Performance Analysis with Quality Function Method Deployment (QFD)

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	ABSTRACT
	Reliable and efficient public transportation is vital for urban areas like Semarang. This study evaluates the operational and service performance of Corridor 1, measures passenger satisfaction, and identifies service indicators needing improvement. Primary data were collected through field surveys and questionnaires distributed to 100 respondents. The methods used include Importance Performance Analysis (IPA), Customer Satisfaction Index (CSI), and Quality Function Deployment (QFD), referring to national and local transportation standards. Findings show that load factors (42% morning, 37% afternoon), bus speeds (25–27 km/h), and waiting times (3.6–3.8 minutes) meet service standards, while headways (7.3–7.6 minutes) remain outside the 2–5 minute peak-hour standard. In the afternoon, only 96% of the fleet operates. Based on IPA and QFD results, seven service indicators are prioritized for improvement: dwell time, onboard cleanliness and health facilities, heat-protective window film, accessibility to stops, user willingness to recommend the service, and passenger waiting times. The implications of this research for educational management are the importance of efficient public transportation to improve accessibility and comfort for students and educators. By improving service indicators, it is expected to support smooth mobility to educational institutions, increase student participation, and support active involvement in academic activities.

INTRODUCTION

Public transportation is a fundamental element in the urban system that plays a vital role in supporting people's daily mobility. The existence of an efficient transportation system not only has an impact on the smooth movement of people and goods, but also has a significant effect on economic productivity and the quality of life of urban communities, including enhancing access to educational institutions (Firdaus et al., 2021). In the context of Indonesia, rapid

population growth and urbanization have created complex challenges in the provision of adequate transportation services, especially in major cities that experience increasingly acute congestion and air pollution problems. This issue becomes particularly relevant in the educational sector, where efficient transport can facilitate access to schools, universities, and other learning centers, thus supporting the overall development of human capital.

Bus Rapid Transit (BRT) has become a mass transportation solution that is widely adopted in various developing countries as a cost-effective alternative to overcome urban mobility problems (Firdaus et al., 2022). The BRT system offers advantages in the form of large carrying capacity, relatively fast travel time, and more efficient operational costs compared to rail-based transit systems. In Indonesia, BRT implementation has been carried out in various metropolitan cities, including Jakarta (TransJakarta), Yogyakarta (TransJogja), and Semarang (Trans Semarang), with the main goal of reducing people's dependence on private vehicles and increasing the accessibility of urban areas. This accessibility is crucial for students, teachers, and academic staff who rely on public transport to reach educational institutions.

Trans Semarang as a BRT system in Semarang City was developed with the vision of becoming the backbone of public transportation that connects various strategic areas in the city. Corridor 1, which serves the Mangkang-Penggaron route, has a strategic position as the main link between the West and East regions of Semarang City. With a long route that covers a large area and a significant volume of passengers, Corridor 1 is a key indicator of the success of the Trans Semarang system as a whole. Even though it has been operating for several years, the Trans Semarang Corridor 1 BRT service still faces various operational challenges that affect service quality, which also impacts the daily commute of many students and educational staff (Yusman et al., 2025). Problems that often arise include high occupancy rates during peak hours, unstable bus speeds, headway irregularities, and the number of fleets that are not optimal in meeting passenger demand (Adhim et al., 2021). This creates inconvenience for users, especially during the peak hours of the morning when mobility to work, school, and other activity centers reaches its highest intensity. Efficient public transport is essential to ensure timely access to educational institutions and improve overall learning experiences.

Evaluation of the performance of BRT services is a crucial aspect in efforts to improve the quality of public transportation. A comprehensive assessment of various performance indicators such as occupancy rate, speed, headway time between buses, fleet number, and user satisfaction level can provide a comprehensive picture of the operational effectiveness of the BRT system (Susanto et al., 2021). In this context, the importance of these services for

educational sectors cannot be overlooked, as reliable transportation impacts student attendance, the punctuality of teachers, and the general accessibility to educational opportunities. An in-depth analysis of these aspects allows the identification of weak points in the system and the formulation of targeted improvement strategies, particularly those addressing the needs of the education sector. In the context of evaluation methodology, Quality Function Deployment (QFD) is an effective approach to translate user needs and expectations into technical specifications that can be implemented by service managers. The QFD method allows for a systematic analysis of the relationship between user satisfaction and operational technical parameters, so that it can generate improvement priorities based on the perception and actual needs of service users, including those in the education sector (Firdaus et al., 2025).

Based on the conditions that have been described, this study formulates a research question: What is the level of suitability of the operational performance of the BRT Trans Semarang Corridor 1 Mangkang-Penggaron to the Minimum Service Standards set? Which operational indicators are a priority for improvement based on user perception analysis? What is the level of user satisfaction with the services available? And how to formulate priority directions for improvement through the implementation of the Quality Function Deployment method (Nova et al., 2025; Pratama et al., 2024). These improvements are essential for ensuring the accessibility and efficiency of transportation services for students, teachers, and educational staff, thereby supporting the broader educational goals of the city.

This research makes a practical contribution for BRT managers in service optimization, provides transparent information for users regarding service quality, and contributes to the development of public transportation evaluation methodology in Indonesia, especially in the implementation of Quality Function Deployment for the Bus Rapid Transit system (Sukwadi et al., 2021). The findings of this research are expected to aid in creating an efficient and reliable transportation system that supports the educational sector and other vital sectors in Semarang City.

RESEARCH METHOD

The research was carried out in Corridor 1 of the Mangkang-Penggaron BRT Trans Semarang which connects the Western and Eastern regions of Semarang City. Data collection was carried out over three working days, namely Monday, Wednesday, and Sunday at 07:00–10:00 WIB and 16:00–19:00 WIB, which is the peak time when Trans Semarang users start and end activities with various goals (Dermawan et al., 2021; Israadi & Satrio, 2021)

The population in this study includes the entire bus fleet and passengers of BRT Trans Semarang Corridor 1 which operates during peak morning and evening hours (Dwiatmoko et al., 2022; Isradi et al., 2021). Based on data from the https://regional.espos.id/brt-trans-semarang-capai-13-juta-penumpang-di-2024-moda-transportasi-terfavorit-2045211 website, the number of passengers on the Trans Semarang BRT Corridor 1 in early 2025 is 2,598,855 people. To determine a representative sample size, a Slovin formula with an error rate of 10% is used:

$$n = N/(1+N(e^2)) \quad n = 2{,}598{,}855/(1+2{,}598{,}855(0.1^2)) \quad n = 100 \text{ respondents}$$

Primary data was obtained directly from the field through observation and distribution of questionnaires. Observations were made on the BRT Trans Semarang Corridor 1 operational vehicles in terms of operational performance, including: load factor, travel speed, headway, travel time, frequency of operational vehicles, and bus waiting time.

Service performance data was obtained through a questionnaire given to users of the Trans Semarang BRT Corridor 1 service, in the form of questions related to the perception and expectations of service users referring to the Regulation of the Mayor of Semarang Number 45 of 2021 dated July 13, 2021 concerning the Minimum Service Standards of the Public Service Agency Technical Implementation Unit of the Trans Semarang Office.

Secondary data is information that already exists and is recollected to complete the research needs, including: (1) Location maps obtained through the official Trans Semarang website; (2) Trans Semarang Minimum Service Standards from Semarang Mayor Regulation Number 45 of 2021; (3) The length of the route and route of the road network from the official Trans Semarang website; and (4) The number of vehicle fleets from Trans Semarang agencies.

RESULT AND DISCUSSION
Respondent Characteristics Analysis

This study involved 100 respondents who were active users of the Trans Semarang BRT Corridor 1 service. Analysis of these characteristics is important to understand user segmentation as the basis for performance evaluation and service development. Respondents were classified by gender, age, education level, occupation, frequency of use, travel destination, and domicile.

The majority of BRT Trans Semarang Corridor 1 users are female (61%) and predominantly within the 21–30 age group (41%), followed by those under 20 years old (27%), indicating that the service is primarily used by the productive age group and students. This demographic suggests a strong demand for services that emphasize technology, punctuality, and convenience. In terms of education, 52% of users hold a D3/D4/S1 degree, showing a high level of public trust and

suggesting that users are more critical and have higher expectations for service quality. The majority of respondents are private-sector employees (48%) and students (30%), underscoring the BRT's role as a key connector between residential areas and workplaces or educational institutions. Furthermore, 74% of users rely on BRT services 3–5 times a week, demonstrating the system's integration into daily routines and its growing significance as a primary mode of transportation in Semarang.

BRT Trans Semarang Corridor 1 Operational Performance

Measurements are taken on Mondays, Wednesdays, and Sundays during peak hours (morning and evening) to get a comprehensive picture of service usage patterns. The load factor describes the utilization rate of bus carrying capacity to the actual passenger volume. Operational speed reflects service efficiency and remains within the safe limit of 30 km/h as regulated in the Semarang Mayor Regulation No. 45 of 2021 concerning minimum service standards. However, recorded headway averages of 7.3 minutes in the morning and 7.6 minutes in the afternoon exceed the peak-hour standard of 2–5 minutes as stipulated in the Decree of the Director General of Land Transportation No. SK.687/AJ.206/DRJD/2002 concerning Technical Guidelines for the Operation of Public Passenger Transport on Fixed and Regular Routes in Urban Areas. Travel time refers to the total duration required for a BRT unit to complete its route, while passenger waiting time is calculated as half the headway value. Currently, 25 buses are operating along Corridor 1 (Mangkang–Penggaron), ensuring regular service across the entire route.

Table 1. Overall results of BRT Trans Semarang Corridor 1 Operational Performance

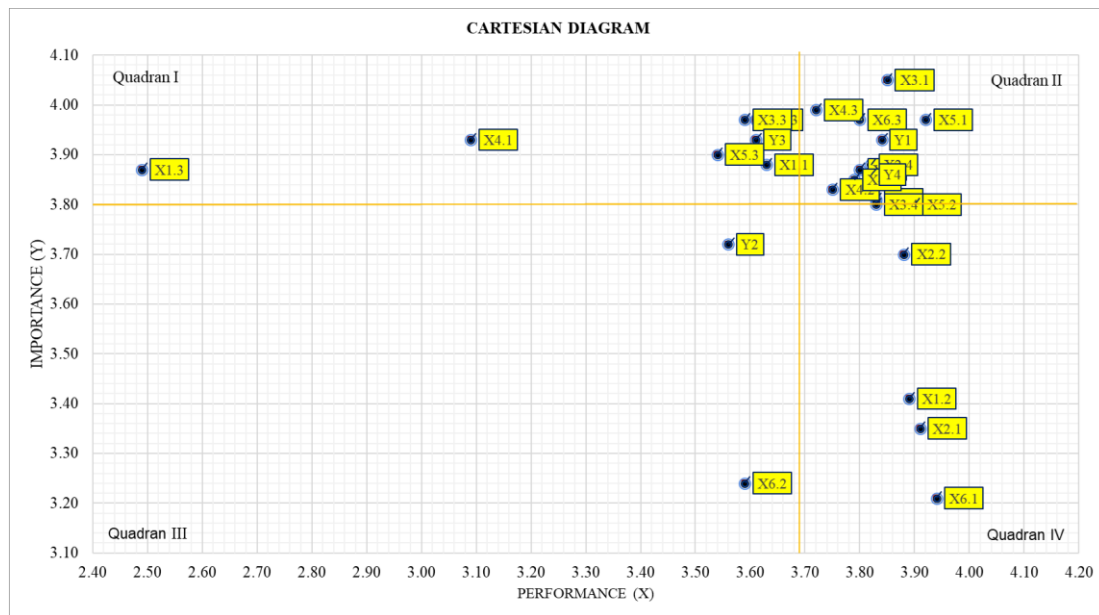| Indicator	Unit	Standard	Morning	Afternoon
Load factor	%	≤ 100	42	37
Travel Speed	km/h	30	25	27
Headway	minutes	2-5 minutes	7.3	7.6
Travel Time	minutes/km	-	3	2
Waiting Time	minutes	7	3.6	3.8
Frequency	Unit (%)	25	25 (100%)	24 (96%)

Importance Performance Analysis (IPA)

The Importance Performance Analysis (IPA) is a descriptive analytical approach employed to systematically identify key service attributes that require prioritization by service providers in order to enhance user satisfaction and meet consumer expectations. The method utilizes a four-quadrant framework that

facilitates the evaluation of service performance in relation to the perceived importance of each attribute from the consumer's perspective.

Table 2. Analysis importance performance analysis (IPA)

Indicator	Total Performance Score	Total Importance Score	Average Performance	Average Importance	GAP
X1.1	363	388	3,63	3,88	-0,25
X1.2	389	341	3,89	3,41	0,48
X1.3	249	387	2,49	3,87	-1,38
X1.4	380	387	3,8	3,87	-0,07
X2.1	391	335	3,91	3,35	0,56
X2.2	388	370	3,88	3,7	0,18
X2.3	361	397	3,61	3,97	-0,36
X2.4	382	388	3,82	3,88	-0,06
X3.1	385	405	3,85	4,05	-0,2
X3.2	383	381	3,83	3,81	0,02
X3.3	359	397	3,59	3,97	-0,38
X3.4	383	380	3,83	3,8	0,03
X4.1	309	393	3,09	3,93	-0,84
X4.2	375	383	3,75	3,83	-0,08
X4.3	372	399	3,72	3,99	-0,27
X4.4	379	385	3,79	3,85	-0,06
X5.1	392	397	3,92	3,97	-0,05
X5.2	390	380	3,9	3,8	0,1
X5.3	354	390	3,54	3,9	-0,36
X6.1	394	321	3,94	3,21	0,73
X6.2	359	324	3,59	3,24	0,35
X6.3	380	397	3,8	3,97	-0,17
Y1	384	393	3,84	3,93	-0,09
Y2	356	372	3,56	3,72	-0,16
Y3	361	393	3,61	3,93	-0,32
Y4	382	386	3,82	3,86	-0,04
limit =			3,69	3,80	

Figure 1. Cartesian Diagram (IPA)

Quality Function Deployment (QFD) Analysis

The first step in Quality Function Deployment (QFD) analysis is knowing the Voice of Customer (VOC), or perceptions of Trans Semarang passengers or customers. After that, proceed with the creation of a House of Quality (HOQ), or quality house (Dewi et al., 2020).

1. Voice of Customer

In this study, the voice of the customer refers to passengers' expectations regarding Trans Semarang services that have not been fulfilled, particularly those service attributes positioned in Quadrant I of the Importance Performance Analysis (IPA) framework.

Table 3. Voice of customer Trans Semarang

No. Atribute	Voice of Customer	Performance Level (X)	Importance Level (Y)	GAP
X1.3	Bus stopping time at each bus stop is 1 minute.	2,49	3,87	-1,38
X4.1	Availability of cleanliness facilities such as trash bins.	3,09	3,93	-0,84
X3.3	Health facilities, such as: first aid kit (P3K) on board.	3,59	3,97	-0,38
X2.3	Window film/layer to reduce sunlight glare.	3,61	3,97	-0,36
X5.3	Access facilities to bus stops that accommodate wheelchair users, people with disabilities,	3,54	3,9	-0,36

No. Atribute	Voice of Customer	Performance Level (X)	Importance Level (Y)	GAP
	the elderly, and pregnant women.			
Y3	Willingness of service users to recommend the service to friends or family.	3,61	3,93	-0,32
X1.1	Waiting time during peak hours is a maximum of 7 minutes.	3,63	3,88	-0,25

The second phase in constructing the House of Quality (HoQ) involves the formulation of the planning matrix. This matrix encompasses several key components, including the importance of customer, customer satisfaction, performance goal, improvement ratio, raw weights, and normalized weights.

2. Importance of Customer (IoC)

The Importance to Customers (IoC) refers to the set of values indicating the relative significance of each attribute as perceived by customers in fulfilling their service expectations (Dewi et al., 2020).

Table 4. IoC Trans Semarang

No. Atribute	Voice of Customer	GOAL	IoC
X1.3	Bus stopping time at each bus stop is 1 minute.	3,87	0,1410
X4.1	Availability of cleanliness facilities such as trash bins.	3,93	0,1432
X3.3	Health facilities, such as: first aid kit (P3K) on board.	3,97	0,1446
X2.3	Window film/layer to reduce sunlight glare.	3,97	0,1446
X5.3	Access facilities to bus stops that accommodate wheelchair users, people with disabilities, the elderly, and pregnant women.	3,9	0,1421
Y3	Willingness of service users to recommend the service to friends or family.	3,93	0,1432
X1.1	Waiting time during peak hours is a maximum of 7 minutes.	3,88	0,1413
	Total Goal	19,64	

3. Improvement Ratio (IR)

IR is a measure of efforts to change the level of satisfaction of Trans Ssemarang users in existing conditions with service attributes. IR is obtained by dividing the goal value by the CSP value.

Table 5. Improvement value of trans semarang service satisfaction ratio

No. Atribue	Voice of Customer	Goal	CSP	IR
X1.3	Bus stopping time at each bus stop is 1 minute.	3,87	2,49	1,55
X4.1	Availability of cleanliness facilities such as trash bins.	3,93	3,09	1,27
X3.3	Health facilities, such as: first aid kit (P3K) on board.	3,97	3,59	1,11
X2.3	Window film/layer to reduce sunlight glare.	3,97	3,61	1,10
X5.3	Access facilities to bus stops that accommodate wheelchair users, people with disabilities, the elderly, and pregnant women.	3,9	3,54	1,10
Y3	Willingness of service users to recommend the service to friends or family.	3,93	3,61	1,09
X1.1	Waiting time during peak hours is a maximum of 7 minutes.	3,88	3,63	1,07

4. Raw Weight (RW)

Based on the results of the RW calculation at Table 20, it is known that the attribute of bus stopping time at each bus stop is 1 minute. is the attribute with the highest Raw Weight value, namely with a value of 6,015; it shows that the attribute has the highest overall importance value compared to other service attributes.

Table 6. RW value of trans semarang service satisfaction

No. Atribute	Voice of Customer	Goal	IR	RW
X1.3	Bus stopping time at each bus stop is 1 minute.	3,87	1,55	6.015
X4.1	Availability of cleanliness facilities such as trash bins.	3,93	1,27	4.998
X3.3	Health facilities, such as: first aid kit (P3K) on board.	3,97	1,11	4.390
X2.3	Window film/layer to reduce sunlight glare.	3,97	1,10	4.366
X5.3	Access facilities to bus stops that accommodate wheelchair users, people with disabilities, the elderly, and pregnant women.	3,9	1,10	4.297
Y3	Willingness of service users to recommend the service to friends or family.	3,93	1,09	4.278
X1.1	Waiting time during peak hours is a maximum of 7 minutes.	3,88	1,07	4.147
Total				32,491

5. Technical Response

Technical response is part of the House of Quality (HOQ), which contains answers from Voice of Customer (Cahyadi & Efranto, 2012).

Table 7. Technical response satisfaction and trans semarang services

RT	Terchnical Response
RT-1	Adjustment of bus stopping time based on timers and GPS monitoring at each stop.
RT-2	Addition of trash bins inside buses and at bus stops, along with scheduled cleanliness inspections.
RT-3	Regular inspection and replacement of first aid kit contents by staff.
RT-4	Installation of heat-protective (UV-blocking) window film and routine inspection of bus window conditions.
RT-5	Adjustment of platform height, addition of ramps (no stairs), and training for drivers and BRT staff to assist priority passengers.
RT-6	Service quality improvement through user performance audits, driver training, and an active public complaint system.
RT-7	Scheduling of buses using GPS tracking systems to ensure punctual arrival times.

6. Absolute Importance (AI)

Absolute importance is the importance value of the technical response obtained from the sum of the results of multiplying the level of importance in each service attribute with the relationship value of the service attribute to the technical response (Hilmy et al., 2021).

Table 8. AI calculation of trans semarang service satisfaction

RT	Relation Score	Goal	AI	Priority
RT-1	12	3.87	46.44	5
RT-2	9	3.93	35.37	7
RT-3	9	3.97	35.73	6
RT-4	12	3.97	47.64	2
RT-5	12	3.90	46.80	3
RT-6	15	3.93	58.95	1
RT-7	12	3.88	46.56	4

7. House of Quality

Quality Function Deployment (QFD) is a structured method used in planning and service development that enables a development team to systematically identify customer needs and expectations, and assess the extent to which a product or service can fulfill those demands (Dewi et al., 2020).
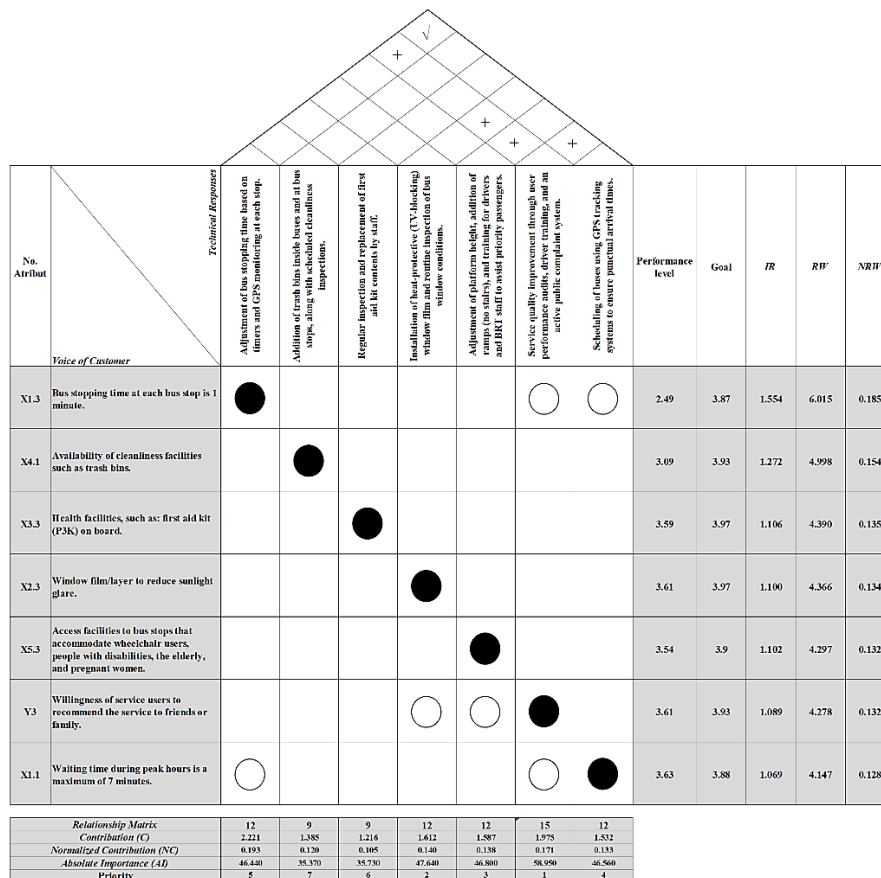
Figure 2. House of Quality (HOQ)

Figure 4 illustrates the House of Quality (HoQ) analysis for BRT Trans Semarang Corridor 1 service performance. Among the top priority attributes, the bus stop dwell time (X1.3) is strongly linked to technical responses such as GPS-based timer adjustments and driver training to ensure consistent one-minute stops at each station. The cleanliness facility (X4.1), particularly the provision of trash bins, is directly related to scheduled sanitation inspections and bin installation, fulfilling user expectations. The health facility attribute (X3.3), such as the presence of onboard first-aid kits, is aligned with regular maintenance and restocking efforts. Solar heat reduction via window film (X2.3) correlates with UV-protective glass installation, enhancing midday comfort. Accessibility for vulnerable groups (X5.3) is addressed through adjustments in platform height, the addition of ramps, and staff training. Additionally, users' willingness to recommend the service (Y3) is associated with improvements in service quality audits and vehicle comfort. Finally, the waiting time expectation (X1.1) of under seven minutes during peak hours is linked to GPS-based scheduling systems, ensuring better arrival predictability. These findings reflect key customer needs and provide a focused roadmap for service improvements.

CONCLUSION

The findings of this study conclude that the operational performance of BRT Trans Semarang Corridor 1 generally complies with applicable standards. Indicators such as load factor, average speed, and passenger waiting time fall within acceptable thresholds set by the relevant regulations. However, the headway during peak hours still exceeds the recommended standard of 2–5 minutes, and the fleet availability in the afternoon does not reach full operational capacity, with only 96% of buses in service. Through the Importance Performance Analysis (IPA) and Quality Function Deployment (QFD) methods, several service indicators were identified as priorities for improvement. These include bus stop duration, availability of cleanliness and health facilities (such as trash bins and first-aid kits), protective window films, accessibility to bus stops, the willingness of users to recommend the service, and the consistency of passenger waiting times. These elements reflect users' perceptions and highlight areas where service delivery does not yet meet expectations.

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