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RECOVERY OF BEARINGS AND DISTANCES FOR INTERNAL LOTS FROM CADASTRAL PERIMETER SURVEY DATA: CASE STUDIES IN SEVERAL STATES OF PENINSULAR MALAYSIA

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Abstract

A study is being carried out to investigate the most appropriate way of determining the missing bearings and distances for internal cadastral lots where the boundary lines are mainly represented on the certified plans (CPs) by scaled distances only. A computer program has been written to compute the bearing and distance for the related lines using the perimeter of the lots which were defined by second class surveys. The computed bearings and distances were later used to re-compute the area of the internal lots and compared with areas given by the certified plans.

Results from test computations which has been carried out in selected areas in several states of Peninsular Malaysia indicate that the average differences between the computed and certified areas for the internal lots is less than 1%. Further efforts are being made so that the differences could be well distributed and minimized within the area specified by the perimeters.

1.0 BACKGROUND

Due to the advent of computer and rapid development of Information Technology (IT), a nationwide technological reforms in the field of cadastral surveying has been noticed. With the mission of being a modern geographic data provider, the Department of Survey and Mapping (DSMM) has initiated a Computer Assisted Land Survey (CALS) system project which initiated the shift from conventional analog cadastral data to digital form and consequently the introduction of the concept of digital database. Starting with its pilot project in Johor (1986) and Pahang (1993), the system has generated a national Digital Cadastral Database (DCDB) at a scale of 1:4,000. The computerisation programme has led to the introduction of the Mini-CALS system in all remaining states of Peninsular Malaysia in 1995.

It has been recognised that the CALS database will be used by GIS/LIS users from other government departments and private sector as the basic building blocks of their systems. In building its DCDB the Department is currently in the cause of contracting-out the data capture process nationwide which mainly involves the conversion of analog data into digital format. The conversion of approximately 6 millions cadastral land parcels throughout the country into digital form is to be carried out under the 7th Malaysia

Development Plan (Abdul Majid, 1997). In implementing this task, careful measure in maintaining the integrity of the information related to the boundary lines which determine the dimension and location of individual land parcel becomes an important issue.

Under the existing cadastral system, the dimension of any land parcel is determined by the bearing and distance of its boundary lines. The area of the parcel is then derived/computed from the surveyed bearings and distances of the related boundaries. However, in some cases, the dimension of the boundary lines is often represented by scaled distances only, particularly in areas where information could only be obtained from old cadastral survey records. For such areas, its perimeter is usually defined by second class standard surveys and part of their internal boundary lines were defined by third class surveys. This paper will report the progress of an investigation leading to the recovery of the required bearings and distances for the scaled boundary lines in such areas in the states of Kelantan, Johor, Selangor, Perak, Terengganu, Kedah and Pahang.

2.0 REVIEW OF CADASTRAL SURVEYS IN THE STUDY AREAS

The bearings and distances which defined the boundaries of each cadastral lot are the information needed in building the DCDB. For some areas in the corresponding states, the conversion process into digital format was interrupted simply due to the inavailability of the bearings and distances for the scaled distance boundary lines.

State (District)	C.P. No	Year of Survey	Total Area (ha.)	No. Of Lots	Min. Lot Size (m^2)	Max. Lot Size (m^2)	Average Lot Size (m^2)
Kelantan (Machang)	1686	1948	14.3	36	344	8,964	3,990
Kelantan (Pasir Mas)	6649	1959	31.7	44	1,416	20,639	7,214
Kelantan (Pasir Mas)	6669	1959	34.6	44	1,679	33,973	7,861
Kelantan (Pasir Mas)	6807	1960	28.7	48	1,315	41,581	5,971
Kelantan (Pasir Mas)	6813	1960	25.6	32	1,700	19,223	8,024
Kelantan (Pasir Mas)	6814	1960	18.2	19	3,480	26,790	9,571
Kelantan (Kota Bharu)	10119	1966	6.7	43	384	4,933	1,592
Kelantan (Alur Pasir)	57048	1984	9.6	21	807	9,524	4,595
Kelantan (Alur Pasir)	57049	1984	7.5	24	144	20,290	3,201
Johor (Muar)	5056	1922	39.4	49	1,897	33,387	8,034
Johor (Johor Bahru)	7105	1929	89.5	65	4,148	25,040	13,772
Johor (Johor Bahru)	7201	1929	92.6	31	13,152	43,251	29,878
Johor (Batu Pahat)	7259	1934	47.9	33	2,200	21,777	14,507
Johor (Batu Pahat)	7262	1935	55.0	39	4,553	26,305	14,115
Johor (Batu Pahat)	7265	1935	67.1	41	2,732	29,820	16,361
Johor (Muar)	7325	1932	35.8	44	936	24,534	8,147
Selangor (Kuala Langat)	22805	1958	35.8	27	9,561	19,678	13,256
Selangor (Ulu Langat)	21350	1956	2.6	16	658	2,125	1,605
Selangor (Kuala Selangor)	22883	1959	19.5	24	8,119	8,144	8,141

Selangor (Kuala Selangor)	21913	1959	51.1	59	8,119	21,878	8,663
Selangor (Ulu Selangor)	22825	1958	43.1	22	12,343	34,828	19,613
Perak (Kuala Kangsar)	25071	1960	2.2	2	10,699	10,901	10,800
Perak (Perak Tengah)	25085	1960	1.3	3	3,994	4,500	4,168
Perak (Selama)	25086	1960	4.6	2	21,777	24,155	22,966
Perak (Lower Perak)	25089	1960	2.2	4	2,782	11,508	5,533
Perak (Batang Padang)	25098	1961	10.2	5	12,748	26,077	20,325
Terengganu (K. Terengganu)	6009	1960	1.2	44	152	304	273
Terengganu (K. Terengganu)	1995	1947	12.1	62	25	7,841	1,950
Terengganu (K. Terengganu)	9658	1969	25.9	70	2,776	8,485	3,700
Terengganu (K. Terengganu)	3512a	1951	2.2	26	177	2,352	849
Terengganu (K. Terengganu)	3512b	1951	3.1	23	51	12,697	1,341
Terengganu (K. Terengganu)	6519a	1961	12.1	5	21,474	25,268	24,205
Terengganu (K. Terengganu)	6519b	1961	7.2	8	5,817	16,010	9,039
Terengganu (K. Terengganu)	2146	1947	18.2	99	202	10,775	1,834
Terengganu (Setiu)	3972	1960	23.4	31	1,518	36,877	7,558
Terengganu (Setiu)	9780	1968	48.8	18	24,827	37,482	27,096
Terengganu (Kemaman)	6526	1961	39.1	42	632	33,968	9,318
Kedah (Baling)	34615	1970	12.6	19	289	14,896	6,614
Kedah (Kota Setar)	22891	1959	8.8	24	1,619	9,333	3,656
Kedah (Kuala Muda)	34158	1966	52.0	34	14,176	16,689	15,307
Kedah (Kubang Pasu)	22874	1959	76.9	31	2,934	40,292	24,794
Kedah (Kubang Pasu)	59870	1992	8.3	7	1,223	20,970	11,840
Kedah (Padang Terap)	22895	1960	4.2	11	2,251	8,296	3,840
Kedah (Padang Terap)	22895	1960	6.9	10	1,796	18,742	6,923
Pahang (Lipis)	658	1913	4.4	4	5,944	17,907	10,914
Pahang (Lipis)	6340	1924	3.1	3	5,649	17,503	10,449
Pahang (Pekan)	7763	1925	39.6	34	2,150	24,635	11,650
Pahang (Pekan)	13947	1938	12.4	17	1,062	17,806	7,266
Pahang (Pekan)	12389	1935	0.5	2	141	4,578	2,360
Pahang (Pekan)	1829	1916	2.7	2	9,485	17,528	13,506
Pahang (Pekan)	26501	1974	2.0	2	8,349	12,222	10,285

Table 1: Statistics of the study areas

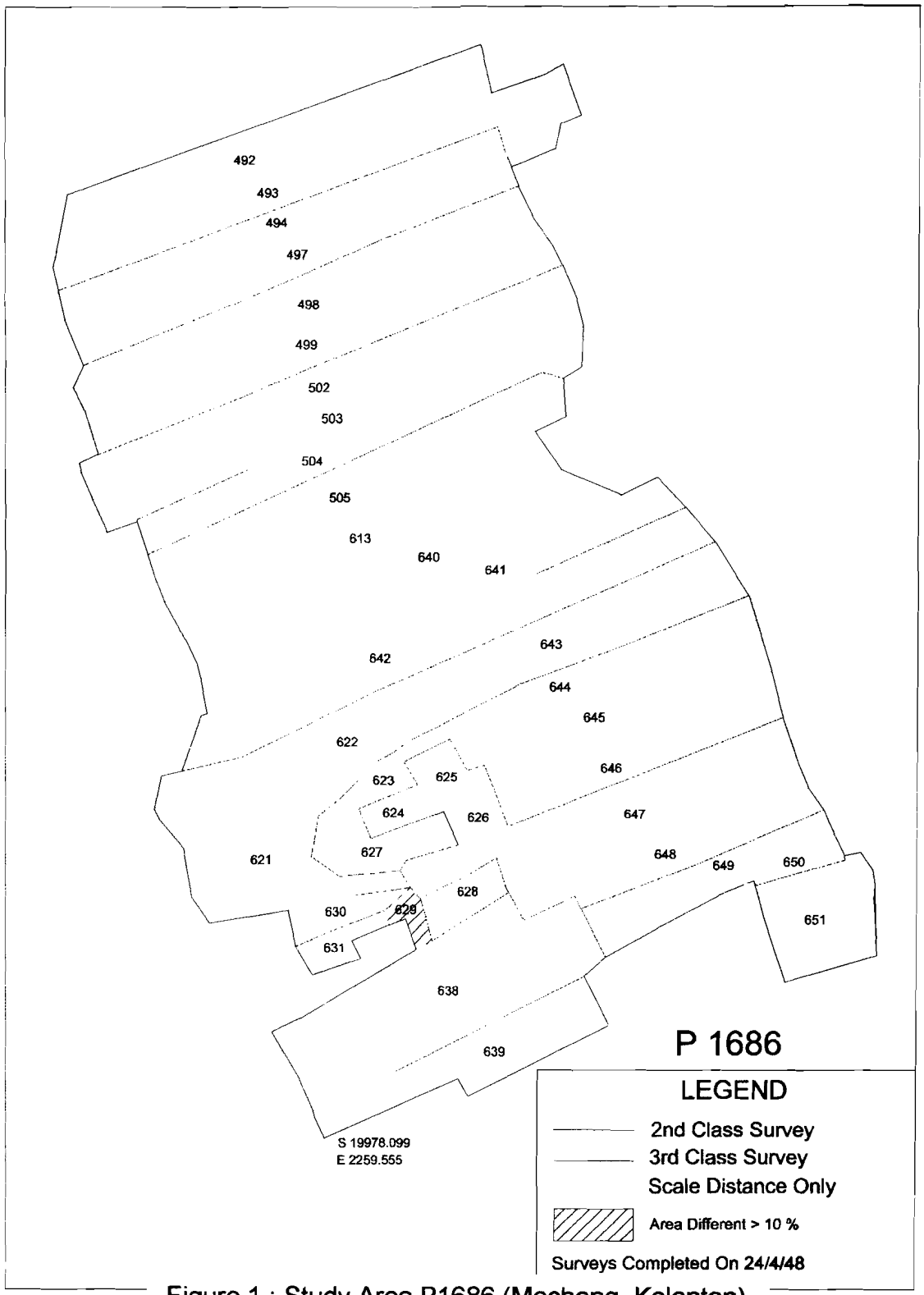


Figure 1 : Study Area P1686 (Machang, Kelantan)

The statistics of the selected study areas is shown in Table 1 together with their respective Certified Plan's number. The lands are located in rural areas and traditionally used for agricultural purposes. An example of the study area represented by CP P1686 located in Macang, Kelantan is shown in Figure 1. Area covered by each CP basically represented by an area bounded by the Second Class perimeter surveys except for two CPs (CP3512 and CP6519) in which each of them comprises of two perimeters (3512a/b and 6519a/b). The area varies from 1 to 93 hectares and the size of their internal lots ranging from few hundred square meters to more than 20 hectares. In general the areas were surveyed as early as 1920's up to 1980's. The normal survey practice for a group of agricultural lots were to provide their external boundaries (perimeter) with Second Class standards survey while their internal boundaries were only defined by the Third Class survey. According to the regulation, not more than 40 lots should be included in such a group and the total area of the group should not exceed 100 acres.

The classification of cadastral survey practices in this country is based on the degree of accuracy required as being outlined in the Survey Regulations (1976). The summary of the permissible closing errors for Second and Third Class surveys is shown in Table 2, while the nearest value of recorded bearing and distance (field and CP) are given in Table 3.

Misclosure	***Second Class***	***Third Class***
Angular	2 ′ 30 ″	5
Linear	1 : 4000	No mathematical limit but shall be able to plot to the scale in final plan

Table 2: Permissible closing errors for Second and Third class surveys

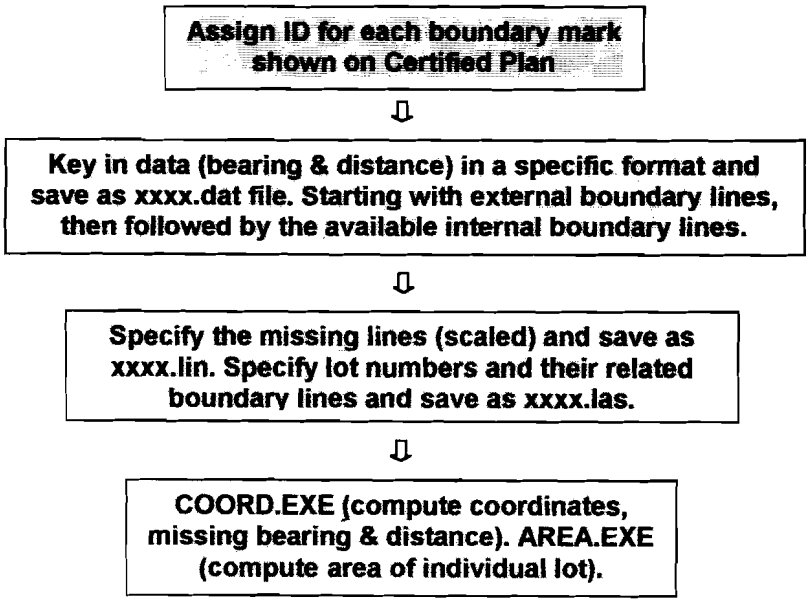
	Second Class		***Third Class***	
	Bearing	***Distance***	***Bearing***	***Distance***
Field Recorded	10 ″	0.01 links	10″	0.01 links
Field Adjusted	10 ″	0.01 links	1 ′	0.1 links
Certified Plan	30 ″	0.01 links	1 ′	0.1 links

Table 3: Nearest value of recorded bearing and distance (in field book and on CP)

Meanwhile on the Certified Plan, the scaled distances for some boundary lines of the internal lots in such a group are given to the nearest 1 link. Using information given on CPs, the recovery of the required bearings and distances for the scaled boundary lines in the study areas is being carried out.

3.0 THE RECOVERY OF MISSING BEARINGS AND DISTANCES

A computer program has been written to compute the bearing and distance for the related scaled distance lines. This is being done by using information given by the second class perimeter surveys (external lots) and third class surveys (internal lots). The outline of the processing methodology involved is shown below.



Prior to the data entry, all distances given on CPs has to be converted to meters and appropriate ID was assigned to each boundary mark. The input data files (xxxx.dat, xxxx.lin and xxxx.las) were later created following format specified by the program. In all cases their perimeter were given by Second Class surveys. Program COORD was first used to re-compute coordinates of each boundary mark. Then the program was used to recover bearing and distance of all specified scaled boundary lines. Finally based on the newly recovered values (computed bearings and distances), area for each lot in the study areas was re-computed using program AREA for further analysis.

4.0 COMPARISONS OF COMPUTED AREAS WITH CP VALUES

The recovery of bearings and distances for scaled distance boundary lines will determine the dimension of each land parcel in such a group of agricultural lots. In view of the development of the DCDB, this will consequently make the conversion process of analog data (bearings and distances for land parcel) into digital format possible. However, as previously mentioned, integrity of this newly derived information related to the scaled distance boundary lines need to be verified so that their inclusion in DCDB will be meaningful and confine to legal aspect of the land ownership under the existing laws and regulations.

It has been outlined in the National Land Code (1983) that the area of the surveyed land parcel is to be computed and to be shown on a certified plan. Under the present cadastral system, the right of the land owners were protected by the land law, in which their boundaries were permanently marked and the area of their land was clearly specified. Therefore, if the areas are to be re-computed using newly derived bearings and distances, their differences from the specified areas (CP) should be within the allowable limit. The practice is to maintain the area so that the difference should not be more than 10%.

The individual area of the group of land parcels in the study areas were computed using the derived/computed bearing and distances and subsequently compared with area given by the certified plans. The summary of results of the comparison are given in Table 4 and Figure 2, respectively.

State (District)	Certified Plan Number	Difference (%)		
		Min	Max	Mean
Kelantan (Machang)	1686	0	16	2.3
Kelantan (Pasir Mas)	6649	0	4	1.4
Kelantan (Pasir Mas)	6669	0	4	0.9
Kelantan (Pasir Mas)	6807	0	6	0.7
Kelantan (Pasir Mas)	6813	0	9	2.5
Kelantan (Pasir Mas)	6814	0	3	0.8
Kelantan (Kota Bharu)	10119	0	4	1.1
Kelantan (Alur Pasir)	57048	0	0	0.0
Kelantan (Alur Pasir)	57049	0	1	0.0
Johor (Muar)	5056	0	8	2.0
Johor (Johor Bahru)	7105	0	2	0.4
Johor (Johor Bahru)	7201	0	2	0.6
Johor (Batu Pahat)	7259	0	2	0.5
Johor (Batu Pahat)	7262	0	2	0.7
Johor (Batu Pahat)	7265	0	2	0.5
Johor (Muar)	7325	0	27	1.2
Selangor (Kuala Langat)	22805	0	1	0.4
Selangor (Ulu Langat)	21350	0	3	1.1
Selangor (Kuala Selangor)	22883	0	0	0.0
Selangor (Kuala Selangor)	21913	0	1	0.0
Selangor (Ulu Selangor)	22825	0	2	0.4
Perak (Kuala Kangsar)	25071	1	1	1.0
Perak (Perak Tengah)	25085	0	0	0.0
Perak (Selama)	25086	0	0	0.0
Perak (Lower Perak)	25089	0	1	0.3
Perak (Batang Padang)	25098	0	0	0.0
Terengganu (K. Terengganu)	6009	0	8	3.1
Terengganu (K. Terengganu)	1995	0	38	2.7
Terengganu (K. Terengganu)	9658	0	1	0.2
Terengganu (K. Terengganu)	3512a	0	5	1.2
Terengganu (K. Terengganu)	3512b	0	42	4.7
Terengganu (K. Terengganu)	6519a	0	1	0.4
Terengganu (K. Terengganu)	6519b	0	2	0.8
Terengganu (K. Terengganu)	2146	0	10	1.8
Terengganu (Setiu)	3972	0	3	0.6
Terengganu (Setiu)	9780	0	1	0.2
Terengganu (Kemaman)	6526	0	2	0.5
Kedah (Baling)	34615	0	1	0.1
Kedah (Kota Setar)	22891	0	3	1.1
Kedah (Kuala Muda)	34158	0	4	0.9
Kedah (Kubang Pasu)	22874	0	2	0.4
Kedah (Kubang Pasu)	59870	0	0	0.0

Kedah (Padang Terap)	22895	0	3	1.3
Kedah (Padang Terap)	22895	0	3	0.9
Pahang (Lipis)	658	0	10	3.3
Pahang (Lipis)	6340	0	0	0.0
Pahang (Pekan)	7763	0	0	0.0
Pahang (Pekan)	13947	0	7	2.8
Pahang (Pekan)	12389	0	0	0.0
Pahang (Pekan)	1829	0	0	0.0
Pahang (Pekan)	26501	0	1	0.5

Table 4: Minimum, maximum and average differences between computed and certified areas for the internal lots of corresponding study areas

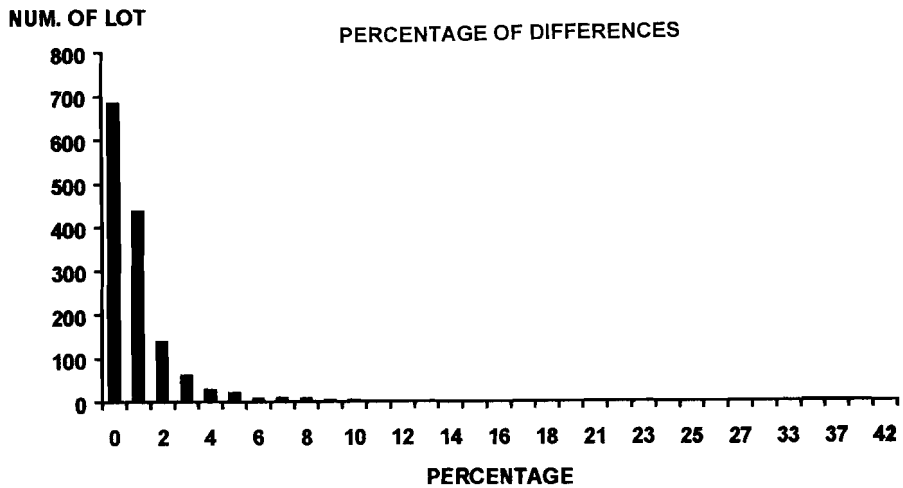


Figure 2: Distribution of differences between computed and certified areas of the internal lots

The average differences between the computed and corresponding CP areas for the internal lots is found to be less than 1% (0.9%). There are 5 lots having differences exceeding 10% where at least one of their boundary lines were defined by the scaled distances (see Table 5). Four (4) of them are rather small lots of less than 0.05 hectare. These are Lot 629 (16%), Lot 175 (38%), Lot 1122 (42%) and Lot 1501 (12%), in which at least one of their short boundary lines were surveyed by third class standard. Since its' area are rather small (for example 0.04 hectare for Lot 629), the differences (of about 50m^2) easily increased to 16%. Meanwhile, a rather large difference in Lot 1995 is believed to be due to the computational error on original certified plan. It was found that the computed area of the corresponding lot using original bearings and distances (from CP) did not agree with the area shown on CP. After checking the field books, it was found that no error in input bearings and distances.

State (District)	CP Number	LotNumber	Year of Surveys	Area (Hectare)	Difference (%)
Machang	1686	629	1948	0.041	16
Muar	7325	1995	1932	0.184	27
K. Terengganu	1995	175	1947	0.003	38
K. Terengganu	3512	1122	1951	0.005	42
K. Terengganu	3512	1501	1951	0.032	12

Table 5: Land parcels with area difference of more than 10%

For each study area, the total computed areas bounded by the perimeter was further compared with the computed perimeter survey (2nd class) values. Their differences would not only reflect the quality of survey for internal lots which were carried out by 3rd class standard, but also the reliability of the recovered bearings and distances for the scaled boundary lines. The differences are shown in 7th column (II-IV) of Table 6. The maximum difference of less than 0.03 hectare is being obtained for perimeter given by CP 6814 (Pasir Mas, Kelantan).

Certified Plan No.	Total CP Area (I)	Total Computed Area (II)	Total Corrected Area (III)	Perimeter Survey Area (IV)	Diff. (!-IV)	Diff. (II-IV)	Diff. (III-IV)
1686	143623	143615	143606	143606	17	9	0
6649	317435	317753	317670	317670	-235	-83	0
6669	345905	345892	345895	345895	10	-3	0
6807	286598	287080	286967	286967	-369	113	0
6813	256773	256819	256817	256817	-44	-2	0
6814	181845	182665	182424	182424	-579	241	0
10119	68355	68461	68462	68462	-107	-1	0
57048	96486	96485	96476	96476	-10	-9	0
57049	76840	76824	76821	76821	19	3	0
5056	393683	392435	392457	392457	1226	-22	0
7105	895190	895248	895119	895119	71	129	0
7201	926224	925677	925678	925678	578	-1	0
7259	478718	478691	478636	478636	82	55	0
7262	550499	550477	550515	550515	-16	-38	0
7265	670817	670950	760956	670956	-139	-6	0
7325	358476	358545	358593	358593	-117	-48	0
22805	357919	357923	357924	357924	-5	-1	0
21350	25672	25647	25647	25647	25	0	0
22883	195387	195386	195386	195386	1	0	0
21913	511093	511020	511019	511019	74	1	0
22825	431496	431507	431507	431507	-11	0	0
25071	21600	21595	21595	21595	5	0	0
25085	12505	12505	12505	12505	0	0	0
25086	45932	45933	45933	45933	-1	0	0
25089	22131	22134	22134	22134	-3	0	0
25098	101627	101634	101634	101634	-7	0	0
6009	12014	12012	12012	12012	2	0	0
1995	120875	120860	120860	120860	15	0	0
9658	259034	259004	259004	259004	30	0	0
3512a	22081	22070	22070	22070	11	0	0
3512b	30832	30832	30832	30832	0	0	0
6519a	121026	121002	121002	121002	24	0	0

6519b	72312	72305	72305	72305	7	0	0
2146	181552	181577	181562	181562	-10	15	0
3972	234293	234304	234304	234304	-11	0	0
9780	487727	487762	487762	487762	-35	0	0
6526	391356	391344	391344	391344	12	0	0
34615	125657	125654	125654	125654	3	0	0
22891	87741	87735	87735	87735	6	0	0
34158	820450	520383	520383	520383	67	0	0
22874	768624	768673	768674	768674	-49	-1	0
59870	82877	82837	82837	82837	40	0	0
22895	42239	42271	42271	42271	-32	0	0
22895	69227	69224	66226	69226	-1	-2	0
658	43655	44050	44050	44050	-395	0	0
6340	31347	31359	31359	31359	-12	0	0
7763	396094	396061	396063	393063	31	-2	0
13947	123530	122205	122205	122205	1325	0	0
12389	4719	4720	4720	4720	-1	0	0
1829	27013	27027	27027	27027	-14	0	0
26501	20570	20569	20569	20569	1	0	0

Table 6: Computed and corrected values of the **area** bounded by the perimeter and their corresponding CP values (area in square metre)

The difference between perimeter survey (2nd class) area and the total CP areas bounded by the perimeter are also shown in Table 6 (see column (I–IV)). On the other hand, their differences would only reflect the quality of 3rd class surveys which were carried out for the internal lots. In general, compared with CP values, the computed values provide better agreement with perimeter survey values.

CP Number	Perimeter (m)	Linear Misclosure
1686	2,126	1:60,885
6649	3,698	1:40,213
6669	2,965	1:68,463
6807	2,794	1:10,386
6813	3,151	1:35,252
6814	2,536	1:49,014
10119	1,392	1:8,896
57048	2,642	1:51,970
57049	2,576	1:19,012
5056	2,560	1:32,162
7105	4,445	1:24,699
7201	5,485	1:94,336
7259	2,988	1:29,053

7262	4,122	1:52,939
7265	4,774	1:40,656
7325	2,649	1:19,894
22805	3,698	1:15,447
21350	787	1:10,123
22883	2,181	1:17,037
21913	3,209	1:11,984
22825	3,263	1:29,707
25071	737	1:17,512
25085	626	1:23,487
25086	866	1:32,561
25089	663	1:53,453
25098	1,557	1:28,932
6009	777	1:15,975
1995	1,944	1:28,362
9658	3,640	1:12,792
3512a	627	1:11,889
3512b	832	1:22,048
6519a	1,437	1:3,377
6519b	1,321	1:9,457
2146	2,040	1:23,834
3972	3,747	1:16,877
9780	3,039	1:12,004
6526	5,332	1:45,661
34615	3,718	1:20,039
22891	2,170	1:19,518
34158	4,296	1:29,130
22874	5,948	1:34,094
59870	1,596	1:10,966
22895	1,201	1:15,759
22895	2,629	1:49,714
658	1,244	1:16,416
6340	961	1:39,178
7763	4,261	1:11,053
13947	1,843	1:34,243
12389	323	1:55,355
1829	660	1:19,385
26501	608	1:17,777

Table 7 : Linear misclosures for the corresponding perimeter surveys (2nd Class)

Linear misclosures for each perimeter surveys also have been computed using the Second Class values given by the corresponding CP. Table 7 shows that misclosures of better than 1:8,000 have been achieved except for one perimeter (first part of CP6519). The linear misclosure for perimeter 6519a is less than 1:4,000. After checking the field books, it was found that no error in input bearings and distances. Therefore, a rather poor misclosure is also believed to be due to the computational error on original certified plan.

Lines	Bearing (deg,min,sec)			Distance (meter)			Class of Survey
	CP	Comp.	Diff.	CP	Comp.	Diff.	
116 – 117	173° 42'	173° 42'	0° 0'	153.451	153.452	- 0.001	3rd
112 –116	282° 12'	282° 12'	0° 0'	71.053	71.053	0.000	3rd
126 – 125	93° 36'	93° 36'	0° 0'	84.631	84.631	0.000	3rd
81 – 79	101° 46'	101° 47'	- 0° 1'	187.509	187.448	0.061	3rd
85 – 84	99° 00'	98° 59'	0° 1'	91.431	91.357	0.074	3rd
150 – 149	107° 08'	107° 08'	0° 0'	26.313	26.313	0.000	3rd
156 – 67	281° 27'	281° 27'	0° 0'	116.114	16.114	0.000	3rd
36 – 37	261° 23' 00"	261° 23 '00"	0° 0' 00"	78.657	78.658	- 0.001	2nd
20 – 21	180° 01' 10"	180° 01' 10"	0° 0' 00"	161.980	161.978	0.002	2nd

Table 8: The recovered bearings and distances for several lines taken from CP 6669 (Pasir Mas, Kelantan)

The reliability of the recovered bearings and distances were further verified by re-computing the bearings and distances for several boundary lines which have been chosen randomly. The computed values were then compared with their corresponding CP values and some of their differences are shown in Table 8. The good agreements (small differences in bearings and distances) shows that the method used for recovery of bearings and distances of the scaled boundary lines in other study areas could be accepted.

5.0 CORRECTED AREA FOR THE INTERNAL LOTS

The percentage of differences for some individual lot is quite significant (more than 5%) and need further attention. The differences should be minimized to any appreciable extent so that the total computed areas would be as close as possible to the perimeter survey values. One way of doing this is applying correction to the computed area (Acomp) based on the following relationship:

$$A_{corr} = A_{comp} + (A_{comp} / A_{per})dA \qquad (1)$$

where A_{per} is the perimeter survey area (given by 2nd class), and dA is the difference between the perimeter survey area and the total computed area (Aper - Atot).

The corrected area for all internal lots in the study areas have been computed and results indicate that after the corrections, there is no significant improvement in the percentage of differences between the corrected areas and the specified CP values. However Table 6 shows that the agreement between the total corrected areas and the corresponding perimeter survey areas improved substantially.

6.0 CONCLUSIONS

Results from test computations which have been carried out in several areas in Kelantan, Johor, Selangor, Perak, Terengganu, Kedah and Pahang indicate that the average differences between the computed and certified areas for the internal lots is less than 1% (0.9%). Some of the lots (Lot 629, Lot 1995, Lot 175, Lot 1122 and Lot 1501) where at least one of their boundary lines were defined by the scaled distances are having differences exceeding 10%. There is no error in input bearings and distances that could results in this differences. However four (4) of them are rather small lots of less than 0.05 hectare in which a small difference could easily increased the percentage to a significant amount. To some extent, the differences could also be attributed to the existing errors in the surveys (Third Class) and also computational error on original CP. Area corrections have been applied so that the differences could be well distributed and minimized within the area specified by the perimeter surveys. However it has been noticed that no significant improvement in the percentage of individual differences between the corrected areas and the specified CP values.

As far as total areas is concerned, the computed/corrected values provide better agreement with perimeter survey values. This shows that in general (except for the above mentioned five lots), the method used for recovery of bearings and distances of the scaled boundary lines in the study areas could be accepted. However further effort is being carried out to improve the way of recovering bearings and distances for the scaled boundary lines of such a group of lots.

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