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# APPLICATION FOR PERFORMANCE ASSESSMENT OF TRANS SEMARANG BUS RAPID TRANSIT PUBLIC TRANSPORT SERVICES

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## Abstract

In a complex procedure, surveys and the delivery of questionnaires to passengers are used to analyze service performance. Because these operations need a lot of equipment and human resources, they become less effective and efficient. The Waterfall system development technique, which comprises four stages—analysis, design, programming, and testing—is used in conjunction with the Importance Performance Analysis (IPA) method for application design. The BRT Trans Semarang Corridor 4 services' performance may be automatically analyzed by the public transport service performance evaluation tool, which will then generate a Cartesian diagram with high and poor performance and importance ratings. Black box testing was used to test the application on five test cases for respondents and seven test cases for administrators, yielding legitimate results or results that met expectations. The Cartesian diagram shows that quadrant I pertains to drivers who maintain traffic order and the provision of safety equipment to be prioritized in service. The public transport service performance assessment application is used to analyze service performance in Corridor 4 of the BRT Trans Semarang. Applications designed to save time and effort while analyzing service performance are available to BRT Trans Semarang managers.

**Keywords:** *Design; Waterfall Method; Service Performance; Questionnaire*

## INTRODUCTION

Public transportation includes moving passengers and goods from origin to destination. For passengers, service quality becomes the level of customer satisfaction [1]. Problems in transportation will be reduced with the advent of public transportation, so that transportation services will support the smooth daily mobility of society [2]. Poor service performance causes a feeling of insecurity and comfort for passengers, thereby increasing the use of private vehicles which are safer and more comfortable [3]. Controlle<sup>21</sup>service satisfaction has a big impact on the level of visitors to a place [4]. Implementation of Bus Rapid Transit (BRT) is a good effort to improve current urban transportation services [5]. The freedom of every person, item, and/or vehicle from interference from unlawful acts, and/or fear in traffic is the meaning of road traffic safety. [6].

Service performance analysis is carried out through respondent surveys using questionnaires in paper form or Google forms, where the survey results are then typed and processed using other devices. This technique requires quite a lot of money, time and effort to print, distribute, collect and enter survey data [7]. The implementation of transportation services faces many challenges, so innovation in transportation services is needed to serve the community. However, the implementation of transportation services often does not meet the

objectives, so evaluation is necessary [8]. Problems in the assessment process for public transportation must be immediately addressed and solutions found.

Solving the problem with new innovation, namely designing and building an application for assessing the performance of public transport services by processing the data using the digitalized or system-based Importance Performance Analysis (IPA) method. Passenger service performance assessment has several methods, such as the Stade Preference method with the Importance Performance Analysis (IPA) method [9]. Data processing using the Importance Performance Analysis (IPA) method produces passenger perceptions of service performance into assessment indicators that are guided by regulations such as Ministerial Regulations and Directorate General Decrees [10]. The problem was solved by building a public transportation service performance application that can be used to analyze transportation service performance and implemented in BRT Trans Semarang Corridor 4 to improve service performance related to drivers who are not orderly in traffic. The system will simplify, speed up and improve the process of assessing transport service performance analysis to achieve more effective and efficient activities, and can reduce costs, time and human resources. Contributions in the field of safety have also increased, especially in the implementation of transport service performance analysis.

## METHODS

The Waterfall method is used to implement a plan using 4 stages to produce a system that is coherent and meets expectations, these stages are analysis, design, programming and testing. The next stage of the Waterfall method can be seen in Figure 1.

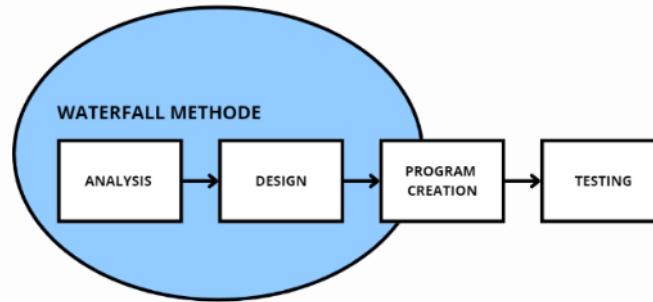


Figure 1. Waterfall Method

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Analysis is divided into 2 needs, namely functional and non-functional requirements. Functional requirements are the implementation of the goals created into a system and non-functional requirements are the tools used when creating the system [11]. Design consists of a use case diagram as a model for the behavior of the information system being created and describes an interaction between one or more actors and the information system to be created [12]. Activity diagram created describes in more detail the use case diagram flow, in the form of a model that describes how an object works with a structured flow from the start point to the end point [13]. Class diagram is a specification that will produce an object and is the core of development that describes the state of a system, as well as offering services to manipulate the

state [14] and plan display on the system. The calculation of service performance analysis uses the **Importance Performance Analysis (IPA)** method with the following steps:

1. Find the score for each performance statement

2. Find the score for each importance statement

3. Determine the total score for each performance statement

$$\Sigma p = (VGx4) + (Gx3) + (NGx2) + (VNGx1) \quad (1)$$

4. Determine the total score for each importance statement

$$\Sigma i = (VIx4) + (Ix3) + (NIx2) + (NUx1) \quad (2)$$

5. Find X performance

$$X = \frac{\Sigma p}{\text{number respondents}} \quad (3)$$

6. Find Y importance

$$Y = \frac{\Sigma i}{\text{number respondents}} \quad (4)$$

7. Find the average performance statement value

$$\bar{X} = \frac{X}{\text{number statements}} \quad (5)$$

8. Find the average importance statement value

$$\bar{Y} = \frac{Y}{\text{number statements}} \quad (6)$$

9. Creation of Cartesian diagrams

$\bar{X}$  = for vertical line

$\bar{Y}$  = for horizontal line

10. Discussion of quadrants

Sample used was 100 respondents obtained from sample population calculations and there were 13 statements [15], statements can be seen in Table 1.

Table 1. Service Performance Statement

No.	Statement
1.	Ticket purchases are made safely
2.	Goods are protected from theft and being exchanged
3.	The vehicle crew's identification information helps passengers recognize the driver
4.	On the bus there is information in the form of a sticker containing an emergency telephone number for complaints
5.	Drivers are orderly in traffic and prioritize safety
6.	The bus has safety equipment (glass breaking device, fire extinguisher and lighting)
7.	The bus provides health facilities in the form of first aid kit
8.	Passenger entry and exit access is easy to use
9.	Inside the bus there are handrails for standing passengers

No.	Statement
10.	Availability of good safety belt facilities <span style="border: 1px solid black; border-radius: 50%; padding: 2px 5px;">9</span>
11.	The rates provided are more flexible for certain groups, such as the elderly, people with disabilities and pregnant women <span style="border: 1px solid black; border-radius: 50%; padding: 2px 5px;">9</span>
12.	There are priority services available for certain groups, such as the elderly, people with disabilities and pregnant women
13.	Announcements during the trip provide clear and understandable information

Program creation is carried out by making applications and implementing designs according to process and data modeling. The MVC development pattern is used in a program framework that emphasizes three important components, namely Model, View, and Controller [16]. Black box testing is used to validate and verify the system so that it conforms to the plan and can be tested on a device without having to pay attention to the software design [17].

## RESULTS AND DISCUSSION

Implementation of the Waterfall method, namely functional requirements analysis, by building a website-based transportation service performance assessment application which is created to automatically analyze the performance of transportation services so as to produce a Cartesian diagram to determine user priorities. The application was created with non-functional requirements in the form of a laptop, mouse, telephone, Laragon, and Visual Studio Code. Use case diagram displays 2 actors, namely admin and respondents with each process. Admin has 4 processes, namely knowing the number of statements, knowing the number of respondents, knowing the assessment of respondents and seeing the results of IPA calculations, while respondents have 3 processes, namely entering the responder 17 personal data form, viewing the questionnaire, and answering the questionnaire statements. The use case diagram can be seen in Figure 2.a. Activity diagrams are carried out between the admin and the system and respondents and the system in a more detailed stage. Admin logs in at the starting point and then the system responds by providing verification so that he can proceed to the next stage. System also displays 5 dashboard and transportation service performance analysis data. Activity diagram for admins can be seen in Figure 2.b.

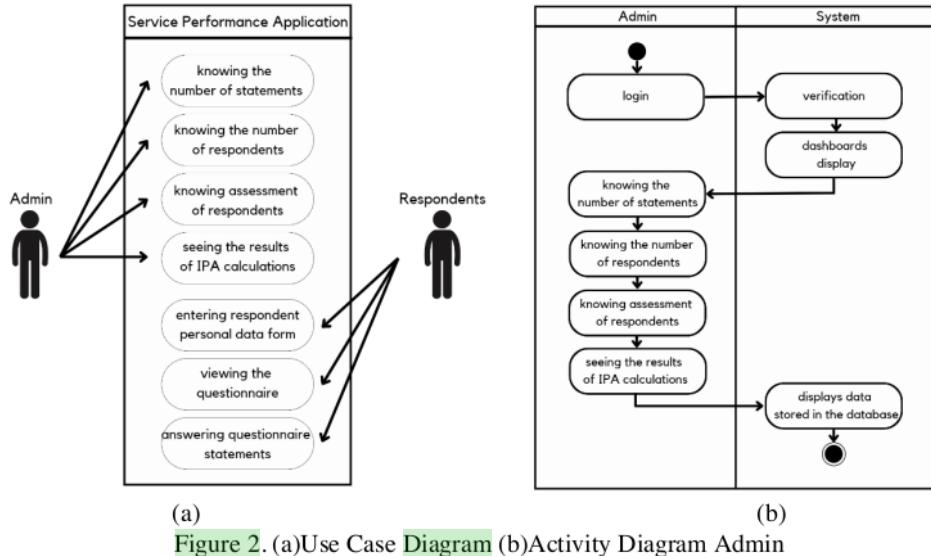


Figure 2. (a) Use Case Diagram (b) Activity Diagram Admin

Respondents log in at the starting point and then the system responds by providing verification so they can proceed to the next stage. System also displays the main page and a thank you display after the respondent has finished answering the statement. Activity diagram for respondents can be seen in Figure 3.a. Class diagram contains 4 database tables, namely user, statement, response and respondent with each integer, specification and action. Each table is related to each other and in general the display plan for the application will be visible with a class diagram because it can describe the state of a system. Class diagram can be seen in Figure 3.b.

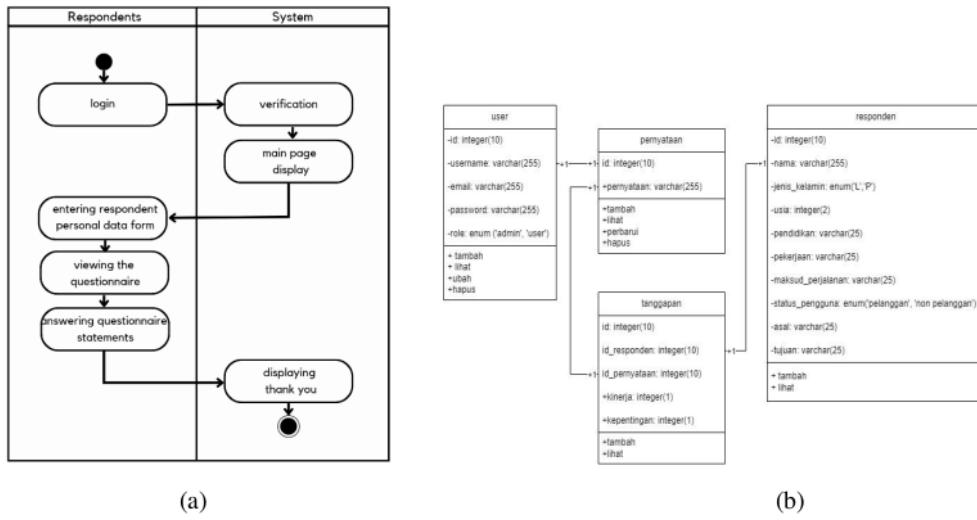


Figure 3. (a) Activity Diagram Responden (b) Class Diagram

The program that has been planned at the design stage will be implemented on a website page, having 2 website pages, namely for admin and for respondents. Access for respondents can be via a link or barcode provided by the admin. Admins who have an email and password can access the dashboards page and access other tabs intended for admins. Next, the implementation of the admin page can be seen in Figure 4.



Figure 4. Dashboards Page

Respondents who have received the link or barcode will go directly to the home page which contains introductory words and procedures for filling out the questionnaire and will then move on to the page for filling in the respondent's personal data. If filling in personal data has been completed, it will continue on the statement page and respondents are directed to be able to select the available statements according to actual conditions related to the performance and interests of transportation services. Statement page for respondents can be seen in Figure 5.



Figure 5. Statement Page

Testing was carried out by admin and respondents with 1 experimenter each. Admin with 7 test cases produced 7 suitability and respondents with 5 test cases produced 5 suitability. The test results obtained from black box testing are 100% conformity between the test scenario or test case and the expected results or <sup>13</sup> the test case is valid. Furthermore, the results of black box testing for admins and respondents can be seen in Table 2 and Table 3.

Table 2. Black Box Testing Results for Admin

No	Test Scenarios and Test Cases	Expected	Test
1.	Empty file in Login	An error message appears and the system will reject the login request.	Valid
2.	The file is filled in at Login	Enter the dashboards page.	Valid
3.	Clicking the “Pernyataan”	A list of statements displayed in the questionnaire appears.	Valid
4.	Clicking the “Responden”	Data on respondents who have filled out the questionnaire appears.	Valid
5.	Clicking the “Penilaian”	A bar chart appears regarding the assessment scores.	Valid
6.	Clicking the “Hasil”	The final result appears in the form of a Cartesian diagram for each statement	Valid
7.	Clicking the “Pengguna”	The user data registered by the system appears.	Valid

Table 3. Black Box Testing Results for Respondents

No	Test Scenarios and Test Cases	Expected	Test
1.	Clicking the “Tampilan Barcode”	A barcode appears which can be scanned by other respondents.	Valid
2.	Clicking the “Mulai Survei”	A personal data form appears for respondents to fill in.	Valid
3.	Empty file in personal data form	An error message appears and the system will reject the login request.	Valid
4.	Files are filled in on the personal data form	Appears on the statement page filled in by the respondent.	Valid
5.	Select all statements according to conditions and wishes, and click send	A thank you page appears as the closing of the questionnaire.	Valid

Analysis of the performance of the Trans Semarang BRT manual service in Corridor 4 can be seen that the average value of each performance statement is 2.5 which is obtained from dividing the number of X by 13 (statements) and will become a vertical line in the Cartesian diagram as well as the average value of each performance statement equal to 2.7 which is obtained from dividing the number Y by 13 (statement) and will be the horizontal line in the Cartesian diagram. The results of the analysis can be seen in Table 4 and Table 5.

Table 4. Performance Analysis Results

Statement Number	Performance				Total Score	X
	1	2	3	4		
1	29	40	60	124	253	2,53
2	26	60	66	88	240	2,40
3	11	78	114	48	251	2,51
4	25	40	90	100	255	2,55
5	32	104	42	8	186	1,86
6	28	110	36	20	194	1,94
7	39	108	21	0	168	1,68
8	0	28	126	176	330	3,30
9	4	24	153	132	313	3,13
10	27	58	66	88	239	2,39
11	16	68	90	80	254	2,54
12	6	74	96	100	276	2,76
13	2	52	108	144	306	3,06
Number X						32,65
Average Value of Each Performance Statement						2,50

Table 5. Importance Analysis Results

Statement Number	Importance				Total Score	Y
	1	2	3	4		
1	24	44	78	112	258	2,58
2	23	46	84	104	257	2,57
3	37	96	33	16	182	1,82
4	36	92	30	32	190	1,90
5	0	2	222	100	324	3,24
6	0	10	150	180	340	3,40
7	34	26	78	108	246	2,46
8	0	18	126	196	340	3,40
9	0	8	78	280	366	3,66
10	28	46	75	96	245	2,45
11	29	40	75	104	248	2,48
12	22	52	81	100	255	2,55
13	3	12	213	80	308	3,08
				Number Y	35,59	
				Average Value of Each Importance Statement	2,70	

The digital service performance analysis calculation displays the score for each statement on the assessment page in the form of a bar chart and contains the number of respondents' frequencies on each Likert scale for both performance and importance. Data comes from the results of respondents' assessments regarding performance and interests. The score for each digital statement can be seen in Figure 6.

↑↓	ID Pernyataan	↑↓	Kinerja	↑↓	Kepentingan
	24		★★★		★★
	25		★★		★★★
	26		★★★		★★
	28		★★★		★★
	30		★★		★★★

Figure 6. Statement Score in App

Data will automatically change on the results page in the form of a Cartesian diagram with a center line. The Cartesian diagram has 4 quadrants with each quadrant having a different color, for quadrant 1 it is red, quadrant 2 is blue, quadrant 3 is yellow and quadrant 4 is green. Average value of each statement X for performance 2.5 and Y for importance 2.7, will be used as the divider or center line in determining the quadrants on the Cartesian diagram. Quadrant 1 with information about low performance and high importance, which means that the performance of the services provided has not been fulfilled but is included in the quadrant that is considered important by users so that it needs to be improved and corrected. The statements that are included in quadrant 1 are statement number 5 and statement number 6. Quadrant 2 with information about high performance and high importance which means that the performance provided is in accordance with the user's wishes so it only needs to be maintained. The statements that are included in quadrant 2 are statement number 8, number 9 and statement number 13. Quadrant 3 with information about low performance and low importance means that performance is considered not optimal and not important enough for users to be improved in the short term, but service awareness still needs to be considered for better service. The statement that is included in quadrant 3 is statement number 2, number 3, number 7 and number 10. Quadrant 4 with information about high performance and low importance, which means that service performance has exceeded expectations because of its low importance. The statements included in quadrant 4 are statements number 1, number 4, number 11, and number 12. Digital Cartesian diagram can be seen in Figure 7.

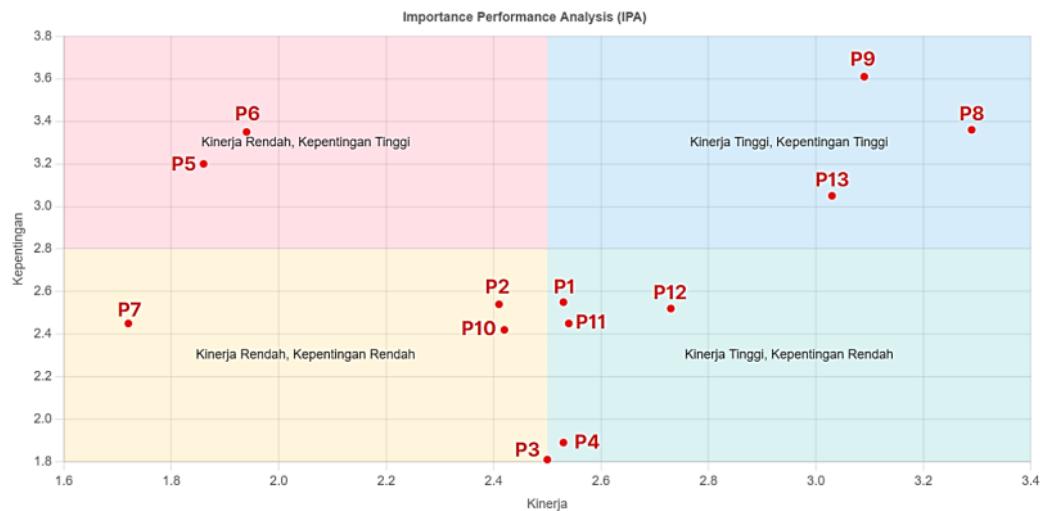


Figure 7. Cartesian diagram in App

The discussion is located on the results page in the form of conclusions for each quadrant. Quadrant 1 means low performance and high importance, quadrant 2 means high performance

and importance, quadrant 3 means low performance and importance and quadrant 4 means high performance and importance. Discussion of the digital quadrant can be seen in Figure 8.

No ↑	Pernyataan	X ↑	Y ↑	Kuadran	↑↓
1	Pembelian tiket dilakukan secara aman	2.53	2.55	Kinerja Tinggi, Kepentingan Rendah	
2	Barang terhindar dari pencurian dan tertukar	2.41	2.54	Kinerja Rendah, Kepentingan Rendah	
3	Informasi tanda pengenal awak kendaraan membantu penumpang mengenali pengemudi	2.5	1.81	Kinerja Rendah, Kepentingan Rendah	
4	Di dalam bus terdapat informasi berupa stiker berisi nomor telepon darurat untuk pengaduan	2.53	1.89	Kinerja Tinggi, Kepentingan Rendah	
5	Pengemudi tertib lalu lintas dan mengutamakan keselamatan	1.86	3.2	Kinerja Rendah, Kepentingan Tinggi	
6	Bus memiliki peralatan keselamatan (alat pemecah kaca, alat pemadam api ringan dan penerangan)	1.94	3.35	Kinerja Rendah, Kepentingan Tinggi	
7	Di dalam bus menyediakan fasilitas kesehatan berupa P3K	1.72	2.45	Kinerja Rendah, Kepentingan Rendah	
8	Akses keluar dan masuk penumpang mudah digunakan	3.29	3.36	Kinerja Tinggi, Kepentingan Tinggi	
9	Di dalam bus terdapat fasilitas pegangan tangan bagi penumpang berdiri	3.09	3.61	Kinerja Tinggi, Kepentingan Tinggi	
10	Tersedianya fasilitas sabuk keselamatan yang baik	2.42	2.42	Kinerja Rendah, Kepentingan Rendah	
11	Tarif yang disediakan lebih fleksibel terhadap kelompok tertentu, seperti lansia, disabilitas dan ibu hamil	2.54	2.45	Kinerja Tinggi, Kepentingan Rendah	
12	Adanya layanan prioritas yang tersedia untuk kelompok tertentu, seperti lansia, disabilitas dan ibu hamil	2.73	2.52	Kinerja Tinggi, Kepentingan Rendah	
13	Pengumuman selama perjalanan memberikan informasi yang jelas dan dapat dimengerti	3.03	3.05	Kinerja Tinggi, Kepentingan Tinggi	

Figure 8. Discussion of Quadrants in App

Digital service performance analysis calculations have steps that are similar to manual calculations, but are carried out automatically. The discussion of the IPA method is displayed with a new face to make it easier for admins to read the results. Analysis processing using the IPA method produces the same data as manual calculations or there is no difference. The BRT Trans Semarang transportation service performance assessment application created has achieved its objectives and can be used to save time and human resources. This application is useful for simplifying, speeding up and improving the process of assessing transport service performance analysis to achieve more effective and efficient activities.

BRT Trans Semarang Corridor 4 still often has accidents caused by reckless drivers [18], according to the results of service performance analysis that services at BRT Trans Semarang Corridor 4 need to be improved, especially regarding drivers who are still less orderly in traffic. The safety equipment on the bus is still not complete, but basically the safety and security of passengers is the main priority [19]. Passenger entry and exit services function well in each corridor in BRT Trans Semarang, because passenger access is always assisted by the bus conductor to open the doors. Travel information regarding the route will always be available throughout the journey using audio so that it can be heard by passengers from the very back seat of the bus. The handrail facilities are appropriate and function well because they help passengers

maintain balance on the bus. Services that have been fulfilled and in line with expectations need to be maintained to maintain the quality of bus services.

Tight security between male and female passengers is one of the factors that causes theft to be rare. Vehicle crew information is not completely necessary because it is not considered that important for passengers. The provision of health facilities on buses is underused because they are dominated by passengers who travel short distances so travel sickness rarely occurs. Safety belts are not provided because passengers are not required to do so. Services can be completed in the long term because they are not yet a priority. Passengers are not allowed to enter before handing over tickets that have previously been purchased at the halter or bus stop, so that there are no passengers without tickets on the bus. Stickers containing emergency telephone numbers can be used by passengers to make service complaints. The fares provided by BRT Trans Semarang are implemented well because they are easily adjusted to certain groups such as children who carry student cards, the elderly and workers. Seats near the door are a form of priority service on buses for the elderly and people with disabilities. The service becomes excessive because it exceeds expectations and has low interest for passengers.

## CONCLUSION

The completed BRT Trans Semarang public transportation service performance assessment application was created using the 4 stages of the Waterfall method, namely analysis, design, programming and testing. The test used is black box testing and produces conformity [20]ween the test case and expectations or is valid. The website-based application can analyze the performance of BRT Trans Semarang services with output in the form of a Cartesian diagram because it uses the Importance Performance Analysis (IPA) method so that it can determine service priorities for passengers and carrying out this analysis will be easier by using the website-based application that has been created.

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