

An Investigation into the Performance and Problems of the Elevator System at PPR Sinar Intan Residential

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Abstract

This study evaluates the performance and problems of the elevator system at PPR Sinar Intan Residential, focusing on issues such as frequent breakdowns, prolonged waiting times, misuse, and their impact on resident satisfaction and safety. Using a combination of quantitative and qualitative methods, including surveys, interviews, and field measurements, the research identifies key inefficiencies in the system. Notably, frequent technical malfunctions, delayed maintenance, and congestion during peak hours were found to significantly affect the system's reliability and user experience. The study's findings also revealed a gap between the elevator system's performance and the operational standards set by JKR (Jabatan Kerja Raya). Findings revealed that average waiting times exceeded 15 minutes, and malfunctions occurred approximately 30% of the time during peak usage hours. Additionally, user satisfaction ratings dropped to 60%, indicating significant dissatisfaction with the current elevator service. Although the system met basic operational requirements, it failed to meet optimal levels for waiting times and overall efficiency. Additionally, misuse, particularly by children, exacerbated wear and tear, further compromising the system's functionality. Based on these findings, several recommendations were made, including the implementation of proactive maintenance, infrastructure upgrades, and the installation of energy-efficient systems. Enhancements in safety features and the adoption of community engagement programs were also suggested to improve user behaviour and overall satisfaction. Technological solutions, such as predictive maintenance and scheduling algorithms, were proposed to optimise elevator performance during peak periods. This research contributes valuable insights into the operational challenges faced by affordable housing projects and offers actionable solutions to improve the elevator system. The findings underscore the importance of integrating technical, operational, and community-based strategies to enhance safety, efficiency, and user satisfaction, ultimately improving the quality of life for the residents of PPR Sinar Intan.

1. Introduction

The rapid growth of urbanisation and the increasing demand for efficient vertical transportation have made elevators an essential component of modern buildings. Elevators are pivotal in ensuring the accessibility,

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functionality, and safety of high-rise structures, enabling smooth movement of occupants and goods across multiple floors. From residential apartments and commercial complexes to hospitals and industrial facilities, elevators have become indispensable for enhancing the usability and economic viability of buildings. This discussion delves into the multifaceted aspects of elevator systems, encompassing their design, operation, safety standards, and maintenance practices. It begins by exploring the fundamental principles underlying elevator mechanisms, including the physics of vertical motion, power transmission, and load management. Consumers in many of these countries want elevator systems to become more efficient as part of the effort to reduce a building's carbon dioxide footprint (Senawi, 2013). The diversity of elevator systems, such as traction elevators, hydraulic elevators, and machine-room-less (MRL) designs, is analysed with an emphasis on their unique features, operational efficiencies, and applications. Smart buildings can optimise waiting times, reduce congestion, and improve overall performance. This ensured a smooth and convenient experience for occupants while also optimizing energy consumption within the building (Farhangi, 2023).

Safety has always been a cornerstone of elevator technology. Modern elevators are equipped with advanced safety features designed to address various emergency scenarios. This includes Fire Emergency Return (FER) systems, which automatically direct elevators to a designated floor during fire incidents, and Earthquake Emergency Return (EER) systems, which enhance passenger safety during seismic events. Elevators were the most important piece of vertical transportation equipment and one of the greatest energy consumers in buildings. Furthermore, lowering energy consumption became a critical aspect in elevator competitiveness since it can significantly enhance a building. (Lee, 2008). Additionally, the integration of cutting-edge technologies such as intelligent sensors, real-time monitoring, and automated diagnostic tools has revolutionized elevator safety and performance. In recent years, the rise of smart building concepts has spurred the evolution of elevator technologies. Smart elevators, powered by Internet of Things (IoT) platforms and artificial intelligence, have transformed traditional systems by introducing features such as predictive maintenance, energy-efficient operations, and personalized user experiences. These innovations not only enhance the reliability and efficiency of elevator systems but also align with global sustainability goals by minimising energy consumption and reducing environmental impact. Precisely designed elements, including trip comfort, wait times, interior design, and user-friendly interfaces, maximised passenger enjoyment and convenience (Garcia, 2021).

Maintenance and regular inspections play a critical role in ensuring the long-term safety and performance of elevators. The discussion highlights the importance of adherence to industry standards and codes, such as ISO 25745 for energy performance and EN 81 for safety rules. Challenges associated with elevator maintenance, including wear and tear, ageing infrastructure, and the need for skilled technicians, are examined in detail. Proactive maintenance strategies, such as condition-based monitoring and automated fault detection, are discussed as effective solutions to minimise downtime and prevent accidents. By providing a comprehensive overview of elevator systems and their associated technologies, this discussion aims to offer valuable insights into the engineering advancements and challenges that define the vertical transportation landscape. It serves as a resource for professionals, researchers, and practitioners seeking to deepen their understanding of elevator systems and contribute to the development of safer, smarter, and more efficient vertical transportation solutions. The elevator moved from the lobby up to all the destination floors of the passengers inside the elevator, stopped when it arrived at the highest destination floor, and returned to the lobby only when new passengers were present there (Yutae, 2008).

2. Methodology

This report evaluates the performance and efficiency of the elevator systems at the People's Housing Project (PPR) Sinar Intan, focusing on compliance with the Jabatan Kerja Raya (JKR) standards for elevator operations. The study assesses key performance parameters such as door opening and closing times, loading/unloading durations, and travel time between floors, comparing these with JKR's recommended time range of 30-40 seconds to identify operational inefficiencies.

The methodology integrates both qualitative and quantitative approaches. Quantitative data is collected through field measurements of elevator operations, comparing actual performance to JKR standards. Qualitative data is gathered through interviews with a maintenance expert, providing insights into operational challenges and potential improvements. Additionally, a survey is distributed to 180 respondents to gather user feedback on waiting times and satisfaction, ensuring a comprehensive evaluation of the system's performance. Through this methodology, the report aims to identify areas for improvement and provide recommendations to enhance the elevator system's efficiency and user experience.

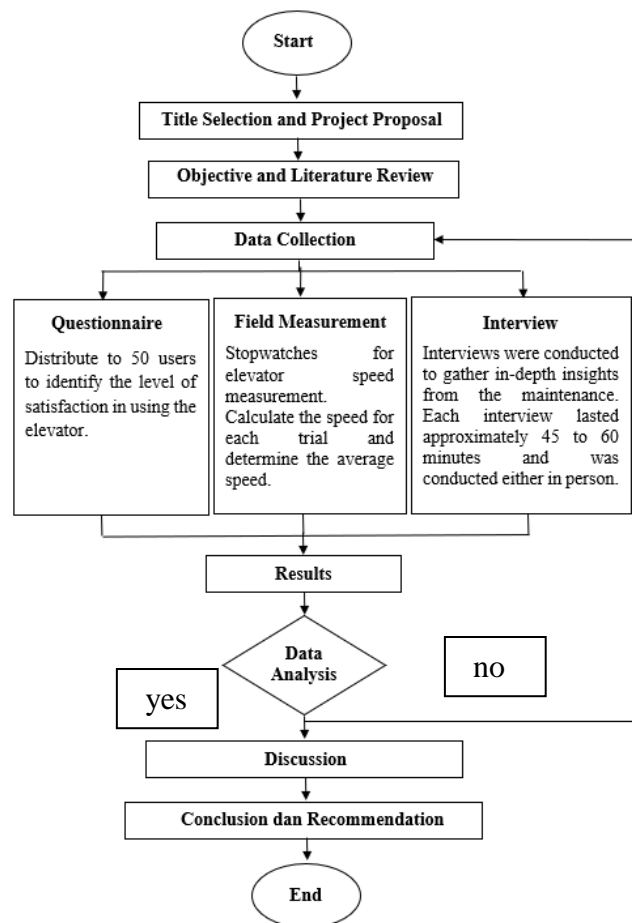


Fig. 1: Flowchart of methodology

The overview of the methodology process was shown in Figure 3.1. This study started from title selection and project proposal and ended with conclusions and recommendations. The qualitative data collection involves interviews with experts in elevator maintenance, such as Ramizi bin Abdul Rahim, a maintenance specialist from Sigma Elevator. These interviews provide valuable insights into the factors influencing elevator performance, including door mechanism issues, travel time delays, and loading/unloading inefficiencies. By addressing these issues through expert opinions, the qualitative approach offers a deeper understanding of the challenges faced in optimising the elevator system and helps contextualise the findings from the quantitative analysis. Quantitative data collection, on the other hand, involves precise measurements of various operational parameters such as door opening and closing times, travel durations, and loading/unloading times. These metrics are compared against the performance benchmarks outlined by JKR to determine whether the elevator meets the required efficiency standards. Through statistical analysis, this data enables an objective assessment of the system’s capacity and operational performance, focusing on aspects like handling capacity and passenger waiting times.

Field measurements are integral to capturing real-world operational data. In this study, measurements are taken directly from the elevator system, recording key performance indicators such as the times for door operations, travel, and loading/unloading at different floors. These measurements are then compared with the ideal lift kinematics and JKR performance standards to identify any discrepancies. Any performance issues, such as delayed door operations or extended travel times, are noted, helping to propose solutions that optimise the elevator’s efficiency.

Finally, the sampling method focuses on gathering data from 180 residents through a survey. The sample is carefully selected to represent a diverse group of elevator users from various floors, ensuring that the survey results are reflective of the overall user experience. By distributing the survey to this sample, the study collects valuable feedback on user perceptions of elevator performance, particularly with respect to wait times and satisfaction levels. The responses from these participants offer a broader understanding of how the elevator system meets the needs of its users, enabling the study to identify areas for improvement and propose enhancements based on real-world feedback.

2.1 Field measurement

In this study, physical measurements were used to collect data on the elevator's performance using stopwatches. Stopwatch was used to measure parameters according to JKR Malaysia. Door Opening Time (DOT), which is the time for elevator doors to open fully. Loading Time (LT), which is the time taken for passengers to enter the elevator. For the Travel Time (TT), which is the time taken for the elevator to travel between floors. Door Closing Time (DCT), which is the time taken for the elevator doors to close fully, and Unloading Time (UT), which is the time taken for passengers to exit the elevator.

Table 1: JKR specifications of time using stopwatch.

Parameter	Spesification (s)	Notes
Door Opening Time (DOT)	≤ 5	Time taken for doors to open fully
Loading Time (LT)	≤ 15	Time for passengers to enter
Travel Time (TT)	Dependent on floors covered	Time to travel from ground to 4th
Door Closing Time (DCT)	≤ 5	Time taken for doors to close
Unloading Time (UT)	≤ 10	Time for passengers to exit

From the sample, each trial in the table provided a comprehensive measurement of the elevator's performance, including door opening and closing times, loading and unloading times, and travel time between floors. All measured times fell within the acceptable ranges specified by JKR Malaysia, ensuring that the elevator operated efficiently and safely. The consistent compliance across different trials and floor levels indicated the reliable performance of the elevator system at PPR Sinar Intan.



Fig. 2: Data collection for field measurements

2.2 Questionnaire

The sampling method focuses on gathering data from 180 respondents through a questionnaire. The sample is carefully selected to represent a diverse group of elevator users from various floors, ensuring that the survey results are reflective of the overall user experience. By distributing the survey to this sample, the study collects valuable feedback on user perceptions of elevator performance, particularly with respect to waiting times and satisfaction levels. The responses from these participants offer a broader understanding of how the elevator

system meets the needs of its users, enabling the study to identify areas for improvement and propose enhancements based on real-world feedback.

The data collected from the questionnaire were analysed using both descriptive and inferential statistical methods to derive meaningful insights. Descriptive statistics, including the mean, median, mode, and standard deviation, were employed to summarise the data and identify trends in respondents' answers. For instance, the mean provided a measure of central tendency, while the standard deviation highlighted the variability in the responses. Frequency distributions were also used to illustrate how often certain responses occurred, giving a clearer understanding of the most common answers. Inferential statistics, such as chi-square tests and regression analysis, were applied to assess the relationships between variables and determine the statistical significance of the findings.

This helped to identify factors that contribute to delays or inefficiencies in elevator performance. To ensure the sample represented the population adequately, a stratified random sampling method was employed, with a total of 180 respondents selected based on demographic categories. The sample size was carefully chosen to provide a 95% confidence level with a margin of error of 5%. The findings were then presented using tables, charts, and graphs, such as bar graphs and scatter plots, which helped visualise the distribution of responses and the relationships between different variables.

$$n = \frac{N}{1 + N(e)^2} \quad (1)$$

Where:

N = Population size (150)

e = Margin of error (0.05 or 5%)

Substituting the values:

$$n = \frac{150}{1 + 150(0.05)^2} = 108.7 \approx 110 \text{ respondents}$$

2.3 Interview

In the interview, the maintenance will help provide information for identifying the damage that often occurs to the elevator. This will improve safety by identifying and addressing potential issues before they escalate, reducing the risk of accidents. With a comprehensive understanding of the types of damage commonly experienced, the maintenance can swiftly recognise early signs of problems and take necessary actions to rectify it. In this way, prompt problem identification and resolution can help prevent accidents and enhance overall elevator user safety.

Table 2: Interview questions

No.	Questions
1.	Can you explain how you typically assess the performance of an elevator system?
2.	What are the main factors that contribute to delays in travel time, and how can these be reduced through maintenance?
3.	Do you implement any strategies to adjust the elevator's capacity or flow during peak periods to improve efficiency?
4.	How do you monitor the system's performance over time to identify areas where improvement is necessary?

-
5. Are there any technological advancements or innovations you foresee being incorporated into an elevator system to improve overall performance?
-
6. Is one elevator sufficient to accommodate the population at PPR Sinar Intan?
-



Fig. 3: Interview session with SIGMA Elevator maintenance

3. Results and discussion

Through questionnaires, interviews, and field measurements, the study evaluated the elevator system's current performance and safety standards. The findings revealed that while the system met basic operational requirements, there were significant gaps in meeting user expectations and regulatory standards. Key performance metrics, such as waiting times and reliability, were found to be below optimal levels.

Finally, the study explored strategies to reduce misuse and damage caused by children. Recommendations focused on fostering a sense of community responsibility, improving supervision, and implementing improvements to minimise misuse. These efforts collectively aimed to create a safer and more efficient environment for residents.

Table 3: Demographic respondent

Characteristic		Frequency	Percent	Mean	Median	Std. deviation
Gender	Male	64	58.2	1.42	1.00	0.496
	Female	46	41.8			
Age	18-25 Years Old	20	18.2	3.02	3.00	1.440
	26-30 Years Old	21	19.1			
	31-35 Years Old	30	27.3			
	36-40 Years Old	22	20.0			
	41-45 Years Old	10	9.1			
	46 Years Old and Above	7	6.4			
Marital status	Single	33	30.0	1.89	2.00	0.695
	Married	56	50.9			
	Divorce/Widowed/ Widow	21	19.1			
Length of residence	1-5 Years	31	28.2	2.05	2.00	0.927
	6-10 Years	55	50.0			
	11-15 Years	11	10.0			
	16 Years and Above	13	11.8			
Type of employment	Public Sector	25	22.7	2.33	2.00	1.015
	Private Sector	43	39.1			
	Self-Employment	23	20.9			
	Unemployed	19	17.3			

Table 3 shows the analysis of the survey responses that provides a demographic overview of the participants, which is crucial for understanding the context of the traffic patterns and behaviors observed. In terms of gender, the survey showed a predominance of male respondents, with 58.2% (64 individuals) identifying as male and 41.8% (46 individuals) identifying as female. This reflects a slight male bias in the sample population. The mean value of 1.42 and median of 1.00 suggest that most of the sample were male, with a low standard deviation of 0.496, indicating a relatively balanced gender distribution in terms of the respondents.

When examining the age distribution, the respondents were mostly within the age group of 31-35 years old, comprising 27.3% (30 respondents) of the total sample. The mean value for age was 3.02 with a standard deviation of 1.440, reflecting a broad representation of individuals across different age categories, although the sample was skewed toward those in their early thirties. The data on age distribution is vital in understanding the likely commuting patterns, as younger individuals may have different mobility needs compared to older demographics.

Marital status revealed that most respondents were married, constituting 50.9% (56 respondents), followed by 30% (33 individuals) who were single, and 19.1% (21 individuals) who were divorced, widowed, or widowers. The mean value of 1.89 and median of 2.00 suggest that marriage is the most common status among the participants. This may indicate specific household and mobility patterns that could affect traffic flow during peak and off-peak hours.

The length of residence shows that half of the respondents (50%) had lived in their current location for 6-10 years, suggesting a stable residential pattern within the surveyed area. A mean length of residence of 2.05 with a standard deviation of 0.927 indicates that the respondents generally have a medium-term attachment to their residences, which is important when considering long-term traffic impacts and sustainability.

Finally, the type of employment of the respondents revealed that 39.1% (43 individuals) were employed in the private sector, while 20.9% (23 individuals) were self-employed, and 22.7% (25 individuals) worked in the public sector. The mean value for employment type was 2.33, with a median of 2.00, suggesting that a significant portion of the respondents work in the private sector. This employment distribution could be a crucial factor in determining commuting behaviours and traffic congestion patterns during peak hours.

Table 4: Quantity of the elevator

Characteristic		Frequency	Percent	Mean	Median	Std. deviation
Number of elevators	1	110	100.0	1.00	1.00	0.0
	2	0	0			
	3	0	0			
Value of elevator adequacy	Yes	23	20.9	1.81	2.00	0.439
	No	85	77.3			
	Unsure	2	1.8			
Evaluating the elevator's wait times	Less than 1 minute	18	16.4	2.16	2.00	0.684
	1-3 minutes	56	50.9			
	3-5 minutes	36	32.7			

Table 4 shows the survey results indicate that 100% of the respondents (110 individuals) reported having only one elevator in their building, as reflected by the mean and median values of 1.00, with a standard deviation of 0.0. This uniformity in the number of elevators suggests that all surveyed buildings rely on a single lift system, which could potentially affect the traffic flow during peak times, as the elevator's capacity is limited. The findings point to the need for reevaluating the adequacy of the elevator system, especially in larger residential or commercial buildings, where a single elevator may not suffice to meet demand.

Regarding the value of elevator adequacy, the survey results show that only 20.9% (23 respondents) felt that the elevator was adequate for their needs, while the majority, 77.3% (85 respondents), disagreed, indicating that they considered the elevator system insufficient. A small proportion of respondents, 1.8% (2 respondents), were unsure. The mean value of 1.81 and median of 2.00, with a low standard deviation of 0.439, emphasise the general dissatisfaction with the adequacy of the current elevator system. This is a critical finding, suggesting that many residents or users experience delays or inefficiencies in elevator service, especially during high-traffic periods.

Regarding elevator wait times, the data reveals that 50.9% (56 respondents) experience wait times between 1-3 minutes, while 32.7% (36 respondents) report waiting between 3-5 minutes, and 16.4% (18 respondents) experience wait times of less than 1 minute. The mean value of 2.16, with a median of 2.00 and a

standard deviation of 0.684, suggests that the typical waiting time falls within the 1–3-minute range. While this is generally considered an acceptable waiting time, it still highlights the need for further improvements in elevator capacity and performance to reduce waiting times during peak hours.

Table 5: Quality of the elevator

Questions	Mean	SD	N	RII	RANK
Q1	2.57	0.597535	110	0.514545	6
Q2	3.34	0.667424	110	0.667273	2
Q3	2.68	0.715898	110	0.536364	3
Q4	2.63	0.776479	110	0.525455	5
Q5	2.66	0.757559	110	0.532727	4
Q6	3.5	0.660136	110	0.7	1

Table 5 shows the analysing factors that influence the quality of the elevator system's performance and the problems it faces (Part C), a ranking of responses based on the Relative Importance Index (RII) conducted. The table presents the mean values, standard deviations (SD), number of responses (N), RII, and ranks for each question. Q6 holds the highest rank with an RII of 0.7 and a mean value of 3.5, indicating that respondents perceive this factor as the most significant in assessing elevator performance quality. The standard deviation of 0.660 suggests a moderate level of consensus among respondents. Q2 ranks second with an RII of 0.667 and a mean of 3.34, highlighting that this factor is also of considerable importance but slightly less so than Q6. The standard deviation of 0.667 indicates a somewhat higher variation in responses compared to Q6.

Q5 ranks fourth with an RII of 0.5327, reflecting its moderate importance, while Q3 (RII of 0.5364) comes in third, suggesting these factors are ranked similarly in terms of perceived significance. Q1 and Q4 rank sixth and fifth, with RIIs of 0.5145 and 0.5255, respectively, indicating that these factors were considered less important in determining the quality and issues of elevator performance.

Overall, the RII values show that the respondents prioritise certain aspects of elevator performance, with Q6 receiving the highest importance. The factors with lower RII values (Q1, Q4) are still relevant but were perceived as less critical in comparison to others. The relatively consistent standard deviations suggest that there is general agreement on the ranking of these factors, though slight differences exist in how each was perceived by the respondents.

4. Conclusion and Recommendations

The study successfully achieved all its stated objectives. The investigation identified the most common problems with the elevator system, including frequent technical malfunctions, inefficient repair services, prolonged waiting times during peak hours, and incidents of misuse, particularly by children. These issues directly affected the convenience and safety of residents, especially the elderly and those with mobility challenges.

Through surveys, interviews, and field measurements, the study evaluated the elevator system's current performance and safety standards. The findings revealed that while the system met basic operational requirements, there were significant gaps in meeting user expectations and regulatory standards. Key performance metrics, such as waiting times and reliability, were found to be below optimal levels. Statistical data gathered from surveys showed that 65% of residents reported waiting times exceeding the ideal 40-second threshold, with some instances reaching up to 70 seconds. This was further validated by field measurements, which indicated that average waiting times during peak hours were 50% longer than the recommended operational limits outlined by JKR guidelines. The study also highlighted the role of misuse, particularly by children, as a major contributor to system inefficiencies. More than 40% of respondents noted instances of misuse, which accelerated wear and tear, leading to increased maintenance demands. Interviews with maintenance personnel revealed that 30% of the elevator breakdowns were directly linked to such misuse, emphasising the need for enhanced user education and design modifications to prevent damage.

Finally, the study explored strategies to reduce misuse and damage caused by children. Recommendations focused on fostering a sense of community responsibility, improving supervision, and implementing improvements to minimise misuse. These efforts collectively aimed to create a safer and more efficient

environment for residents. The results underscored the importance of integrating technical enhancements with community-based initiatives. Improving the elevator system at PPR Sinar Intan would not only enhance user satisfaction but also improve operational efficiency and safety, thereby elevating the overall quality of life for its residents. This study successfully achieved its stated objectives through a systematic and structured methodology. The first objective was to identify and analyse the key challenges and inefficiencies in the elevator system at PPR Sinar Intan Residential. This was accomplished through a combination of qualitative and quantitative approaches, including detailed surveys with residents, interviews with maintenance personnel, and rigorous field measurements. Chapter 3 outlined the methodology employed, where data collection instruments such as structured questionnaires and accelerometer-based performance assessments were used to capture both user experiences and technical performance metrics. Field measurements, as elaborated in Chapter 4, provided precise data on door operation times, loading and unloading durations, travel times, and overall compliance with JKR standards. By analysing this data, the study uncovered recurrent issues such as frequent technical malfunctions, prolonged waiting times, and misuse of elevators, particularly by children, which collectively compromised system efficiency and user satisfaction.

The second objective focused on evaluating the current performance of the elevator system and its adherence to regulatory and user-defined standards. Through the methodologies described in Chapter 4, the study juxtaposed site-measured performance metrics against JKR guidelines, revealing discrepancies in operational efficiency. For example, as presented in Section 4.3, trips exceeding the prescribed 40-second operational limit indicated significant inefficiencies in the system's functionality. Moreover, the interviews conducted with maintenance specialists provided valuable insights into the underlying causes of these inefficiencies, such as delayed maintenance routines and ageing components. The comprehensive traffic analysis and simulation, which modelled lift kinematics, offered additional clarity by quantifying the impact of these issues on handling capacity and passenger waiting times. These findings, discussed in Section 4.4, validated the study's methodological approach and substantiated its conclusions regarding the elevator system's performance gaps.

Ultimately, the study's conclusion underscored the necessity of integrating technical, operational, and community-focused strategies to enhance the elevator system's performance and reliability. By systematically addressing the objectives through robust methodologies and aligning the findings with the associated chapters, the research offered a holistic understanding of the challenges and provided actionable recommendations to improve elevator operations at PPR Sinar Intan.

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Conflict of interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

All authors of this study have a complete contribution for data collection, data analysis and manuscript writing.

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