

# Advanced Technologies in Land Administration of Taiwan

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**Key words:** computer assisted mass appraisal system, close range photogrammetry, LiDAR, cadastral survey, ENC

## SUMMARY

Department of Land Administration, Ministry of the Interior (MOI) is the land administrative authority in Taiwan. It oversees the land registrations, land value assessments, real estate transactions, cadastral surveys and sea area administration, related to FIG commission's missions.

The usage of Big Data and AI is expected to perform land value assessment automatically. By integrating computer models and land value benchmark, MOI is capable to improve the land value management and strengthen real estate data analysis and application.

Advanced technologies and improved measures of cadastral survey are the response to manpower shortage in land office after expanding provided services. In addition to research outsourcing land re-survey business, MOI also develops a 3D National Map, cadastral survey aided by close-range photogrammetry and ground LiDAR to reduce time and labor in field work.

Regarding the value-added mapping of Electronic Navigation Charts (ENC), MOI set up the "Taiwan Electronic Navigation Chart Center" (TENCC) on 15th Nov. 2019, which is to facilitate the release of Taiwan's ENC .

## SUMMARY (Traditional Chinese)

內政部地政司負責土地測量、登記、地價、不動產交易及方域等行政管理業務，近年來積極運用先進科技發展相關應用，與國際測量師聯合會各委員會任務息息相關。

有關地價查估方面，期望利用大數據分析及 AI 技術建立電腦大量估價模型以輔助地價查估，藉由整合電腦模型及基準地資料，強化不動產資料的分析與應用，落實地價查估之科學、公正及客觀。

有關地籍測量創新技術及精進措施部分，為因應地政事務所業務種類增加導致人力短缺，除研擬委外辦理土地複丈外，內政部亦發展三維國家底圖、近景攝影測量及地面光達輔助地籍測量業務，以降低外業的時間與人力。

有關電子航行圖加值製作，本部 2018 年 11 月 15 日成立「臺灣電子航行圖中心」(Taiwan ENC Center)，推動我國電子航行圖之國際發行工作。

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## **1. ABOUT DEPARTMENT OF LAND ADMINISTRATION, MINISTRY OF THE INTERIOR**

Ministry of the Interior (MOI) is one of the largest agencies in Taiwan. The business scope of MOI includes land administration, civil affair, household registration, construction, police service, fire service, conscription, immigration and national park management. Department of Land Administration is responsible for national land policy, including land surveying and registration, land value, land right equalization, land right adjustment, land readjustment, land expropriation, land utilization, territorial administration, geographic name management, real estate trading management, etc.

The Land Value Division is in charge of land value setting and announcement, formulation of land tax rate laws and policy, and supervises the local governments in announcing each district land value. If the land value is considered too high or too low, guidance will be requested to make land value balanced and fair.

The Land Survey Division is responsible for the national survey business planning and promotion. Provided service includes national coordinate systems, basic control survey network, cadastral surveys, national maps, basic topographic maps, DTM, HDmap, survey industries and its professional surveyor management, and photogrammetry plans approval.

Regarding the value-added mapping of Electronic Navigation Charts (ENC), the “Taiwan Electronic Navigation Chart Center” (TENCC) was established by MOI on November 15, 2018. The main task of TENCC is to facilitate the international release of Taiwan’s ENC.

## **2. ADVANCED TECHNOLOGIES IN LAND VALUE APPRAISAL**

The assessment of land tax base in Taiwan is based on the land value district method. The “Land Value District Method”, which is used for estimating land value, divides the land of the same nature, similar land price, and connects lots into the same land value district. It then uses the median of the unit price from the transactions or incomes in the district as the value of each land in the district. Due to the scarcity of land transaction cases, land and building prices need to be split by the real estate transactions cases. Land Value District Method can quickly estimate the prices of a large number of lands at the same time, while having the disadvantage of ignoring the differences between lands and generating excessive subjective judgments in the process of evaluation and splitting the value.

As stated above, we focus the following issues:

1. Land Value District Method might ignore the difference of lands:

In the same land value section, the median unit price of all cases in the section is used as the unit price of each land in the area to estimate the land value. However, due to the fragmentation of land in Taiwan and the complicated usage, the division of land value district still has its limitations, and the land value cannot reflect the specific conditions of each land.

2. Lack of objective data in the appraisal process:

The comparison method is the main method used for land value appraisal, and it is supported by the income method and the cost method. When it comes to the price factor required by the comparison method, the adjustment rate is determined based on the rules of thumb. This method lacks scientific analysis and is too subjective. The standards for building unit price, decoration cost, and reasonable profit also lack an objective basis in the process of splitting the land and building price, which hinders its fairness.

In order to solve the problem of opening up, MOI has implemented the "Land Price Evaluation Technology Refined and Real Estate Actual Transaction Price Information Application Development Research" since 2018, using technologies such as Big Data analysis and geographic information systems (GIS) to establish a scientific and objective land value appraisal mechanism to improve the assessment of taxable land prices in Taiwan. Main items include: researching and establishing a computer assisted mass appraisal system, establishing revaluation of land value benchmark system, and a land price monitoring mechanism.

In the research and establishment of a computer assisted mass appraisal system, MOI carried out the following projects:

1. Establishing a real estate appraisal database:

The real-value registration data will be standardized, and then analyzed by the Big Data method. After that, it uses GIS to integrate and build a real estate appraisal database.

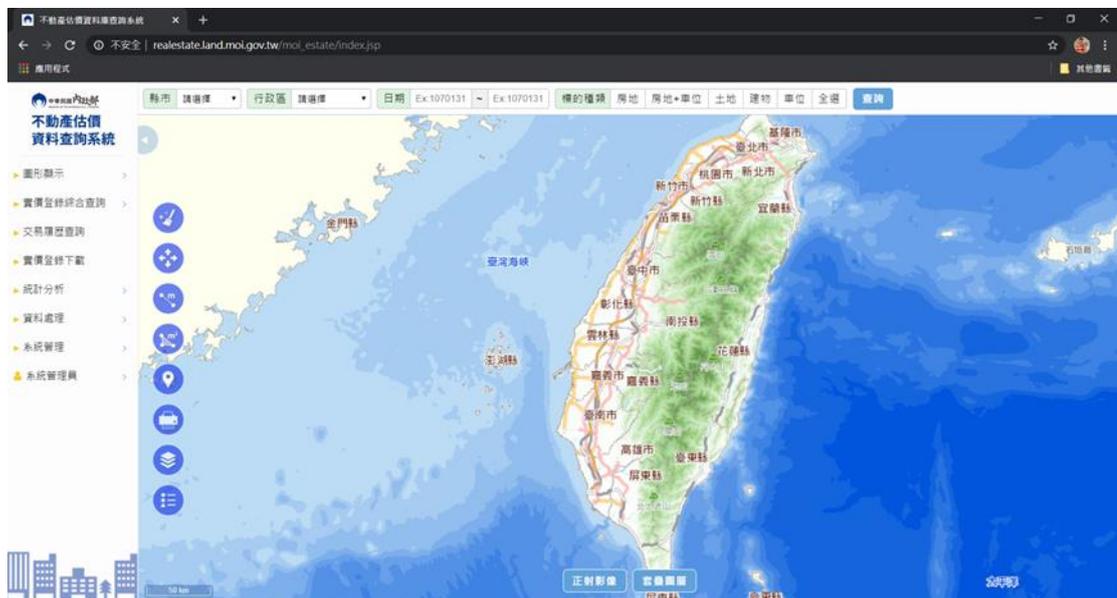


Figure 1. Real Estate Appraisal Database Query System

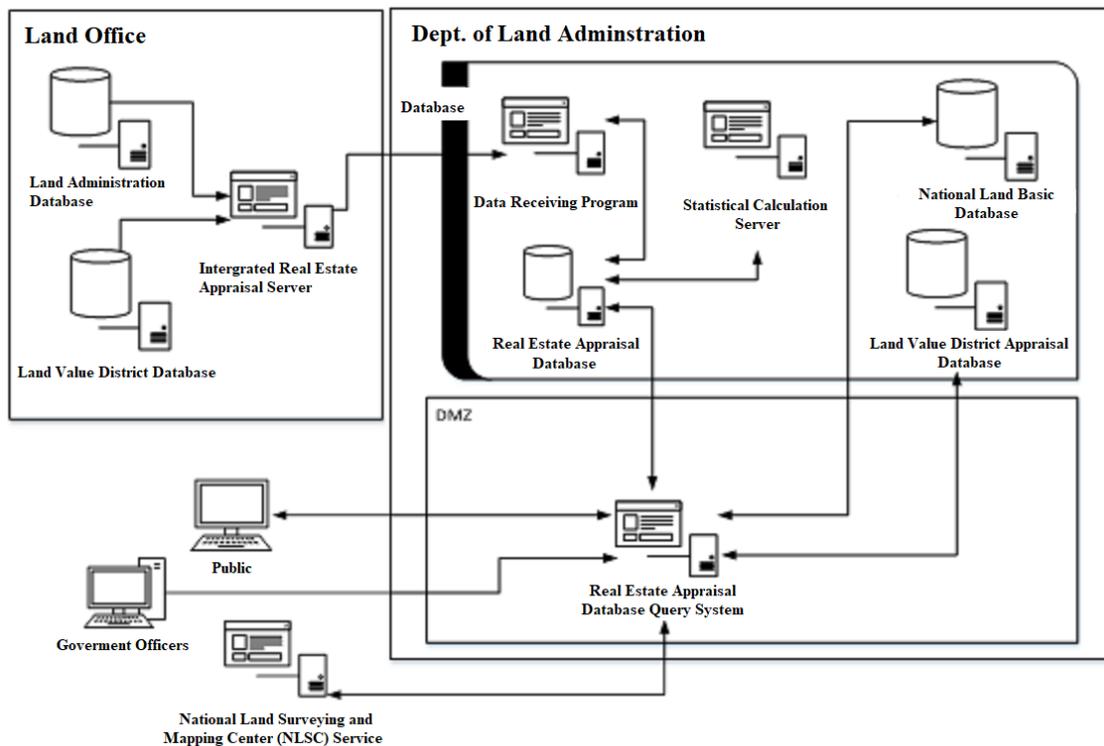


Figure 2. Infrastructure of Real Estate Appraisal Database Query System

2. Establishing impact price factors:

The actual price registration data can be used to determine factors affecting the real estate price across the country, and standardize each parameter and adjustment rate.

3. Establishing a computer assisted mass appraisal system:

Use the characteristic price method or the Artificial Neural Network (ANN) method to build a computer assisted mass appraisal model to gradually establish an appraisal system in Taiwan to improve the science and fairness of land value assessment.

4. Training of professionals in the public sector for computer assisted mass appraisal:

Computer assisted mass appraisal is a comprehensive subject. In addition to real estate appraisal expertise, cross-domain knowledge such as statistics, Big Data analysis, and GIS is required. To operate computer assisted mass appraisal system sustainably, it is necessary to cultivate cross-domain expertise among cross-domain land value personnel.

In the establishment of the revaluation of land value benchmarks and the land value equivalent monitoring mechanism:

1. Establishing the revaluation of land value benchmarks:

Using the benchmark land selecting approach, each of the residential, commercial, industrial, and non-urban land in different districts across the country selects one benchmark land as the central land value control point. Multiple real estate appraisers will be hired to check the estimates annually.

2. Establishing national land price parity and monitoring land prices:

The revaluation of land value benchmarks assessed by MOI is considered as the first-class revaluation of land value benchmarks. The second-class revaluation of land value benchmarks is established from the inspection carried out by the land value personnel of each municipality, county (city) government or a real estate appraiser, along with the first-class revaluation of land value benchmarks as references. The national land price parity is then established by using both first-class and second-class revaluation of land value benchmarks. Changes in land value across the country can be quickly acknowledged. With the professional and impartial stand of the real estate appraiser, the valuation results of local control benchmarks can be in line with the actual market condition, without being affected by external factors.

With the improvements listed above, the land value appraisal system in Taiwan will be fairer, more scientific and objective. The real estate market changes will be grasped in real time.

### **3. ADVANCED TECHNOLOGIES IN LAND SURVEY**

In order to economize manpower of government agencies, MOI already considers to outsource partial cadastral survey business. In addition, we also apply advanced technologies such as close-range photogrammetry and ground-based LiDAR in cadastral survey to reduce the consumption of resources, and still achieve high accuracy.

#### **3.1 Outsourcing cadastral survey**

Land offices are in charge of cadastral survey in Taiwan, including land re-survey, building measurement, cadastral resurvey, location survey of superficies and servitude, survey designated by courts, issued cadastral and building survey result maps. Land re-survey refers to the lands in the cadastral survey area that have been processed according to law. When the boundaries of the land are unclear due to natural or human factors, the land owner or manager can apply to local land offices for land re-survey. The cadastral resurvey refers to re-drawing a new cadastral map after measuring the coordinates of each boundary that designated by the land owner. Due to the enormous number of applications and the need for field surveys, land re-survey and cadastral resurvey require a lot of manpower. The heavy workload also makes the surveyors turnover rate quite high. Therefore, MOI plans to formulate laws and contracts for outsourcing these cadastral survey business above, so that local governments can delegate the work to qualified survey industries, saving local government personnel resources, increasing the efficiency of government, and guarding people's rights. It can also provide stable amount of cases for local survey industries, and create new public-private collaboration.

#### **3.2 3D National Map**

MOI uses "Taiwan e-Map (as 2D National Map) combining with 3D data such as high-resolution DTM and basic topographic maps to upgrade 2D national map into 3D. After discussion, the data construction of 3D National Map will start with buildings, roads, railways and MRT. In 2019, MOI has built 3 million (LOD1 to LOD2), and 92 LOD3 building models. 3D building data standards have also been released. 3D road, railway data and their data standards will be completed in the following few years, MOI is also building a multi-dimensional national map service platform to improve the convenience of value-added

applications. Hoping cross-ministerial governance can all work under the same basic map, and it can also help to achieve the goals of smart cities, geospatial data sharing and the application of the Internet of Things.



Figure 3. 3D National Map

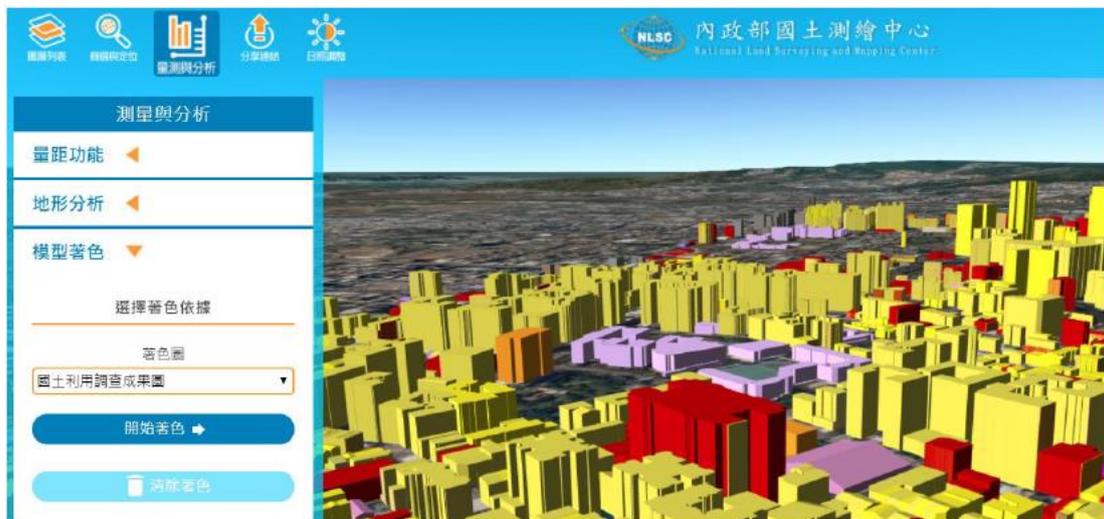


Figure 4. Multi-Dimension National Map Service Platform

### 3.3 Resurvey with close range photogrammetry

In order to record the field survey situation in detail, MOI has been developing a Portable Panoramic Image Mapping System (PPIMS) that integrates GNSS real-time positioning and photogrammetry, and applies it to cadastral survey (Figure 5a, 5b). Using images for measurement has the following advantages: 1.fast gathering field survey information and permanent storage; 2.only a few control points need to be measured in the field, which greatly shortens field work time; 3. image intuition. Compared with traditional theodolites, which can only be displayed in points or lines, the public without professional survey knowledge can also understand geo-information more easily. In order to cooperate with the system operation, MOI also developed software, called MAPS (Measurement and Adjustment on Panorama System, Figure5c). MAPS function includes panoramic image stitching, spherical panoramic image measurement, and multi-station spherical image adjustment in the hope of building a cadastral

survey observation database for querying and assisting land re-survey business indoor or fieldwork. After verification, the accuracy of this technology meets the requirements of cadastral survey and will be applied in the future.

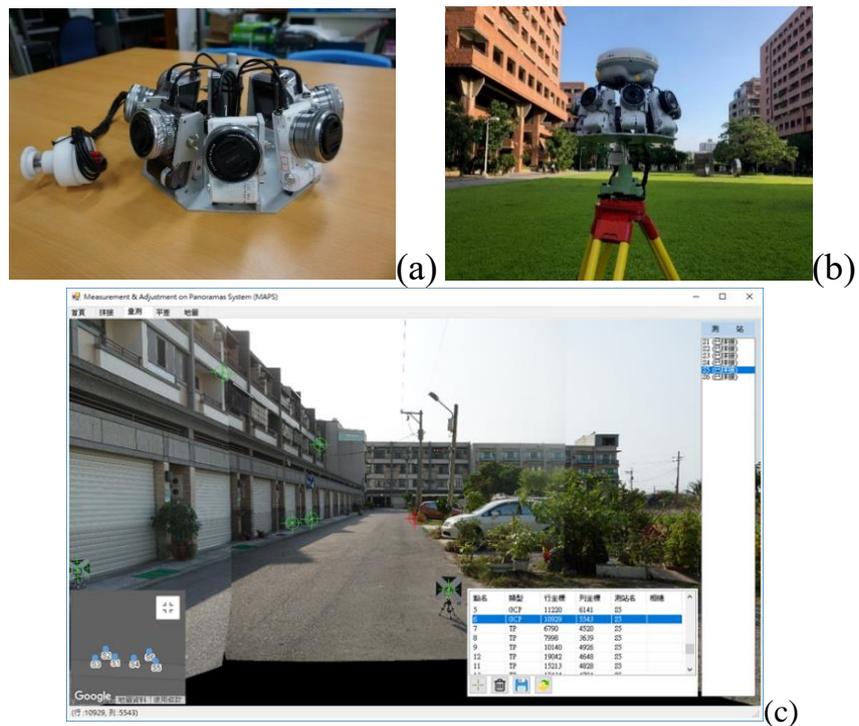


Figure 5. (a, b) PPIMS device (c) MAPS user interface

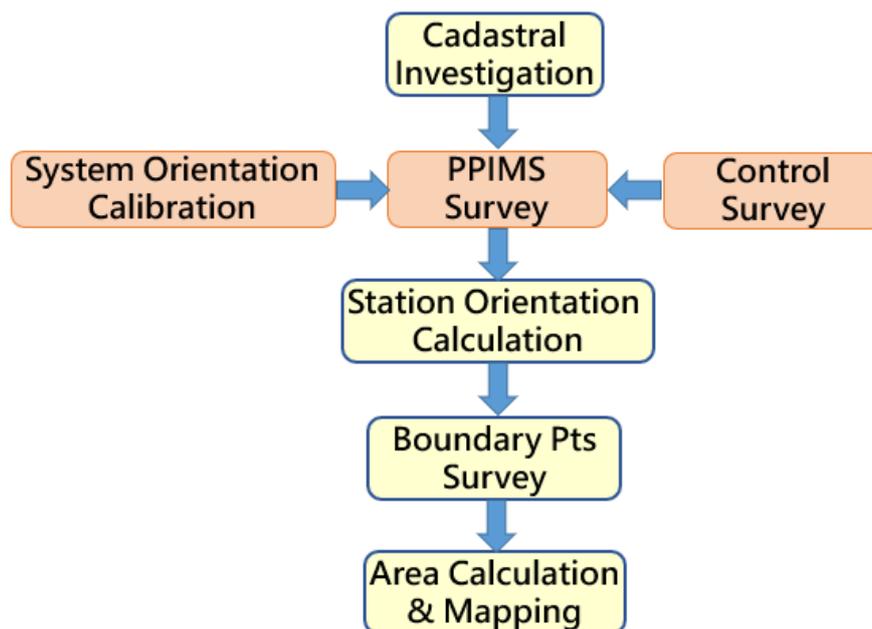


Figure 6. Procedure of MMS use in cadastral survey

Table 1. Accuracy Result of Boundary Pts

Boundary Pts	$\sigma_E(m)$	$\sigma_N(m)$	$\Delta E(m)$	$\Delta N(m)$
999	$\pm 0.008$	$\pm 0.008$	0.034	0.030
1004	$\pm 0.006$	$\pm 0.006$	0.004	0.006
1013	$\pm 0.008$	$\pm 0.008$	0.014	0.023
1110	$\pm 0.007$	$\pm 0.006$	0.006	0.019
998	$\pm 0.007$	$\pm 0.007$	0.002	0.013
1000	$\pm 0.009$	$\pm 0.009$	0.044	0.031
Mean Error(m)			0.017	0.020
RMSE(m)			0.024	0.022

### 3.4 Using Ground-based LiDAR to Assist Cadastral Survey

The traditional cadastral survey use theodolite to measure the surface objects or natural boundary on site. The boundary point will be confirmed after overlaying the survey data with the cadastral map. These procedures cost a lot of manpower, time and money, while the accuracy depends on the quality of control points, instruments and the personnels' skills. MOI tries to use multi-period LiDAR data (two sets of ground-based LiDAR datas, one set of vehicle LiDAR data, and one handheld LiDAR scanner data), the accuracy is up to centimeter level. It also integrates surveying and mapping data and shown on cadastral maps to assist surveyor to be aware of the on-site situation before field work, or to help public understand the relative position between cadastral boundaries and ground objects, and applies it to parcel surveys for cadastral resurvey. The procedure is shown in Figure7. The results are shown in the figure8. The LiDAR point cloud data overlays the camera's color information to show the real environment and the overlay cadastre map, helping surveyors to identify the location of the land boundary.

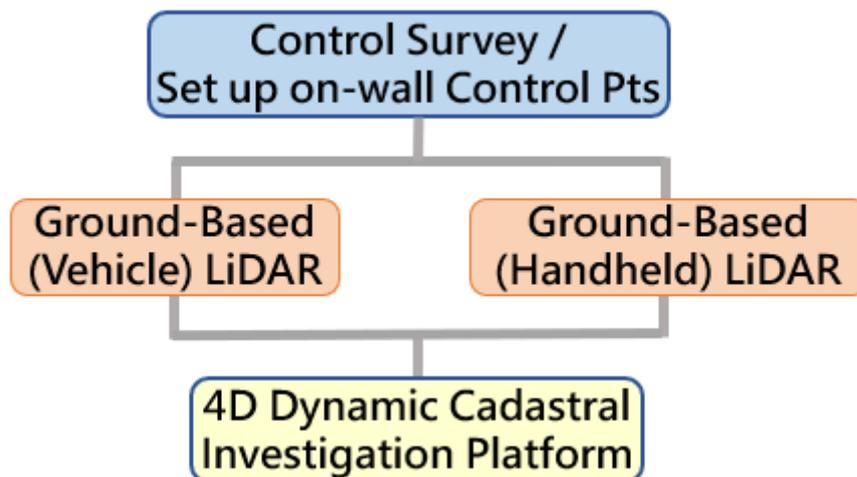


Figure 7. Procedure of using Ground-based LiDAR in Cadastral Survey

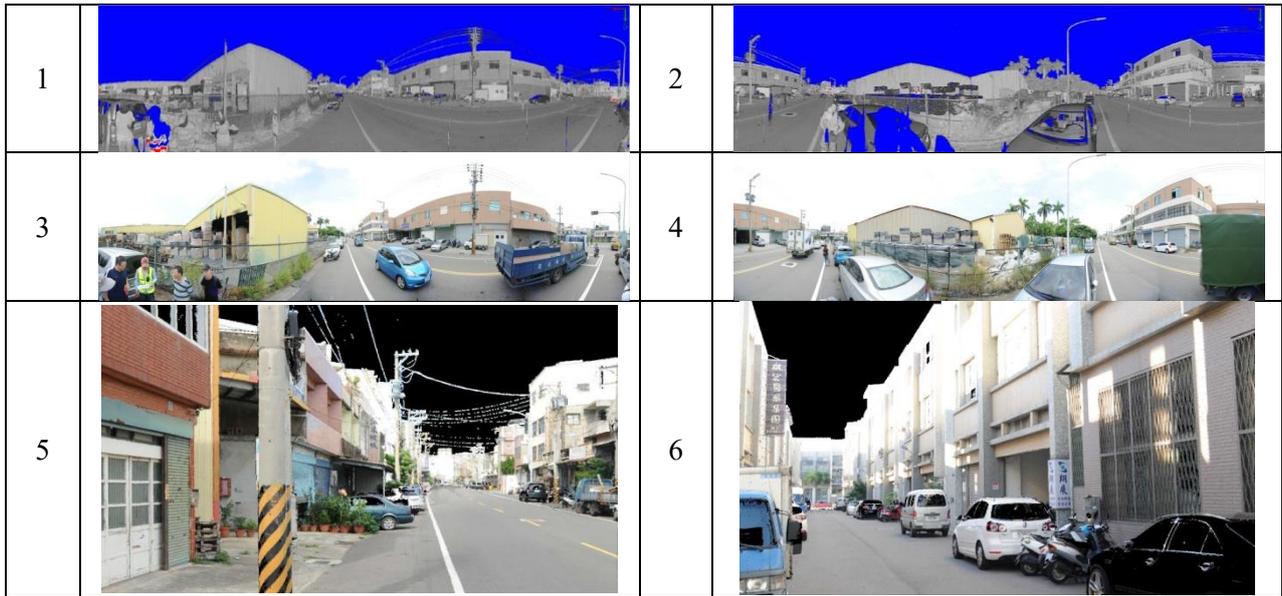


Figure 8. Ground-based LiDAR (with Camera Color Information)

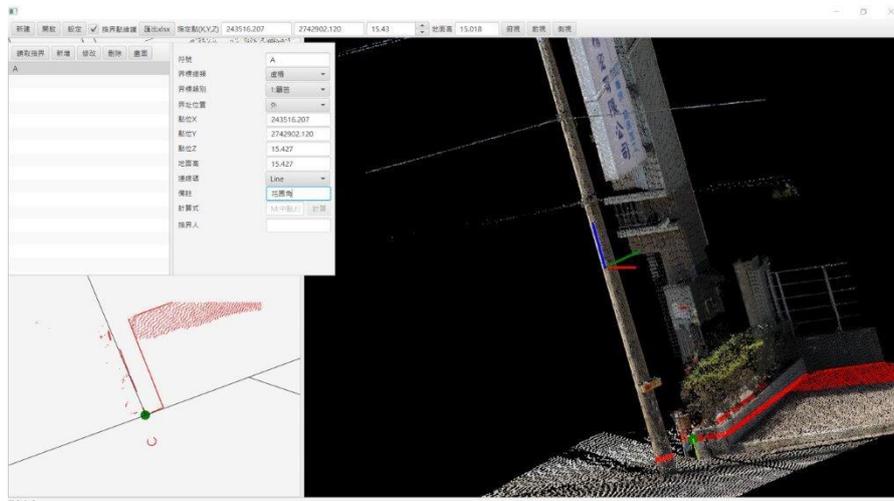


Figure 9. LiDAR Data Overlay Cadastral Map Using in Border Identification

MOI also cooperates with smart government policies to continue developing autonomous vehicle technology, using mobile mapping system to obtain road and street views, and developing automatic mapping technologies to produce point clouds and vector HDmaps for self-driving cars to enhance mapping technology of Taiwan, and to benefit the development of Taiwan's survey industry.

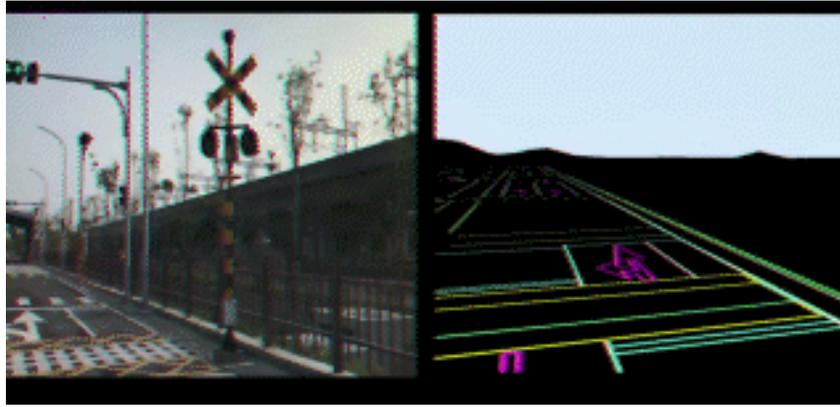


Figure 10. Hdmap of Demostration Field

#### 4. ADVANCED TECHNOLOGIES IN TERRITORIAL ADMINISTRATION

In recent years, marine vessels have been introduced to the Electronic Chart Display and Information System (ECDIS) with the advance of science and technology, which can display navigation data and ENC on an electronic display in vector format at the same time. Conduct sea area surveys and data collection, and carry out inspection and verification of map information in accordance with the standardized Electronic Navigation Chart (ENC) set by the International Hydrographic Organization (IHO) in order to safeguard sovereignty and shoulder the obligation and responsibility of maintaining navigation security since 2015. Therefore, the "Taiwan Electronic Navigation Chart Center" (TENCC) was established to produce, update and maintain electronic navigation charts on November 15, 2018. It also assisted in providing relevant marine information in accordance with the needs of various Ministries simultaneously. So far, 33 ENC chart frames covering Taiwan's important commercial (industrial) harbors have been issued, providing domestic and foreign shipping users services to inquire and purchase. In addition, the inspection projects of flag state inspection (FSC) and port state control (PSC) business have been included in Taiwan's ENC, which was officially implemented on January 1, 2020. International merchant ships (cargo ships) entering and leaving Taiwan's harbors should carry the latest ENC issued by Taiwan to maintain navigation safety. At present, Taiwan's ENC results have been internationally recognized as being included in the UKHO AVCS system (the world's largest ENC service system with the highest coverage). Furthermore, in order to ensure the timeliness and correctness of the contents of the maps, in addition to continuing the updating and maintenance of related maps, and planning to produce ENC in accordance with the new international mapping standards, it will also actively participate in international related technical working groups or meetings to strengthen professional technology of mapping, to display the results of Taiwan's electronic navigation chart issuance, and look forward to fulfilling the responsibilities of coastal states and jointly maintaining international navigation safety.

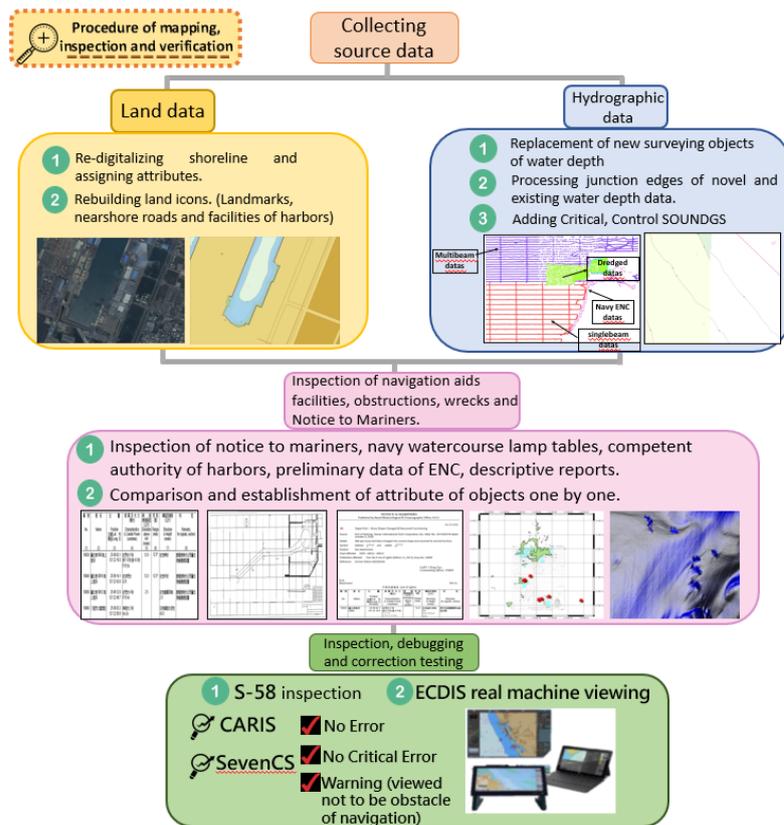


Figure 11. Procedure of ENC Mapping and Verification

Table 2. ENC Product List

Cell ID	Title	Edition	Update	Reissue	Edition Date	Update Date	Scale
1U404528	APPROACHES TO KINMEN AND XIAMEN	3	0	0	02.01.2020	02.01.2020	45000
1U419232	PENGHU ISLANDS SOUTHEASTERN PART	1	0	0	07.10.2019	07.10.2019	45000
1U419233	PENGHU CHANNEL AND ISLANDS	1	0	0	03.11.2019	03.11.2019	45000
1U420220	LIUQIU ISLET TO KAOHSIUNG HARBOUR	1	1	0	06.11.2019	15.12.2019	45000
1U420221	KAOHSIUNG TO ANPING	1	1	0	22.11.2019	13.12.2019	45000
1U420231	WAISANDING SAND BAR TO FANGYUAN	1	6	0	20.09.2019	21.12.2019	45000
1U420240	OFFSHORE CHANGHUA TO TAICHUNG	1	0	0	30.12.2019	30.12.2019	45000
1U420242	TAICHUNG TO TONGXIAO	2	0	0	30.12.2019	30.12.2019	45000
1U420252	OFFSHORE TAIWAN NEAR BAISHAJIA	1	0	0	24.10.2019	24.10.2019	45000
1U421220	SOUTHEAST TAIWAN TO LANYU	2	0	0	02.01.2020	02.01.2020	45000
1U421222	LANYU AND APPROACHES	2	0	0	02.01.2020	02.01.2020	45000
1U421230	TAIDONG CHENGONG TO CHANGBIN	1	0	0	12.11.2019	12.11.2019	45000
1U421232	OFFSHORE TAIDONG NEAR SANXIANTAI	1	0	0	13.11.2019	13.11.2019	45000
1U421233	SHUILIANBI TO HUALIEN HARBOR	1	0	0	25.02.2019	25.02.2019	45000
1U421242	CHILAI PI TO WUSHIBI	1	0	0	25.02.2019	25.02.2019	45000
1U421243	SUPAO HARBOR TO SANDIAOJIAO	1	4	0	26.02.2019	15.11.2019	45000
1U421250	BAISHAJIA TO TAMSUI RIVER	1	4	0	23.08.2019	14.01.2020	45000
1U500334	MAGONG HARBOUR AND APPROACHES	1	0	0	21.09.2019	21.09.2019	8000
1U500341	KAOHSIUNG HARBOUR	1	1	0	26.08.2019	02.01.2020	8000
1U500351	HUALIEN HARBOR AND APPROACHES	1	1	0	25.02.2019	15.05.2019	8000
1U500353	KEELUNG HARBOUR	1	2	0	31.05.2019	30.09.2019	12000
1U500357	TAICHUNG HARBOUR	1	9	0	18.05.2019	31.12.2019	12000
1U500358	BUDAI COMMERCIAL HARBOR	1	0	0	13.04.2019	13.04.2019	8000
1U50039A	YUNG AN LNG PORT	1	0	0	22.01.2019	22.01.2019	8000
1U50348A	HEPING INDUSTRIAL HARBOR	1	0	0	27.02.2019	27.02.2019	8000
1U50351A	SUPAO HARBOR	2	4	0	13.04.2019	14.10.2019	8000
1U50353B	SHENAO BAY	1	0	0	05.03.2019	05.03.2019	4000
1U50354A	TAIPEI HARBOR	1	3	0	08.04.2019	08.12.2019	4000
1U50361A	MAILIAO HARBOR	1	2	0	02.04.2019	21.12.2019	8000
1U500202	WUSHI FISHING PORT	1	1	0	25.02.2019	05.03.2019	8000
1U591001	ANPING HARBOUR	1	0	0	14.07.2019	14.07.2019	8000
1U690302	LUNG-TUNG NAN-KOU YACHT PORT	1	0	0	25.02.2019	25.02.2019	2000
1U691901	MATSU NANGAN FUAO BAY	1	0	0	28.02.2019	28.02.2019	2500

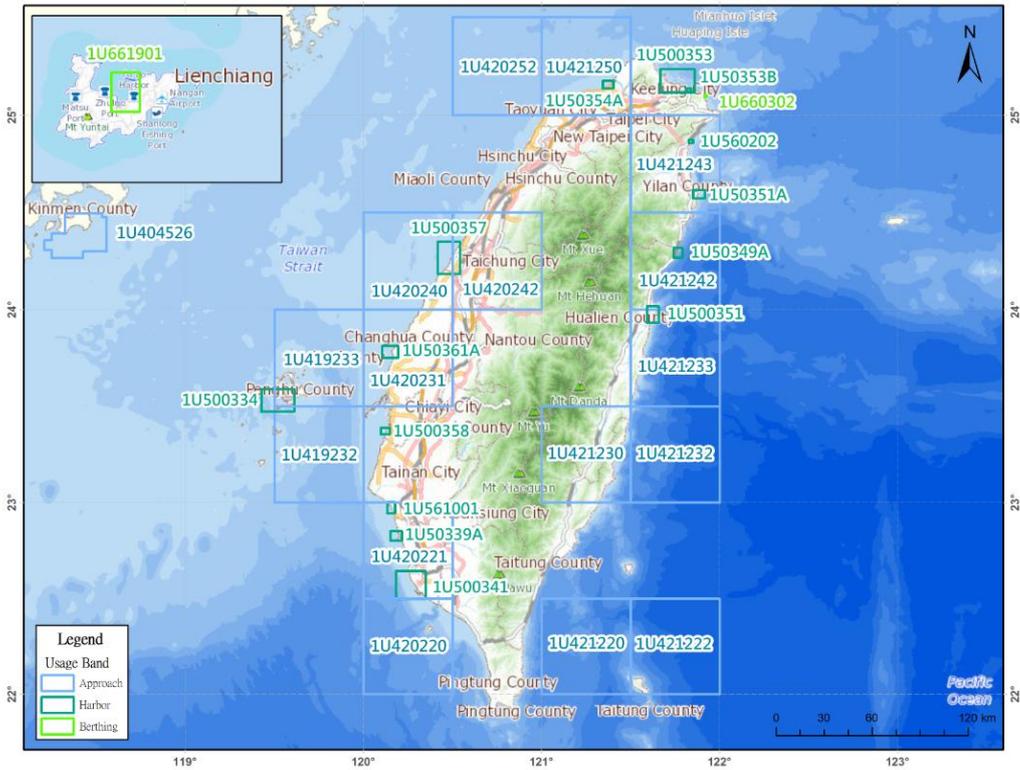


Figure 12. ENC Chart Frame Number

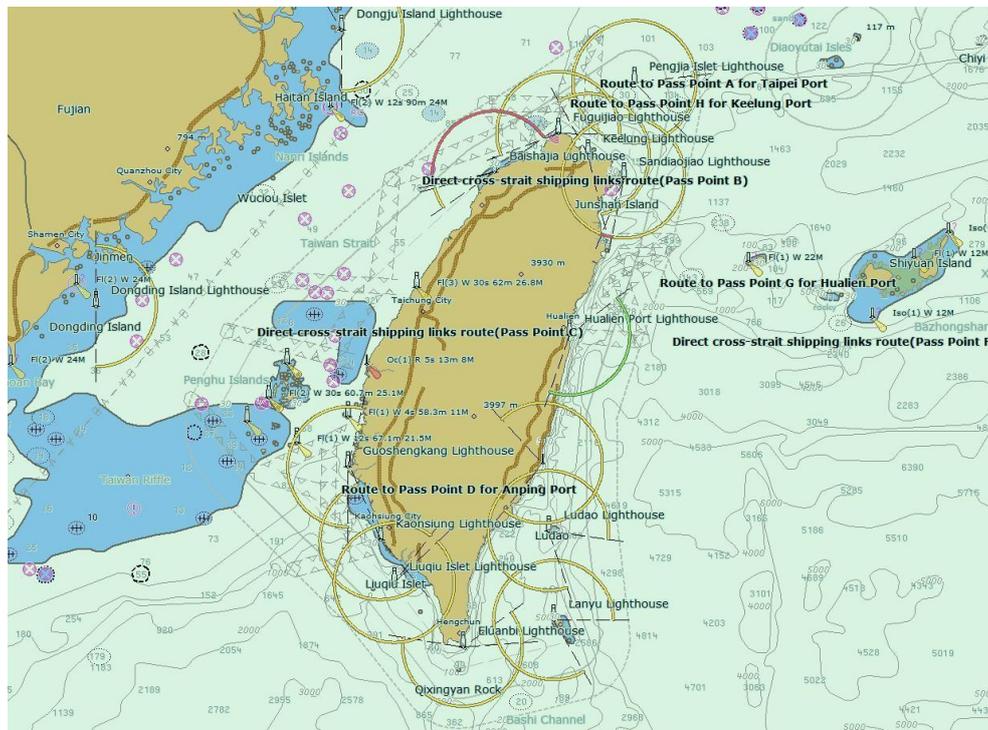


Figure 13. ENC Chart

## **5. FUTURE WORKS AND CONCLUSION**

As technology progresses, MOI applies advanced technologies on related land administration businesses, such as: real estate appraisal, cadastral survey and ENC. In the real estate appraisal, MOI has already established a real estate appraiser and benchmark system for decades. By using Actual Selling Price database and Big Data Analysis, MOI develops a computer assisted mass assessment system. It establishes an objective standard with land value impact factors and individual land value assessments within district land value. The Ministry of the Interior, the Ministry of Finance and the local government work together with the real estate appraisal profession to achieve the scientific, objective, and professional policy of land taxes, to reflect the individual land parcel conditions and market prices, and to achieve advanced land assessing techniques. In the advanced cadastral survey technologies, by approving the law and administrative procedures, the private survey industries can assist the business that previously can only be operated by government agencies. By using close-range photogrammetry and LiDAR, we improve the surveying and mapping efficiency and accuracy of traditional cadastral survey that ensure the rights and interests of people. In addition to ensuring the navigation safety of marine vessels, ENC can contribute to the development of unmanned ships and safeguard the sovereignty of Taiwan's waters. In summary, the goals of these plans are all trying to use better, faster and easier way to provide people government high quality services. In the future, with the help of smart technologies such as Cloud, IOT, AI, and 5G in land administration business, MOI can make Taiwan a smart country, which its government service can reach deep into people's living.

## REFERENCES

- 江志宏(1998)。市價比較法中估價個別因素等級及修正率之研究。逢甲大學土地管理研究所碩士論文。
- 魏如龍、陳奉瑤 ( 2003 ) 。類神經網路於不動產價格預估之研究。國立政治大學地政學系研究所碩士論文，國立政治大學。
- 林娟妃(2006)。高雄地區影響住宅價格因素之研究-以市場比較法為例。國立屏東商業技術學院不動產經營學系碩士論文，國立屏東商業技術學院。
- 龔永香(2007)。客觀標準化不動產估價之可行性分析-市場比較法應用於大量估價。國立政治大學地政學系碩士論文，國立政治大學。
- 花敬群(2010)。電腦大量估價模型於實務應用之探討。金融聯合徵信雙月刊，12，27-36。
- 高瑞豐(2013)。不動產估價特殊影響因素模式之研究-以台南市新化區為例。長榮大學土地管理與開發學系碩士班碩士論文，長榮大學。
- 陳翊書(2016)。我國政府地價公示制度問題與改進方法之研究。國立台北大學不動產與城鄉環境學系碩士論文，國立台北大學。
- 王群猛(2016)。銀行聚集與不動產價格之關係-以台北市辦公商圈為例。國立政治大學地政學系碩士在職專班碩士論文，國立政治大學。
- 林惠敏(2016)。不動產實價登錄資料結合複迴歸分析法的台灣房價估算模型之研究。實踐大學資訊科技與管理學系碩士論文，實踐大學。
- 蔡佩儒(2018)。便利商店對周邊不動產價格之影響。國立政治大學地政學系碩士論文，國立政治大學。
- 劉正倫、蔡季欣、林昌鑑、湯美華(2019)。三維國家底圖建製。國土及公共治理季刊，2，84-89。
- 內政部(2019)。108 年度自駕車用地圖標準及移動測繪技術發展供作案期末報告書。出版地點：內政部。
- 內政部(2019)。108 年度利用光達技術辦理地籍測量及建立視覺化時態地籍調查表可行性驗證實務研析期末報告書。出版地點：內政部。

## BIOGRAPHICAL NOTES

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