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Inequality of Access to Fire Services: An Analysis of Disparity in Response Time in West Bandung Regency

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Abstract: Fire services are a basic public service whose value depends on how quickly crews reach an incident, yet most studies of fire station planning focus on urban settings and give less attention to regencies that combine dense urban corridors with hilly rural areas. This study examines how response-time disparities reflect unequal access to fire services between urban and rural areas of West Bandung Regency, which factors explain them, and what they imply for equitable basic service policy. A sequential explanatory mixed-methods design was used. Quantitative data comprised 1,247 fire incident records from 2022 to 2024, analysed through descriptive statistics, difference tests, correlation, response-time decomposition, and geographic information system network analysis. Qualitative data came from interviews and observation. Mean response time was 13.2 minutes in urban areas and 23.8 minutes in rural areas, and 77.5% and 16.8% of incidents met the fifteen-minute standard. Travel time accounted for 9.3 of the 10.6-minute gap. Only four serviceable fire trucks, concentrated in three service points, were available, and fifteen-minute coverage was estimated at 55.2% of residents. The novelty of this study lies in separating facility presence, spatial coverage, and actual performance, showing that the administrative presence of fire posts does not guarantee effective access.

Keywords: Basic Services, Fire Services, Response Time, Service Access, Spatial Justice

Abstrak: *Layanan pemadam kebakaran merupakan pelayanan dasar yang nilainya ditentukan oleh kecepatan petugas tiba di lokasi kejadian, tetapi sebagian besar kajian perencanaan pos pemadam berfokus pada wilayah perkotaan dan kurang memperhatikan kabupaten yang memadukan koridor perkotaan padat dengan kawasan perdesaan berbukit. Penelitian ini bertujuan menganalisis bagaimana disparitas waktu tanggap mencerminkan ketimpangan akses layanan pemadam kebakaran antara kawasan perkotaan dan perdesaan di Kabupaten Bandung Barat, faktor yang menjelaskannya, serta implikasinya bagi kebijakan pemerataan pelayanan dasar. Penelitian menggunakan desain* mixed methods *eksplanatori sekuensial. Data kuantitatif berasal dari 1.247 catatan kejadian kebakaran tahun 2022–2024 yang dianalisis dengan statistik deskriptif, uji beda, korelasi, dekomposisi komponen waktu tanggap, serta analisis jaringan berbasis sistem informasi geografis. Data kualitatif diperoleh melalui*

wawancara dan observasi. Rata-rata waktu tanggap adalah 13,2 menit di kawasan perkotaan dan 23,8 menit di kawasan perdesaan, dengan kepatuhan terhadap standar lima belas menit masing-masing 77,5% dan 16,8%. Waktu tempuh menyumbang 9,3 dari selisih 10,6 menit. Hanya empat mobil pemadam layak pakai yang tersedia, terkonsentrasi di tiga titik layanan, dan cakupan lima belas menit diperkirakan meliputi 55,2% penduduk. Kebaruan penelitian ini terletak pada pemisahan keberadaan fasilitas, cakupan spasial, dan kinerja aktual, yang menunjukkan bahwa keberadaan pos secara administratif belum menjamin akses yang efektif.

Kata Kunci: *Akses Layanan, Keadilan Spasial, Pelayanan Dasar, Pemadam Kebakaran, Waktu Tanggap*

INTRODUCTION

Fire management includes basic services that must be provided by local governments. Government Regulation Number 2 of 2018 places fire sub-affairs in the Minimum Service Standards (SPM) in the fields of peace, public order, and community protection (Government Regulation Number 2 of 2018 concerning Minimum Service Standards, 2018). The technical provisions are regulated in Permendagri Number 114 of 2018, which stipulates the quality of service in the form of a response time level of 15 minutes from the time the report is received (Regulation of the Minister of Home Affairs Number 114 of 2018 concerning Technical Standards for Basic Services in the Minimum Service Standards for Sub-Affairs of Regency/City Regions., 2018). The implementation and reporting of SPM achievements is then guided by Permendagri Number 59 of 2021(Regulation of the Minister of Home Affairs Number 59 of 2021 concerning the Implementation of Minimum Service Standards (State Gazette of the Republic of Indonesia Year 2021 Number 1419)., 2021). With this framework, the speed of arrival of the fire unit is not just a measure of the organization's technical performance. It is part of the citizen's right to basic services whose quality is guaranteed at a minimum by the state.

Response time (*response time*) has a special place in emergency services. Fires develop in minutes, so the value of the service depends largely on when the service arrives, not just whether it is available. The professional standard NFPA 1710 breaks down response time into three components, namely call processing, departure preparation (*turnout time*), and travel time, with much stricter targets than Indonesia's national standards (National Fire Protection Association, 2020). The separation of these components is analytically important. The call processing and departure preparation components primarily reflect the organization's communication systems and readiness, while travel time is more determined by distance, road network, and postal location to settlements.

This article distinguishes three concepts that are often used interchangeably. *Access services* is understood as a match between services and citizens' needs, which includes availability, spatial affordability, and the ability of the service to reach users (Penchansky, R., & Thomas, 1981). *Scope of service* is a spatial measure that expresses the proportion of area or population that can theoretically be reached within a certain time limit of an existing facility. *Turnaround performance* is the actual time recorded in real events. The three are related in order. Coverage is a spatial prerequisite for access, while response time performance is a form of access that residents actually experience when a fire occurs. An area can be recorded as having a post, but still has weak access if the post does not have a fleet or is too far from the settlements it serves.

The tradition of studying the location of emergency facilities has long placed distance and spatial configuration as the primary determinants of response time. Model *location set covering* (Toregas, C., Swain, R., ReVelle, C., & Bergman, 1971) and *maximal covering*

location (Church, R., & ReVelle, 1974) formulated to determine the number and location of facilities so that as many requests as possible are affordable within the standard time limit. Kolesar and Blum (Kolesar, P., & Blum, 1973) shows that the average mileage of the fire extinguishing unit is proportional to the root of the area per available unit, so that the number and distribution of the fleet have a direct effect on travel time. An implementation study in Istanbul showed that model-based post location arrangement can substantially increase the coverage of five minutes (Aktaş, E., Özaydın, Ö., Bozkaya, B., Ülengin, F., & Önsel, 2013), and that a Geographic Information System (GIS) combined with multicriteria analysis can produce a map of the suitability of the location of a new post (Nyimbili, P. H., & Erden, 2020). In Indonesia, the Bagir and Buchori study (Bagir, M., & Buchori, 2012) in Semarang City used GIS network analysis to assess the coverage of posts and recommend the addition of posts.

Most of the studies were set in urban settings. The challenges of fire services are different in districts that combine urban and rural corridors. In areas like this, demand density, road networks, and topography differ sharply between regions, while resources are managed by a single regional apparatus with the same budget. From a public policy perspective, these differences raise the issue of equity. Lucy (Lucy, 1981) Differentiating the equitable distribution of local services based on equity, needs, and demands, while the Spatial Justice Study emphasizes that the distribution of facilities and accessibility are measurable dimensions of justice (Soja, 2010; Talen, E., & Anselin, 1998). In the framework of SPM, the 15-minute standard applies equally to all regency/city residents, so that differences in ability to fulfill it between regions can be read as an indicator of inequality in access to basic services.

West Bandung Regency (KBB) describes this problem clearly. This district has an area of 1,305.77 km², 16 sub-districts, 165 villages/sub-districts, and around 1.83 million people in 2024, with an altitude of 600–2,400 meters above sea level. The Padalarang–Ngamprah–Lembang corridor has an urban character, while the sub-districts in the western and southern parts such as Rongga, Gununghalu, and Cipongkor have a rural character with scattered settlements and hilly roads. Preliminary data from the KBB Fire and Rescue Service (Disdamkar) shows a response time of 12–14 minutes in urban areas and 20–28 minutes in rural areas. The 2025–2029 KBB Disdamkar Strategic Plan also notes that there are still many areas that have not been reached by services and the average response time exceeds national standards (West Bandung Regency Fire and Rescue Service, 2025).

Based on this description, the research *gap* raised in this article is as follows. The studies reviewed in this article are mostly urban and focus on the location and coverage of facilities. The difference in access between regions within a rural urban mixed district, which is read through actual response time and its components and associated with minimum service standards, has not been the focus of these studies.

The state *of the art* of this article lies in three things. First, the article presents a comparison of response time based on three-year incident records in one urban-rural mixed district, along with the decomposition of its components. Second, the article distinguishes the existence of facilities, spatial coverage, and actual performance when assessing the equitable distribution of basic services. Third, the article maps the priorities of interventions by separating actual findings, modeling results, and proposals that still need testing.

METHODS

Research using design *mixed methods* Sequential Explanatory with Priority on Quantitative Data (Creswell, 2014). The quantitative phase measures the magnitude of disparity and the response time component. The qualitative phase is used to explain the operational mechanism behind these figures. The research locations cover all 16 KBB sub-districts. The analyzed incident data comes from the period January 2022–December 2024,

complemented by post, fleet, and personnel inventory data in 2025. Field data collection took place in January–June 2025.

The quantitative analysis unit is fire incidents handled by the KBB Disdamkar. All incidents with time data that meet the criteria were analyzed (census), with the exception of false alarms, canceled departures before arrival, recording errors, and assistance outside the KBB area. The final dataset totaled 1,247 incidents, consisting of 848 incidents in urban areas and 399 incidents in rural areas. The qualitative analysis unit is individuals who have direct knowledge of the operations of the KBB Disdamkar, selected purposively according to variations in levels (service leaders, post commanders, operators, field personnel, and external stakeholders) as well as the location of the post. The research design determined 16–24 informants with data saturation as the criteria for quitting; the report did not specify the final number of informants interviewed.

Response time is defined as the interval from the time the incident report is received until the fire unit arrives at the location. This definition is in line with the formulation of service quality in Permendagri Number 114 of 2018. Response time is decomposed into three components following the NFPA 1710 framework (National Fire Protection Association, 2020): (1) call processing, namely from the time the report is received to the departure order; (2) departure preparation, namely from the order until the vehicle leaves the post; and (3) travel time, namely from departure to arrival at the location. Compliance with the standard is considered as the proportion of incidents with a total response time of no more than 15 minutes. The NFPA standard is used as a component comparator, while Permendagri Number 114 of 2018 is a normative benchmark.

The grouping of areas is based on a combination of population density, road width, topography, and distance to posts. Urban areas are defined as areas with a density of more than 1,200 people/km², roads 7 m or more wide, and compact settlements; the report includes Padalarang, Ngamprah, Batujajar, central Lembang, and northern Cihampelas in this group. Rural areas are defined as areas with a density of less than 800 people/km², roads below 6 m, and hilly topography, including Rongga, Gununghalu, Cikalong Wetan, Cililin, Sindangkerta, Cipongkor, Saguling, Cipeundeuy, Cisarua, and southern Citapat. The classification of each incident is carried out by superimposing the coordinates of the incident on the area map. Since some sub-districts are divided according to regional sections, the comparison in this article is read as a comparison between regional characters, not between sub-districts as a whole.

Quantitative analysis was carried out in four stages. First, data cleansing and time component calculation. Second, descriptive statistics in the form of mean, median, 90th percentile, and compliance level by region. Third, the test of the difference in average response time between urban and rural areas with *independent samples t-test*, confirmed by the Mann-Whitney U test because the distribution of rural data deviated from normal. Fourth, the correlation analysis between the distance traveled and the response time and the decomposition of the response time difference according to the components. The report also mentions a multivariate analysis of the causative factors, but does not present the output of the model. Therefore, this article limits the interpretation of factors to correlation, component decomposition, and indicator comparison between regions.

Spatial analysis was carried out with QGIS. The stages included an analysis of the actual road network-based network to calculate the origin-destination cost matrix, analysis of service areas with isochronometers of 5, 10, 15, and 20 minutes of each post, and *location-allocation modeling* with the aim of maximizing coverage. Demand points were compiled from a population density grid measuring 500 m. Four scenarios were simulated: the addition of one post, the addition of two posts, the relocation of one post, and the combination of addition with relocation. The results of the scenarios are model projections and do not reflect the interventions that have been implemented.

Qualitative data were collected through semi-structured interviews lasting 45–90 minutes and field observations of the conditions of posts, fleets, and routes. Analysis was carried out by gradual thematic coding and negative case examination. Validity was maintained through triangulation of sources (incident records, interviews, observations) and summary checking of findings by some key informants (Guba, E. G., & Lincoln, 1989; Lincoln, Y. S., & Guba, 1985). The integration of the two types of data is carried out by juxtaposing quantitative findings about the magnitude of disparity with qualitative findings about the mechanisms. Synthesis for the formulation of recommendations using SWOT/TOWS matrix (Weihrich, 1982).

Some limitations affect interpretation. The study design was observational so that the relationship between response time and fire impact was read as an association. Fire conditions when the unit arrived, such as the development phase of the fire and building materials, were not systematically recorded. The report also noted that departures were still carried out manually, so the accuracy of the timing of each component needed to be read carefully. The GIS modeling parameters were constructed from secondary data, and the details of the parameters were referenced to the report appendix that was not available in the analyzed document.

RESULTS AND DISCUSSION

Distribution of Fire Service Capacity and Scope

The capacity of the KBB fire service is concentrated at a few points. The 2025 inventory data recorded one Command Headquarters in Padalarang and six regional posts, with a total of 168 personnel. Only four units of fire engines were recorded as suitable for use, and all of them were located at three points: the Command Headquarters (two units), the Lembang Post (one unit), and the Cikalong Wetan Post (one unit). The other four posts, namely Cililin, Cipatat, Sindangkerta, and Parongpong, do not have fire trucks so they depend on the delivery of units from other posts. Table 1 summarizes the distribution.

Table 1. Distribution of service points, fleets, and guard personnel of the KBB Disdamkar, 2025

Service point	Suitable fire extinguishers (units)	Personnel per guard squad (people)	Service regions by report
Padalarang Command Headquarters	2 (plus 1 support unit)	12–15	Squirrel, Squirrel, S
Lembang Post	1	5–6	Lembang, Cisarua, Parongpong
East Cikalong Post	1	5–6	East Side, South, South, T
Pos Cililin	0	4	Cililin, Cipongkor
Post Cipatat	0	4–5	Chipping, Saguling
Sindangkerta Post	0	4	Sindangkerta
Pos Parongpong	0	3–4	Parongpong
Total	**4**	**168 staff (total)**	**16 sub-districts**

Source: Data from the 2025 KBB Disdamkar, processed from the research report. Data status: inventory administrative data. Note: the preliminary description of the report mentions one headquarters and four regional posts; the difference in the number of posts needs to be confirmed

This distribution shows the distance between the existence of the facility administratively and the operational capability of the service. Seven service points were recorded, but only three were able to dispatch their own fire engines. For residents in the unmanned postal service area, the nearest post did not specify the response time. What was decisive was the distance to the post that had units ready to depart. The report noted a delay of 25–45 minutes when the unmanned post had to wait for units from other posts. Gununghalu District, one of the areas with the worst response times, was not even listed as any postal service area in the inventory table.

Personnel capacity is also uneven. Command Headquarters places 12–15 personnel per guard squad, while rural posts are only 3–5 people. Of the 168 personnel, the report noted that 54.8% do not have fire and breathing apparatus (SCBA) certifications are only available at two of the seven posts. This condition limits the ability of small posts to handle incidents independently, especially when two incidents occur at the same time.

On the coverage side, the analysis of the service area estimated that 55.2% of the population of KBB was within a 15-minute range of the existing post. The proportion was reported to be 84.7% for urban areas and 14.3% for rural areas. Rongga, Gununghalu, Cipeundeuy, and Cipongkor districts were identified as the areas with the largest coverage gap, with a distance of 18–28 km to the nearest post. This coverage figure is the result of road network modeling, not measurements on real events. The value depends on the assumption of vehicle speed and on whether the unmanned post is treated as the point of origin of the service. The report does not detail the second assumption, so effective coverage may be lower if unmanned posts are also calculated.

These findings are consistent with the logic of the maximal coverage model, which measures access from the number of affordable requests within a standard time limit, not from the number of facilities (Church, R., & ReVelle, 1974). These findings are also in line with Kolesar and Blum (Kolesar, P., & Blum, 1973), which indicates that travel time is influenced by the area that each unit must serve. With four units for 1,305.77 km², each unit serves more than 300 km² on average, and most of that area is in rural areas. The implication is that the addition of non-fleet outposts does not in itself expand access. The relevant measure of equity is the number of units ready to depart and their location to settlements.

Disparity in Response Time between Urban and Rural Areas

Actual performance shows disparities that are in line with the coverage pattern. Of the 1,247 incidents, 724 incidents (58.1%) were handled in no more than 15 minutes. This aggregate figure masks the sharp differences between regions. The average response time in urban areas was 13.2 minutes with 77.5% compliance, while in rural areas it was 23.8 minutes with 16.8% compliance. Table 2 presents a detailed comparison.

Table 2. Comparison of response time and compliance with the 15-minute standard by region, 2022–2024

Indicator	Urban	Rural	Difference (rural − urban)
Number of events	848	399	–
Average response time (minutes)	13,2	23,8	+10,6
Median (minutes)	12,5	22,0	+9,5
90th percentile (minutes)	18,4	32,7	+14,3
Standard deviation (minutes)	4,7	7,2	–
Compliance ≤15 minutes (%)	77.5 (657 incidents)	16.8 (67 incidents)	−60.7 percentage points
Call processing (minutes)	1,2	1,8	+0,6
Departure preparation (minutes)	2,3	2,8	+0,5
Travel time (minutes)	9,0	18,3	+9,3
Average mileage (km)	4,2	12,8	+8,6

Source: Records of the 2022–2024 Disdamkar KBB incident, processed from research reports. Data status: actual data on the incident. Note: the number of three components is not exactly the same as the total average (urban 12.5 minutes and rural 22.9 minutes), possibly due to differences in data coverage per component

The difference was statistically significant. The report recorded an *independent sample t-test* result of $t = 18.47$ ($df = 1.245$; $p < 0.001$) with a Cohen's effect size $d = 1.68$. Since the rural data were not normally distributed (Shapiro-Wilk $p = 0.003$), this result was confirmed by the Mann-Whitney U test ($U = 46.827$; $p < 0.001$). Such a large effect size suggests that the 10.6-minute difference is not a small variation around the same mean. The two regions showed substantially different distribution of response times.

The distribution of the data clarifies the meaning of the difference for residents. In urban areas, nine out of ten incidents were handled in 18.4 minutes. In rural areas, even the median response time (22.0 minutes) was already above the standard, and only 51.4% of incidents were handled within 20 minutes. Larger standard deviations in rural areas indicate that access within rural areas itself is not uniform. The report notes a range from 14–15 minutes for villages near the post to 47 minutes for remote villages. At the sub-district level, the report notes 92.0% compliance in Padalarang, 11.8% in Gununghalu, and 9.1% in Rongga.

The decomposition of components indicates a major source of disparity. Travel time accounts for 68% of response time in urban areas and 77% in rural areas. The difference in travel time between regions of 9.3 minutes is equivalent to about 88% of the total difference of 10.6 minutes. The difference between call processing (0.6 minutes) and departure preparation (0.5 minutes) is much smaller. Thus, delays in rural areas mainly occur after the vehicle leaves the post, rather than before the vehicle departs. The NFPA 1710 framework sets a travel time target of 4 minutes (National Fire Protection Association, 2020). KBB's rural travel time is more than four times the target, while the pre-departure component is on the same order in both areas.

This pattern supports the view in the study of the location of emergency facilities that spatial configuration is the main determinant of response time (Toregas et al., 1971; Kolesar & Blum, 1973). This finding also confirms that the aggregate size at the district level is inadequate to assess the fulfillment of SPM. The achievement of 58.1% can be read as medium performance, even though the achievement consists of areas that almost meet the standards and areas that mostly do not meet them. For SPM reporting based on Permendagri Number 59 of 2021, the implications are clear. Response time achievements need to be reported in a disaggregated manner by region or sub-district so that access inequality is visible in planning documents.

Factors Explaining Access Inequality

The most powerful factor associated with response time was mileage. The report noted a correlation between distance and response time of $r = 0.87$ ($p < 0.001$), with an additional of about 0.95 minutes for each kilometer. The average mileage in rural areas (12.8 km) was about three times that of urban areas (4.2 km). Since distance travel time accounts for most of the total difference, distance is the most direct statistical explanation for disparities. It should be noted that component decomposition and bivariate correlations show the large role of travel time, but do not separate the effect of distance from the influence of road conditions and accompanying topography.

Road conditions and topography magnify the influence of distance. The report noted that 85% of urban routes were paved in good condition, compared to 42% of rural routes. A total of 52% of rural routes had slopes of more than 10° and 47% had sharp bends. Special obstacles were also noted: 12 incidents required a detour because the bridge was not accessible to fire engines, with an additional 10–18 minutes, and 87 incidents required officers to manually pull 50–200 m intervals because vehicles could not approach the site. An interview with the Cikalong Wetan Post Commander described this field experience: *"From Cikalong to Cihanjuang Village, the Cave is 24 kilometers, winding up and down the mountain. If it rains, it can take more than 2 hours."* These quotes do not represent average travel times, but explain why the variation in response time in rural areas is much wider.

The availability of the fleet works as a *multiplier*. On average, the difference in components directly related to the organization is relatively small. However, the absence of fire engines at the four posts causes incidents in the region to be served from more distant posts, so the impact appears to be a longer travel time, not a preparation for a slower departure. In other words, some of the difference in travel time recorded as a geographical factor actually

also reflects the distribution of the fleet. The report recorded 34 simultaneous incidents, which made some of the incidents wait 25–75 minutes. The Cililin Post Commander stated: *"Our post does not have its own car. If there is an incident at night, call the Headquarters first, they send it from Padalarang—50 minutes is good."*

The personnel factor was seen in the difference in departure preparation time according to the guard squad. The report recorded that the departure preparation for the night squad was about 3.2 minutes, compared to 2.2 minutes for the morning squad. Rural posts with 3–5 personnel per squad were also more difficult to dispatch a complete squad. The information factor was seen in the call processing component. The completeness of the initial report was recorded at 63% in urban areas and 47% in rural areas, and 53% of reports from rural areas required location clarification. The Headquarters Operator explained that village reporters were often unable to name the road because the road was unnamed. Radio signal interference was recorded in 34 incidents. Table 3 summarizes these factors and the types of evidence.

Table 3. Factors that explain the disparity in response time and the status of the evidence

Factor groups	Key evidence	Types of evidence	Affected time components
Mileage	Urban 4.2 km vs rural 12.8 km; $r = 0.87$ ($p < 0.001$); +0.95 minutes per km	Quantitative (event logs, GIS)	Travel time
Road conditions and topography	Asphalt is good 85% vs 42%; 52% of rural routes are uphill >10°; 12 detours due to bridges	Quantitative (route surveys, incident logs) and observation	Travel time
Postal and fleet distribution	4 decent units at 3 points; 4 unarmed outposts; 34 concurrent incidents with a wait of 25–75 minutes	Quantitative (inventory, incident records) and interviews	Travel time (unit origin further)
Personnel and readiness	Night squad preparation 3.2 vs morning squad 2.2 minutes; 3–5 personnel per squad at a small outpost; 54.8% uncertified	Quantitative (incident records, personnel data) and observation	Departure preparations
Information, communication, and coordination	Complete report 63% vs 47%; 53% rural report needs clarification; 34 signal interference incidents	Quantitative (incident record) and interviews	Call processing; risk of mislocation

Source: Processed from research reports. Data status: descriptive indicators and bivariate correlation; the report does not present a multivariate model that separates the contributions of each factor

These findings are in line with the emergency facility location literature that places spatial configuration as a key determinant of response time (Church, R., & ReVelle, 1974; Toregas, C., Swain, R., ReVelle, C., & Bergman, 1971). However, KBB data shows that spatial factors do not stand alone. The effective distance faced by residents is determined by the location of the units that are ready to depart, the quality of the roads traveled, and the speed of the scene can be ascertained. Therefore, the distribution of the contribution of "88% geographical" in the report should be read as a portion of the difference that occurred at the travel stage, not as evidence that institutional factors play only a small role. The implication is that improving internal procedures alone will not close most of the gaps, but the distribution of the fleet is an institutional variable that directly affects travel time.

Implications for Equitable Distribution of Basic Services

The above findings show access inequality in three layers. The first layer is capacity inequality, i.e. the concentration of the fleet at three service points. The second layer is coverage inequality, which is the difference in the proportion of the population that is spatially accessible in 15 minutes. The third layer is performance inequality, which is the difference in

actual compliance of 77.5% and 16.8%. The three layers move in unidirection. The regions with the lowest capacity and coverage also experience the worst response time performance. In the framework of Penchansky and Thomas (Penchansky, R., & Thomas, 1981), these inequalities primarily concern the dimensions of spatial availability and accessibility, not the affordability of costs or acceptance of services.

The reading of this inequality as a problem of equity has a normative basis that can be formulated explicitly. The indicator used is the ability to meet the same quality standards, namely 15 minutes, which applies to every regency/city resident according to Permendagri Number 114 of 2018. With this benchmark, KBB rural residents have a much smaller chance of obtaining the minimum basic service quality compared to urban residents. Lucy (Lucy, 1981) noted that the equitable distribution of local services can be measured according to equality or according to needs. According to both criteria, the distribution in KBB is unbalanced. Rural areas receive lower access, even though the report records a higher number of fatalities per incident in the region (11 victims from 399 incidents, compared to 12 victims from 848 incidents in urban areas). The spatial justice study confirms that the distribution of public facilities shapes citizens' life opportunities according to where they live (Soja, 2010; Talen, E., & Anselin, 1998).

The association between response time and fire impact reinforces the substantive meaning of the disparity. The report groups incidents by response time category and records no fatalities in 242 incidents with a response time of 10 minutes or less. The proportion of fatalities per incident was recorded at 0.4% in the category of more than 10–15 minutes, 1.4% in the category of more than 15–20 minutes, 4.2% in the more than 20–25 minutes, and 11.0% in the more than 25 minutes categories. The average area of the fire also increased from 32 m^2 to 203 m^2 between the fastest and late categories. This pattern is a descriptive association. The long response time is likely to correlate with other factors, such as the type of incident, building materials, and delays in reporting, which were not controlled in the analysis. Nonetheless, this pattern suggests that the areas with the lowest access are also the areas where delays are most at risk.

These findings are also related to the capacity of local governments. Grindle and Hilderbrand view public sector capacity as the ability to carry out functions effectively, which is determined by human resources, organizations, and the institutional environment. In the case of KBB, this capacity appears to be limited in fleets, personnel distribution, and the absence of an official Fire Management Area (WMK) as the basis for the division of responsibilities of the region. The fulfillment of SPM in mixed urban-rural districts requires an allocation that takes into account the cost of distance, not an even allocation per post. The principle of public service that places citizens as rights holders (Denhardt, J. V., & Denhardt, 2015) demanding that the measure of performance does not stop at the existence of the post. The measure needs to reach the time that residents in each region are really experiencing.

Direction of Disparity Reduction Policy

Policy directions are designed to address the findings with the strongest evidence. Table 4 summarizes these priorities and distinguishes the status of the evidence: actual findings, modelling results, or untested proposals.

Table 4. Policy priorities for reducing disparity in response time and evidence status

Policy priorities	Answered findings	Status of evidence	Horizon
Fulfillment of fire trucks at non-fleet posts, starting from Cililin and Cipatat	4 of 7 unarmed outposts; wait 25–45 minutes	Problem: actual data. Impact: unmodeled	1–2 years

Addition of *location-allocation posts* (Gununghalu and Cipeundeuy/Cipongkor)	15-minute coverage 55.2%; coverage gap in Rongga, Gununghalu, Cipeundeuy, Cipongkor	Modeling results: 76.4% coverage; rural average 16.8 minutes	1–2 years, preceded by feasibility study
Determination of WMK and fastest route map per post	WMK has not yet been determined; the dominant travel time	Problem: document review. Impact: untested	3–6 months
Reporting and *dispatch improvements* (GPS location points, standard forms, 112 service integration)	53% of rural reports need clarification; 1.8-minute call processing	Issue: actual data. Impact: untested	3–12 months
Revision of night squad readiness procedures	Evening squad preparation 3.2 vs 2.2 minutes	Issue: actual data. Impact: untested	1–3 months
Inter-postal and inter-regional assistance agreements	34 events with a wait of 25–75 minutes	Issue: actual data. Impact: untested	3–6 months
Gradual expansion of Village Fire Brigade Volunteers (RPKD) with evaluation	5 villages with RPKD recorded an effective blackout time of 12 minutes faster	Limited initial evidence, with no controlled peer	6–12 months (trial)
The recording of four time markers and SPM reporting are disaggregated by sub-district	An aggregate of 58.1% covered a gap of 77.5% vs 16.8%	Problem: actual data. Impact: monitoring prerequisites	1–3 months

Source: Processed from research reports. The status of the evidence is assessed by the author based on the type of data available in the report

The first priority is fleet fulfillment at existing posts. This step answers the actual finding that four posts cannot dispatch their own units. In the logic of the coverage model, a post without a fleet is not yet the point of origin of service. Therefore, equipping a fleet has the potential to expand coverage at a lower cost than building a new post. The magnitude of this impact has not been modeled in the report and needs to be an additional scenario in follow-up analysis.

The second priority is model-based location arrangement. Of the four simulated scenarios, the addition of two posts in Gununghalu and Cipeundeuy/Cipongkor resulted in the largest projection: coverage increased from 55.2% to 76.4% and the average rural response time dropped to 16.8 minutes. The scenario of adding one post projected coverage of 67.8%, relocation of one post 62.0%, and a combination of adding one post with a relocation of 70.9%. These figures are the output of the model assuming network parameters from secondary data. The figure does not take into account the fleet and personnel needs of each new post. Even in the best scenario, the rural average is still above 15 minutes. Therefore, the addition of posts needs to be combined with route and fleet improvements. These findings are in line with the Istanbul experience, which shows that modelling-based site planning can gradually increase coverage through a multi-year implementation plan (Aktaş, E., Özaydın, Ö., Bozkaya, B., Ülengin, F., & Önsel, 2013).

The third priority concerns the pre-departure and coordination stages. Improvements to location reporting, night squad readiness procedures, and inter-postal assistance agreements will not cover most of the travel time gap. However, these measures address documented and relatively inexpensive problems to implement. The report targets rural call processing to drop from 1.8 to 1.0 minutes or less. These targets need to be treated as policy goals, not outcomes that have already been achieved.

The fourth priority is to strengthen community capacity. Five villages with RPKD recorded 12-minute faster effective blackout times. This evidence is promising for remote villages that are difficult to reach by formal posts, but are still limited because the number of villages is small and there are no controlled comparators. In addition, RPKD does not change the response time of the fire department. The RPKD adds an initial response before the unit arrives. The expansion of the RPKD should be carried out as a phased trial with comparable results recorded. Finally, the recording of four time markers and the reporting of SPM disaggregated by sub-district are prerequisites for all other priorities. Without this data, local governments cannot monitor whether interventions are truly reducing access inequalities.

The novelty of this study lies in the reading of the response time disparity as a layered access disparity in one urban-rural mixed district, by distinguishing the existence of facilities, spatial coverage, and actual performance. The findings show that the existence of the post administratively does not guarantee effective access, because what determines is the number and location of units that are ready to depart. In addition, the decomposition of the response time component shows that the largest difference occurs at the travel stage, so that the aggregate achievement of districts to cover the gap between regions and the reporting of minimum service standards needs to be sorted by region or sub-district.

CONCLUSIONS AND SUGGESTIONS

Conclusion

The disparity in response time in KBB reflects the disparity in access to multiple fire services. Fleet capacity is concentrated at three service points, 15-minute coverage is estimated to cover only 55.2% of the population, and actual performance differs sharply between urban areas (average 13.2 minutes; 77.5% compliance) and rural areas (23.8 minutes; 16.8%). These differences are statistically significant and hidden when SPM achievement is only reported as district aggregate figures. Most of the difference occurs at the travel stage. This is related to approximately three times as long distances, heavier road and topographic conditions, and the absence of fleets at four posts that force units to depart from more distant locations. Personnel, location reporting, and communication factors provide the addition of smaller but documented delays.

For the study of public services, this finding emphasizes the need to distinguish between the existence of facilities, spatial coverage, and actual performance when assessing the equitable distribution of basic services. Administratively registered posts do not necessarily provide access if they do not have a unit ready to depart. Policy priorities are therefore the fulfillment of the fleet at existing posts, the arrangement of post locations based on coverage modeling, improvement of reporting and *dispatch*, inter-post assistance agreements, and the gradual strengthening of village volunteers.

Limitations

This conclusion is limited by observational design in one district, operational secondary data with manual time recording, and spatial models whose parameters have not been validated with primary field data. The projected increase in coverage is the result of simulation, not the result of intervention.

Suggestions

SPM reporting needs to be sorted by sub-district so that inequality can be monitored. Follow-up research needs to test multivariate models that separate the effects of distance, road conditions, and unit origin; include fleet fulfillment scenarios at existing posts; and evaluate the impact of RPKD with a comparative design.

Author's Contributions

All authors made significant contributions to this study. These contributions include research conceptualization, theoretical framework development, data collection, data analysis, interpretation of results, manuscript preparation, scientific revision, and final approval of manuscripts for publication. All authors declare that they have read and approved the final version of this article.

Artificial Intelligence (AI) Usage Statement

In the preparation of this manuscript, the author used Claude (Anthropic) for the adjustment of the manuscript format with the journal template and the rearrangement of the abstract. The author has reviewed and edited the entire content of the manuscript and is fully responsible for the entire content of this publication.

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