Pioneering the Use of Unmanned Aerial System (UAS) for Land Surveys and Titling in the Philippines

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SUMMARY

One of the binding constraints to economic development and poverty reduction in the Philippines is its constricted land market. Time-consuming and costly land title application process is a major barrier in securing land rights. This hurdle is found in the conduct of land surveys. The use of unmanned aerial systems (UAS) or drones is potential reform that can address the said issue. A group of reformers introduced drone-supported survey methodology which can lower the costs and hasten the conduct of surveys hence improving the land titling process.

The reform is guided by the Development Entrepreneurship framework, an approach to development where its supports reform leaders in using entrepreneurial principles and practices to introduce transformational reform. The goal is to find technically sound and politically feasible reforms. The drone reform addresses the technical soundness component by conducting several researches and flights to prove that the data acquired through drones meet the government's standard of survey accuracy. As for its political feasibility, the reform became instrumental in the issuance of government policies that recognize and accept drones as additional tools to surveying. Moreover, for the reform to become more acceptable, it conducted several drone-supported survey activities that led to the issuance of land titles, and training module development to serve as guide for geodetic engineer professionals, students, academic institutions, government agencies, local government units, and drone enthusiast and interest groups.

Since its inception in 2016, the reform impacted land surveying and titling process in the Philippines as more and more private surveyors and government offices incorporate drones in their work. It is also important to note that community involvement is crucial when undertaking drone operations. Their cooperation and proper understanding of a land survey activity and how it could benefit them facilitated a smooth process.

ABSTRACT

To date, there are still around 2 to 4.8 million untitled parcels in the Philippines. In its 10-point socioeconomic agenda, the present Duterte administration promised to "ensure security of land tenure to encourage investments, and address bottlenecks in land management and titling agencies." One of the areas that is seen to contribute to this agenda is the conduct of subdivision surveys of cadastral lots, particularly agricultural lands, among other activities.

To increase the pace of titling, the use of unmanned aerial system (UAS) for land survey and mapping was introduced. To start off, it was a must to determine the accuracy of UAS-generated data and their acceptability. With this, several researches and pilot flights were conducted to determine whether UAS can meet the land survey accuracy standards of the government. Partnerships were formed among the academe, professional associations, private sector, public sector and a non-government organization. The results yielded that the use of UAS can be an alternative tool to generate orthomosaic images that when processed correctly can provide parcel information comparable to information obtained ground survey.

Moreover, the results of the studies were used as input into the development of policy that would recognize and accept UAS as an additional or alternative survey technique that could help titling programs of the government. The concept of development entrepreneurship was utilized to push for this reform. This led to the adoption of a drone policy by the government and to the increasing use of the said technology by government offices, private surveyors, and academic institutions. In addition, capacity-building activities have also been conducted to demonstrate the use of the UAS technology.

1. INTRODUCTION

The use of UAS, also known as drones, in the field of property rights is an emerging field in the Philippine land sector, specifically in land survey, subsequently leading to land titling. A time and cost study of land titling in the Philippines identified two major barriers to residential titling—time-consuming and costly. Both are found in the conduct of land survey. The use of drones is introduced as a reform to address the said issues.

A major bottleneck in title application is getting an approved land survey. The Philippines has established standards for land survey accuracy, and professional geodetic engineers (GEs) have localized tariffs for their services. On average, a subdivision survey costs Php 10,000 or $200 per parcel, using such tools as Transits, Total stations, and GPS (see Table 2). This cost is burdensome to shoulder by low to middle income Filipino landowners. It can also take sixty (60) days, at the very least, to survey a lot and have it approved by appropriate authority (Technology for Property Rights, 2017). This number can go up to months and even years which also translates to more expenses. The use of drones is sought to help alleviate this problem.

The challenge of introducing this reform is two-fold. First is to determine its technical soundness. Aerial photogrammetry, as a means of providing cadastral/parcel information, has been tested a few decades earlier but had been considered insufficient in terms of accuracy. This paper cites several researches to support the idea that drones can provide accurate parcel information. Second is that the reform should be politically feasible, that it is acceptable by the geodetic engineering community, government agencies, and local government units as they are the primary users of the technology. This paper narrates the hurdles that the reform has gone through throughout the years. A major turning point in this reform, however, is when the government issued policies that recognizes and allows the use of drones for surveying.

The drone reform is being undertaken by the Technology for Property Rights project of the Foundation for Economic Freedom (FEF) with the support of The Asia Foundation (TAF)-Philippines and Omidyar Network in partnership with the Land Management Bureau (LMB), a bureau under the Department of Environment and Natural Resources (DENR). LMB is the government agency at forefront of land administration and management while DENR is the primary government agency in-charge of the conservation, managing, development, and proper use the country's natural resources. This reform propelled the approval and issuance of government policies supporting the use of UAS in conducting land surveys.

2. LITERATURE REVIEW

2.1 Residential Land Titling in The Philippines

A fundamental economic challenge confronting the Philippines is how to accelerate inclusive growth by creating more and better jobs to reduce poverty. One of the binding constraints to this endeavor is a constricted land market due, in part, to the lack of formal titles.

In the Philippines, two basic principles support land ownership, the Regalian Doctrine and right to private ownership. The former states that all lands belong to the State and private ownership of land can only be granted by the State. The latter, protected under the Constitution and under existing laws, gives land owners absolute control and exclusive rights on the basis of legal, state-conferred ownership, subject only to certain limitation on police power (like the rules on nuisance, environmental protection, and land use) and eminent domain.

Lands of the public domain or lands owned by the State is classified into agricultural, forest or timber, mineral lands, and national parks. These also include those that are intended for public use and for some public purpose such as roads, bridges, schools, etc. There are also patrimonial properties that are not intended for public use. On the other hand, there is the private domain which is the lands granted by State for private ownership and is only limited to agricultural lands (i.e. subclassified into residential, commercial, industrial, etc.), also referred to as alienable and disposable lands (as what it has been called before in the previous Constitution).

One source of private land titles is the direct grant from alienable and disposable lands in favor of qualified citizens. These land grants are classified into three: free, homestead, and sales patents. Free patent is issued to longtime (30 years) actual occupants and cultivators of agricultural lands. It has recently included occupants of public residential lands through Republic Act (RA) 10023 or the Residential Free Patent Act enacted in 2010.

There are an estimated 24 million lot parcels in the Philippines under the alienable and disposable lands and only half million are titled. Of the untitled parcels, eight million are residential lands and four million are agricultural lands (DENR-LAMP, 2004). Since 2011, 50,000-60,000 residential titles are issued per year starting 2011 from 5,000-6,000 titles annually since 2003 (DENR, 2016).

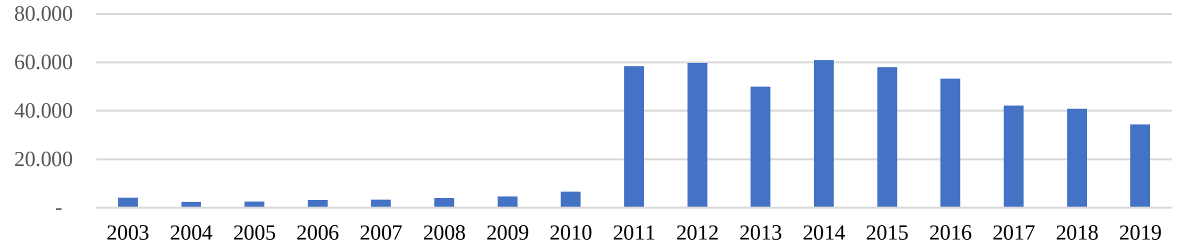

Figure 1. Residential Free Patents Issued, 2003-2019

Source: compiled data from DENR

Moreover, there are two major ways to apply for a residential land title. One is the judicial mode where one acquires a land through acquisitive prescription, a mode of acquiring ownership by a possessor through the requisite lapse of time, which proves to be expensive on the part of the landowners. One has to pay for the professional fee of the lawyer, the cost of land survey, and other court- related costs (Chikiamco & Fabella, 2011). Coupled with at least more than a year to decades to complete, the whole process can be taxing and tedious.

The other mode is through an administrative procedure where one applies for the free patent. One can also buy the land through bidding. For the former, as created by RA 10023, one can apply title for a land as long as the applicant is a Filipino citizen who is an actual occupant of the land for at least 10 years, the lot is in an area which is zoned as residential, the application is supported by: 1) a survey plan based on an actual survey conducted by a licensed geodetic engineer and approved by the DENR, and 2) a technical description of the land applied for, together with 3) supporting affidavit of two (2) disinterested persons who are residing in the barangay of the city or municipality where the land is.

2.2 Titling Process

There are five macro processes in public land titling particularly in the application of a Residential Free Patent: 1) adjudication; 2) subdivision survey; 3) community-level processing; 4) provincial processing; and 5) title registration and title issuance (Technology for Property Rights, 2017).

In the Adjudication stage, which this study also refers to as the "pre-application" stage, a lot occupant applies for a free patent. The status of the applied lot if it is alienable and disposable and still untitled is verified. There are two ways of how land adjudication is done. First is the systematic adjudication in which the government approaches the people. This method selects areas with many untitled lands. Ideally, the process progresses from one lot to another, one barangay to another, and one municipality to another, aiming to register all untitled parcels in a locality (province). Before the DENR and LGU deputized public land inspectors (DPLIs) can do this, they have to organize their own data, in the form of the Consolidated Cadastral Map (CCM) and Rapid Land Tenure Appraisal (RLTA) report. The local Assessor adds data from tax declarations to this RLTA profile so they can discern which lots have potential for titling. The DPLI inspects these lots and interview the occupants.

The other is sporadic adjudication where the people approach the government. The lot occupant approaches the DPLI, who asks the community level records officer to check if the lot applied for can be titled. The DPLI interviews the applicant and conducts field inspection. He/she then helps the applicant to understand the basis of his/her claim and identifies the documents that have to be submitted to support the claim.

Several applicants may live on a single mother lot. When one applies for a portion of the lot, DENR requires a separate technical description for each parcel and this is where subdivision surveys come in. Surveyors or geodetic engineers (GE) have to get authorization to conduct surveys. After getting copies of existing survey data from the DENR regional offices and once they have agreed with the lot occupants on a subdivision scheme, they conduct the actual field survey. The surveyors or GEs are required to submit supporting papers for approval. An approved survey plan is a basic requirement for titling.

Once the applicant has completed the requirements, the community level officer receives them and assigns an application number. Several validation activities by the said officer are done such as double- checking the availability of the lot, confirming the technical description, etc. After receiving the documents from community level office, the provincial level officer signs the free patent and endorses it to the local land registry for registration. The free patent is scanned by a staff of the local land registry. Then, the original title is issued and released to the applicant. Said title is also inputted into the database and storage facility of the land registry.

2.3 Land Survey and Unmanned Aerial Systems

Land survey is the measurement and lay-out of directions and lengths of lines to form the boundaries of a real property (Anderson & Mikhail, 1998). One of its purpose includes providing technical description of a land property as an input to ownership document such as a land title. Because of this, the formalization of ownership through land titling depends on the accurate measurements of the metes and bounds of a land. The standard methodology in land survey includes establishment of control points that serve as the reference for position and direction of a parcel lot and measurement of parcel corners using an optical instrument such as the total station or use of a (GNSS) receiver in Real Time Kinematic (RTK) mode. Using unmanned aerial system or UAS is an emerging methodology in the conduct of land survey.

In recent years, advancements and the commercialization of UAS provided geodetic engineers and other professionals dealing with spatial information an opportunity of using photogrammetry in different survey activities with the least cost and larger area coverage over a short period of time. Currently, UAS's accepted use include orthophotomosaicking for various monitoring activities and generation of digital elevation models (DEM) for topographic map production. UAS with photogrammetric and remote sensing capability has been recognized as mature enough to support the development of geo-information products and services (Colomina & Molina, 2014).

UAS is a set of complementary technologies brought together to achieve a specific task and there currently exists a range of different systems. UAS main components include an aerial platform, a sensor payload, ground control station, communications data link and control. Typical aerial platforms are in the form of fixed-wing or rotary craft. The payload is usually a small or medium format optical digital camera or other remote sensing sensors. Data communication link allows connection between the sensor and storage device. Ground control station provides real world positioning for the images. Control deals with the UAS being remotely controlled or auto-piloted. Auto-pilot mode usually depends on two navigation technologies: Global Navigation Satellite System (GNSS) and inertial navigation systems (INS) or a combination of both.

UAS can be classified in terms of nano-micro-mini UAS or in terms of close-short-medium range. Nano-micro-mini UAS classes are differentiated in terms of weights, payload sizes. This class include UAS with model specific small portable computer ground controller such as the Trimble UX5 and the software only ground controller such as SenseFly's Swinglet CAM, eBee and Phantom Professional. Other classification is related on the type of platform used such as fixed wing and rotor type.

In topographic mapping and volumetric computation, the use of UAS was determined to be more cost effective, with no loss in accuracy, as compared to traditional survey methods for land parcel with area not less than 10 acres (4.05 hectares) to 200 acres (80.94) hectares considering locations with little to no vegetation (Fitzpatrick, 2016).

Manyoky et.al (2011) investigated the use of UAS in cadastral surveying for two study areas in Switzerland. The scope of the study includes UAS data acquisition in comparison with conventional data acquisition methods. Acquisition of UAS data is done by tracing boundary corners from processed ortho- photo images that delineates the boundaries of parcels. The same corner points were obtained from the ground using conventional surveying techniques. It was concluded that the two methodologies are found to be comparable in terms of time expenditure, accuracy and completeness, however the limiting factor for UAS obtained data is the image orientation due to low cost camera used, image quality and the definition of the ground control points. Furthermore, the required level of accuracy for cadastral surveying was said to be obtained, coupled with the advantage of UAS in having high flexibility and efficiency in capturing the surface, having an output ortho-images, and elevation models.

Barnes & Volkmann (2015) provided pilot tests in Albania and concluded that UAS offers a new approach for acquiring and producing high-resolution map. The tests provided results comparable to traditional surveying techniques with positional errors between 10 to 14 centimeters. However, they recommend the use of such technology over smaller areas and not for large areas such as counties or states. In the Philippines, the allowable position of error for isolated survey, specifically for relocation or verification survey shall not exceed ±10 centimeters. These are followed by geodetic engineers practicing land surveying in the Philippines and are stipulated in DENR Administrative Order 2007-29 and its implementing rules and regulation (DENR, 2007) provided in DENR Memorandum Circular 2010-13 (DENR, 2013).

3. FRAMEWORK

3.1 Development Entrepreneurship

Development entrepreneurship is a new way of approaching development work. It supports leaders in using entrepreneurial principles and practices to introduce transformational reform. The goal is to find technically sound and politically feasible reforms (Faustino, 2012).

A technically sound reform has three characteristics: 1) transformative; 2) can be institutionalized; and 3) scalable. First, a proposed reform that is transformative means that it has the capability of changing incentives and behavior of people, organizations, and institutions that enhances public good and produce better development outcomes. Second, this reform can be incorporated into current structures such as formal institutions and bureaucratic practices. The proposed reform, eventually, will be considered as the new "status quo" ensuring that it is sustainable policy-wise. Lastly, the reform should be scalable which means that it can stand by itself even with limited funding and can expand beyond its originally intended scope.

On the other hand, a politically feasible reform has the capacity of being accepted into current political structures. In short, the reform is favored and accepted by the political environment. Apart from the characteristics being sought and advocated by the model, entrepreneurial principles and practices are observed in implementing reforms. Navigating through complex development challenges and 'wicked' problems to discover elusive, technically sound, and politically possible pathways to reform involves a great deal of trial and error and a relatively high tolerance for uncertainty.

The push for the use of drones in land survey in the Philippines is being undertaken and guided by the development entrepreneurship model.

4. METHODOLOGY

This part of the paper shows how the use of UAS in land survey has unfolded since its inception in late 2015 using the development entrepreneurship framework.

4.1 Technically Sound

4.1.1 Pilot Test in Cordova, Cebu

The first activity undertaken is a pilot test in Cordova, Cebu in March 2016. The goal is to determine whether drone data can meet the accuracy standards set by the government. Fortunately, the team has the support of LMB, DENR Region VII, province of Cebu, and the local government of Cordova. The team partnered with Walter Volkmann and Oliver Volkmann of Micro Aerial Projects L.L.C. (MAP), a provider of innovative geospatial solutions such as geodetic, cadastral, topographic, and photogrammetric surveying, geographic information systems (GIS), UAS operations, and Skyeye, Inc. (now Skyeye Analytics, Inc.), a local drone service provider in the Philippines.

A comparison was made between the coordinate measurements using a total station (operated by a GE of DENR Region 7) and the coordinate measurements using small UAS acquired aerial images and the Structure-from-Motion (SfM) mapping technique shows an average horizontal difference of 0.052 meters or 5.2 cm and falls within the 10 cm positional accuracy.

The team believes that if UAS technology is proven to be sufficiently accurate, LMB may issue a policy allowing and encouraging the use of UAS for surveying as an additional technique to add to the traditional toolsets of TS and RTK GNSS. This may pave the way for the geodetic engineering community public as well as private, to more efficiently address the technical challenges concerning land surveying and titling in the Philippines.

Figure 2. Title applicants determining their property on the map (left) and drone reform team composed of FEF, TAF, LMB, MAP, and Skyeye, Inc. (right)

4.1.2 Presentations

After the success of the pilot test, the team, along with LMB, made presentations on the drone reform in front of partners and stakeholders in different conventions and conferences. However, the most notable is the presentation to the National Convention of the Geodetic Engineers of the Philippines (GEP) in Bohol in November 2016. The reform was met with both positivity and doubts. Positivity in terms of the ability of the technology to provide additional information such as high-resolution maps that can be generated in a shorter period of time compared to using traditional surveying methods.

Doubts include the accuracy of the drone-generated photos and if the technology can be really used in land surveying. Also, the issue on drone prices may discourage a geodetic engineer to get one and use it. Nevertheless, the team was advised by one of the GEP National Board Member, Prof. Epifanio Lopez (also the Chair of the Professional Regulatory Commission Board of Geodetic Engineering), to conduct a rigorous academic study to prove the accuracy of drones in land surveying. This is to have drones fly over various terrains to determine whether the data gathered can meet current accuracy standards and if what circumstances require the use of drones.

4.1.3 Demonstration of the Test Bed

The pilot test in March 2016 convinced the team the need for a test bed before conducting actual surveying and mapping activities using drones. The team is confident that accuracy standards required will be achieved at 95% confidence level once a suitable test bed has been established and used to formally document mapping accuracies.

In March 2017, the team got Walter Volkmann of MAP as the resource person in demonstrating Structure-from-Motion (SfM), a low-cost, user-friendly and advanced photogrammetric technique for obtaining high-resolution datasets at a range of scales. He introduced the VMAP dual frequency GNSS in a test flight at Bacoor, Cavite, assisted by Skyflix, Inc., to show that its output meets the Philippines' standard surveying accuracy. The demonstration was participated by GEs from LMB, the regional offices of DENR, the National Mapping and Resource Information Authority (NAMRIA), educators and students from the University of the Philippines (UP), and drone practitioners.

4.1.4 Academic Research

Following the presentation of the team to the National Board of GEP, the team took the challenge of conducting an academic research. The team sought for the assistance of the Geodetic Engineering Department of the University of the Philippines (UPDGE) and Prof. Epifanio Lopez himself.

An academic research was conducted in March 2017 to provide a scientific basis on the applicability or non-applicability of UAS for land surveying taking due consideration to obtaining accuracies that conform to the Manual for Land Surveys. Three sites were chosen in Norzagaray, Bulacan, 50km north of Manila. These are Brgy. Tigbe, Brgy. Poblacion, and Brgy. FVR (see Figure 4). The drone used was Trimble UX5 (see Figure 5) which covered approximately 18 hectares, 26 hectares and 15 hectares, respectively. The activities were participated by the same GEs from LMB and DENR regional offices during the test bed demonstration. The positional survey accuracies of the coordinates of the GCPs in the ground survey and orthophoto are within the 10-cm requirement. The outputs from Brgy. Tigbe study area provided the best results in terms of accuracy in position, distance, direction and area. Outputs from Brgy. Poblacion also showed a relatively positive result. However, the output from Brgy. FVR is observed to be the least successful. Based on this, one cannot readily say that topography is a significant factor that affect accuracy since the study area in Brgy. Tigbe which was observed to be sloping compared to the study area in Brgy. Poblacion provided better result.

Figure 3. Brgy. Poblacion, Brgy. Tigbe, and Brgy. FVR (left to right)

Another research was conducted by FEF and UPDGE with the support of the Atlas Network in the last quarter of 2019 where various consumer drones were compared in terms of their applicability in land surveying. Based on the results, it can be said that low-end unmanned aerial vehicles (UAVs), such as the DJI Phantom 4 Advanced with its 20MP camera sensor, may be applicable for property surveying along with the likes of high-end UAVs, such as the WingtraOne. It is important to note that even high-end UAVs, such as the JOUAV CW-007, have their operational limitations. Flight parameters, such as flying height above take-off, should always be taken into consideration when preparing flight plans for respective UAVs. The clear advantage of higher end UAVs with regard to property surveying is their capability of covering a larger area with detailed results such as that of the WingtraOne. The WingtraOne covered the same target area as the DJI Phantom 4 Advanced, but accomplished it with one 14-

minute flight and produced a 1.09-cm/pixel ortho-image, while the DJI Phantom 4 Advanced needed four 15-minute flights to cover the same area and produced a 1.63-cm/pixel ortho-image. The lower ground sampling distance (GSD) output value reflects significantly on how identifiable features are on the ground. Having a GSD of less than 2-cm/pixel does not necessarily guarantee an output that may pass the accuracy standards. It is recommended to target a GSD of less than 2-cm/pixel based on the ±10-cm limit in terms of position for isolated surveys such as relocation and verification surveys.

With these results, one can say that the use of UAS can be an alternative tool to generate orthomosaic images that when processed correctly can provide parcel information comparable to information obtained ground survey. It has the advantage of covering a relatively large area compared to ground survey, can be done with minimum GCP which is another time-consuming survey activity given that the UAS has either a Post-Processed Kinematic or RTK GNSS ready platform.

However, similar to other technologies, it also has several challenges and limitations. Weather condition such as wind velocity and battery lifespan must be considered in the planning and implementation of a UAS data acquisition. Wind velocity may sometimes affect the clarity of the output images. Battery lifespan is an important factor in planning the flight area coverage. In terms of data processing, software, hardware and peopleware must be considered. In terms of data extraction, proper and accurate delineation of target points depend on its clarity and visibility on the processed orthomosaic.

4.2 Politically Feasible

4.2.1 Policy Development and Issuance

The initiative to develop and issue a policy that would support the use of drones in land surveying started right after the first drone flight in March 2016. The first formal drone policy review meeting was on June 2016. This was followed by a series of policy review committee (PRC) meetings with LMB until December 2017. PRC is the committee in LMB in-charge of policy deliberations, approval, and issuance. The meetings include the following discussions such as what kind of policy to issue and which government agency could issue it the quickest to hasten its implementation in national and regional levels. Also, the discussions include what should the policy include such as general provisions, technical notes, etc.

The team, along with LMB, resolved to issue two policies—a memorandum circular and a technical bulletin issued by LMB. A total of five (5) PRC meetings were held before the policy is approved spanning from June 2016-December 2017. Apart from the PRC meetings, other internal meetings, demonstrations, and interventions were made by team. For the policy development, the team sought the assistance of Prof. Epifanio Lopez and Engr. Louie Balicanta of the UPDGE.

After a series of meetings and consultations, two drone policies were issued on December 27, 2017. These are the LMB Memorandum Circular (LMC) No. 2017-003 and LMB Technical Bulletin No. 2 series of 2017. The former recognizes UAS as one of the instruments that may be used in the conduct of land survey. While the latter contains standards and guidelines needed in the implementation of the LMC. The policies took effect last January 26, 2018.

4.2.2 Policy Application

In November 2018, the team went to Brgy. Sta. Fe, Esperanza, Agusan del Sur, a province in the Southern part of the Philippines of the Mindanao island to demonstrate the use of drones for surveying according to the procedure in the Technical Bulletin - and specifically for subdivision surveying leading to issuance of 123 land titles. The partners here are DENR Region 13, particularly the Surveys and Mapping Division and the Provincial Government of Agusan del Sur, and UPDGE. This activity is part of the provincial government's mass titling activity.

The team briefed the GEs of provincial government of Agusan del Sur and DENR 13 on the preparations needed before the actual flights. Coordination with the LGU and constituents of Brgy. Sta, Fe was done in order to solicit their support and participation in this activity. The team then flew to Agusan del Sur and conducted a week of reconnaissance, drone flights, and validation. The drones used were a quadcaptor—DJI Phantom 4 Advanced--and a fixed-wing—EasyMap. Of both drones, the DJI Phantom 4 Advance produced better results in terms of image quality and accuracy.

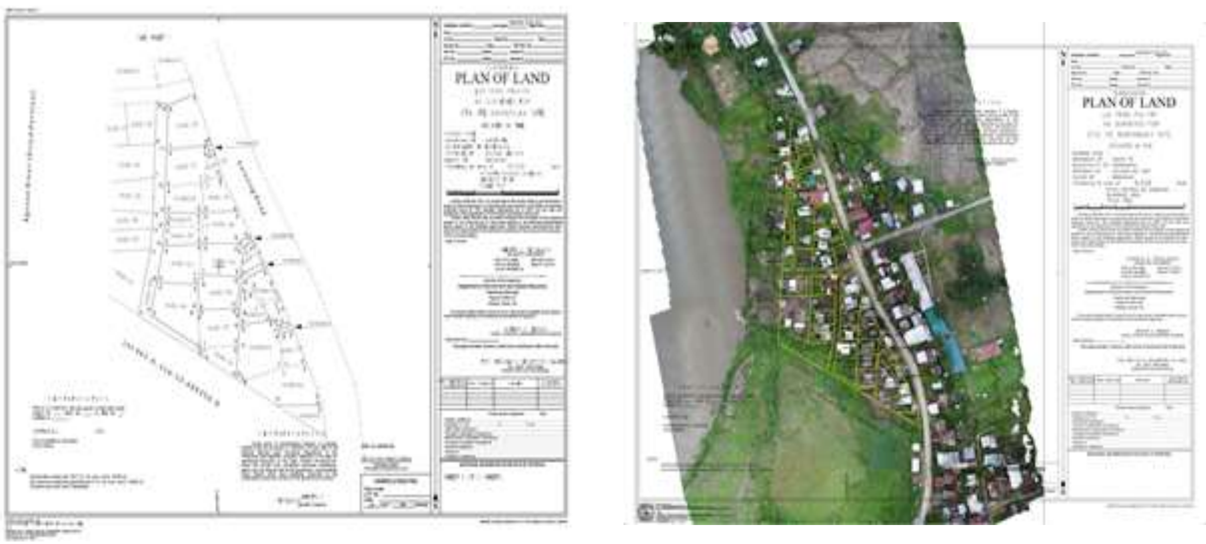

Figure 4. Approved survey plan using drone-supported survey methodology

It is important to note that when one has to have his/her land survey, a private GE needs to be hired. But in the case of the province of Agusan del Sur, a surveying team headed by a GE was hired by the provincial government to conduct free survey among residential free patent applicants and its properties. This is a noteworthy governance innovation on the part of the provincial government.

The team assisted more mass titling activities by the DENR. After Region 13, the team provided technical support in the conduct of drone-supported surveys in Regions 5 & 7 in partnership with their local DENR offices. In Region 5, the site was at Brgy. Basiad, Sta. Elena, Camarines Norte where around 200 land parcels were surveyed. In Region 7, 50 land parcels were surveyed in Brgy. Cogon, Dumanjug, Cebu.

Figure 5. Digitized orthophoto of Brgy. Basiad, Sta. Elena, Camarines Norte (left) and Brgy. Cogon, Dumanjug, Cebu (right)

4.2.3 Training Module

Along with the policy issuance and application, the team also developed a training module for drone-supported surveying to serve as guide for geodetic engineering professionals, students, government agencies, local government units, and academic institutions that offer GE courses. The goal is to spread the knowledge on the application of drone technology in the land surveying and titling. The training module was developed with the assistance of Prof. Epifanio Lopez, UPDGE, and LMB.

The development of the training module was finished by the end of 2018 then it was rolled out in 2019. A pilot test was held in March 2019 with the UPDGE as the main academic partner institution. Various academic institutions, government agencies, and local government units were selected as participants. After the success of the pilot test, the module was rolled out in three areas in the Philippines in partnership with several academic institutions that were also the participants last March 2019. These are the University of Southern Philippines Foundation in Cebu City for Visayas island group, Bicol University in Guinobatan, Albay for the Luzon island group, and Caraga State University in Butuan City for the Mindanao island group. The training module underwent several revisions as the partner institutions also provided further inputs. By the second half of 2019, the training module was finalized.

5. RESULTS AND DISCUSSION

The paper demonstrated the implementation of the drone reform in the land surveying and titling using the Development Entrepreneurship approach. The team is successful in proving that drones can be as accurate as other surveying equipment and in getting policies out to support its use in land surveying.

5.1 Technically Sound and Politically Feasible

Determining the technical soundness of a reform is as important as its political feasibility. Sometimes, managing the interests of stakeholders is harder in introducing a reform and its sustainability is the hardest. While these reforms are initially and primarily geared towards increasing the issuance of titles, it had other positive effects in land governance. With data and maps, relevant government agencies can use these data in land use planning, tax mapping, disaster risk reduction, etc.

The technical soundness of the reform is anchored on two academic researches conducted by the team. The results of said researches support the idea the survey data acquired with the support of drones meet the drone accuracy standards set the by the government. Drone technology can be used in addition and in support of traditional surveying instruments to survey and map larger areas in a shorter period. More importantly, it can provide graphical presentation and more accurate information on land parcels through high resolution aerial photos while still meeting the government's accuracy standards. The use of drones upgrades the conduct of land surveying and mapping in the Philippines.

The approval and issuance of two drone policies by LMB marked the beginning of the reform's slow acceptance by the GE community, government agencies, and LGUs in their conduct of surveys. Despite this, the reform was still met with hesitation and resistance—technical and procedural in nature. There are still doubts as to the drone's survey accuracy while the others are concerned with drone registration, training, etc. With this in mind, the team conducted policy demonstrations in selected mass titling activities of DENR and developed a training module on drone-supported surveying to be used by GE professionals, students, government agencies, local government units, and drone enthusiasts. These initiatives resulted to an increasing number of organizations using drones in surveys (see Table X). These organizations are composed of government agencies, LGUs, private firms and individuals, non-government organizations, and academic institutions. The use of drones for surveying and titling is becoming widely acceptable as GEs start to include drones in their arsenal of survey equipment,

5.2 Improved Conduct of Land Survey and Titling

With the work the reform is in now, one can say that drones will have a big role in improving the conduct of land survey in the Philippines. In terms of its impact on land titling, the team is yet to answer whether using drone in land surveying is cost-effective as the geodetic engineering profession depends on a prescribed survey rate for various types of land surveys. However, given the pace of improving drone technology, availability, and increasing number of uses, prices are constantly going down.

As for the time element, it would normally take ten (10) days to finish data acquisition using traditional survey instruments over a five (5) hectare lot. With drones, this can go down to two (2) days. Using a drone to survey a lot that is less than five (5) hectares may not be efficient. To reiterate, the decision to use drones has to weigh cost and benefits for any given task. Bottomline is that the drones are better used for surveying larger areas of land that are five (5) hectares and above.

Lastly, community participation or the title applicants' involvement in the process of land survey is highly significant. The community includes the potential title applicants, local GEs, the local government officials, and the regional DENR office. Without their active participation, the drone reform would not be possible. Constant coordination with the government offices is key in driving the activity forward. Providing orientation and capacitation to local GEs on how drone-supported survey works is also crucial especially in the preparation of survey returns. Finally, it is important that the potential title applicants are informed on what is going to happen, what can be expected, and what they will get from acquiring a title. Once this is clear to them, one can guarantee the community's cooperation which is instrumental in completing the title application process through land survey using drones.

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