Conventional Approach to Harmonious Coordinated Cadastral Database Weakness

K S Looi, K L Chan, M F Isahak, H Hamzah, N Muda, B W Lim, W C Yeap and L C Tan

1Department of Survey and Mapping Malaysia, 50578, Kuala Lumpur, Malaysia
2Geoinformation Department, University of Technology Malaysia, 81310, Skudai, Johor, Malaysia

looi@jupem.gov.my

Abstract. The eKadaster system depended solely on the use of coordinated cadastral database known as the National Digital Cadastral Database (NDCDB) with an expected accuracy of ±10cm. Till date, there is an approximately of 7.8 million land parcels and 21.9 million boundary markers in the NDCDB that covers the total area of 132,183 km². However, the NDCDB accuracy of ±10cm is still not at a satisfactory acceptance level and the adjustment keeps continuing without carrying out verification to the data sources weakness of varying accuracy and input errors. Thus, the foremost important corrective is to ensure the adjustment input files to have the exact value of the sources by further divided the existing adjustment blocks into smaller blocks to verify the input data line by line. A well distributed cadastral control points and latest NDCDB accessibility are also extensively needed to plan and to strengthen the adjustment network. The comparison result of the randomly picked ground truthing points in the field has shown a significant impact on the displacement accuracy that meet the expected tolerance of ±10cm or better after the data input file is cleaned without input error. And to further strengthen the adjustment network in order to make NDCDB accuracy better, the current cadastral control points shall need to tie to a highest accuracy fundamental network.

1. Introduction

The eKadaster system had been implemented by the Department of Survey and Mapping Malaysia (DSMM) from 1st May 2010. It marked the beginning of a fully automated cadastral survey system where the survey computation procedure depended solely on the coordinated cadastral system (CCS) database known as the National Digital Cadastral Database (NDCDB).

The intention of the NDCDB was to have a homogeneous and seamless database with survey accurate coordinate accuracy of ±10cm [1] reference to the Geodetic Datum of Malaysia (GDM) known as the GDM2000 Geocentric Cassini Soldner system [2]. Previously established Digital Cadastral Database (DCDB) was migrated to NDCDB in 2006 with adjustment from 25,000 Global Satellite Navigation System (GNSS) observed grid-based Cadastral Control Infrastructure (CCI) points and it was further adjusted in 2012. The migration had undergone quality assurance at every level of its formation as shown in figure 1 and figure 2.

During this period, approximately a total of 2,891 adjustment blocks was created following the reserved route in between the land parcels [3]. For example, the adjustment blocks for the state of Pulau Pinang are as shown in figure 3 and figure 4. And to strengthen the existing cadastral control
network, DSMM had identified and established additional Cadastral Reference Mark (CRM) from 2012 onwards. At present, there are approximately 100,202 cadastral control points have been established to strengthen the adjustment network.

2. Issues
The aim of NDCDB is to achieve the accuracy of ±10cm between the boundary marks in the NDCDB to their respective physical location on the ground. From 2010 till late 2019, block adjustment is continuously processed by entrusting the adjustment input files having no input errors [4].

But lately, DSMM started to realise why its accuracy of ±10cm is far below expectation [5]. This mindful thought has led to the verification of the adjustment input files and found issues among others, are inaccurate or insufficient number of cadastral control points, wrongly geometrical matched the
boundary marks, inaccurate connection line resulting features being pushed to wrong location, non-compliance and missing lots resulting incomplete database [3]. Some of the findings are shown in figure 5, figure 6 and figure 7.

Figure 5. Wrongly input of bearing and distance value.

Figure 6. Wrongly input of connection line value.
3. The Approach

DSMM need to determine the adjustment input files to have the exact value as those shown in the Certified Plans which are the source data for adjustment. It is a tedious process to verify the input data line by line and to ease the verification process, the previous 2,891 adjustment blocks are further divided into smaller blocks of 5,163 as shown in table 1 [3]. This is to enable the line by line checking for data input errors.

The need to include non-compliance and missing lots cadastral fabrics from multiple layers into NDCDB is also important to portrait the latest NDCDB for control network planning and adjustment. Once the adjustment block is confirmed free from data input error, then the distribution of the cadastral control points will need to identify in order to strengthen its adjustment network. The availability of the traverse lines from current survey files and their cadastral control points tie-up are also used as additional input data as shown in figure 8.

With this verification procedure, DSMM will have a higher confidence level of the adjustment result and to plan for the next course of action. The tasks are done using a customised application named Localised Adjustment and Append Module (LAAM) as shown in figure 9.

Table 1. New smaller adjustment blocks.

| NO. | STATE     | NEW BLOCK OF ADJUSTMENT |
|-----|-----------|-------------------------|
| 1.  | PERLIS    | 84                      |
| 2.  | LABUAN    | 10                      |
| 3.  | MELAKA    | 230                     |
| 4.  | N. SEMILAN| 364                     |
| 5.  | P. PINANG | 244                     |
| 6.  | PAHANG    | 466                     |
| 7.  | WPK/PUTRAJAYA | 141           |
| 8.  | KEDAH    | 378                     |
| 9.  | PERAK    | 868                     |
| 10. | KELANTAN | 444                     |
| 11. | SELANGOR | 692                     |
| 12. | TERENGGANU | 413                   |
| 13. | JOHOR    | 829                     |
| TOTAL |          | 5163                   |
4. Findings

After the data input file for the respective block is cleaned then it is used to perform the adjustment. The adjustment result will then compare with randomly picked ground truthing points in the field. Table 2 and figure 10 shown the displacement result before the data input file is cleaned. Table 3 and figure 11 shown the displacement result after the data input file is cleaned.
Table 2. Maximum displacement of 1.856m before cleaned for block T02001.

| BIL | NO parcels | LEN | SAND | DIA | FLO | PORE | BLOCK | BEZ | PER | ARI | NOS |
|-----|------------|-----|------|-----|-----|------|--------|-----|-----|-----|-----|
| 23  | PUTT11_2018 | 210 |     |     |     |      |        |     |     |     |     |
| 24  | PUTT20_2018 | 370 |     |     |     |      |        |     |     |     |     |
| 32  | PUTT11_2016 | 210 |     |     |     |      |        |     |     |     |     |

Figure 10. Maximum displacement of 1.856m before cleaned for block T02001.
Table 3. Maximum displacement of 0.068m after cleaned for block T02001.

| BIL   | NOFAIL | STN_ID   | STN_NO | STN_TYPE | GP_T | GP_U | BLOCK | BIZA_T | BIZA_U | ANJAKA T | ID_BATU | N  |
|-------|--------|----------|--------|----------|------|------|-------|--------|--------|-----------|---------|-----|
| 0286  | PUT220 | 2020     | 0401   | 0        | BKL  | BKL  | T02001| 88482 | 1384882 | T02001   | 0.031   | -0.006 | 0.065 |
| 4016  | PUT220 | 2017     | 0401   | 0        | BKL  | BKL  | T02001| 86140 | 0009260 | T02001   | -0.009  | -0.000 | 0.000 |
| 3907  | PUT1731 | 2016     | 2181350 | 0788   | BKL  | BKL  | T02001| 12126 | 2240  | T02001   | 0.014   | -0.048 | 0.020 |
| 3951  | PUT1509 | 2016     | 92955  | 22977   | BKL  | BKL  | T02001| 19295 | 22977  | T02001   | 0.050   | 0.000  | 0.050 |
| 3954  | PUT1509 | 2016     | 92955  | 22977   | BKL  | BKL  | T02001| 19295 | 22977  | T02001   | 0.050   | 0.000  | 0.050 |
| 3904  | PUT1728 | 2016     | 2181350 | 0788   | BKL  | BKL  | T02001| 12126 | 2240  | T02001   | -0.014  | -0.048 | 0.020 |
| 4015  | PUT220 | 2017     | 0401   | 0        | BKL  | BKL  | T02001| 86802 | 23893  | T02001   | 0.008   | -0.047 | 0.048 |
| 3906  | PUT1728 | 2016     | 2118450 | 0111   | BKL  | BKL  | T02001| 12119 | 3111   | T02001   | -0.010  | -0.040 | 0.041 |
| 3908  | PUT1731 | 2016     | 2093950 | 0204   | BKL  | BKL  | T02001| 12094 | 021049 | T02001   | -0.098  | -0.040 | 0.040 |
| 3909  | PUT1731 | 2016     | 2118450 | 0111   | BKL  | BKL  | T02001| 12119 | 3111   | T02001   | -0.010  | -0.040 | 0.041 |
| 3905  | PUT1728 | 2016     | 2093950 | 0204   | BKL  | BKL  | T02001| 12094 | 021049 | T02001   | -0.008  | -0.040 | 0.041 |
| 1088  | PUT302 | 2019     | 7863422 | 2704   | BKL  | BKL  | T02001| 17366 | 2227657| T02001   | 0.030   | 0.014  | 0.033 |
| 9896  | PUT204A | 2018     | 7739213 | 0795   | BKL  | BKL  | T02001| 17739 | 257279 | T02001   | -0.032  | -0.005 | 0.032 |
| 9897  | PUT204A | 2018     | 7739213 | 0795   | BKL  | BKL  | T02001| 17739 | 257279 | T02001   | 0.000   | -0.031 | 0.031 |
| 22    | PUT1433 | 2016     | 0071936 | 1691   | BKL  | BKL  | T02001| 10607 | 0651071 | T02001   | 0.021   | 0.017  | 0.027 |
| 1102  | PUT1569 | 2019     | 8496314 | 0934   | BKL  | BKL  | T02001| 18496 | 093515 | T02001   | -0.019  | 0.019  | 0.027 |
| 21    | PUT1433 | 2016     | 0032496 | 0163   | BKL  | BKL  | T02001| 10324 | 016352 | T02001   | 0.021   | 0.017  | 0.003 |
| 9955  | PUT661 | 2019     | 7791614 | 2253   | BKL  | BKL  | T02001| 17792 | 0225372 | T02001   | -0.014  | 0.019  | 0.024 |
| 1088  | PUT302 | 2019     | 7863422 | 0262   | BKL  | BKL  | T02001| 17569 | 0271446 | T02001   | -0.019  | -0.004 | 0.019 |
| 1290  | PUT2261 | 2019     | 7747614 | 4900   | BKL  | BKL  | T02001| 17747 | 0490123 | T02001   | 0.008   | -0.015 | 0.017 |
| 4038  | PUT331 | 2017     | 1749455 | 6168   | BKL  | BKL  | T02001| 17494 | 5561642 | T02001   | 0.009   | -0.014 | 0.017 |

Figure 11. Maximum displacement of 0.068m after cleaned for block T02001.

The comparison result has shown a significant impact on the displacement accuracy before and after the data input file is cleaned. The displacement between the ground truthing with NDCDB which is adjusted from the cleaned data input file meet the expected tolerance of ±10cm or better.

5. Conclusion and the way forward
To conclude the finding from the adjustment result above has led to how the NDCDB should be developed to meet the expected accuracy of ±10cm. The foremost important aspect to achieve the needed accuracy is to input the data free from error compare to its sources and not only depending on the control network’s density alone. Of course, a well-planned cadastral control network with the highest accuracy will not make NDCDB better if the data source to develop the NDCDB contain
errors. Thus, to strengthen the cadastral control network, DSMM has planned to establish the highest accuracy Positional Reference Mark (PRM) as the fundamental network in 2022. The PRM is based on GNSS technique and is made to support the NDCDB adjustment. This will be in addition to the current available CRM as control points for the adjustment. And the PRM is an additional to the current sixty-five (65) RTK CORS Stations or zero-order network available in the Peninsular Malaysia. The CRM established previously will then tie to this PRM in order to strengthen the control network for adjustment. The establishment of CRM is a continuing process with more to build within an adjustable block to improve the quality of the NDCDB.

References
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