et al., 2023; Dingsoeyr et al., 2019; Najihi et al., 2022; Rindell et al., 2021; Santos et al., n.d.; Serrador & Pinto, 2015; Shrivastava & Rathod, 2014). Additionally, this research will conduct an in-depth analysis of the impact of Agile usage on dental clinic inventory performance, focusing on aspects such as inventory accuracy, stock management effectiveness, and overall clinic operational process efficiency. Thus, the main objective of this research is to significantly contribute to enhancing the effectiveness and quality of dental clinic inventory management through a modern and adaptive approach using Agile methods.

The benefits of this research are not limited to solving concrete problems related to dental clinic inventory management but also significantly contribute to deepening the understanding of inventory system development in the dental clinic environment more broadly. The research findings are expected to provide a deeper insight into the challenges, needs, and practical strategies in managing dental clinic inventory and demonstrate the po-

Enhancing Inventory Management in Dental Clinics through Agile Methodology: A Practical Approach–Denny Jean Cross Sihombing

26 | P a g e

tential application of Agile methods as a relevant and efficient solution. Additionally, this research will offer practical recommendations that can guide dental clinic managers in implementing Agile methods in their inventory management. These recommendations include customized implementation steps tailored to dental clinics' characteristics and specific needs, strategies for improving efficiency in stock monitoring and procurement planning, and the appropriate use of information technology to support overall inventory management processes. Therefore, this research's benefits are academic and practical, as it can provide valuable guidance for dental clinics in optimizing their inventory management with an innovative and adaptive approach.

METHODS

The Development of dental clinic inventory systems using Agile methodology follows four main stages, as depicted in Figure 1, beginning with Requirement Definition to identify system needs, planning to plan Development with team formation and product backlog creation, Development involving iterative Development of system features. Finally, Functional Testing and User Acceptance Analysis are used to test functionality and analyze user acceptance before operational implementation. These stages ensure that the developed inventory system not only meets the needs of dental clinics but is also responsive to changes by utilizing Agile principles in efficient and adaptive inventory management.
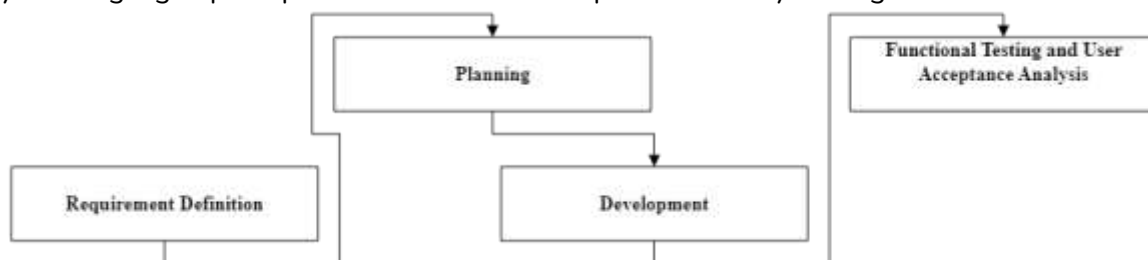

Figure 1. Research Stages

Requirement Definition

Requirement Definition is the first stage in developing a dental clinic inventory system using Agile methodology. In this stage, the main activities include identifying the needs of the dental clinic inventory system through an initial analysis of existing inventory management processes. Additionally, interviews with clinic stakeholders, such as dentists, administrative staff, and warehouse personnel, are conducted to understand their requirements better. The outcome of this stage is a list of functional and non-functional requirements for the inventory system, including desired features and constraints that need to be considered.

Planning

In the second stage, Planning, the system development team identifies and forms a team consisting of software developers, business analysts, testers, and possibly system end-users. A project plan includes sprint schedules, resource allocation, and critical milestones in Development. A product backlog is also determined, containing a list of tasks to be completed in the Development of the dental clinic inventory system.

Enhancing Inventory Management in Dental Clinics through Agile Methodology: A Practical
Approach–Denny Jean Cross Sihombing
27 | P a g e

Development

Moving on to the third stage, Development, the development team begins the first iteration of developing the inventory system according to the previously determined product backlog. Daily stand-up meetings monitor progress, resolve obstacles, and adjust plans if necessary. The main activity in this stage is developing inventory system features according to the needs established in the Requirement Definition stage.

Functional Testing and User Acceptance Analysis

Lastly, in the fourth stage, Functional Testing and User Acceptance Analysis, the dental clinic inventory system is thoroughly tested for functionality to ensure that features work correctly per specifications. End-users of the dental clinic are involved in testing to conduct user acceptance analysis of the system. Feedback from users is used to make any necessary improvements or adjustments before implementing the system operationally in the dental clinic.

RESULTS AND DISCUSSION

Requirements Definition

The results of the Requirement Definition stage in developing a dental clinic inventory system demonstrate a thorough analysis process of system needs as shown in Table 1. The dental clinic inventory system requirements are identified through an initial analysis of existing inventory management processes. This analysis includes evaluating difficulties in stock monitoring, the need for more transparency in inventory information, and challenges in timely procurement planning. Furthermore, interviews are conducted with various stakeholders of the dental clinic, including dentists, administrative staff, and warehouse personnel, to gain a deeper understanding of their needs related to the new inventory system to be developed. The results of these interviews are then summarized into a list of functional and non-functional requirements for the inventory system, including desired features such as accurate stock tracking, automatic updates upon item arrival and departure, and easily accessible and understandable inventory reporting. Additionally, constraints that need to be considered have also been identified, including data security aspects, integration with existing systems, and the system's ability to adapt to potential changes in future needs. This stage provides a solid foundation for developing an inventory system that meets the needs and expectations of users in the dental clinic environment.

Tabel 1. Results of defining requirements

Source of Data	Results
Initial analysis of existing inventory management processes at the clinic	Evaluation of difficulties in stock monitoring, lack of transparency in inventory information, and challenges in timely procurement planning
Interviews with stakeholders of the dental clinic (dentists, administrative staff, warehouse personnel)	Deeper understanding of their needs related to the new inventory system.
Summarization of interview results into a list of functional and non-	List of requirements includes features like accurate stock tracking, automatic updates upon item arrival

Enhancing Inventory Management in Dental Clinics through Agile Methodology: A Practical Approach–Denny Jean Cross Sihombing

28 | P a g e

Source of Data	Results
functional requirements for the inventory system	and departure, and easily accessible and understandable inventory reporting.
Identification of constraints such as data security, system integration, and adaptability to future changes	Constraints to be considered in system development, ensuring compatibility and robustness of the inventory system.

Planning

The results of the Planning stage in developing a dental clinic inventory system encompass crucial steps in project preparation. Firstly, the development team involved in this project is identified, consisting of software developers, business analysts, testers, and possibly system end-users. This diverse team is expected to contribute holistically to developing a responsive and efficient inventory system. Subsequently, a project plan is created, including sprint schedules, resource allocation, and critical milestones for system development. This project plan guides the development team in effectively managing time, budget, and other resources.

In this planning stage, a product backlog containing a list of tasks to be completed during inventory system development is also determined. This product backlog includes various tasks and features that must be developed, tested, and implemented to achieve the set goals. With structured and well-organized results from the Planning stage, the dental clinic inventory system development project is expected to run smoothly and efficiently according to the established vision and objectives.
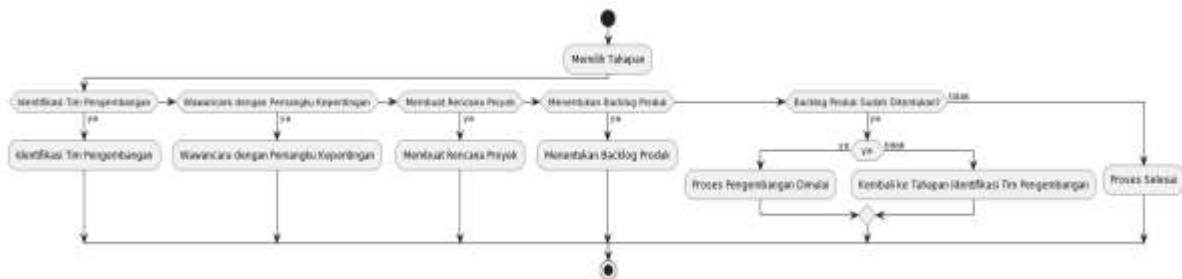

Figure 2 The Planning Phase

Figure 2 illustrates the decision-making process in the structural development stage of a system. First, users are prompted to select the stages to be followed in system development, including Identifying the Development Team, Stakeholder Interviews, creating a Project Plan, and Defining the Product Backlog. Subsequently, the Defining the Product Backlog stage serves as a junction to check if the Product Backlog Has Been Determined. If yes, then the development process commences. However, if not, users will return to the Identifying the Development Team stage to initiate the decision-making process again. This diagram provides a clear overview of the decision flow required in the system development stage, enabling users to see the stages to be traversed visually and the connections between each stage. Thus, this diagram can aid in guiding the inventory system development process in a more structured and effective manner.

Development

The Development stage involves a series of crucial activities. The process begins by executing the first iteration according to the previously established product backlog. This product backlog includes a list of tasks and features that need to be developed or improved in the dental clinic inventory system. Subsequently, the development team regularly conducts daily stand-up meetings to monitor project progress, address emerging obstacles, and adjust development plans if necessary. These daily meetings allow team members to share information, improve coordination, and ensure consistent progress in system development. During the development process, the team implements the inventory system features identified in the previous Requirement Definition stage. These include essential features such as accurate stock tracking, automatic updates upon item arrival and departure, and easily accessible and understandable inventory reporting. Thus, the Development stage yields tangible progress in the dental clinic inventory system, strengthens teamwork, and maintains focus on achieving project goals effectively as shown in Figure 3.
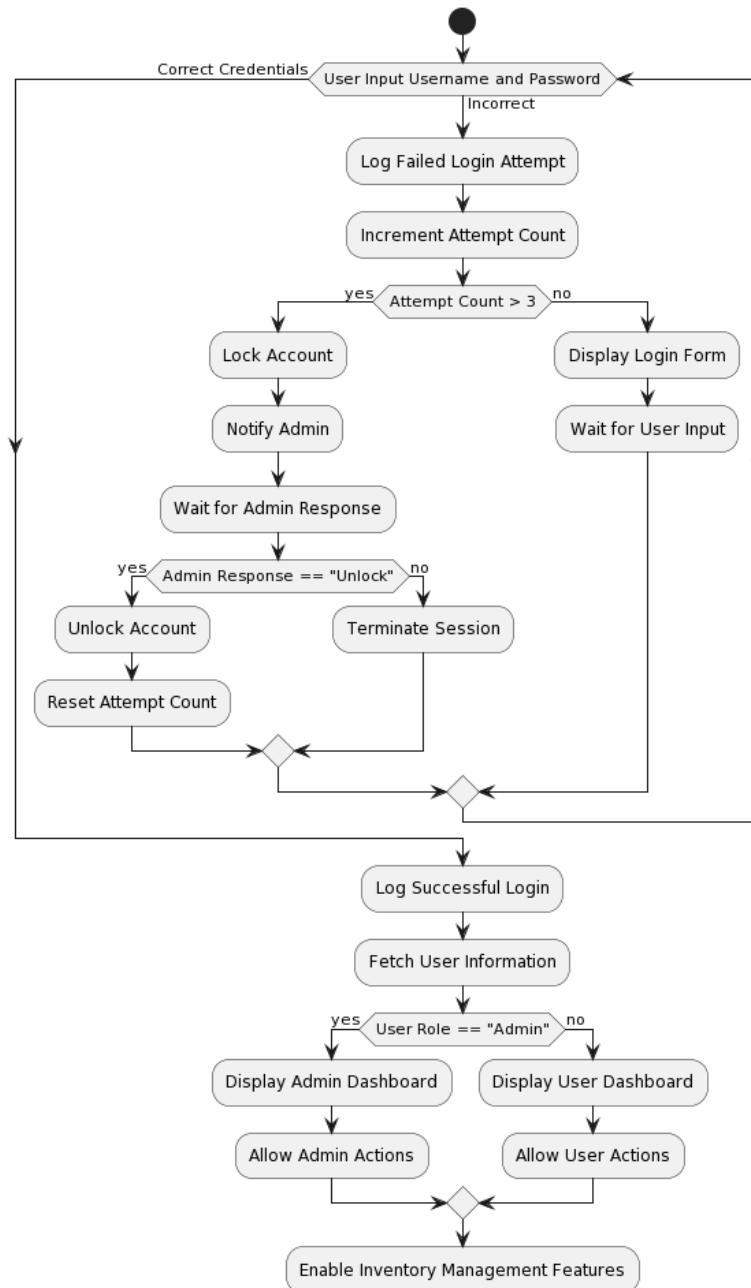
Enhancing Inventory Management in Dental Clinics through Agile Methodology: A Practical Approach–Denny Jean Cross Sihombing

30 | P a g e

Figure 3 Development Phase

Functional Testing and User Acceptance

The results of the Functional Testing and User Acceptance Analysis stage in developing a dental clinic inventory system demonstrate satisfactory achievements. The functional testing stage was successfully conducted by thoroughly testing the system's functionality, yielding positive results. The application passed various user scenarios and situations without encountering significant issues or bugs. Additionally, the User Acceptance Analysis stage involves the active participation of end-users from the dental clinic in testing the system. The user acceptance analysis results indicate user satisfaction with the functionality

Enhancing Inventory Management in Dental Clinics through Agile Methodology: A Practical
Approach–Denny Jean Cross Sihombing
31 | P a g e

and performance of the tested inventory system, meeting user needs and expectations effectively. Although no significant issues were found, some suggestions for improvements and minor adjustments have been made to enhance the overall user experience. Thus, the Functional Testing and User Acceptance Analysis stage has been completed, showing that the dental clinic inventory application has passed functional testing well and has been well-received by end-users.

CONCLUSION

The development of dental clinic inventory systems using Agile methodology holds great potential for addressing complex challenges in inventory management, such as the need for more transparency in stock monitoring and difficulties in timely procurement planning. By implementing an Agile methodology, dental clinics can improve inventory management efficiency, reduce the risk of losing information about expiration dates or item conditions, and ensure more coordinated and high-quality patient services. The primary contribution of this research is to provide practical guidance and fundamental concepts for dental clinics to implement adaptive and responsive inventory management strategies in response to changing needs and rapid market dynamics in the dental healthcare sector. Additionally, the research results contribute to developing efficient and effective inventory systems in dental clinic environments, thus serving as a strong foundation for further research and development in this field.

REFERENCE

Al-Hassan, M., & AlQahtani, S. (2019). Preparedness of dental clinics for medical emergencies in Riyadh, Saudi Arabia. *Saudi Dental Journal*, *31*(1), 115–121. https://doi.org/10.1016/j.sdentj.2018.11.006

Almeida, F., Simões, J., & Lopes, S. (2022). Exploring the Benefits of Combining DevOps and Agile. *Future Internet*, *14*(2). https://doi.org/10.3390/fi14020063

Alsaleh, S. A., Alzawawi, A. S., Alzuhair, A. A., Kalagi, S. A., Al-Madi, E. M., & Dutta, A. K. (2024). Investigating the role of internet-based educational application in the dental sciences. *Heliyon*, *10*(1). https://doi.org/10.1016/j.heliyon.2023.e23643

Al-Saqqa, S., Sawalha, S., & Abdelnabi, H. (2020). Agile software development: Methodologies and trends. *International Journal of Interactive Mobile Technologies*, *14*(11). https://doi.org/10.3991/ijim.v14i11.13269

Bhat, S., Birajdar, G. K., & Patil, M. D. (2023). A comprehensive survey of deep learning algorithms and applications in dental radiograph analysis. In *Healthcare Analytics* (Vol. 4). Elsevier Inc. https://doi.org/10.1016/j.health.2023.100282

Birant, S., İlisulu, S. C., & Özcan, H. (2023). Parents' perspective towards dental radiography for children. *Journal of Dental Sciences*, *18*(4), 1778–1785. https://doi.org/10.1016/j.jds.2023.05.015

Bomström, H., Kelanti, M., Annanperä, E., Liukkunen, K., Kilamo, T., Sievi-Korte, O., & Systä, K. (2023). Information needs and presentation in agile software development. *Information and Software Technology*, *162*. https://doi.org/10.1016/j.infsof.2023.107265

Cao, R., Qiu, P., Xu, B., Lin, J., Chu, D., & Fan, Z. (2023). Effectiveness of interventions to reduce aerosol generation in dental environments: A systematic review. In *Preventive Medicine Reports* (Vol. 35). Elsevier Inc. https://doi.org/10.1016/j.pmedr.2023.102383

Chau, R. C. W., Thu, K. M., Yu, O. Y., Hsung, R. T. C., Lo, E. C. M., & Lam, W. Y. H. (2024). Performance of Generative Artificial Intelligence in Dental Licensing Examinations. *International Dental Journal*. https://doi.org/10.1016/j.identj.2023.12.007

Cheng, F. C., Wang, Y. L., Tang, L. H., Wang, L. H., Huang, G. F., & Chiang, C. P. (2023). Correlation between dental professionally topical fluoride application and children's dental use for dental caries under the National Health Insurance system in Taiwan from 2008 to 2021. *Journal of Dental Sciences*, *18*(3), 1310–1322. https://doi.org/10.1016/j.jds.2023.04.006

Das, A. K., Islam, M. N., Billah, M. M., & Sarker, A. (2021). COVID-19 pandemic and healthcare solid waste management strategy – A mini-review. In *Science of the Total Environment* (Vol. 778). Elsevier B.V. https://doi.org/10.1016/j.scitotenv.2021.146220

Dingsoeyr, T., Falessi, D., & Power, K. (2019). Agile Development at Scale: The Next Frontier. In *IEEE Software* (Vol. 36, Issue 2, pp. 30–38). IEEE Computer Society. https://doi.org/10.1109/MS.2018.2884884

Hossain, N., Mobarak, M. H., Hossain, A., Khan, F., Mim, J. J., & Chowdhury, M. A. (2023). Advances of plant and biomass extracted zirconium nanoparticles in dental implant application. In *Heliyon* (Vol. 9, Issue 5). Elsevier Ltd. https://doi.org/10.1016/j.heliyon.2023.e15973

Joda, T., Bornstein, M. M., Jung, R. E., Ferrari, M., Waltimo, T., & Zitzmann, N. U. (2020). Recent Trends and Future Direction of Dental Research in the Digital Era. *International Journal of Environmental Research and Public Health*, *17*(6). https://doi.org/10.3390/ijerph17061987

Mahdi, S. S., Battineni, G., Khawaja, M., Allana, R., Siddiqui, M. K., & Agha, D. (2023). How does artificial intelligence impact digital healthcare initiatives? A review of AI applications in dental healthcare. In *International Journal of Information Management Data Insights* (Vol. 3, Issue 1). Elsevier B.V. https://doi.org/10.1016/j.jjimei.2022.100144

Montoya, C., Roldan, L., Yu, M., Valliani, S., Ta, C., Yang, M., & Orrego, S. (2023). Smart dental materials for antimicrobial applications. *Bioactive Materials*, *24*, 1–19. https://doi.org/10.1016/j.bioactmat.2022.12.002

Najihi, S., Elhadi, S., Abdelouahid, R. A., & Marzak, A. (2022). Software Testing from an Agile and Traditional view. *Procedia Computer Science*, *203*, 775–782. https://doi.org/10.1016/j.procs.2022.07.116

Pourhajibagher, M., Bahrami, R., & Bahador, A. (2023). Application of photosensitive dental materials as a novel antimicrobial option in dentistry: A literature review. In *Journal of Dental Sciences*. Association for Dental Sciences of the Republic of China. https://doi.org/10.1016/j.jds.2023.12.019

Rindell, K., Ruohonen, J., Holvitie, J., Hyrynsalmi, S., & Leppänen, V. (2021). Security in agile software development: A practitioner survey. *Information and Software Technology*, *131*. https://doi.org/10.1016/j.infsof.2020.106488

Santos, R., Cunha, F., Rique, T., Perkusich, M., Almeida, H., Perkusich, A., & Icaro Costa, ´. (n.d.). *A Comparative Analysis of Agile Teamwork Quality Instruments in Agile Software Development: A Qualitative Approach*. https://doi.org/10.18293/DMSVIVA2023-217

Serrador, P., & Pinto, J. K. (2015). Does Agile work? - A quantitative analysis of agile project success. *International Journal of Project Management*, *33*(5). https://doi.org/10.1016/j.ijproman.2015.01.006

Shrivastava, S. V., & Rathod, U. (2014). Risks in Distributed Agile Development: A Review. *Procedia - Social and Behavioral Sciences*, *133*, 417–424. https://doi.org/10.1016/j.sbspro.2014.04.208

Shu, H., Yu, X., Zhu, X., Zhang, F., He, J., Duan, X., Liu, M., Li, J., Yang, W., & Zhao, J. (2024). Visualisation of Droplet Flow Induced by Ultrasonic Dental Cleaning. *International Dental Journal*. https://doi.org/10.1016/j.identj.2023.12.005

Song, C., Liu, R., Kong, B., Gu, Z., & Chen, G. (2024). Functional hydrogels for treatment of dental caries. In *Biomedical Technology* (Vol. 5, pp. 73–81). KeAi Communications Co. https://doi.org/10.1016/j.bmt.2023.05.002

Wang, C., Miao, L., Wang, Z., Xiong, Y., Jiao, Y., & Liu, H. (2021). Emergency Management in a Dental Clinic During the Coronavirus Disease 2019 (COVID-19) Epidemic in Beijing. *International Dental Journal*, *71*(1), 32–39. https://doi.org/10.1111/idj.12609

Wang, Y. L., Cheng, F. C., & Chiang, C. P. (2024). The implication of instructional design for deciduous tooth identification in a dental morphology course for undergraduate dental students. *Journal of Dental Sciences*, *19*(1), 515–523. https://doi.org/10.1016/j.jds.2023.09.019