Identifying the relevant features of the National Digital Cadastral Database (NDCDB) for spatial analysis by using the Delphi Technique

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Abstract. This paper explains the process carried out in identifying the relevant features of the National Digital Cadastral Database (NDCDB) for spatial analysis. The research was initially a part of a larger research exercise to identify the significance of NDCDB from the legal, technical, role and land-based analysis perspectives. The research methodology of applying the Delphi technique is substantially discussed in this paper. A heterogeneous panel of 14 experts was created to determine the importance of NDCDB from the technical relevance standpoint. Three statements describing the relevant features of NDCDB for spatial analysis were established after three rounds of consensus building. It highlighted the NDCDB’s characteristics such as its spatial accuracy, functions, and criteria as a facilitating tool for spatial analysis. By recognising the relevant features of NDCDB for spatial analysis in this study, practical application of NDCDB for various analysis and purpose can be widely implemented.

1. Introduction
1.1. National Digital Cadastral Database
Since 2010, the cadastral surveyed information in Malaysia is kept digitally in the form of a survey accurate spatial database, namely the National Digital Cadastral Database (NDCDB). NDCDB is the improved version of the State Digital Cadastral Database (PDUK). PDUK was referenced to the respective ten state origins and was initially developed internally for the Department of Survey and Mapping Malaysia (DSMM). The coordinate system applied in PDUK was incompatible with GIS and satellite-based technology [1]. Data integration was also challenging and required a good understanding of map projections and transformation coordinates. Yusoff and Halim [2] describe the shortfalls of PDUK for spatial analysis were because of its low spatial accuracy of meter levels, topologically incorrect for spatial queries due to lack of connective an adjacent information and different set of spatial attributes were stored and sometimes duplicated in the same lot parcel. To overcome the shortcomings of PDUK, DSMM introduced the Geocentric Datum of Malaysia, 2000 (GDM2000) and adopted it to comprehensively readjust the nationwide cadastral survey data based on International Terrestrial Reference Frame (ITRF2000) and Geodetic Reference System 1980 (GRS80) reference ellipsoid. The survey accurate NDCDB was the result of the GDM2000 and the Coordinated Cadastral System (CCS) concept implementation. Its database structure became GIS format friendlier with the implementation of the cadastral fabrics readjustment and repopulation exercise. Today, the
NDCDB contains two types of data; the primary NDCDB – that has been verified and accepted as survey accurate by using absolute positioning survey and the ‘relative NDCDB’ – that has been verified and accepted as relatively correct by using the relative surveying methods and computation. The ‘Relative NDCDB’ is a temporary database and is the outcome of the non-seamless accuracy of NDCDB which was either due to the previously lower class survey, poor cadastral control network connections, and undeveloped, remote land or simply blunder errors. Nevertheless, continuous survey work are being carried out by DSMM to achieve the desired centimetre level spatial accuracy of NDCDB.

1.2. Why is NDCDB required for spatial analysis?
Spatial analysis enables one to answer complex spatial questions that include determining relationships, making predictions or finding the best location for planning, implementation or recovery purposes, thus eliminates risk and cost investments. However, a person is considered spatially-enabled to make sound decision-making when the basis of the spatial analysis which is the cadastral data are official, authentic, complete, comprehensive, updated and accessible [3]. NDCDB is primarily used in Malaysia for survey works, but not exclusively, for spatial analysis. Therefore, unused or incorrect usage of cadastral data (NDCDB) for spatial analysis may reduce the analysis’s reliability when land and people’s relationship is the concern. The significance of the cadastral data has been discussed extensively internationally, but identifying the relevant features of NDCDB for spatial analysis is limitedly studied. The situation has led to various perceptions and misinformation on NDCDB. Sometimes, underused. The benefits of factoring geolocation into spatial analytics are many, such as improved communication, better collaborations, informed decision making and increase investments. A strong statement to describe NDCDB’s technical relevance is deem necessary to enable it.

1.3. Delphi Technique
The Delphi technique was chosen in this study to determine the relevant features of NDCDB for spatial analysis. The technique provides a platform where consensus by subject matter experts can be achieved on a topic despite the limited evidence, lack of precise information and prior research [4, 5]. Moreover, the Delphi technique is suitable for application whenever policies, plans, or ideas have to be based on informed judgment. The disadvantages associated with face-to-face meetings by using email and online questionnaire, can be avoided [4, 6] and elude influential result and inaccurate analysis.

2. Research Methodology
2.1. Questionnaire design, validity, and reliability
Questionnaires were used to collect data in this study. In designing the questionnaires for Round 1, open-ended close structured questions were formed based on the overall research framework, while close-ended close structured for Round 2 questionnaire was the result of the Round 1 qualitative analysis result. Waweru and Omwenga [8] mentioned a minimum of three participants or 10% of the overall sample is sufficient for qualitative pretesting. The questionnaires were assessed for validity by 4 experts and pretested for reliability by 3 mock Delphi participants. All experts in this study were in agreement that all of the six questions related to identifying the technical significance of NDCDB for spatial analysis are relevant, which resulted in the calculated Content validity index (I-CVI) value as 1.00. According to Polit and Beck [7], the experts must agree on the content validity of an item (I-CVI of 1.00) when the panel consists of five or fewer experts. Pretesting was carried out respectively for Round 1 and Round 2 questionnaires which provided valuable feedback that contributed to the overall refinement of the study.

2.2. Composition and panel size
To date, there are no standards that stipulate the panel selection criteria. Considering NDCDB has a direct association with the land, cadastral and GIS domain, a heterogeneous group of a panel of experts
was set up in this study to diversify member’s background and reduce bias result. Initially, 18 potential members were carefully selected based on the criterions used by previous Delphi researchers [4, 9, 10], but the final totalled panel size was 14 and exceeded the recommended minimum panel size [11]. The Delphi participants can be summarized in three major groups: policy makers, interest group, and stakeholders. The profiles of the Delphi participants are as shown in Table 1.

### Table 1. Profile of Delphi Heterogeneous Participants

| Criteria/ Panel | Groups | Specialist | job-relevant experience | expert’s certification or accreditation | current management level | labelled experts by social acclamation | expert’s contribution inside and outside of the organisation |
|-----------------|--------|------------|-------------------------|----------------------------------------|--------------------------|--------------------------------------|----------------------------------------------------------|
| 1               | Policy Makers | Survey & Cadastre | >20 years | Professional body and professional board members | Decision maker | Yes | National and international level |
| 2               | Interest Group | Survey & Cadastre | >20 years | Professional body and professional board members | Decision maker | Yes | National and international level |
| 3               | Interest Group & Stakeholders | Survey & Cadastre | >20 years | Professional body and professional board members | Decision maker | Yes | National and international level |
| 4               | Policy Makers & Stakeholders | GIS & Civil Engineering | >20 years | Professional body | Decision maker | Yes | National and international level |
| 5               | Interest Group & Stakeholders | Survey & Cadastre | >20 years | Professional body | Decision maker | Yes | National and international level |
| 6               | Policy Makers | Survey & Cadastre | >20 years | Professional body and professional body council member | Decision maker | Yes | National and international level |
| 7               | Policy Makers | Land law, Survey & Cadastre | >20 years | Professional body | Decision maker | Yes | National and international level |
| 8               | Policy Makers & Stakeholders | Land & Cadastre | >20 years | Subject matter expert | Decision maker | Yes | National and international level |
| 9*              | Policy Makers & Stakeholders | Land & GIS | >20 years | Subject matter expert | Decision maker | Yes | National and international level |
| 10              | Stakeholders | Utility planning & GIS | > 20 years | Subject matter expert | Decision maker | Yes | National and international level |
| 11              | Policy Makers & Stakeholders | Planning & GIS | >20 years | Professional Body | Decision maker | Yes | National and international level |
| 12              | Policy Makers & Stakeholders | Land & Cadastre | >20 years | Professional Body | Decision maker | Yes | National and international level |
| 13              | Stakeholders | Planning & GIS | >20 years | Professional Body | Decision maker | Yes | National and international level |
| 14              | Interest Group & Stakeholders | Survey & Cadastre | >20 years | Professional body and professional board members | Decision maker | Yes | National and international level |
| 15              | Stakeholders | Cadastre & GIS | >20 years | Subject matter expert | Decision maker | Yes | National level |

*Note*: The participant was involved during the 1st round only.

#### 2.3. Consensus Building

Holey, Feeley, Dixon and Whittaker [12] described the minimum round for consensus building can be two but, three rounds are common in most studies. However, if group consensus is desirable and the sample is heterogeneous, then Skulmoski, Hartman and Krahn [13] highlighted three or more rounds
might be required. In this study, Round one is the foundation for identifying issues of the research area, while the following rounds two and three are consensus building rounds.

2.3.1. Round 1
An email inviting participation, explaining the study, outlining the Delphi process and requesting responses to the question was sent to the potential participants. Round 1 questionnaire was also attached for them to complete. The questions were focused on the participants’ expertise views on the technical relevance or relevant features of NDCDB for spatial analysis. Upon agreeing to participate the Delphi process, participants were given seven days to respond to the questionnaire questions. A cut-off date was set to determine the timeline of Round 1. Only 15 participants as shown in Table 1 agreed to participate and returned the completed questionnaire through email or hand-delivered. Each response was of anonymity and was collated then sent via e-mail to each participant, instead of a face-to-face group discussion, to reduce bias results. They were instructed to review the response from other anonymous respondents and were able to revise their responses within seven days.

2.3.2. Round 1 Result
Responses from Round 1 were analysed by using the Thematic Analysis process. The qualitative data was firstly scrutinised, and emerging patterns or findings that were identified as nodes were processed using the Nvivo 11 Plus software. The nodes were listed under the Free Nodes theme. From the Free Nodes, a deductive approach was used to generate the Parent Node theme which is the technical significance or relevant features of NDCDB for spatial analysis. Similar ideas related Parent Node theme were clustered together into emerging sub-themes namely ‘Survey accurate,’ ‘Homogenous dataset,’ ‘GIS-ready’ and ‘Facilitating format.’ Statements that best described the essence of the majority of opinions within each emerging sub-theme mentioned were generated and presented as the ‘original statements; in Table 2. The ‘original statements’ provided the basis for Round 2 questionnaires.

2.3.3. Round 2
Participants were presented with an online questionnaire that included the ‘original statements’ shown in Table 2. A five-point Likert scale was used to gather participant’s opinion and perception on the statements and linguistic scales from 5 points as being “strongly agree”, 4 points for “slightly agree”, 3 points for “less agree”, 2 points as “disagree” and Lastly 1 point as "strongly disagree". Five-point scales was preferred to transmit as much information and reduce stifle respondents. Space was provided for optional comments justifying their scale allocation decisions. All 15 original participants were offered via e-mail to participate in Round 2 and were requested to respond within seven days. Delphi process in Round 1, was repeated in Round 2. Only comments were added by the Round 2 timeline.

| No | Original Statements | Rephrased Statements |
|----|---------------------|---------------------|
| 1  | The NDCDB has the spatial accuracy of centimeter level and is the most accurate land related database. | The NDCDB has the spatial accuracy of centimeter level which is equivalent to land title registration requirement and therefore perceived to be the most spatially accurate database as far as the land-related database is concerned. |
| 2  | NDCDB may not be seamlessly accurate, but the positional spatial accuracy of the NDCDB is survey accurate and is suitable for most user’s spatial accuracy requirements and spatial analysis purposes. | Despite not being seamlessly accurate where some plots are of higher accuracy, the positional spatial accuracy of the NDCDB is survey accurate and is sufficient for most user’s spatial accuracy requirements and spatial analysis purposes. |
| 3  | The criteria of NDCDB which are GIS-ready, survey accurate and homogenous dataset enables it as a facilitating tool for data integration, sharing, and convergence with other geospatial data or GIS-based application system and non-geospatial data. | No amendments. |
2.3.4. Round 2 Result
The number of participants allocating points to each statement in Round 2 was totalled as 14. 1 participant was transferred to a new agency and had to be withdrawn from the panel member. Likert scale points allocated were analysed with descriptive statistics using SPSS version 23 software. No statements were removed as the means values were higher than 4.00 as shown in Table 3. Additional comments received suggested minor amendments which were presented as ‘rephrased statements’ in Table 2, with the aim of moving towards group consensus and stability.

2.3.5. Round 3
The Round 2 methodology was repeated but with the rephrased Statement 1 and 2, and original Statement 3. The original and rephrased statements became the basis for Round 3 questionnaire. 14 participants were offered to participate in Round 3 and were requested to respond within three days.

2.3.6. Round 3 Result
The number of respondents received in Round 3 was totalled as 14 or 100% feedback. Analysis methodology in Round 2 was repeated in Round 3. The increase in mean values was found in the ‘rephrased statements’ as shown in Table 3 with means value are more than 4.70. The Median and Interquartile Range (IQR) are best statistical choices to measure central tendency and dispersion to calculate data scored on an ordinal scale in Delphi processes [14]. The median values in Round 3 were all 5.0 while the IQR values were within 0.00 to 1.00, which is suitable as consensus indicator for 5-unit scales [15]. The values showed consistency and high agreement, and therefore it was decided the Delphi process has come to a group consensus and stability which in result supports the decision that further Delphi rounds were unnecessary. Moreover, additional comments were not received in this round.

### Table 3. Statistical analysis of Round 2 and 3

| Statement | Round 2 | Round 3 | Mean Percent Change |
|-----------|---------|---------|---------------------|
|           | N   | IQR | Median | Mean | Std. Deviation | N | IQR | Median | Mean | Std. Deviation |
| Statement 1 | 14 | 1.00 | 5.00 | 4.57 | 0.514 | 14 | 1.00 | 5.00 | 4.86 | 0.363 | 5.80% |
| Statement 2 | 14 | 1.00 | 5.00 | 4.64 | 0.497 | 14 | 0.00 | 5.00 | 4.79 | 0.426 | 3.00% |
| Statement 3 | 14 | 1.00 | 5.00 | 4.64 | 0.497 | 14 | 1.00 | 5.00 | 4.71 | 0.469 | 1.40% |

3. Analysis
3.1. Statistical result analysis
Analysis of the Delphi technique results showed a change in participants’ views towards consensus (agreement) and stability in Round 3. Therefore, the Delphi is concluded to have reach panel consensus and stability in Round 3 as indicated by a trend towards the following: i) the median for the 5-Point Likert scale is the highest measure (5 – “strongly agree”) to all statements; ii) the IQR values are within 0.00 to 1.00 which indicate high agreement; iii) the increase of mean values in each round; iv) percent change between each statement from both rounds are less than 15% and is considered stable [14]; v) a decrease in comments in each round; and vi) the evolution of statements towards consensus.

3.2. Agreed statements on the relevant features of NDCDB for spatial analysis
The final and agreed statements describing the relevant features of NDCDB for spatial analysis by the Delphi panel as per Round 3 are as follows:
• **Statement 1**: The NDCDB has the spatial accuracy of centimetre level which is equivalent to land title registration requirement and therefore perceived to be the most spatially accurate database as far as the land-related database is the concerned.

• **Statement 2**: Despite not being seamlessly accurate where some plots are of higher accuracy, the positional spatial accuracy of the NDCDB is survey accurate and is sufficient for most user’s spatial accuracy requirements and spatial analysis purposes.

• **Statement 3**: The criteria of NDCDB which are GIS-ready, survey accurate and homogenous dataset enables it as a facilitating tool for data integration, sharing, and convergence with other geospatial data or GIS-based application system and non-geospatial data.

4. **Conclusion**
This study has achieved its objective to establish statements that best describes the relevant features of NDCDB for spatial analysis based on the consensus of experts related to land, cadaster and GIS domain by optimising the Delphi technique. Agreement and stability of the consensus on the statements were achieved during Round 3. The agreed statements as stated in paragraph 3.2 of this paper have defined NDCDB to be the most accurate land based databases as far as GIS is concern, its spatial accuracy is sufficient for most spatial analysis purposes and its criteria or characteristics facilitates spatial analysis activities. The established statements could aid land surveyors, land administrators, and GIS users, as well as the general public, to recognize the importance of NDCDB and adopt it for the critical stance to spatial thinking. The notion of becoming spatially enabled signifies the importance of NDCDB in providing basic and crucial components to allow sound and transparent decision-making, but not limited to spatial analysis.

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