

## Reliability Assessment of Pasar Baru and Plaza Bogor Buildings

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### ABSTRACT

The Pasar Baru Bogor and Plaza Bogor buildings have been in operation for decades, so it is necessary to analyze the reliability of the buildings to ensure their structural and operational conditions. This research evaluates the physical reliability of both buildings through visual observation and concrete quality testing using the method Non-Destructive Test (NDT) with the tool Hammer Test Type N. The evaluation covers five main aspects: architecture, structure, utilities and fire protection, accessibility, and building and environmental planning. The results of the research on the Pasar Baru Bogor Building show that the reliability value of the architectural aspects is 83.30%, structure 93.06%, utilities and fire protection 42.50%, accessibility 68.25%, and building and environmental planning 63.46%, with a total reliability of 64.08% which is classified as "Not Reliable." Concrete compressive strength testing shows results between 25.69 MPa and 65.81 MPa, so the structure is declared "Safe". The Plaza Bogor Building has an architectural aspect reliability value of 89.00%, structure 100%, utilities and fire protection 61.67%, accessibility 72%, and building and environmental planning 66.60%, with a total reliability of 76.66% which is categorized as "Less Reliable." Concrete compressive strength testing shows results between 23.72 MPa and 65.84 MPa, which meets structural reliability standards. Thus, the Pasar Baru Bogor Building has low reliability although the building structure is safe, while the Plaza Bogor Building has good structural reliability, but other aspects require improvement to increase reliability maximum .

**Keywords:** building reliability, building functional suitability, visual observation, Non Destructive Test

### INTRODUCTION

The Pasar Baru Bogor and Plaza Bogor buildings are two centers of trading activities in Bogor City that have an important role in the community's economy. Pasar Baru Bogor Building is a traditional market that has been operating for 31 years, with a building area of 26,232 m<sup>2</sup> and accommodates 2,068 kiosks and 201 los that provide various basic needs. Meanwhile, Plaza Bogor, as a shopping and entertainment center with a building area of 21,679 m<sup>2</sup> that accommodates 405 stalls, has been established for 28 years without ever undergoing renovation or fire, so its condition requires further evaluation. As both buildings age, a reliability check is required to building assess their structural condition and suitability to support trading activities. Building reliability is the ability of a building to perform its function as planned, but in reality there are cases where buildings are not reliable. Therefore, an assessment of building reliability is needed in order to determine the reliability value of a building so that it can be concluded whether the building is still fit for function or not [1]. The inspection is carried out visually and through testing *Non-Destructive Test* (NDT) using *Hammer Test type N* to determine the quality of concrete in structural elements. The criteria for the physical reliability of buildings include aspects of comfort, health, safety, convenience and harmony with the environment. Aspects of physical observation in the field are carried out in terms of architecture, structure, utilities, accessibility, and building and environmental planning [2-5].

The function of the building is a provision for fulfilling the technical requirements of the building, both in terms of building and environmental planning, as well as its reliability. Building functions include residential, religious, business, social and cultural functions. And special functions are provisions regarding the fulfillment of administrative requirements and technical requirements of building buildings [6], [14].

- 1) Building administrative requirements include:
  - (1) the status of land rights;
  - (2) Building ownership status; and
  - (3) Building Permit (IMB).
- 2) Building technical requirements include:
  - (1) building layout requirements; and
  - (2) Building reliability requirements [7-9].

By considering the importance of building reliability in supporting trade activities, evaluation of the Pasar Baru Bogor and Plaza Bogor buildings is a must to ensure the safety, comfort, and function of the building in accordance with applicable regulations [10-13].

## RESEARCH METHODOLOGY

### Material

The stages carried out in the Feasibility Analysis of the Pasar Baru Bogor and Plaza Bogor buildings are presented in the form of the following flowchart:

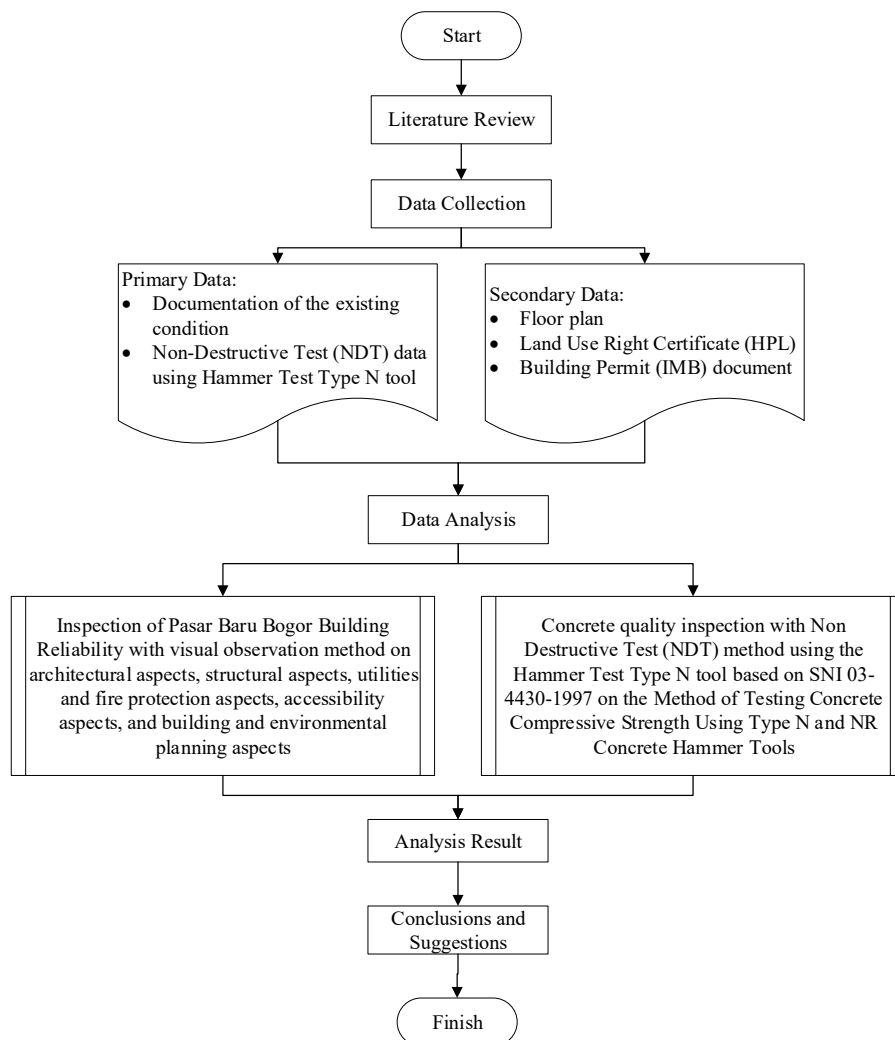


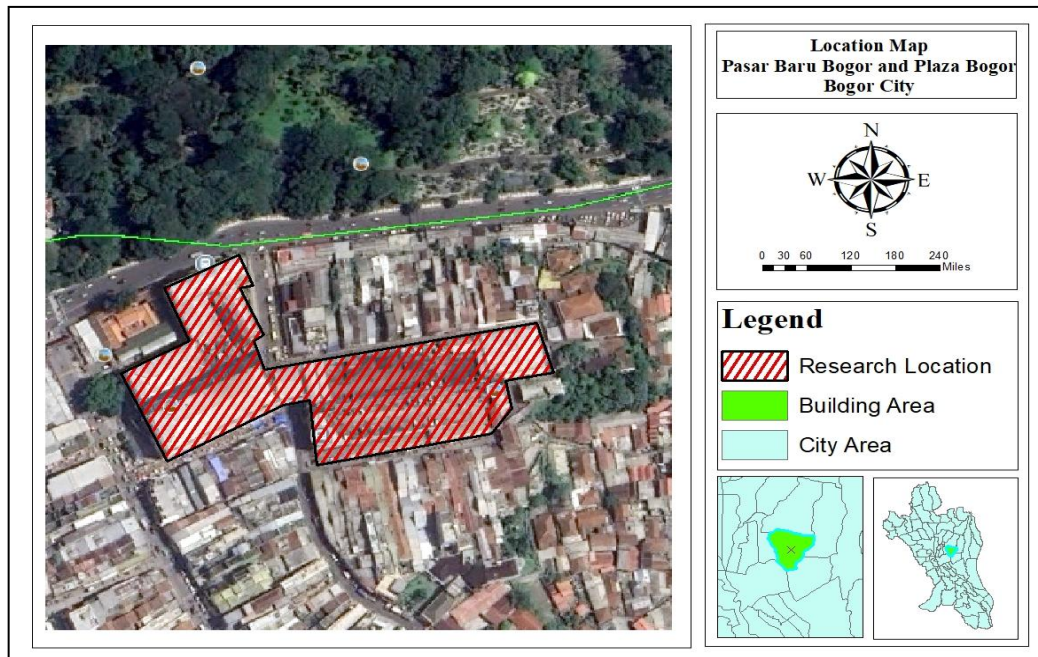
Figure 1. Research Flowchart Source: Analysis result, 2024

This research begins with the preparation of needs to identify the reliability of buildings, followed by a literature review using technical regulations [20], [22]. Data were collected through field surveys (building dimensions and reliability assessment) and supporting documents. Data were

analyzed using MS Excel to determine building reliability (reliable  $\geq 95\%$ , less reliable 75-95%, unreliable  $< 75\%$ ) and approximate value of concrete quality (MPa) [15-17].

### Methods

This research was conducted at the Pasar Baru Bogor building with coordinates latitude: -6.603647; longitude: 106.800016, and Plaza Bogor building with coordinates latitude: -6.60360; longitude: 106.7997, located at Jalan Suryakencana Number 3, Babakan Pasar Village, Central Bogor Subdistrict, Bogor City, West Java, Indonesia. This research was conducted from September 2024 to April 2025. A map of the research location is shown in Figure 2.



**Figure 2.** Research location map (Source: Google Earth)

At the data collection stage, there are two types of data that can be used in this study, namely primary data and secondary data. Primary data is data obtained from field surveys such as data obtained from measurements on existing buildings to determine their dimensions, and assessments of administrative requirements and technical requirements to determine the reliability of the Pasar Baru Bogor and Plaza Bogor buildings as well as data from bounce tests with Hammer Test Type N on concrete which will be analyzed using the application MS Excel to determine the quality value of existing concrete. Secondary data is data obtained not from survey results in the field, but data obtained from related parties as supporting and complementary data in this study. Secondary data used in this study are building plan drawings, Land Use Right Certificate (HPL), and Building Permit Documents (IMB) [17], [19], [21].

### Data Analysis

Data analysis is carried out by processing data based on primary data and secondary data listed in Figure 1 (flowchart) using MS Excel, namely an assessment of administrative requirements and technical requirements which includes an assessment of architectural aspects, structural aspects, aspects of utilities and fire protection, accessibility aspects, and aspects of building and environmental planning to determine the condition of the Pasar Baru Bogor and Plaza Bogor buildings can be stated in a reliable, less reliable, or unreliable condition. The criteria for building reliability values are shown in Table 1.

**Table 1.** Building Reliability values criteria [9]

No.	Assessed Aspect	Reliable	Less Reliable	Not Reliable	Assessment Weight
1	Architecture	95-100	75 - < 95	< 75	10,00
2	Structure	96-100	85 - < 96	< 85	30,00
3	Utilities and fire protection	97-100	95 - < 97	< 95	50,00
4	Accessibility	98-100	75 - < 98	< 75	5,00
5	Building and environmental planning	99-100	75 - < 99	< 75	5,00
<b>Total</b>					<b>100,00</b>

To determine the value of quality concrete ( $f'c$ ). This method is used to test and evaluate the surface hardness of concrete. The test is carried out by giving an-load a non-destructive test was conducted using the Hammer Test Type N tool impact on the surface of the concrete using a mass driven by a certain energy. Concrete compressive strength requirements (Structural Concrete Requirements for Building) [20].

## RESULTS AND DISCUSSION

The assessment of the existing reliability of the building was carried out by visual inspection in the field in accordance with applicable administrative requirements and technical requirements. Existing reliability checks are carried out to ascertain whether two buildings these can be declared fit for purpose or repairs and development must be carried out.

### 1. Administrative data

The assessment of building reliability is also reviewed from the completeness of administration which is one of the requirements to declare the Pasar Baru Bogor and Plaza Bogor buildings reliable or not. The administrative data of Pasar Baru Bogor and Plaza Bogor buildings is shown in Table 2.

**Table 2.** Administration data of Pasar Baru Bogor and Plaza Bogor buildings

No.	Administration Data	Pasar Baru Bogor	Plaza Bogor
1	Building Permit (IMB)	Available	Available
2	Building Tax (PBB)	Available	Available
3	Building Picture	Available	Available
4	Ownership Letter	Available	Available
5	Year of Development	1993	1997

(Source: Building administration data of Pasar Baru Bogor and Plaza Bogor buildings)

### 2. Function space

The space functions of the Pasar Baru Bogor and Plaza Bogor buildings can be reviewed in Table 3.

**Table 3.** Space function of Pasar Baru Bogor and Plaza Bogor buildings

No.	Space Function	Pasar Baru Bogor (m <sup>2</sup> )	Plaza Bogor (m <sup>2</sup> )
1	Management Office	256.41	36
2	Stall	16,130.4	3645
3	Los	1,567.8	0
4	Parking	3,685.867	3215.6
5	Hallway	3,368	13982
6	Stairs	520	691
7	Toilet	416	90.0
8	Musala	288	19
<b>Total building area</b>		<b>26,232</b>	<b>21,679</b>

### 3. Architecture aspect reliability assessment results (Weight value = 10)

The assessment of architectural aspects is reviewed on several existing components of the Pasar Baru Bogor and Plaza Bogor buildings, so that the weight of the reliability value on architectural aspects can be obtained after the analysis is carried out. The weighted value of the reliability of the architectural aspects of the Pasar Baru Bogor and Plaza Bogor buildings is shown in Table 4.

**Table 4.** Weight reliability value of architectural aspects of Pasar Baru Bogor and Plaza Bogor buildings

No.	Component Functioning Condition	Function Weight (%)	Pasar Baru Bogor (%)	Plaza Bogor (%)
1	User suitability of function	10	9.91	10
2	Wall	8	7.98	8
3	Floor	8	7.85	8
4	Roof Covering	8	8	6
5	Rainwater Gutter	6	0	0
6	Wall Plastering	6	5.99	6
7	Floor Plastering	6	5.8	5.8
8	Wall Cladding	6	4.8	5.6
9	Floor Coatings	6	4.56	5.2
10	Doors and <i>Rolling Doors</i>	8	7.76	8
11	Window	7	6.75	6.3
12	Vents	7	7	7
13	Ceiling Covering	6	5.8	5.01
14	Stairs/Lift	8	0	8
<b>Total architecture reliability score</b>		<b>100</b>	<b>82.20</b>	<b>89.00</b>

(Source: Analysis result)

### 4. Reliability assessment results of structural aspects (Weight value = 30)

The value of the structural aspects of the Pasar Baru Bogor and Plaza Bogor buildings can be obtained by visual inspection in the field to analyze the weight of the building reliability value in the structural aspects. The weighted reliability values of the structural aspects of the Pasar Baru Bogor and Plaza Bogor buildings are shown in Table 5.

**Table 5.** Weight reliability value of the structural aspects of the Pasar Baru Bogor and Plaza Bogor buildings

No.	Component Functioning Condition	Function Weight (%)	Pasar Baru Bogor (%)	Plaza Bogor (%)
1	Foundation	25	25	25
2	Column Structure	20	19.16	20
3	Structure Beams	15	14.16	15
4	Column-beam <i>joint</i>	15	14.96	15
5	Floor slab	5	4.91	5
6	Ceiling hanging	5	4.99	5
7	Stair plates/beams	6	6	6
8	Miscellaneous, Console beam, canopy, etc.	5	5	5
9	Joist	4	3.88	4
<b>Total structural reliability value</b>		<b>100</b>	<b>98.06</b>	<b>100</b>

(Source: Analysis result)

### 5. Reliability assessment results of utilities and fire protection aspects (Weight value = 50)

The , the weight of the reliability value of utilities and fire protection aspects of the Pasar Baru Bogor and Plaza Bogor buildings assessment of utilities and fire protection aspects is carried out by means of visual observations in the field is shown in Table 6.

**Table 6.** Weight reliability value of utilities and fire protection aspects of Pasar Baru Bogor and Plaza Bogor buildings

No.	Component Functioning Condition	Function Weight (%)	Pasar Baru Bogor (%)	Plaza Bogor (%)
1	Fire Alarm System	10	0	10
2	Sprinkler	10	0	0
3	Hydrants	10	0	6.67
4	Fire Extinguisher tube	10	0	0
5	Ordinary Stairs	10	10	10
6	Clean Water	5	5	5
7	Dirty Water	5	2.5	5
8	PLN Power Source	5	5	5
9	Generator Power Source	5	0	0
10	Direct Cooling System	5	0	0
11	Lightning Protection Main System	5	5	5
12	Lightning Protection Installation	5	5	5
13	Telephone Installation	5	0	0
14	Sound System Installation	10	0.1	10
<b>Total utility reliability value</b>		<b>100</b>	<b>32.61</b>	<b>61.67</b>

(Source: Analysis result)

6. Accessibility aspect reliability assessment results (Weight value = 5)

The assessment of the accessibility aspect of a building involves several important aspects that must be considered to ensure that the building can be used by everyone, including people with disabilities. The weighted value of the reliability of the aspects of accessibility the Pasar Baru Bogor and Plaza Bogor buildings is shown in Table 7.

**Table 7.** Weight of the reliability value of accessibility aspect of Pasar Baru Bogor and Plaza Bogor buildings

No.	Component Functioning Condition	Function Weight (%)	Pasar Baru Bogor (%)	Plaza Bogor (%)
1	Basic size of space	15	15	15
2	Pedestrian path and ramp	15	12.3	0
3	Parking area	15	11.85	15
4	Supplies and equipment	10	9.48	10
5	Toilet	20	16.80	17
6	Accessibility Elevator	10	0	0
7	Doors	15	15	15
<b>Total accessibility reliability value</b>		<b>100</b>	<b>80.43</b>	<b>72.00</b>

(Source: Analysis result)

7. Reliability assessment results of building and environmental planning aspects (Weight value = 5)

The assessment of the building and environmental planning aspects of the building includes various important elements related to the sustainability of a building in the context of the surrounding environment. The weighted value of the reliability of the building and environmental aspects of the Pasar Baru Bogor and Plaza Bogor buildings is shown in Table 8.

**Table 8.** Weight of the reliability value of the building and environmental planning aspects of the Pasar Baru Bogor and Plaza Bogor buildings

No.	Component Functioning Condition	Function Weight (%)	Pasar Baru Bogor (%)	Plaza Bogor (%)
1	Conformance to Coefficient Building Base (KDB)	40	35.41	28
2	Conformance to Coefficient Building Floor (KLB)	40	8.05	19
3	Conformity to the Line Building Setback (GSB)	20	20	20
<b>Total building and environmental planning reliability value</b>		<b>100</b>	<b>63.46</b>	<b>66.6</b>

(Source: Analysis result)

## 8. Total reliability assessment results building

The reliability of the building is assessed from several aspects, namely aspects of architecture, structure, utilities and fire protection, accessibility, and building and environmental planning. The results of the total reliability value of the Pasar Baru Bogor Building are shown in Table 9 below.

**Table 9.** Results of the total reliability value of the Pasar Baru Bogor Building

No.	Assessed Aspect	Reliability Value (%)	Assessment Weight (%)	Total Reliability Value (%)	Category
1	Architecture	8.22	10	82.20	Less Reliable
2	Structure	29.42	30	98.06	Reliable
3	Utilities and fire protection	16.30	50	32.61	Not Reliable
4	Accessibility	4.02	5	80.43	Less Reliable
5	Building and environmental planning	3.17	5	63.46	Not Reliable
<b>Total</b>		<b>61.14</b>	<b>100</b>		

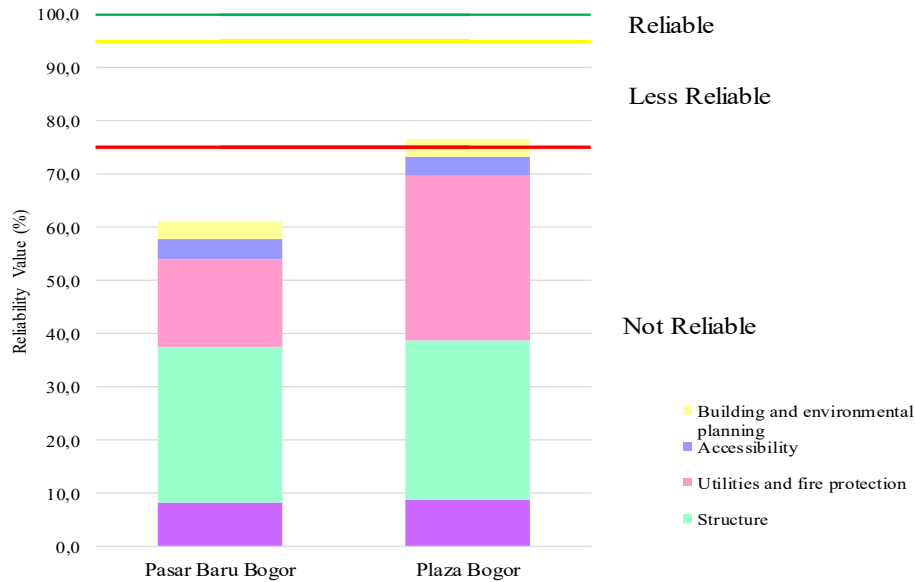
(Source: Analysis result)

The results of the total reliability value of the Plaza Bogor Building are shown in Table 10 below.

**Table 10.** Results of the total reliability value of the Plaza Bogor Building

No.	Assessed Aspect	Reliability Value (%)	Assessment Weight (%)	Total Reliability Value (%)	Category
1	Architecture	8.90	10	89.00	Less Reliable
2	Structure	30	30	100	Reliable
3	Utilities and fire protection	30.83	50	61.67	Not Reliable
4	Accessibility	3.60	5	72	Not Reliable
5	Building and environmental planning	3.33	5	66.6	Not Reliable
<b>Total</b>		<b>76.66</b>	<b>100</b>		

The results of the total reliability value of the Pasar Baru Bogor and Plaza Bogor buildings are also shown in Figure 3 below.



**Figure 3.** Results of total building reliability value (Source: Analysis result)

Testing the strength of building structures to determine the quality of concrete is carried out by the method Non Destructive Test (NDT) or testing without damaging the building structure being tested. Based on the test results using Hammer Test Type N, the estimated minimum and maximum values of concrete in the structural elements of the Pasar Baru Bogor Building are shown in Table 11 below.

**Table 11.** Estimated concrete compressive strength of structural elements of Pasar Baru Bogor Building

Area	Structure Elements	Minimum Value		Maximum Value		Average	
		kg/cm <sup>2</sup>	MPa	kg/cm <sup>2</sup>	MPa	kg/cm <sup>2</sup>	MPa
<b>Ground Floor</b>							
	Column	397.33	38.97	671.11	65.62	527.25	51.71
<b>First Floor</b>							
	Column	381.67	37.43	669.11	65.62	529.41	51.92
<b>Second Floor</b>							
	Column	262.00	<b>25.69</b>	671.11	<b>65.81</b>	482.09	47.28
	Beams	282.00	27.66	633.33	62.11	499.69	49
	Slab	435.67	42,73	633.33	62.11	537.57	52.72
<b>Third Floor</b>							
	Column	282.66	27.72	671.11	<b>65.81</b>	492.87	48.33
	Beams	406.22	39.84	601.33	58.97	494.8	48.52
	Slab	404.33	39.65	526.00	51.58	475.27	46.61
<b>Fourth Floor</b>							
	Beams	381.11	37.37	633.33	62.11	522.51	51.24
	Slab	468.89	45.98	633.33	62.11	552.38	54.17

(Source: Analysis result)

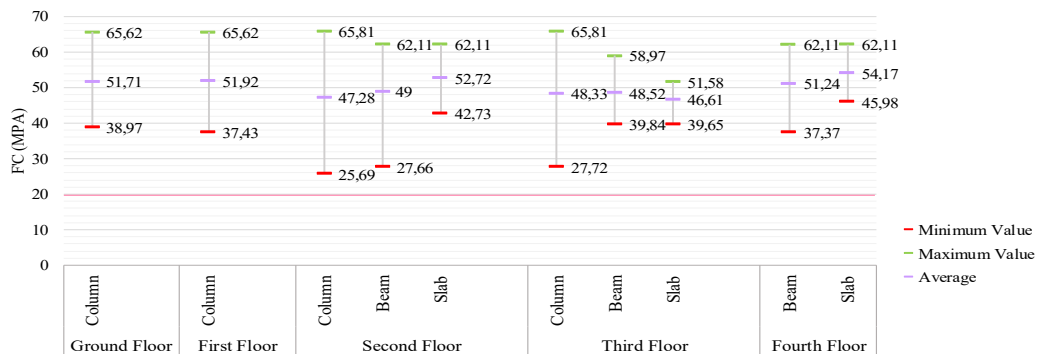
The results of testing the compressive strength of concrete using Hammer Test Type N obtained an estimate of the minimum and maximum value of concrete quality in the structural elements of Plaza Bogor Building shown in Table 12 below.

**Table 12.** Estimated concrete compressive strength of structural elements of Plaza Bogor Building

Area	Structure Elements	Minimum Value		Maximum Value		Average	
		kg/cm <sup>2</sup>	MPa	kg/cm <sup>2</sup>	MPa	kg/cm <sup>2</sup>	MPa
<b>Basement</b>							
	Column	337.77	33.14	615.11	60.34	475.86	46.68
<b>Ground Floor</b>							
	Column	241.78	<b>23.72</b>	651.11	63.87	439.09	43.07
<b>First Floor</b>							
	Column	257.33	25.24	631.11	61.91	423.5	41.55
	Beams	341.78	33.53	584	57.29	448.57	44.00
	Slab	385.11	37.78	631.33	61.93	525.67	51.57
<b>Second Floor</b>							
	Column	349.44	34.28	671.11	<b>65.84</b>	562.99	55.23
	Beams	294	28.84	625.33	61.34	485.89	47.67
	Slab	456.89	44.82	633.33	62.13	573.81	56.29
<b>Third Floor</b>							
	Column	364.33	35.74	671.11	<b>65.84</b>	522.34	51.24
	Beams	458.89	45.02	619.33	60.76	529.9	51.98
	Slab	496	48.66	613.33	60.17	565.11	55.44
<b>Fourth Floor</b>							
	Column	339.44	33.30	631.11	61.91	491.63	48.23
	Beams	315.56	30.96	510	50.03	424.19	41.61
	Slab	481.56	47.24	633.33	62.13	582.09	57.10

(Source: Analysis result)

The minimum and maximum values of concrete quality in the structural elements of the Pasar Baru Bogor Building also can be seen in Figure 4 below.



**Figure 4.** Concrete quality distribution chart of structural elements of Pasar Baru Bogor Building (Source: Analysis result)

The minimum and maximum values of concrete quality in the structural elements of the Bogor Plaza Building can be seen in Figure 5 below.

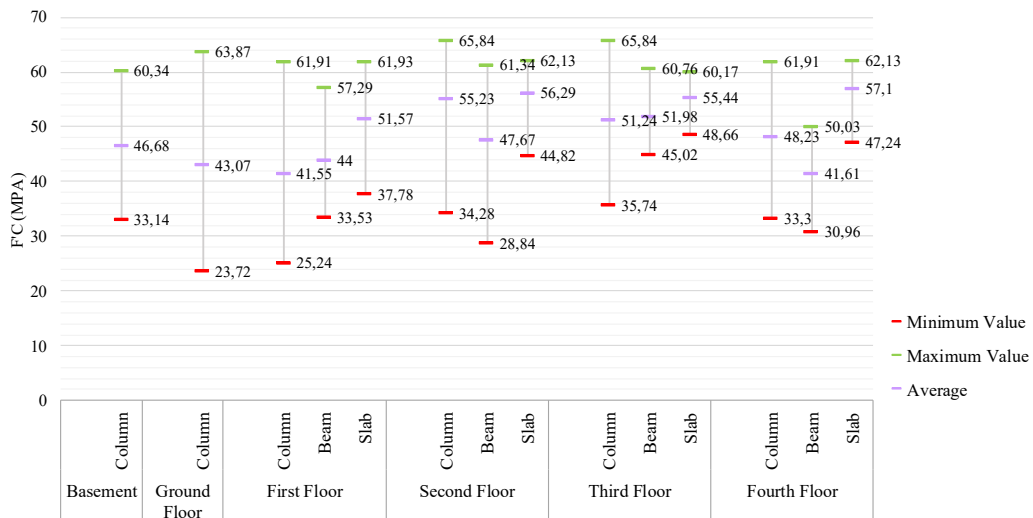


Figure 5. Concrete quality distribution chart of structural elements of Plaza Bogor Building (Source: Analysis result)

## CONCLUSIONS

Referring to reliability assessment using the visual observation method in the Pasar Baru Bogor Building obtained the weighted reliability value of architectural aspect of the 82.20%, the structural aspect of 98.06%, the aspect of utilities and fire protection of 32.61%, the accessibility aspect of , the aspect of building and environmental planning of 80.43%63.46%, and the total reliability value of the Pasar Baru Bogor Building 61.14% Table 1 Criteria Building Reliability Value , it can be concluded that the Pasar Baru Bogor Building is included in the "Not Reliable" category. The results of the analysis of the reliability of the Plaza Bogor Building based on five aspects of reliability, namely architecture, utilities and fire protection, accessibility, and building and environmental planning, the total reliability value of the Plaza Bogor Building is 76.66%, only the structural aspect reaches a "Reliable" value of 100%, while other aspects are below the standard value of provisions which is <95%, so that the Plaza Bogor Building is categorized as "Less Reliable". Concrete compressive strength testing in accordance with SNI 2847-2019 (structural concrete requirements for building buildings), the provisions of the minimum value of concrete quality are 21 MPa. Based on the data Hammer Test, the minimum compressive strength value of the structural elements of the Pasar Baru Bogor Building is 25.69 MPa and the maximum value is 65.81 MPa so that the Pasar Baru Bogor Building can be declared "Safe" because this value exceeds the limit of concrete quality requirements. In the Plaza Bogor Building, the concrete compressive strength test results were minimum 23.72 MPa and the maximum value was 65.84 MPa, also meeting the reinforced concrete quality standards > 21 MPa. However, it is recommended to carry out periodic repairs and maintenance to maintain the quality and strength of structural elements.

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