Urban Development and Resilience in the Kingdom of Bahrain: A 3D-enabled National Geospatial Programme for a Sustainable Future

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SUMMARY

Manama, 2020. Bahrain is an island state in the Arabian Gulf with a surface area of 783km^2 and a population of over 1.5 Million. The Survey and Land Registration Bureau (SLRB) is the government body in charge of land and property registration, cadastral survey, national mapping, and charting of the land and sea of the Kingdom of Bahrain.

SLRB underpins the national economy by providing confidence in land transactions and securing property ownership that underpins 8.4% of GDP through real estate, business and construction activities[1]. SLRB generates over 20 Million BHD annually through property services and registration duties to the Ministry of Finance and National Economy consolidated revenue and registers transactions of property valued over 1 Billion BHD annually. Ranked 17th globally for ease of registering property and 3rd in the MENA region, Bahrain's competiveness and attractiveness for investment is greatly improving with the implementation of a broad suite of real estate reforms including the establishment of the Real Estate Regulatory Authority (RERA) providing strength and confidence in the property market through improved regulation of property development, introduction of valuation standards, licensing and professional development of real estate practitioners.

The United Nations Committee of Experts for Global Geographic Information Management (UN-GGIM) recognises the important role of geospatial information to a nation's development and supporting the monitoring and reporting of the Sustainable Development Goals (SDGs). Modernisation of national mapping supports the Kingdom's ambitious infrastructure and development march by greatly improving the accuracy and reliability of geospatial information essential for planning, decision making, infrastructure and services, housing and urban development, and the improved integrated management of the land and marine environments.

By harnessing world class geospatial technologies and fostering local capabilities, SLRB is striving to ensure Bahrain is a leader in building the knowledge based digital economy directly contributing to Bahrain's Economic Vision 2030, the Government Program, and the National Fiscal Balance programme.

1. INTRODUCTION

Population: 1.5 Million
Projected 2030: 2.2Million
Land Area: 783km^2
Rate of land area increase approx: 0.03%
Urbanisation rate: 90%
No.reg.Vehicles: 716,106
Source: iGA 2018 Open Data Portal, SLRB 2019

The Survey and Land Registration Bureau (SLRB) is the government body in charge of land and property registration, cadastral survey, national mapping, and charting of the land and sea of the Kingdom of Bahrain.

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SLRB is forging a new era of national mapping by introducing a geospatial foundation to the production and dissemination of national mapping data. This paper will introduce Bahrain's comprehensive National 3D Mapping project and modernisation of national mapping programme that is the foundation of a geospatial ready nation.

SLRB provides confidence in land transactions and property ownership through land registration and survey services in accordance to Law No. 13 of 2013 the Property Registration Law and associated regulations. SLRB guarantees and ensures the integrity of the land registry (record of ownership) and cadastre (record of property boundaries) via the Title Deed. SLRB's digital topographic mapping of the natural and built environment enables national planning, to facilitate urban development and all major infrastructure projects. SLRB is responsible for maintaining national survey and mapping standards for surveying practice and professionals.

SLRB is divided into three (3) general directorates:

- The General Directorate of Surveying
- The General Directorate of Land Registration
- The General Directorate of Resources and Information Systems

The first two directorates collaborate to carry out the main SLRB responsibilities, while support is provided by the third general directorate's branches include Human Resources and Finance, and Information Systems.

SLRB is now moving to the next phase of a 4-5year modernisation programme in delivering its National 3D Mapping Project through a modern data management and dissemination production environment, a data-collection and capability programme. Delivery of these will establish a new production system which enables the Topographic Survey Directorate (TSD)

to collect, use, produce products, manage and make available fundamental 2D and 3D geospatial data to users. The approach is to embed technology and data delivery through business transformation ensuring that SLRB's investment in the National 3D Mapping Project is aligned to SLRB's Vision:

"To provide trusted high-quality land information services, expertise and to be a model for Government sector management through investing in excellence to support the future needs of the Kingdom of Bahrain"

Directly contributing to Bahrain's Economic Vision 2030 and the Government Programme, modernisation of national mapping supports the Kingdom's ambitious infrastructure and development strategy. By greatly improving the accuracy and reliability of geospatial information necessary for planning, decision making, housing and urban development, property services and investment, this will enable better integrated management of the land and marine environments.

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SLRB's vision of progressing towards a modern object feature based national mapping environment will well-equip Bahrain's readiness for a future of 3D City modeling, 3D street-mapping, self-healing maps for autonomous vehicles, smart cities, smart APIs, the Internet of Things (IoT), and a national cloud-based framework for geospatial data sharing and exchange – intelligent geospatial information for a Smart City. SLRB's role in laying the foundation for an Artificial Intelligence based economic future is clear and SLRB is leading the advancement of geo-AI in Bahrain. By harnessing world class geospatial technologies and investing in local capabilities, SLRB is striving to ensure Bahrain is a leader in building the knowledge based digital economy.

2. A COMPREHENSIVE LAND AND PROPERTY REFORM PROGRAMME FOR THE DIGITAL ECONOMY

Encapsulated within the SLRB strategic framework developed with the assistance of Ordnance Survey of Great Britain in 2014, SLRB is tracking a course of development and efficiency that is contributing directly to national development. Pillars of reform include modernisation of national mapping and cadastral survey, enhanced land and property e-services, land registration efficiency, and private sector development. An accompanying study by KPMG in 2012-2013 set course for comprehensive real estate reforms. Enacted by Royal decree in October 2017 and tasked to implement a new Law No. 27 of 2017 for Organisation of the Real Estate Sector, Bahrain established a Real Estate Regulatory Authority. Since late 2017, International Development Ireland (IDI) has been guiding the transition from establishment to operation of the new regulator that is geared to provide confidence in the property market for investors, financiers, developers and practitioners. Additional reforms

include the national adoption of international property measurement and valuation standards, standards for the mapping of underground utilities, and SLRB now exploring the power of geospatial through mobile mapping, UAV capture and 3D-city modelling. A flagship initiative is the Sand Search Project headed by the Hydrographic Survey Directorate that will foster good governance in the coordination of marine sand resource management and cross-government coordination of responsible agencies that manage the marine environment. For SLRB, the Sand Search project involves acquisition of a new hydrographic vessel equipped with the latest sea-floor mapping technology and sub-bottom profiler to determine the depth and quantity of marine sand in Bahrain. The forecasted development and reclamation plans of the Government Programme call for multi-Millions of cubic metres of sand that must be identified and managed in the national interest to fulfill the planned road, rail, urban development and major transport projects in the pipeline.

3. MODERNISATION OF NATIONAL 3D MAPPING FOR A SMART, SAFE AND RESILIENT NATION

To keep abreast of existing and future demands for digital mapping and intelligent geospatial services, SLRB must transform its long-standing map production and operations from engineering Computer Aided Design (CAD) based environment to object feature orientated digital map production. SLRB maintains a rich representation of the natural and built environment by surveying through photogrammetric and field survey techniques of over 150 feature types within a set of 478 discrete Logical Map Boundaries (LMBs) readily utilised across government and the private sector as the predominate authoritative reference upon which national planning and decision making is made. However, the CAD environment for map production causes limitations in not being able to identify or maintain individual geographic features, poor attribution and limited metadata, no auto generalisation and labelling capabilities and restrictions in 3D annotation. Moreover, the authoritative CAD format does not meet the needs of users requiring mapping data in fully annotated, application neutral open geospatial formats.

TSD have also introduced a programme where other ministries involved with the development of infrastructure have to provide ‘as-built surveys’ of any new project which is used to up-date the base map. The data format from the various ministries still has to be standardised and this is work in progress. It is hoped that in the future all new projects will have ‘as-built surveys’ done to a few standard data formats to enable automated update into the 1:1000 base map/database.

4. NATIONAL MAPPING DATA MODEL

In January 2014, TSD took delivery of a comprehensive 2D+3D logical model referred to as the ‘National Mapping Data Model for the Kingdom of Bahrain’ that was designed to open

standards such as ISO/OGC/INSPIRE/SC57 amongst others to cover all geographic features in the Kingdom of Bahrain after consultation with all major stakeholders. The 2+3D National Mapping Data Model was created to enable the provision of intelligent geospatial data within SLRB and to stakeholders including Government, the private sector and citizens. The model supports effective data analysis and was built to provide consistency in the way SLRB produced, used, and maintained data for distribution to its stakeholders.

By 2018, as part of the Underground Utilities project to study the positional accuracy and management of utilities data and records, funds were set aside to re-visit the database to enable the utilities project to showcase the full 'interoperability' potential of the National Mapping Data Model structured physical model 'prototype database' to take in all SLRB data in addition to all the available stakeholder data of a strategic project infrastructure development site in various CAD-based and geospatial formats.

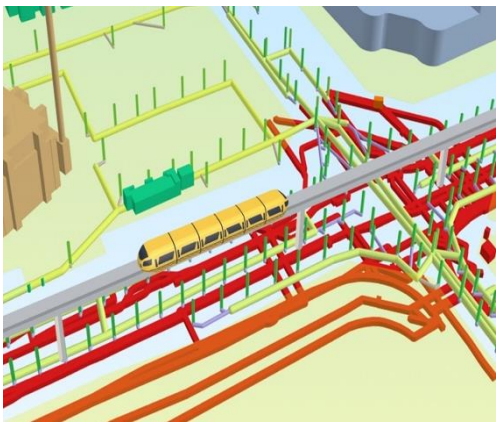
Foremost, the National Mapping Data Model is to be utilised to underpin the SLRB national mapping production environment. Ensuring that data of other data custodians across government can also be received, and to also ensure data products and services provided by SLRB are compatible and interoperable with other key stakeholder's requirements. In future, the National Mapping Data Model will be beneficial for the adoption by stakeholders to advance their geospatial environments and is an important basis for the future development of a national data sharing and exchange environment by the collective of geospatial-related stakeholders and the Information and eGovernment Authority (iGA) particularly in light of national progress towards AWS Cloud technology uptake and development.

Enabling a future environment of Web services, the SLRB geospatial production environment will be ISO/OGC standards compliant ensuring full interoperability and allowing registry based discovery of services and features supporting Web Mapping Services (WMS)/Web Feature Services (WFS) and support for smart geospatial API development. Whilst the focus now is on modernising the core production and maintenance environment, the system will be scalable to the future functional requirements of an advanced national mapping system.

5. TOWARDS AUTONOMOUS VEHICLES AND SELF-HEALING MAPPING

Bahrain is also looking ahead to explore the potential viability of 3D street mapping to provide a self-healing automated update of road corridor related features to meet current and future demands for road corridor management including traffic, street furniture, street facing natural and built environment, network and navigation, with vision to establish geospatial services beneficial to autonomous vehicles for possibly L4 and L5 autonomous driving systems. Given the country's limited size, and relatively flat topography, Bahrain is an ideal test bed and proving ground attracting world leading tech-firms and start-ups to actualise their innovations.

6. FROM UNDERGOUND UTILITIES TO AS-BUILT SURVEY STANDARDS



Urban environments by their very nature are complex, dynamic, and ever-challenging for governments to control and cater for future services demand. Bahrain boasts a very modern near-fully underground network of utilities. Whilst connectivity and maintaining supply is the key to consumer satisfaction, knowing where and what is underground is a challenge. SLRB in partnership with the Ministry of Works, Municipalities Affairs and Urban Planning (MoWMAUP), and the Electricity and Water Authority (EWA) were tasked by H.E. Deputy Premier to study the current state of location information of underground utilities in Bahrain.

Ordnance Survey International with utilities management and mapping specialists from the UK studied the collection and management of location information of underground utilities across the sector. This lead to the adoption of the Bahrain Mapping Standard for Underground Utilities based on international standards and best practices including UK PAS128 and USA specifications. A supporting data capture and delivery specification ensures new data collected is to standard and in an open format readily compatible and transferable across users' and asset managers' systems.

When it comes to Utilities, mistakes are costly. It's a contemporary challenge faced by all modern urban cities. Delays, strikes, injuries, and interruption to normal city-function and transport contribute massive direct and indirect costs to the national economy. The study reported that in the UK alone the costs of unreliable information of underground assets account for 5.5 Billion GBP of street works, 6 Million work hours of disruption, 12 deaths and 600 injuries due to strikes, and 150 Million GBP attributed to third-party damages. The estimated benefit of reforms in the sector to Bahrain just in terms of reduced project delays is in the order of 10's of Millions BHD for any large infrastructure project.

The answer is reliable, authoritative, accurate and well described data that is readily available to those that 'need to know' in the utilities and infrastructure services development and asset management sector. Unfortunately, you cannot 'pick up' an entire city to look underneath and map all underground utilities in one go. The introduction of standards and improved data collection and management is a cycle of continuous improvement to update the national records of asset owners. Whenever a new service is installed, a utilities survey conducted, or an inspection hole or excavation is carried out, records must be updated and the updates shared. Better and reliable positional information is the much needed first step requiring technical awareness by engineers and surveyors and contractual-based compliance measures to ensure data provision post completion of works.

Precise data alone cannot fully address the problem. The very confined and congested underground and road corridor environment must be managed in full synchronization with asset owners, infrastructure developers, engineers and planners. Services and infrastructure must be planned well ahead of time. Re-routing services is immensely costly and time intensive. If a major project collides with an unknown significant pipe or cable asset, costs and schedules can blow out exponentially in units of 100s of Millions BHD and years of delay. Within Bahrain both private consultants and surveying firms are key. Firms responsible for installation or maintenance of underground assets must ensure utilities, such as pipes or cables, are placed in the correct location and their position accurately recorded to the agreed standards and specification when installed or inspected. They too will benefit from better information and records with reduced need for digging trial holes, reducing hazards involved and cost over-runs.

The project plays an important role in achieving the objectives of the Bahrain Economic Vision 2030 and the Kingdom's progressive development agenda towards a globally competitive economy. The project provided key recommendations aimed at generating efficiencies across the utilities sector directly supporting utility owners with better information about the 3D position and attributes of their aboveground and underground assets. Through improved information capture and records management, knowing what assets are buried allows construction and infrastructure projects to plan and progress efficiently, contributing directly to sustainable urban growth.

7. UAV 3D CITY-MODELLING

The mainstreaming of UAV technologies in the mapping world has revolutionised traditional airbourne capture techniques. SLRB in 2019 commenced a pilot programme to test new capture platforms and available COTS data processing applications. The preliminary verdict is clear. UAV imagery is an important contributor to SLRB's core business of feature change detection, advanced 3D-City and acute urban-area modeling.

Image source: SLRB 2019

The business applications tested included applications for real property valuation, detection of municipal violations, performing remote as-built surveys, and most notably being a powerful tool for cadastral mapping in very dense urban areas and corridors overcoming longstanding GPS field survey challenges of 'urban canyoning' restricting GNSS and CORS signal

visibility. SLRB and its partners are looking towards establishing a continuous and 'on-demand' geospatial capture programme to fulfil a broad spectrum of cross-government applications directly supporting the Nation's infrastructure and urban development programme.

8. NATIONAL COMMITTTEE FOR GEOSPATIAL INFORMATION GOVERNANCE (NCGIG)

HRH Prime Minister's Edict 15/2017 established the National Committee for Geospatial Information Governance (NCGIG) that held its inaugural meeting on the 19th October 2017. Building upon more than two decades of coordination of GIS portal development, referred to as the Bahrain Spatial Data Infrastructure (BSDI) and many successful geospatial initiatives via the previous National GIS Steering Committee, a revised mandate now takes focus on geospatial data management and geospatial data standards. Improved coordination, collective purchasing, and collaboration in the sharing of reliable and up-to-date geospatial data is vital to deliver and maintain infrastructure and support economic, social and environmental development. The Committee is chaired by the CEO of iGA, H.E. Mohamed Al-Qaed and deputy chaired by the General Director of Survey, H.E. Naji Sabt. The NCGIG reports to the Ministerial Committee for Development Projects and Infrastructure.

9. FUTURE OF LAND MANAGEMENT IN AN INCREASINGLY URBAN ENVIRONMENT

Keeping infrastructure and services up to demand in line with development is a challenge faced by all emerging economies. Confidence-in and adherence to national spatial planning, master plans, development controls and stable zoning provides the real estate market confidence to invest. 'Plug and play' is the leading point of attractiveness for investors in Bahrains' major development areas such as Bahrain Bay and Financial Harbour districts ensuring services are ready to connect. To the extent of focused Fintech investment promotion, financial aimed property developments are now providing world class secure, reliable, uninterrupted power supply (UPS) facilities as part of turn-key ready occupation critical to the banking sector and HQ operations.

Traffic congestion is already presenting challenges for the island. Bahrain in 2020 will be one of the first Nations to implement nationwide 5G network connectivity. GeoAI applications can offer key solutions to automated monitoring of traffic movement, enabling solutions such as smart signaling ensuring flow and decongestion of the network at peak times. This information can then feedback to provide real traffic load analysis to planners with high-fidelity and confidence. Bahrain by the 1960s had less than 18,000 vehicles and a population of around 160,000. In fact Bahrain cleverly changed from driving on the left to a right-side driving traffic network in 1967 in readiness for GCC land

connectivity. Come 2020, nearly 800,000 cars are on-road and the population of 1.5 Million is rapidly growing. Approximately 2 Million vehicles cross the causeway annually. At peak, crossings can equate to over 150,000 vehicles on a single day. The population is on track to double by 2035 if growth not curtailed. Measures are required now to mitigate the urban growth and mobility impact to ensure sustainability. Table 1. below provides insight to the principles of urban decision making necessary to advance Bahrain.

Table 1. Key Lessons for an Urban decision-maker from a land management perspective

1. **Ensure the integrity and quality of the land administration system** and ensure national survey and topographic mapping is available to all infrastructure and development project agencies, developers, planners and engineers for a common project view. Adapt to the changing market demands.
2. **Government concentrated focus on infrastructure and services for future demand** and coordinated planning to support urbanisation and development. Ensure synchronisation between projects that can otherwise obstruct normal city functioning and delay projects.
3. **Ensure a national spatial planning framework is in place** from national master plans through to local district detail plans and zoning with control measures that limit excessive development and incentivise minimal impact projects.
4. **Harness green growth, energy efficiency and green building design**. Embrace cultural heritage and public green open spaces. Incentivise mixed use and multifunctional development i.e. office and retail by day and gastronomy by night.
5. **Pedestrian and bicycle friendly first, centered on clean mass transit mobility** – integrated planning to de-clutter the road network and incorporate studies of network user behavior.
6. **Master infrastructure strategies, plans and implementation** that keeps ahead of the pace and change of development.
7. **Map the underground, adopt standards for data collection and exchange** and ensure sector-wide collaborative management of the common underground environment. Importantly, with such competition in an acutely limited space to operate, a fully coordinated and regulated utilities sector is key.
8. **Master development process streamlining** to encourage investment and fast-track projects.

10. MODERNISATION OF CADASTRAL SURVEY, THE COMPLEX PROPERTY PROBLEM

Bahrain's property landscape has in just a mere few decades transitioned from relatively simple low-rise and singular or plural villa-on-parcel properties to a dense urban environment. Bahrain come 2020, is rapidly transforming to dense, complex, and novel mixed-use property developments. The advent of complex Master Community Developments (multiple sub-developments with relationship to a master developers' area plan) presents new challenges for

both the registry and surveyors alike. Management and maintenance of roads, services and infrastructure are also presenting challenges. An apartment today, will have rights, restrictions, and responsibilities to disjoint parts of buildings or developments such as an accessory parcel i.e. an assigned car park and common property rights and responsibilities to leisure areas and pool facilities. The parcel may even exist in space such as an overhang, extension or suspended feature.

Image source: Courtesy RERA 2019, NASS Corp. 2019

Questions quickly arise. Whilst complex properties are easily represented on the 3D engineering plans, what level of detail is necessary to record these in the land registry? How can surveyors ensure cadastral integrity by way of quality of measurements and records in such complex and shared space? What should be described and communicated visually, geospatially or textually. What should be registered? Are the survey and property registration laws keeping pace with the complexity of associated rights? In terms of off plan sales, when a 'design' is registered as an off-plan project for pre-build sales, how can registries compare a final 'as-built' survey of the property at building completion and permit individual title registration of parts? Was a new floor added or the gym converted to a penthouse apartment in the final build? Quite clearly, the land administration, planning and development control authorities must work in full unison to adapt to the changing landscape and market demand.

Common property and common areas are multifarious and come with an equally complex bundle of rights and responsibilities. Complex Master Developments are tempered by the management and maintenance of services and infrastructure by multiple and possibly mixed developments, owners and tenants. Owners and occupiers need confidence in services supply and maintenance up keep, and confidence in service fee stability. Governments need confidence in services provision if provided by owners or developers, or be willing to adopt the services and infrastructure obligation.

These are complex topics that necessitate pragmatic approaches and iterative modernisation programmes for land registries and their cadasters to ensure maintenance of the integrity of the cadastre that meets contemporary market needs. Access to credit demands that the market

and financiers have confidence in the title-deed and land administration system – a principle foundation of the economy. The newly established RERA is currently working through these very issues and implementing resolutions for an improved legal and management framework that takes into account such community developments and their owners associations. Figure 1 takes a look at the SLRBs inputs to the master land development mega-process that is current under review by RERA and responsible agencies. It's a team-effort and not one agency can operate in isolation.

SLRB is heading this challenge on several key fronts; introduction of Bahrain property measurement standards, modernisation of cadastral survey to progress towards volumetric 3D-surveys of complex properties, electronic lodgement, modernisation of land registry and legal amendments to enable electronic registration and steps to address the 3D description of complex property. 'As-built' surveys are also key and Bahrain has introduced the Bahrain Specification for undertaking As-Built Surveys. Engineers and their contractors will be contractually obliged to submit post construction as-built surveys to confirm what was planned (as approved in the planning and building permit steps) was actually what was built and sold in off-plan projects. Consumers need confidence that what they purchased off the plan is what they received at key-handover.

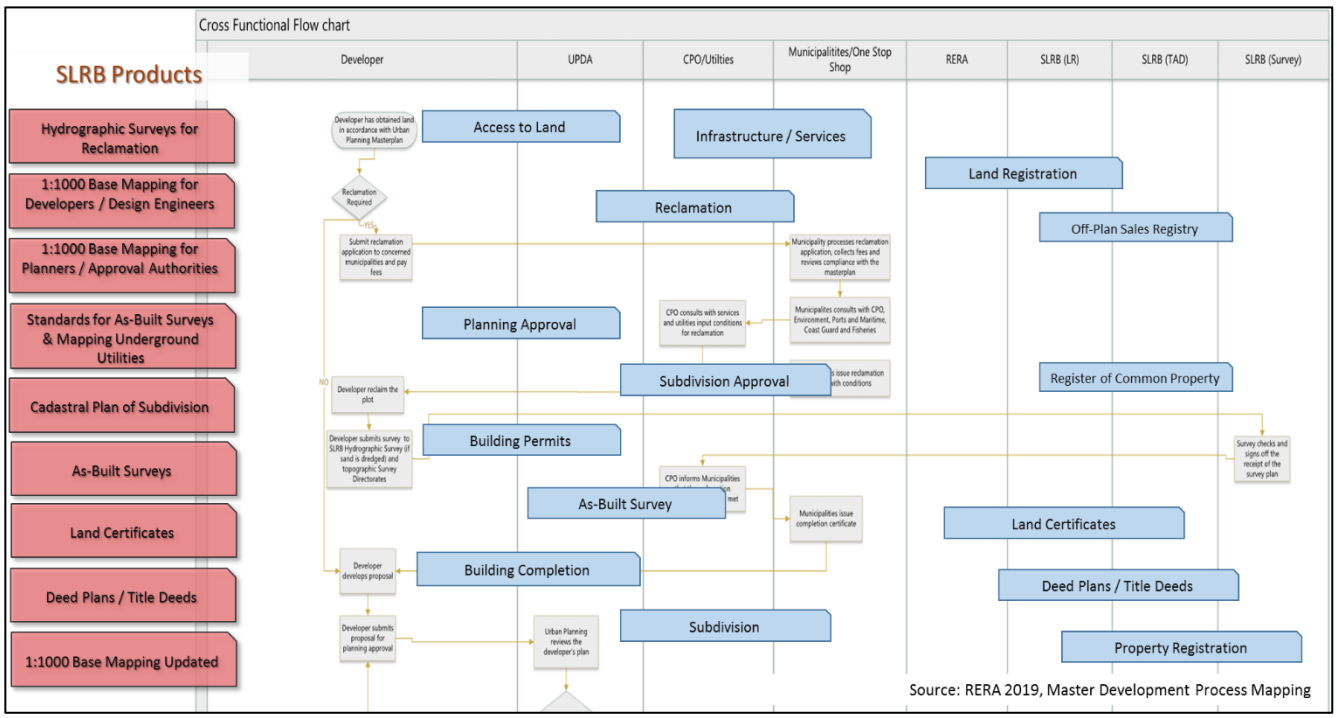


Figure 1. SLRB Enabling the Development Process (Master Land Development Process Mapping, RERA 2019 adapted)

These are not easy reforms. Land registries globally are facing these challenges. The LADM standard was not designed for complex master developments in 3D space. There are many technical solutions, but they need to be supported by modern legal frameworks and must be

accompanied by professional and capable private sector surveyors and engineers that can adopt and adhere to national standards for survey and property measurement. Urban Planning and Building Permit authorities must be capable to receive, interpret and validate complex electronic design data and plans. Robust processes are required in the Land Registry and Survey Departments, data management and QC/QA environments must be installed to underpin these modern property systems. And not forgetting historical records and legacy media need to be brought along for the ride!

How can the State provide guarantee of ownership and protect the public interest? Modern and ambitious developers and their visionary architects are transforming the landscape. The land administration system must keep pace. In Bahrain, it requires a harmonised cross-agency and integrated approach to land management.

11. RERA – A NEW ERA OF CONFIDENCE IN REAL ESTATE AND PROPERTY DEVELOPMENT IN BAHRAIN

In 2015, when RERA was envisaged, real estate accounted for 4.1% of GDP, and construction 7.4% of GDP. The real estate sector was recognised as a key target for development to ensure diversification of the economy. After a boom in the early 2000s, the real estate market was badly affected by the 2008 financial crisis. Many real estate development projects stalled mid-construction while others still in the planning phase did not attract the necessary investment to begin. Off-plan developments were particularly hard-hit, and for several years signature projects in highly visible areas languished unfinished. The reputational damage to the sector was significant, and it became clear that more comprehensive regulation of the sector was in order to prevent such instances from recurring.

Law No. 28 of 2014 (*since repealed*) concerning property development (Property Development Law) was developed and issued to regulate future off-plan developments and sales. The Property Development Law aimed to set regulations that protect buyer rights and prevent developers from abandoning their commitments. One mechanism to do so was by requiring developers to open an escrow account holding a percentage of the value of the project value. The Property Development Law was followed by Legislative Decree No. 66 of 2014 concerning settlement of stalled real estate development projects (the Stalled Projects Law), which outlined mechanisms to resolve existing stalled projects. In parallel to these efforts, several other legal instruments pertaining to the regulation of the real estate sector were in the process of being drafted by various government entities. These were combined into a single overarching draft real estate law (the RERA Law) addressing the gaps identified earlier in the SLRB study of the sector.

The new law was referred to Parliament in May 2016 and has since been issued and published in the Government Gazette on 03rd August, No. 3325 as Law No. 27 of 2017 Organising the Real Estate Sector. The new law replaces the provisions of the previously mentioned Law No. 28 of 2014. The comprehensive law addresses the regulation of all sector-related commercial activities, including development, off-plan sales, property valuation, property management, broker activity, property ownership and mortgage regulations. It also establishes a real estate

regulator to carry out and oversee all government functions and responsibilities related to the sector.

Now in its 3rd year of operations headed by CEO H.E. Shaikh Mohamed Bin Khalifa Al-Khalifa, with support and guidance of the IDI team of international consultants, RERA has established itself as the driving force behind solidifying confidence in the real estate market and is currently setting the national strategy for further development of the real estate profession and property development sector.

12. LAND AND PROPERTY REFORMS ARE KEY TO COMPETIVINESS AND ECONOMIC DIVERSIFICATION

Bahrain in 2020 ranks 17th globally and 3rd in the MENA region in the Ease of Registering Property rising from 26th in the previous year. SLRB is a recognised global leader in the implementation of property registration. The annual IFC/World Bank Group Doing Business survey supports nations' efforts to improve the ease of setting up and conducting business and improving the investment climate in 189 economies worldwide. It's a tool to track and encourage improvement and reduce 'red tape'.

The core focus of the report is tracking Time, Cost and Number of Procedures. The ranking is not an end to itself. Moreover, it is a tool to promote competiveness, foreign direct investment (FDI) and national growth. In Registering Property terms, the real gain is the improved contribution of the land management, real estate and construction sectors' contribution to overall economic growth and stability. Confidence in the land administration system equates to financial institutions' (FIs) confidence in the cadastre. That the property survey is correct and representative of the measurable boundary of ownership and Title Deed record of ownership has indefeasible integrity. Security of tenure and confidence in the cadastre allows FIs to enhance consumers access to credit and is the foundation of a healthy and robust economy. Whilst global rankings are important, SLRB is implementing wide-ranging reforms to improve the quality of the land administration system to strengthen its contribution to the land management sector and safeguard the Cadastres' role as a key pillar of the overall economy.

13. CONCLUSION

SLRB is playing a pivotal role in contributing to Bahrain's ambitious progress march. SLRB is now moving to the next phase in delivering its National 3D Mapping Project through a modern data management and dissemination production environment, a data-collection and capability improvement programme. Delivery of these will establish a new production system that will enable SLRB to capture, use, produce products, manage and make available fundamental 2D and 3D geospatial data to users. The approach is to embed technology and consumer focused data delivery in a business transformation programme ensuring that SLRB's investment in the National 3D Mapping Project is aligned to SLRB's Vision and national strategic development framework.

To temper and control urban development, Bahrain is noticeably in need of a cohesive national land use and development policy – embodied within a national strategy that addresses green growth and low-carbon (climate change) development and that is urban development, mobility and energy efficiency focused, that acutely addresses the national context and development ambition. This will entail mainstreaming of associated SDG and climate targets and indicators into the public financial management system. SLRB is taking the necessary steps to modernise the land administration system and national mapping, making sure it is well placed to fully support the drive towards national development and fiscal balancing for a safe, resilient and sustainable future.

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BIOGRAPHICAL NOTES

Dr Mathew WARNEST

Is the Advisor for Survey Affairs in the Office of the Head of the Survey and Land Registration Bureau. Mathew has broad experience over 15 years in the public and private sectors in land administration and spatial information management throughout South East Asia, Africa and the Middle East. He specialises in national level programming and policy development, translating national development objectives into practical implementation. He holds specialist skills in land administration, geospatial information management, land information systems and urban and rural development. Mathew has previously contributed to the National Green Growth and Low Carbon Strategy for Rwanda with the Smith School for Enterprise and Environment, University of Oxford, and has undertaken various consultancy assignments with UNFAO, The World Bank, IFC and the private sector. Mathew was awarded the Thornton-Smith Medal from the University of Melbourne, Department of Infrastructure Engineering, Geomatics Discipline in 2020 for outstanding contributions to the surveying/geomatics profession. Mathew was recently appointed to the Programme Advisory Committee for Civil Engineering at the University of Bahrain. He holds a PhD in Engineering (University of Melbourne), BGeom (Surveying), BSc (Environmental studies).

Mr Jon DAVIES MRICS
Jon qualified with an MSc in Land Surveying at UCL before spending 7 years throughout Africa and the Middle East as a Land Surveyor and Party Chief in the oil exploration field becoming a Member of the Royal Institute of Surveyors in 1991. After a year in the UK specialising in GPS surveys he spent 10 years in Zimbabwe initially as a Lecturer in Land Surveying and then he set up his own company specialising in RTK GPS. His company consulted for the Surveyor General to write the specifications and standards for cadastral surveys by GPS in Zimbabwe. Returning to the UK in 2001 Jon spent 12 years working for various survey companies in managerial positions working on Railway and the Crossrail projects in the UK. He moved to his present job in The Kingdom of Bahrain in 2014 as Chief of Survey Operations and Product Development and then in 2016 as Advisor/Consultant to the Topographic Survey Directorate (TSD) of the Survey and Land registration Bureau, (SLRB).

Mr Isa Ali ABDULLA
Isa qualified in the United Kingdom at the University of East London whilst working at The Survey Land and Registration Bureau as a Surveyor. He quickly rose through the ranks to position of Chief of Cadastral Data in 2012. In 2017, he was promoted to Director of the Topographic Survey Directorate which is his present post.

Eng. Naji SABT SALIM SABT
General Director of Survey of the Survey and Land Registration Bureau since 2007, Eng. Naji Sabt holds a Masters in Business Administration from the University of Glenmorgan, United Kingdom and Bachelor of Civil Engineering from the University of Bahrain. He is Member of the Board for the Real Estate Regulatory Authority and the National Space Science Agency. He represents SLRB on the Ministerial Committee for Development Projects and Infrastructure and is co-chair of the National Committee for Geospatial Information Governance. He has held the position of Head of the Valuation for Public Benefit Committee since 2018.

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