Comparison analysis of accuracy and precision on GNSS K706 Oem Board and GPS Topcon HiperPro

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Abstract. GNSS technology has been widely used in the field of surveys and mapping. According to Abidin this is because GNSS can be used regardless of time, is not affected by the topography of the survey area, and provides accuracy with a wide spectrum. GNSS technology also has several disadvantages, one of which is price. The tool used to implement GNSS technology has a high price, for example is the geodetic type which has prices ranging from hundreds of millions of rupiah. The last few years have found low-cost GNSS. which has a cheaper price. To find out the quality of low-cost GNSS a test was carried out. In this study a low-cost GN70 Oem Board was tested.

This study focuses on testing accuracy and precision. The method used for testing is RTK, and Static for data as a reference. RTK data acquisition uses the NTRIP method with CORS Surabaya as the base. There are 3 test locations in this study. The first is in BM01ITS or "bits", the second ITS Stadium or "bstd", and third Sakura Park or "bskr".

Horizontal and vertical deviation standards on the K706 OEM board has better quality than Topcon HiperPro. This is evidenced by the standard deviation of the K706 superior in 4 research points, while HiperPro only excels at two research points. Horizontal RMSE both devices have the same quality. This is evidenced by the RMSE of the K706 superior in 3 research points, and HiperPro excels in 3 research points. For vertical RMSE, the K706 is better than HiperPro. This is evidenced by the standard deviation of the K706 superior in 5 research points, while HiperPro only excels at one research point.

1. Introduction
At present the method of determining a point on the surface of the earth is experiencing technological advances. This is indicated by the availability of measuring equipment equipped with the latest digital technology. One method of positioning a point on the surface of the earth is using GPS [1]. Using positioning has been widely used, especially in the field of surveying and mapping [5]. According to [2] GPS technology is widely used due to tropospheric monitoring. The GNSS method also has several disadvantages, namely in terms of price, expensive tools [4]. Innovations in GPS positioning technology run very fast, both on geodetic type GPS equipment, mapping type and navigation type. In addition to the three-type GPS, in recent years low-cost / low-cost GPS devices have also experienced significant developments [6,8]. The problem of GPS accuracy of single frequencies caused by ionospheric bias [3]. The research about low cost GPS was already done for static observation [9].
Based on the above, a study was conducted on the accuracy comparison of low-cost dual frequency GNSS, namely GNSS K706 OEM BOARD from COMNAV to GPS Geodetik Topcon HiperPro. In this research, the Real Time Kinematic (RTK) method for data acquisition is used, and the static method for collecting data as a reference.

In this study an analysis of accuracy and precision testing was carried out. The data acquisition results from the Oem K706 will be compared to the results of data acquisition from topcon HiperPro.

With this study, it is expected to be able to determine the feasibility level of the GNSS K706 Oem Board in its use for geodesic measurement, and this research is very useful in saving the budgetary costs of a GNSS tool.

2. Methodology

2.1. Study area and data

The location of the study was conducted in Surabaya, East Java, precisely there were 3 locations scattered in Surabaya, the first being at ITS BM01, ITS Surabaya Stadium, and the last being in Sukolilo Sakura Park Surabaya.

![Research location](image1)

Figure 1. Research location.

In this study there are only two types of data used, namely primary and secondary data. The primary data collected by researchers is the data in the form of x, y, z coordinates. The research points obtained from measurements using GPS Geodetik Topcon HiperPro and GNSS K706 Oem. Secondary data
collected is BIG Surabaya's Rinex Statistics Cors data and ITSN CORS belonging to the ITS Geomatics Engineering Department.

Coordinate data is obtained by measuring directly in the field using each tool, the K706 Oem Board and Topcon HiperPro.

Rinex data from Cors Surabaya station and ITSN was obtained by asking the relevant agencies.

2.1.1. Stage of research implementation

![Implementation Flowchart](image-url)

Figure 2. Implementation Flowchart
• Preparation
The Preparation Phase includes identifying and formulating problems regarding the measurement method used, the location of the study. In addition, it also collects information relating to GPS, CORS, RTKNTRIP and others related.

• Implementation
At the implementation stage, before the data collection was carried out orientation and determination of location to find a suitable location for research. The sampling location is in 3 locations, namely Bm01 ITS called "bits", the ITS Stadium is called "bstd" and Sakura Park is called "bskr". Each location was measured using the RTK method for 2 minutes with an epoch per second, so as to get 120 sample data. Data collection was carried out on both tools, namely Topcon HiperPro and GNSS K706 OEM.

The reference data was taken at 3 observation points using the Topcon HiperPro tool with a length of observation of 12 hours.

• Processing
The acquisition data obtained by the RTK method is coordinate data x, y, z (* txt) converted to (^ xls).

Data from data acquisition with Topcon HiperPro and K706 Oem are then calculated using RMSE and Standard Deviation for accuracy and precision analysis.

• Finishing
In the final stage, a report is made from the results of conclusions and analyzes that have been carried out in the previous stage.

3. Result and Discussion

3.1. 3 Measurement results of reference coordinates.
The reference coordinates are used for calculations on RMSE and also as a comparison between the results of HiperPro and K706. The reference coordinates are taken using the Topcon HiperPro tool with 12 hours of observation. The following are the results of the reference coordinates.

| Point | NORTHING UTM(meters) | EASTING UTM(meters) | HEIGHT UTM(meters) |
|-------|----------------------|---------------------|---------------------|
| Bstd  | 9194459.113          | 697904.733          | 31.683              |
| Bskr  | 9193208.343          | 697904.733          | 34.517              |
| Bits  | 9194685.943          | 698075.536          | 32.286              |

3.2. Results of measurement of real time kinematic (RTK) method
Measurements using the RTK method are carried out at each point of research. Each point was observed for 2 minutes. Data acquisition is done by the NTRIP method using an internet connection. For Corss used are Cors Surabaya and ITSN.

For the RTK method, the results that will be presented are of two kinds, the first is the result that gets the fix solution and the second is the overall observation data. The following are the results of measurements using the RTK method.
Topcon HiperPro
Data acquisition was observed for 2 minutes. And every second the data is recorded, so that there are 120 coordinate data. After that, the average calculation is done to get one coordinate for comparison with the K706 Oem Board.

The following are the results of data acquisition using Topcon HiperPro using the RTK method.

Table 2. Coordinate results for all observation data of Topcon HiperPro RTK method.

| Point | Cors | Koordinat UTM (m) |
|-------|------|-------------------|
|       |      | X                | Y                | Z     |
| Bits  | CSBY | 698075.080       | 9194686.144      | 33.376|
|       | ITSN | 698077.188       | 9194686.833      | 39.354|
| Bskr  | CSBY | 698974.204       | 9193208.265      | 36.055|
|       | ITSN | 698974.437       | 9193208.204      | 35.779|
| Bstd  | CSBY | 697904.705       | 9194459.158      | 33.329|
|       | ITSN | 697898.971       | 9194467.548      | 48.018|

Table 3. The results of the coordinate fix solution of Topcon HiperPro RTK method

| Point | Cors | Koordinat UTM Fix (m) |
|-------|------|-----------------------|
|       |      | X                    | Y                    | Z     |
| Bits  | CSBY | -                    | -                    | -     |
|       | ITSN | 698075.739           | 9194685.919          | 33.497|
| Bskr  | CSBY | -                    | -                    | -     |
|       | ITSN | 698974.455           | 9193208.225          | 36.053|
| Bstd  | CSBY | 697904.729           | 9194459.168          | 33.316|
|       | ITSN | 697899.127           | 9194468.250          | 39.570|

Note: For those marked "-" it means that the data has no fix ambiguity

K706 Oem Board
For data acquisition with the K706 Oem Board is done the same as Topcon HiperPro. The following are the results of data acquisition using Topcon HiperPro using the RTK method.

Table 4. Coordinate results for all observation data for the RTK K706 Oem Board method

| Point | Cors | Koordinat UTM (m) |
|-------|------|-------------------|
|       |      | X                | Y                | Z     |
| Bits  | CSBY | 698076.059       | 9194685.736      | 33.948|
|       | ITSN | 698074.534       | 9194684.707      | 37.377|
| Bskr  | CSBY | 698973.940       | 9193208.396      | 35.989|
|       | ITSN | 698974.228       | 9193206.942      | 35.546|
| Bstd  | CSBY | 697904.736       | 9194459.125      | 33.315|
|       | ITSN | 697904.127       | 9194459.313      | 21.157|
### Table 5. The results of the coordinate fix solution for RTK K706 Oem Board method

| Point | Cors | X     | Y     | Z    |
|-------|------|-------|-------|------|
| Bits  | CSBY | 698074.537 | 9194684.498 | 37.548 |
|       | ITSN | -     | -     | -    |
| Bskr  | CSBY | 698974.608 | 9193207.093 | 36.552 |
|       | ITSN | -     | -     | -    |
| Bstd  | CSBY | 697904.752 | 9194459.101 | 33.104 |
|       | ITSN | 697905.073 | 9194457.837 | 33.647 |

- Standart deviation

  Calculation of Deviation Standard here is divided into 2, namely Standard Deviation for the entire data and Standard Deviation for data that gets a fix solution [7]. Here are the results.

### Table 6. Overall data deviation standart

| Alat   | Point | Cors | SD Horz (m) | SD Vert (m) |
|--------|-------|------|-------------|-------------|
| K706   | BSKR  | CSBY | 0.081       | 0.066       |
|        |       | ITSN | 2.027       | 5.433       |
|        | BSTD  | CSBY | 0.128       | 0.039       |
|        |       | ITSN | 0.376       | 0.856       |
|        | BITS  | CSBY | 0.324       | 0.309       |
|        |       | ITSN | 0.539       | 1.117       |
| HiperPro | BSTD | CSBY | 0.213       | 0.295       |
|        |       | ITSN | 0.097       | 0.193       |
|        | BITS  | CSBY | 0.260       | 0.343       |
|        |       | ITSN | 8.128       | 15.039      |

### Table 7. Standart deviation fix solution.

| Alat   | Point | Cors | SD Horz (m) | SD Vert (m) |
|--------|-------|------|-------------|-------------|
| K706   | BSKR  | CSBY | -           | -           |
|        |       | ITSN | 0.448       | 0.738       |
|        | BSTD  | CSBY | -           | -           |
|        |       | ITSN | 0.002       | 0.007       |
|        | BITS  | CSBY | 0.011       | 0.039       |
|        |       | ITSN | 0.007       | 0.037       |
| HiperPro | BSKR | CSBY | -           | -           |
|        |       | ITSN | 0.448       | 8.817       |
|        | BSTD  | CSBY | -           | -           |
From table 5, it can be concluded that the horizontal standard deviation of OEM K706 is better than HiperPro. This is evidenced by K706 having a better standard deviation than HiperPro on 4 data (CSBY level, ITSN score, bstd CSBY, and ITSN bits), while HiperPro has a better standard deviation than K706 in 2 data (ITSN bstd, bits CSBY). The standard vertical deviation of the K706 is better compared to HiperPro. This is evidenced by K706 having a better standard deviation than HiperPro on 4 data (ITSN score, bstd CSBY, bits CSBY and bits ITSN), while HiperPro has a better standard deviation than K706 on 2 data (bstd ITSN, CSBY bsk).

The smallest standard horizontal deviation value is at the "bskr" point with CORS CSBY which is equal to 0.081 meters and the smallest vertical standard deviation is at the point "bstd" with CORS CSBY. The highest standard horizontal and vertical deviation is at the "bits" point with the ITSN CORS which is equal to 8,128 meters for horizontal and 15,039 meters for vertical. According to the author's analysis this is because the antenna specifications used in the study are not good. Besides that, the point in the BM01 ITS has the most obstacle which causes multipath influence, and affects the results obtained.

Table 8. Comparison of deviation standard results of measurement of K706 Oem Board with RTK method tool specifications.

| SD          | Spesifikasi | Kesimpulan |
|-------------|-------------|------------|
| Horz (m)    | Vert (m)    | Horz (m)   | Vert (m)   | Horz (m)     | Vert (m) |
| 0.081       | 0.066       | 0.0025     | 0.005      | TS           | TS        |
| 2.207       | 5.433       | 0.0025     | 0.005      | TS           | TS        |
| 0.128       | 0.039       | 0.0025     | 0.005      | TS           | TS        |
| 0.376       | 0.856       | 0.0025     | 0.005      | TS           | TS        |
| 0.324       | 0.309       | 0.0025     | 0.005      | TS           | TS        |
| 0.539       | 1.117       | 0.0025     | 0.005      | TS           | TS        |
| 0.213       | 0.183       | 0.0025     | 0.005      | TS           | TS        |
| 2.248       | 8.817       | 0.0025     | 0.005      | TS           | TS        |
| 0.287       | 0.295       | 0.0025     | 0.005      | TS           | TS        |
| 0.097       | 0.193       | 0.0025     | 0.005      | TS           | TS        |
| 0.260       | 0.343       | 0.0025     | 0.005      | TS           | TS        |
| 8.128       | 15.039      | 0.0025     | 0.005      | TS           | TS        |

From the comparison above states that the results of the entire data state the incompatibility with what is stated in the specifications. According to the analysis of the author, this can be caused by the antenna specifications used in the study is not good, so the results of measurements are not in accordance with what was stated specified. In addition, the influence of multipath around the research area also determines signal reception, so the results obtained are not thorough.

- **Root Mean Square**

RMSE calculation is done by comparing per-epoch data with Topcon HiperPro data with a measurement duration of 12 hours through post processing using Topcon Tools software. The RMSE calculation here is divided into 2, namely RMSE for the entire data and RMSE for the data that gets the fix solution. The smaller the RMSE value the more accurate the data is generated. Here are the results.
Table 9. RMSE results overall data RTK method.

| Alat  | Point | Cors  | RMSE Horz (m) | RMSE Vert (m) |
|-------|-------|-------|---------------|---------------|
| K706  | BSKR  | CSBY  | 0.562         | 1.662         |
|       |       | ITSN  | 1.592         | 5.091         |
|       | BSTD  | CSBY  | 0.305         | 1.472         |
|       |       | ITSN  | 1.338         | 0.895         |
|       | BITS  | CSBY  | 0.012         | 1.431         |
|       |       | ITSN  | 0.848         | 10.667        |
| HiperPro | BSKR | CSBY  | 0.499         | 1.090         |
|       |       | ITSN  | 1.876         | 7.068         |
|       | BSTD  | CSBY  | 0.087         | 1.538         |
|       |       | ITSN  | 0.060         | 1.127         |
|       | BITS  | CSBY  | 0.053         | 1.646         |
|       |       | ITSN  | 10.371        | 16.194        |

From the results of the RMSE calculation above, the K706 Oem has the same quality as the HiperPro on the horizontal RMSE. This is proven by K706 having RMSE better than HiperPro on 3 data (ITSN, CSBY, and ITSN bits), and HiperPro having RMSE better than K706 in 3 data (CSBY, CSBY, and ITSN bstd). The vertical RMSE of the K706 has better quality compared to HiperPro. This is evidenced by K706 having RMSE better than HiperPro on 5 data (ITSN cycle, ITSN and CSBY bstd, and ITSN and CSBY bits), and HiperPro having better RMSE than K706 on 1 data (CSBY account).

The smallest horizontal RMSE value is at the "bits" point with the binding of CORS CSBY, and the smallest vertical RMSE is at the point "bstd" with the CORS ITSN. The largest horizontal and vertical RMSE is at the "bits" point with the binding of the CORS ITSN. According to the author's analysis this is because the antenna specifications used in the study are not good. Besides that, the point in the BM01 ITS has the most obstacle which causes multipath influence, and affects the results obtained.

Table 10. RMSE Results Fix Solution RTK Method.

| Alat  | Point | Cors  | RMSE Horz (m) | RMSE Vert (m) |
|-------|-------|-------|---------------|---------------|
| K706  | BSKR  | CSBY  | -             | -             |
|       |       | ITSN  | 1.757         | 5.091         |
|       | BSTD  | CSBY  | -             | -             |
|       |       | ITSN  | 1.184         | 0.895         |
|       | BITS  | CSBY  | 0.023         | 1.431         |
|       |       | ITSN  | 1.234         | 10.667        |
| HiperPro | BSKR | CSBY  | -             | -             |
|       |       | ITSN  | 0.204         | 7.068         |
|       | BSTD  | CSBY  | -             | -             |
|       |       | ITSN  | 0.044         | 1.127         |
|       | BITS  | CSBY  | 0.055         | 1.646         |
|       |       | ITSN  | 10.869        | 16.194        |

From the results of the RMSE calculation above, the K706 Oem has the same quality as the HiperPro on the horizontal RMSE. This is proven by K706 having RMSE better than HiperPro on 3 data (ITSN, CSBY, and ITSN bits), and HiperPro having RMSE better than K706 in 3 data (CSBY, CSBY, and ITSN bstd). The vertical RMSE of the K706 has better quality compared to HiperPro. This is evidenced by K706 having RMSE better than HiperPro on 5 data (ITSN cycle, ITSN and CSBY bstd, and ITSN and CSBY bits), and HiperPro having better RMSE than K706 on 1 data (CSBY account).
4. Conclusion
Based on the research that has been done, it can be concluded as follows:

- From the Standard Deviation test states that the results of the K706 Oem Board do not match what is stated in the application. This can be because the antenna specifications used in the study are not good, so the results of the measurements are not in accordance with what is stated as specified. In addition, the influence of multipath around the research area also determines signal reception, so the results obtained are not thorough.

- From the standard deviation calculation, states that the K706 em board has a standard horizontal and vertical standard deviation that is better than Topcon HiperPro. This is evidenced by the standard deviation of the K706 superior in 4 research points, while HiperPro only excels at two research points.

- From the RMSE calculation, the K706 has the same quality as the HiperPro on the horizontal RMSE. This is evidenced by the RMSE of the K706 superior in 3 research points, and HiperPro excels in 3 research points. For vertical RMSE, the K706 is better than HiperPro. This is evidenced by the standard deviation of the K706 superior in 5 research points, while HiperPro only excels at one research point.

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