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Development of Web and Mobile Health Services Information System Using Waterfall Method

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Abstracts - The increasing demand for fast, accurate, and efficient healthcare services has encouraged the development of integrated information systems. This study aims to design and develop a Health Service Information System (SILAKES) based on web and mobile platforms at the Oputa Yi Koo Heart and Blood Vessel Hospital (RSJPD) in Kendari. The system is developed to facilitate patients in accessing doctor schedules, taking queue numbers online, consulting services, checking blood stock availability, and filling out satisfaction surveys. The development process adopts the waterfall (linear sequential model) method, which consists of five stages (requirement definition, system and software design, implementation and unit testing, integration and system testing, operation and maintenance). The results of this study show that SILAKES improves the efficiency of hospital staff and provides convenience for patients to access health services without space and time constraints. The implementation of this system also contributes to the digitalization of hospital services and supports the enhancement of overall healthcare service quality.

Keywords : Health Information System, Codeigniter, Web, Mobile, Waterfall

INTRODUCTION

The increasing mobility of patients demands faster and more efficient communication, both between patients and healthcare facilities and between patients and their doctors. The implementation of information systems contributes to improved efficiency, effectiveness, and productivity across various types of institutions governmental, private, and individual while also supporting the creation of a more advanced and prosperous society. One of the vital sectors that has received significant government attention is healthcare, particularly hospitals.

Every hospital is required to provide services that are fast and accurate to ensure patient safety. This requirement aligns with the Regulation of the Minister of Health No. 1691/Menkes/Per/VIII/2011 concerning Hospital Patient Safety, which needs to be updated to match the development and service demands in healthcare facilities. Therefore, revising this regulation is an important step. RSJPD Oputa Yi Koo currently uses the Khanza Information System; however, this system is limited to the hospital's internal scope, with access restricted by space and time. As a result, patients cannot take queue numbers online, check doctors' schedules, or access other important information from outside the hospital.

Therefore, to develop an information system that can be accessed without limitations of space and time, it is necessary to apply a systematic and structured software development method, one of which is the waterfall method (Basten & Ardhiansyah, 2022). The waterfall method is the most commonly used software development model for developing systems (Adi Kurniyanti & Murdiani, 2022). The waterfall method is a structured development approach consisting of several stages: requirement definition, system and software design, implementation and unit testing, integration and system testing, operation and maintenance (Pricillia & Zulfachmi, 2021).

In developing healthcare information systems, the Waterfall method provides clear documentation at every stage, making verification and maintenance easier. This is essential because such systems demand reliability, data security, and consistency across service units (Sahara et al., 2023). Each phase in the Waterfall method is closely interconnected, where a new stage can only begin once the previous one has been fully completed. This structured

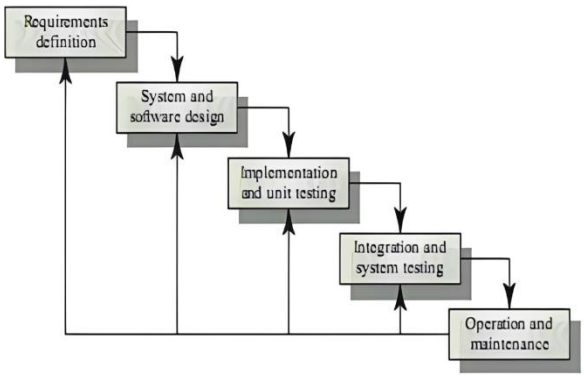
sequence helps developers ensure that all system requirements are thoroughly met before proceeding to the next phase, thereby guaranteeing better quality in the final system (Saputra et al., 2022).

Besides that, a systematic review by (Ikhyana et al., 2023), shows that online queuing and registration systems can accelerate service processes, reduce patient waiting times, and increase efficiency and satisfaction for both users and healthcare workers. Similar results were demonstrated in a study by (Santoso & Hidayat, 2024), who developed a web- and mobile-based online queuing system using the FIFO method, which proved effective in reducing queue congestion and improving the orderliness of healthcare services.Additionally, research conducted by (Yulia Ekadianti et al., 2024) confirmed that the implementation of a website-based registration information system can reduce manual queueing at counters, simplify patient registration, and assist administrative staff in managing patient data. The study revealed that most healthcare institutions that adopted an online registration system experienced significant improvements in service quality and patient convenience during the outpatient registration process.

Therefore, to simplify and speed up healthcare services such as queue number retrieval, doctor schedule checking, and blood stock availability, the author designed and developed a Web- and Mobile-Based Health Service Information System. With this system, hospital staff will be better assisted in carrying out their duties, while patients will find it easier to access health service information at the hospital. Patients can register for queue numbers and check other healthcare services more efficiently and quickly, without being affected if the hospital's desktop system encounters technical issues.

RESEARCH METHOD

To develop an information system that meets the required needs, the design was carried out using the waterfall method. This method has undergone several refinements in each stage of its development, making it remain relevant for use to this day (Prasetyo & Putra, 2021).



Source: (Ardiansyah et al., 2022)
Figure 1. Waterfall Model

According to Heydari et al., (2023), the waterfall method encompasses stages ranging from conceptual modeling, prototype design, and initial release to the official launch. Shamsulhuda Khan & Shubhangi Mahadik (2022) emphasize that each phase requirements gathering, design, implementation, testing, deployment, and maintenance must be completed sequentially, ensuring a clear workflow, early detection of obstacles, and a more refined final product. Ardiansyah et al., (2022), also state that the waterfall model follows a gradual and structured software development process. The waterfall model consists of a series of sequential stages that must be carried out during software development, including:

1. **Requirements definition**
   The first step aims to thoroughly examine user and system needs. This phase involves information gathering, problem identification, and the formulation of objectives to be achieved. The results of this analysis serve as the foundation for determining the application's features, required data, and constraints that must be met (Purba, 2021).
2. **System and software design**
   This stage is a planning and problem-solving process to build a software solution. During this phase, developers and designers create a comprehensive design that includes algorithm development, system architecture planning, logical diagram schematics, and data structure definition. Essentially, all activities focus on the software design, including further steps to ensure that the design is ready for implementation (Aroral, 2021).

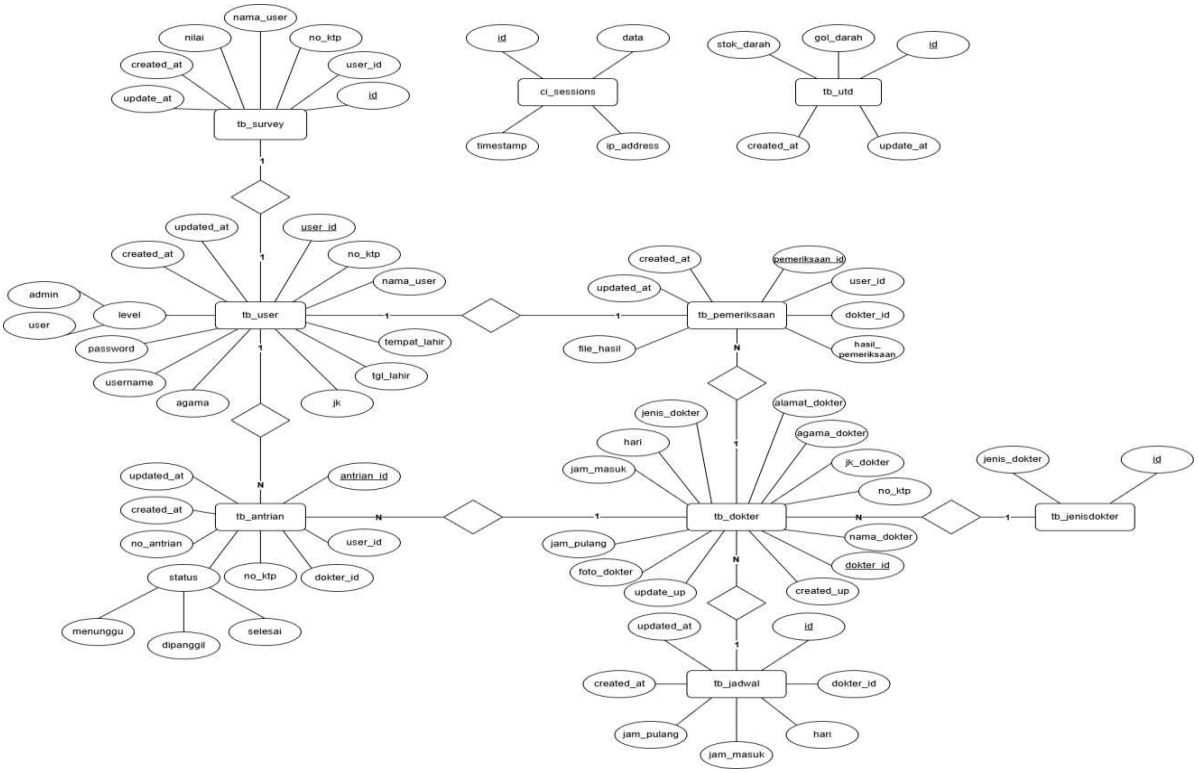
3. **Implementation and unit testing**
   In this phase, the designs created in the previous stage are transformed into an actual program. Each module or unit of code is built according to specifications and then verified to ensure it aligns with the established design and requirements (Rumetna et al., 2022).
4. **Integration and system testing**
   Feature testing is carried out to ensure the functionality and performance of each feature and to detect deficiencies. This study uses Blackbox Testing because it only requires defining the lowest and highest input boundary values, making it simple to apply. The number of test scenarios is determined by the number of input columns, entry rules, and variations in lower–upper boundary data. This method helps detect unexpected inputs that may compromise data validity (Akbar & Fauzi, 2023). However, Felicio et al., (2023) note that although Blackbox testing based on OpenAPI can serve as an alternative when Whitebox testing is difficult to implement, this approach typically only detects status-code errors (5XX) and does not cover response validity, endpoint flow, performance, or security.
5. **Operation and maintenance**
   The final stage of the waterfall method is software operation and maintenance. In this phase, the completed application is used by end-users while regular maintenance is performed. Maintenance includes fixing errors that were not detected in earlier stages, improving the implementation of system modules or units, and updating and adjusting features to keep up with evolving needs (Herawati et al., 2021).

RESULT AND DISCUSSION

The design of this health service information system includes creating designs using Unified Modeling Language (UML) diagrams, specifically a use case diagram, as well as database design illustrated through an Entity Relationship Diagram (ERD) and a Logical Record Structure (LRS).

1. Entity Relationship Diagram (ERD)

Entity Relationship is a database modeling method that uses a conceptual schema to represent the semantic



Source: Research Result (2025)
Figure 2. Entity Relationship Diagram (ERD)

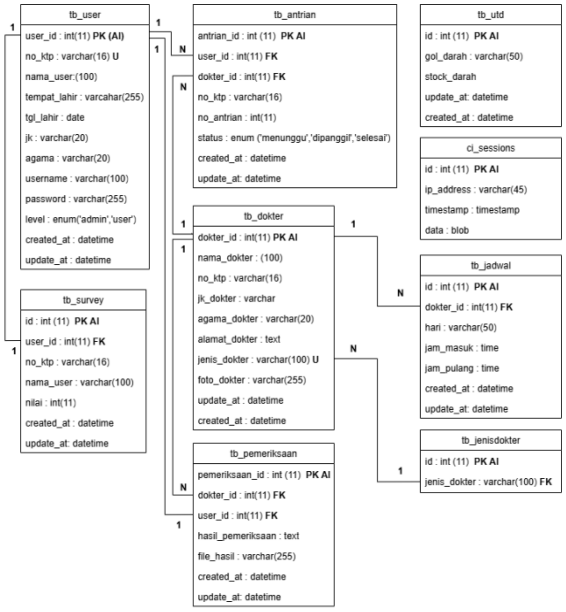
data model of a system. This modeling is applied to relational databases using a top-down approach. The visual representation of this model is known as an entity-relationship diagram, commonly referred to as an Entity Relationship Diagram (ERD) (Pulungan et al., 2023). The following is the Entity Relationship Diagram (ERD) for the health service information system:

The figure above shows the design of the Entity Relationship Diagram (ERD) for the health service information system. The diagram consists of nine entities, seven of which have relationships between tables: tb_user, tb_dokter, tb_jenisdokter, tb_survey, tb_pemeriksaan, tb_jadwal, and tb_antrian. The remaining two tables have no relationships: tb_utd, whose data stands alone, and ci_sessions, which is a default table from CodeIgniter 4 used solely for authentication and session management, and therefore has no connections with the other entities.

2. Logical Record Structure (LRS)

According to Fauzan et al., (2024), the Logical Record Structure (LRS) is the structured form of the Entity Relationship Diagram (ERD), where each entity is converted into database tables along with their attributes and relationships. This process provides a clearer view of the data structure, table connections, and information flow used in system design and implementation.

The following is the Logical Record Structure (LRS) of the health service information system:



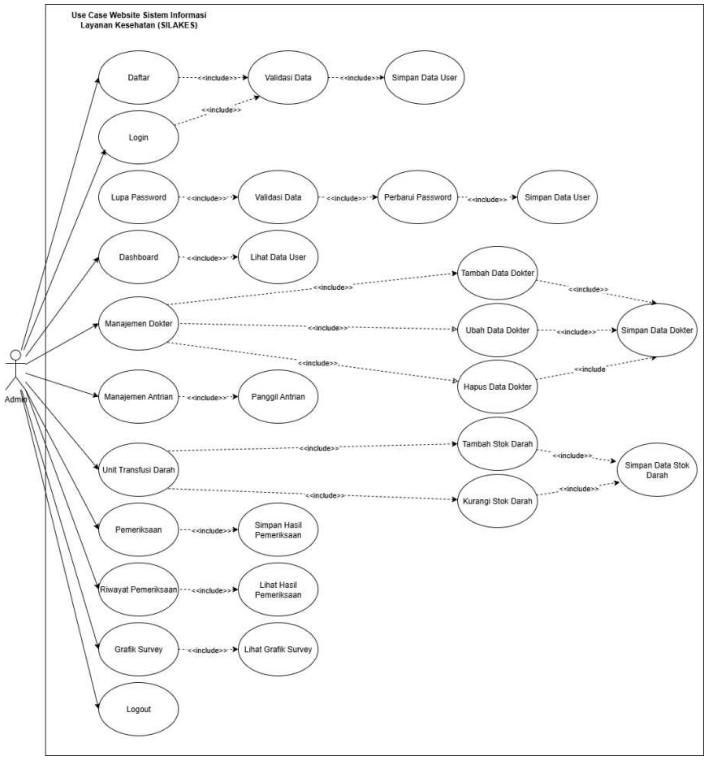
Source: Research Result (2025)

Figure 3. Logical Record Structure (LRS)

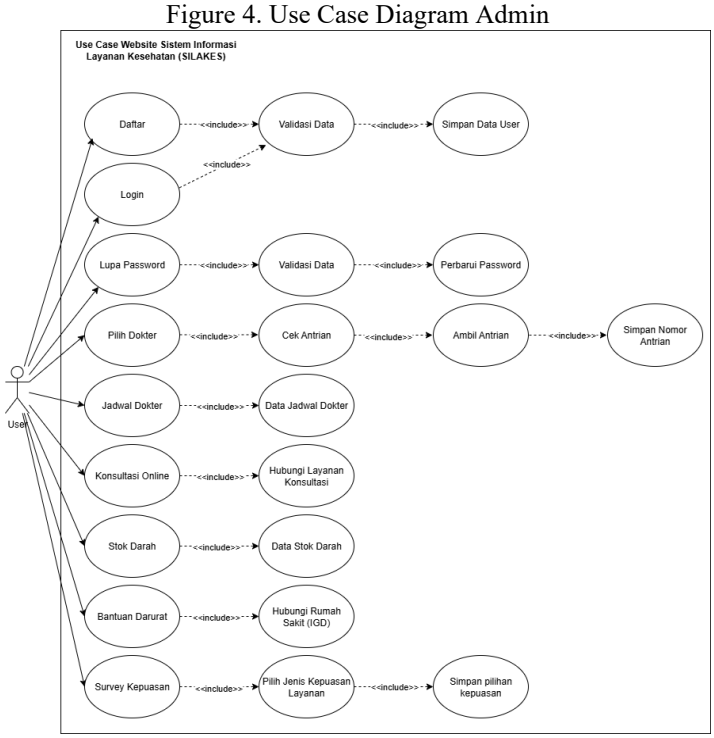
The figure above shows the Logical Record Structure (LRS) design of the health service information system. The Logical Record Structure serves as a detailed representation of the previously created Entity Relationship Diagram (ERD).

3. Use Case Diagram

The following is the Use Case Diagram of the health service information system:



Source: Research Result (2025)
Figure 4. Use Case Diagram Admin



Source: Research Result (2025)
Figure 5. Use Case Diagram User

In Figure 4, the admin manages core hospital data (doctors, queues, blood stock, survey reports), with all critical processes handled via include relationships. In Figure 5, users can access services independently—checking doctor schedules, taking queue numbers, online consultations, viewing blood stock, requesting emergency assistance, and completing satisfaction surveys—while key data still undergoes validation and storage. The table below summarizes the differences in access rights between admin and users:

Table 1. Summary of Access Rights Differences

No.	Aspect	Admin	User
1	Access	Manages doctors, queues, blood stock,	Accesses information, takes queue

	Rights	survey reports, and medical examinations.	numbers, consults online, and provides service satisfaction feedback.
2	Purpose	Maintains, manages, and updates all hospital data and services.	Utilizes health services and monitors information.
3	Interaction	Involves more CRUD (Create, Read, Update, Delete) processes.	Focuses on registration, queue retrieval, and information access.

Source: Research Result (2025)

4. User Interface

The following are the user interface displays for both the user and the admin:

a. User Interface Admin

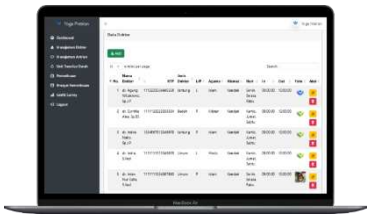
The admin interface includes a login, registration, and forgot password page for account access, followed by a dashboard displaying registered patient data. It also provides pages for managing doctors, monitoring and calling patient queues, updating blood stock, entering medical examination results, viewing examination history, and monitoring patient satisfaction through the survey chart page.

Source: Research Result (2025)
Figure 6. Login Page (Admin)

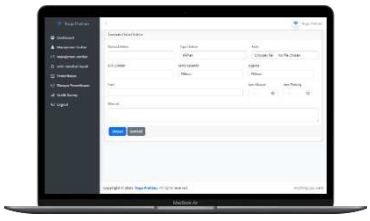
Source: Research Result (2025)
Figure 7. Registration Page (Admin)

Source: Research Result (2025)
Figure 8. Forgot Password Page (Admin)

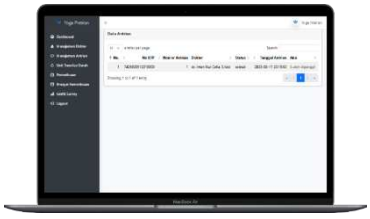
Source: Research Result (2025)
Figure 9. Dashboard Page



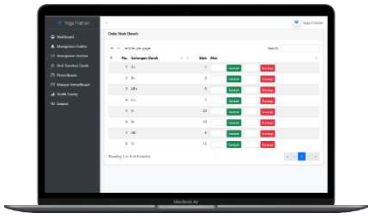
Source: Research Result (2025)
Figure 10. Doctor Management Page



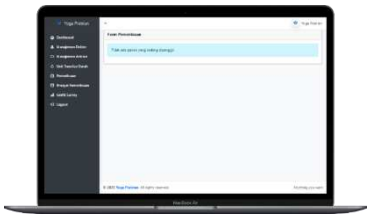
Source: Research Result (2025)
Figure 11. Add/Edit Doctor Page



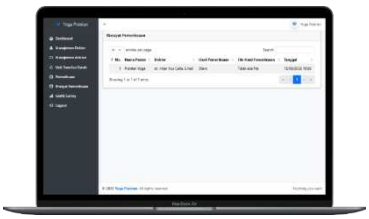
Source: Research Finding (2025)
Figure 12. Queue Management Page



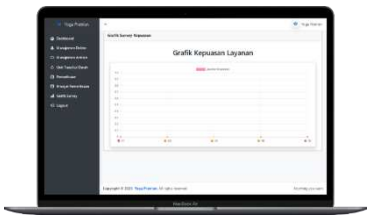
Source: Research Finding (2025)
Figure 13. Blood Transfusion Unit Page (Admin)



Source: Research Result (2025)
Figure 14. Medical Examination Page



Source: Research Result (2025)
Figure 15. Medical Examination History Page



Source: Research Result (2025)
Figure 16. Survey Chart Page

b. User Interface User

The user interface includes login, registration, and password recovery, leading to the home page as the

main entry point. Users can select doctors, take queue numbers, view schedules, access online consultations, check blood availability, request emergency assistance, submit satisfaction surveys, and view information about the developer and hospital.

Source: Research Result (2025)
Figure 16. Login Page (User)

Source: Research Result (2025)
Figure 17. Registration Page (User)

Source: Research Result (2025)
Figure 18. Forgot Password Page (User)

Source: Research Result (2025)
Figure 19. Home Page

Source: Research Result (2025)
Figure 20. Select Doctor Page

Source: Research Result (2025)
Figure 21. Queue Retrieval Page

Source: Research Result (2025)
Figure 22. Doctor Schedule Page

Source: Research Result (2025)
Figure 23. Online Consultation Page

Source: Research Result (2025)
Figure 24. Blood Transfution Unit Page (User)

Source: Research Result (2025)
Figure 25. Satisfaction Survey Page

Source: Research Result (2025)
Figure 26. Emergency Assistance Page

Source: Research Result (2025)
Figure 26. Information Page

5. Testing Result

Table 2. Blackbox Testing Result

Feature Tested	Test Description	Expected Output	Actual Output	Status
Registration (Admin & User)	Testing display, empty form validation, registered ID number, and new registration	System shows validation messages and redirects appropriately	As expected	Valid
Login (Admin & User)	Testing empty input, invalid credentials,	System displays alerts/messages or	As expected	Valid

	restricted access, and successful login	redirects to dashboard		
Forgot Password (Admin & User)	Testing reset view, empty input, mismatched/invalid data, and successful reset	System shows validation notifications and redirects to login page	As expected	Valid
Dashboard (Admin)	Accessing the main admin dashboard page	System displays dashboard page	As expected	Valid
Doctor Management (Admin)	Viewing, adding, editing, deleting doctor data	System updates and displays doctor data correctly	As expected	Valid
Queue Management (Admin)	Viewing queue list and calling patients	Queue status updates from 'waiting' to 'called'	As expected	Valid
Blood Transfusion Unit (Admin & User)	Viewing, adding, reducing, or checking blood stock	System updates or displays blood stock accurately	As expected	Valid
Medical Examination (Admin)	Inputting examination results	System displays success message	As expected	Valid
Medical Examination History (Admin)	Viewing/searching examination history	System displays accurate history data	As expected	Valid
Survey Chart (Admin)	Viewing survey chart	System displays survey chart data	As expected	Valid
Home (User)	Viewing main page	System displays main page correctly	As expected	Valid
Select Doctor (User)	Selecting doctor before queue retrieval	System displays available doctors	As expected	Valid
Queue Retrieval (User)	Viewing and taking queue numbers	System shows queue page or requests login	As expected	Valid
Doctor Schedule (User)	Viewing doctor schedule	System shows schedule or 'No schedule available'	As expected	Valid
Online Consultation (User)	Accessing consultation page	System redirects to WhatsApp	As expected	Valid
Emergency Assistance (User)	Viewing emergency page and contact	System redirects to WhatsApp with location	As expected	Valid
Satisfaction Survey (User)	Viewing and submitting feedback	System shows 'Thank you for your feedback'	As expected	Valid
Information (User)	Viewing hospital/developer info	System displays information correctly	As expected	Valid
Logout (Admin & User)	Ending login session	System redirects to login page	As expected	Valid

Source: Research Result (2025)

Testing using the Blackbox method shows that all features function as expected. The system successfully handles various input conditions, including empty or incomplete forms and duplicate entries, while providing appropriate notifications to users. These results confirm that the system is technically stable and designed to support user convenience and ease of use.

CONCLUSION

This study successfully implemented the SILAKES web and mobile health service system using the Waterfall method, ensuring structured development, complete documentation, and compliance with user requirements. SILAKES has improved hospital efficiency and service quality by enabling patients to access schedules, queues, consultations, blood stock, and surveys anytime, while staff benefit from faster data management and streamlined workflows. Future enhancements like real-time synchronization, automated

notifications, and AI analytics could further optimize operations and support the development of smart hospitals in Indonesia.

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