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***Abstract*— Slum settlements are one of the issues in urban planning and management in Indonesia. To address this issue, innovative methods are needed to improve the spatial and environmental quality of settlements. This study uses photogrammetric mapping to produce photo data that supports orthophoto processing.**

Orthophoto serve as digital architectural media with the potential to support efforts to improve slum areas. This study aims to explore the role of orthophotos in the planning and spatial improvement of slum settlements. Orthophoto not only provide accurate and detailed information about settlement conditions but also support various aspects of planning, implementation, and evaluation of improvements. The use of orthophotos can enhance the effectiveness and efficiency of efforts to improve the quality of life for residents in slum areas. The research method used includes a literature review and relevant case analysis. The results show that orthophotos can provide accurate and detailed information about the physical conditions of settlements, facilitating the planning and implementation of improvements. Additionally, orthophotos can be used to monitor and evaluate slum improvement programs. This study emphasizes the importance of using orthophotos to support efforts to improve the quality of slum settlements in Indonesia.

Furthermore, this study also demonstrates that the use of photogrammetric technology in mapping slum settlements can expedite the data collection process and reduce costs compared to traditional methods. With orthophotos produced from photogrammetry, urban planning can be more responsive to dynamic changes in the physical and social conditions of slum areas. The implementation of orthophotos in settlement improvements also allows for community involvement in the planning process, as detailed visual information facilitates communication and participation from residents in identifying problems and solutions that align with their needs.

Keywords—orthophoto, digital architecture, slum area

I. INTRODUCTION

Slum settlements represent one of the main challenges in urban planning and management in Indonesia. With the continuous increase in urbanization rates, it is crucial to address this issue promptly. Slum areas are often characterized by poor building conditions, inadequate infrastructure, and limited access to basic services such as clean water and sanitation. According to data from the Central Statistics Agency (BPS), around 30% of the urban population in Indonesia lives in slum areas [2]. This condition not only negatively impacts the health and well-being of residents but also hinders the overall social and economic development of the city.

One innovative method that can be used to address this issue is drone technology. By processing aerial photographs, orthophotos can be produced. Orthophotos are geometrically corrected aerial images that have high accuracy and can be used as maps. This technology enables more detailed and accurate mapping of slum areas, facilitating the planning and implementation of improvements.

The use of drone technology in 3D mapping provides an opportunity to quickly and accurately gather the necessary information, which can support better decision-making in maintaining the sustainability of residential areas [1]. Additionally, the use of drone technology in 3D mapping also allows for more detailed monitoring of environmental changes over time. According to [5], the use of orthophotos can enhance the effectiveness of urban planning by providing more detailed and accurate spatial information.

In the field of digital architecture, orthophotos serve as a medium that supports various aspects of slum settlement planning and improvement. Orthophotos provide a clear visual representation of the physical conditions of settlements, including the layout of buildings, roads, and other infrastructure. Drone technology enables repeated mapping with high spatial resolution, which can facilitate the identification of environmental changes and settlement dynamics that may occur [6]. This is important for designing appropriate and effective interventions. Additionally, orthophotos can also be used to monitor progress and evaluate improvement projects in real time, ensuring that each stage aligns with the established plans [8].

This study aims to explore the role of orthophotos in the spatial improvement efforts of slum settlements in Indonesia. Using literature review methods and relevant case analyses, this research will examine how orthophotos can support

various aspects of planning, implementation, and evaluation of slum settlement improvements. The findings of this study are expected to contribute to improving the quality of life for residents living in slum areas and supporting better decision-making in urban planning.

II. METHODS

Slum settlements are one of the issues in urban planning and management in Indonesia. To address this issue, innovative methods are needed to improve the spatial and environmental quality of settlements. This study uses photogrammetric mapping to generate photo data that supports orthophoto processing. Orthophotos function as digital architectural media with the potential to support efforts to improve slum areas. This study explores the role of orthophotos in the planning and spatial enhancement of slum settlements. Orthophotos not only provide accurate and detailed information about settlement conditions but also support various aspects of planning, implementation, and evaluation of improvements. The use of orthophotos can enhance the effectiveness and efficiency of efforts to improve the quality of life for residents in slum areas. The research method used includes a literature review and relevant case analysis. The results show that orthophotos can provide accurate and detailed information about the physical conditions of settlements, facilitating the planning and implementation of improvements. Additionally, orthophotos can be used to monitor and evaluate slum improvement programs. This study emphasizes the importance of using orthophotos to support efforts to improve the quality of slum settlements in Indonesia.

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The implementation method of this research aims to evaluate the use of orthophotos as digital media in efforts to improve spatial conditions in slum areas. The research is conducted through several stages, including data collection, data analysis, and the production of orthophoto results. Data collection is carried out through field surveys, which involve direct surveys of slum areas to identify existing physical and spatial conditions, as well as photogrammetric measurements and GPS to determine accurate coordinate points. The stages of Field Data Collection include:

a. GPS Measurement

The GPS measurement method is used to obtain GCP (Ground Control Points) and ICP (Independent Check Points) coordinates using the static method with a radial network model for GCP points and Real-Time Kinematic for ICP points with 5 times fixed data recording. Before measurement, GCP stakes are installed covering the entire area and ICP points are installed in the slum areas. In this research, 6 GCP points and 10 ICP points are installed.

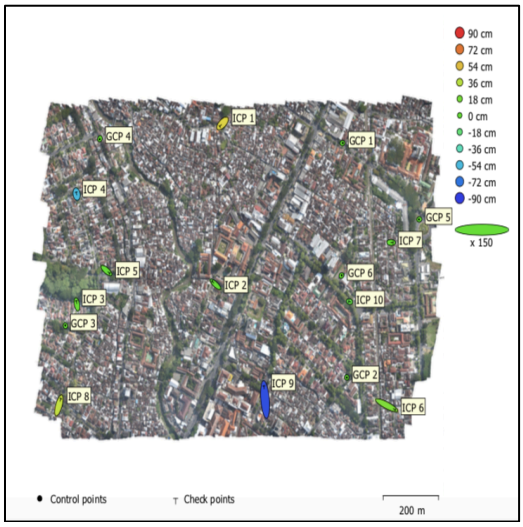

FIGURE 1. GPS Measurement

b. Photogrammetric Measurement

The photogrammetric measurement method is conducted using a drone with a vertical camera position over an area of 25 hectares. Premark installation on GCP and ICP stakes is done before shooting; the premark serves as a marker on the photo to facilitate the identification of control points during photo data processing in software and ICP points during accuracy testing. Orthophoto processing covers the entire research area with sufficient resolution for detailed analysis.

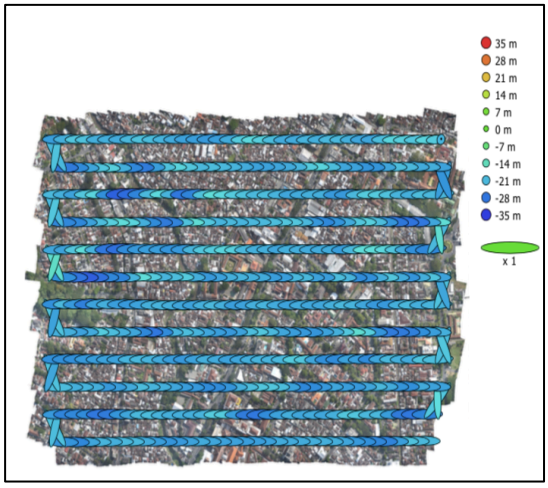

FIGURE 2. Installation on GCP and ICP

In the data analysis stage, the accuracy of georeferenced orthophotos can be tested to identify building structures, roads, rivers, and public facilities in slum areas according to field conditions. The continuity of orthophotos can be used for periodic monitoring to assess the effectiveness of improvements made and to evaluate changes and developments in the slum areas.

c. Map Layout Desain

The processed data is then used to create a map layout that meets cartographic standards. This step aims to produce an Orthophoto map that will be used as a Digital Architectural Medium in efforts to improve the spatial layout of slum areas.

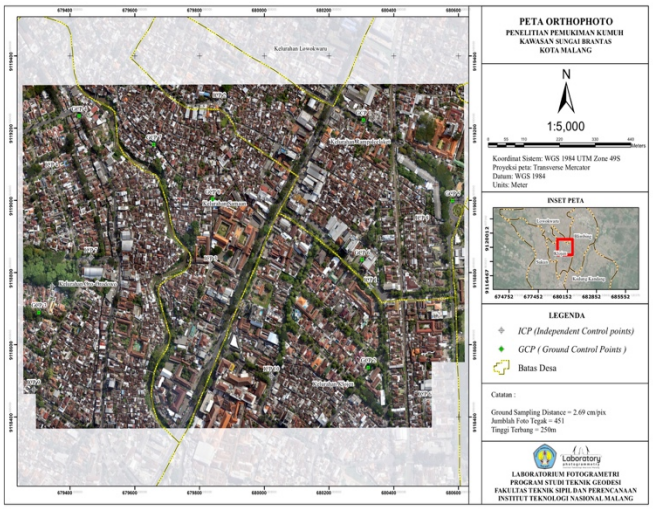

FIGURE 3. Layout Desain

III. RESULTS AND DISCUSSION

The GPS measurement method for obtaining GCP and ICP coordinates is carried out using the static method with a radial network model for GCP points and the Real Time Kinematic (RTK) method for ICP with data recording five times for a fixed position. Before the measurements, GCP markers are installed to cover the entire area, including the central part, and ICP markers are installed in clusters within the slum area. In this study, 6 GCP markers and 10 ICP points were used. Static GPS measurements are conducted to collect GCP data, where the GCP points are tied to the national reference points at the cors station. ICP measurements are performed using the RTK method to obtain ICP coordinates.

TABLE 1. ACCURACY TEST GCP COORDINATES

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
GCP 1	1.4462	0.209919	-0.0545823	1.46237	1.546 (5)
GCP 2	0.0920679	-0.462784	-0.0346082	0.473121	1.922 (7)
GCP 3	-0.477415	1.26208	0.0119409	1.34941	1.500 (4)
GCP 4	-0.784637	-1.68951	0.0886553	1.86493	1.919 (6)
GCP 5	-1.53934	-0.397162	0.0129824	1.58981	1.550 (5)
GCP 6	1.23822	1.00235	0.229045	1.60946	0.994 (7)
Total	**1.0682**	**0.988937**	**0.103931**	**1.4594**	**1.607**

The table shows the total error results for GCP with an average value of 1.4 cm and the total error results for ICP with an average value of 46 cm. These results indicate that the data can be used as a reference for the accuracy of the orthophoto.

TABLE 2. ACCURACY TEST ICP COORDINATES

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
ICP 10	-3.99108	0.865744	-6.21711	7.43846	1.385 (5)
ICP 1	-13.7762	-11.6489	47.255	50.5818	0.623 (5)
ICP 2	-16.4925	12.2642	-0.763452	20.5669	2.434 (5)
ICP 4	-1.66486	7.62422	-54.2175	54.7763	0.492 (6)
ICP 3	-3.19843	13.862	15.6107	21.1206	1.049 (6)
ICP 6	41.7691	-17.5889	20.9162	49.915	1.672 (6)
ICP 5	15.8961	-11.1875	11.4574	22.5636	3.522 (6)
ICP 7	9.02249	-0.34477	10.7399	14.031	0.697 (6)
ICP 8	9.55413	26.9207	38.5095	47.9477	0.493 (5)
ICP 9	-5.45371	53.2397	-82.3344	98.1996	3.860 (5)
Total	**16.4027**	**21.2861**	**37.9494**	**46.5005**	**1.995**

The photo data processing stages are performed using Agisoft Metashape software to obtain orthophoto and DEM, with the orthophoto data later used as the basis for acquiring information on slum settlements. The resulting orthophoto is illustrated in Figure 4 from the photo data processing, which will subsequently be used as a Digital Architectural Medium in efforts to improve the spatial layout of slum areas.

FIGURE 3. Orthophoto

CONCLUSION

By utilizing photogrammetric mapping technology, orthophotos are able to provide accurate and detailed information about the physical conditions of settlements, which is highly useful in various aspects of planning, implementation, and evaluation of improvements. The research results indicate that orthophotos can enhance the

effectiveness and efficiency of improvement efforts, as well as support real-time monitoring and evaluation of programs. Therefore, the use of orthophotos is highly recommended to improve the quality of life for residents in slum areas and to support better decision-making in urban planning in Indonesia

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