Fintech for geo-spatial transformation and Real estate management

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SUMMARY

The need for providing reliable, evidence-based open and/or low-cost data which describe a "spatially enabled" society. But today we realize that we have an additional task to ensure that these data and tools are used intelligently by the society and governments and through that to ensure the transition from the stage of a "spatially enabled" society to the stage of a "spatially mature" society: a society that is able to use the available spatial information and tools in a smart way in order to achieve sustainable prosperity for all.

Societies are to a great extent spatially enabled due to the extended use of affordable smart devices, cognitive computing for all to improve human decision-making, provision of personalized information and the Internet of Me, Internet of Things. Valuers and Surveyors has a challenge to increase the "usability" of spatial data, systems and land tools, establish a mechanism for a consistent and repeatable update of information to compare & monitor the "geospatial maturity" of our society: the ability to retrieve the right information and use it to optimize activities required to achieve the SDGs.

Embracing our smart world where the continents connect: enhancing the geospatial maturity of societies is the theme of this FIG Congress. In this policy related paper we will explore the question of - Does Smart contracts Distributed ledger technologies (DLT) lead to geospatial transformation and sustainable real estate management.

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1. INTRODUCTION

The Geospatial industry is estimated to be worth USD 502 Billion in 2016. Between 2012-2016 the industry is growing at the rate of 10.9% and the economic impact growth rate is at 16.9%. From USD 2.98 Trillion in 2012, the economic impact of geospatial technologies and services is estimated to have reached USD 6.94 Trillion by 2016 (Source : GMC analysis). The Global world product is 107 trillion USD and the real estate valuation is 227 Trillion USD. The Outstanding securitized debt is 94 Trillion USD, how much must the globe save per year to meet our infrastructure need before 2030?

As the factors that govern the property markets are many, this research work bases its analysis on the factors related to property rights and access to credit of property markets as stated in the International property markets score card designed by the center of international private enterprise (CIPE) and the International real property foundation (IRPF). Health of property markets = function f (Appropriate regulation, property rights, access to credit, effective governance, rational dispute resolution, financial transparency) where f can be defined as "health of property markets function" with the form based on knowledge of the parameters in the country.

2. SCOPE OF THIS RESEARCH

Geospatial data is core to the 2030 Sustainable Development Agenda. It is in this context Surveyors could contribute to create that link of accessibility through digital identity linked to Geographical information. Embracing our smart world where the continents connect: enhancing the geospatial maturity of societies is the theme of this FIG Congress. In this paper we will explore the question of - Does use of FinTech lead to sustainable real estate management? The scope of this work is related to the relevance of parameters for better property markets.

3. SUSTAINABLE DEVELOPMENT GOALS AND SUSTAINABLE REAL ESTATE MANAGEMENT

To achieve sustainable development, sustainable real estate management of urban interconnected hubs, have a crosscutting role among and across the 17 goals and 169 targets of the Sustainable Development Goals (SDGs). "An integrated system trying to separate out

different but unconnected ‘boxes’ – e.g. registry and records or survey or rural-urban – is unlikely to help improve the performance of the system. A poor land administration system will increase the differences in development between states as inadequate information about the impact on environment due to lands and water resource usage will render the government and the people of a nation handicapped in controlling their own destiny.” (Velpuri et al, 2009)

4. FINTECH AND SUSTAINABLE DEVELOPMENT GOALS

“Blockchain is a distributed, decentralized, immutable, peer-to-peer, trustless and anonymous ledger / database”. Other forms of Distributed ledger technologies could be - DAPPs - decentralized applications DAOs - decentralized autonomous organizations, DACs - decentralized autonomous corporations.

During the seventh session of UN Economic and Social council, Dave Lovell, chair of the UNGGIM- geo spatial societies made the following statement -

“GGIM Geospatial Societies thanks the standards community for their vitally important work in developing standards and fully supports the use of existing international standards applicable to the creation, management and use of geospatial information, infrastructures and delivery arrangements. GGIM Geospatial Societies would like to highlight the importance of accelerating the process of developing new international standards given the rapid development of new technologies applicable to the achievement of the SDGs.

In this regard we wish to draw attention to the importance of the work of ISO/TC 307 dealing with Blockchain and Electronic Distributed Ledger Technologies. A technology which has been hailed by custodians as being the future of the real estate management industry with potential to streamline processes such as land and property registration, valuation of property and many more digital actions.”

“The relevance of financial technology in filling the credit gaps for a sustainable financing in real estate projects by augmenting the traditional financing mode for real estate. The key dynamics within cryptocurrency and technology that may be of interest to sustainable financing in real estate is still prone towards the elitist, tech-centric outlook of disruptive technology start-up culture. It is reckoned that one blockchain does not fit all” (Velpuri et al 2016)

4.1 . ISO standards for blockchain - smart contracts

Transactions of property are conducted via "smart contracts" – digital rules in the blockchain that process the agreement and any specified conditions. Buying and selling could still take place via agents, or the smart contract can be advanced to incorporate the sale rules and make this decision automatically. The blockchain for each property grows as transactions are added

to the ledger. A housing market without agents, conveyancers and a land-titles office may seem decades away, but a handful of countries have already piloted blockchain land registration system.

From the report of the UN Secretariat - Implementation and adoption of standards for the global geospatial information community, E/C.20/2017/8/Add.1 - " The Charter for the Land Administration DWG was presented at the side meeting of the Expert Group on Land Administration and Management at the Fourth High Level Forum on UN-GGIM in April 2016 in Ethiopia. Following its approval at the OGC's 99th Technical Meeting in June 2016, the DWG has formed a direct liaison with ISO/TC 211 and the Expert Group to ensure shared goals are developed and the work programs of both groups are synergistic. As a result of this liaison, a joint meeting was held in Delft, The Netherlands in March 2017. The event consisted of a 2-day Expert Group meeting (http://ggim.un.org/Delft_Meeting.html) followed by 2 days of technical focus on the Land Administration Domain Model (LADM) with the following preliminary actions identified:

(a) The International Federation of Surveyors (FIG) to make a new work item proposal (NWIP) to ISO/TC 211 to initiate a review of the LADM;
(b) ISO Stage 0 – project, given potential broad scope;
(c) OGC Innovation Program prototyping capabilities to potentially be utilized;
(d) Global Land Tool Network (GLTN) support for developing countries; and
(e) To be in collaboration with FIG, ISO/TC 211, OGC, World Bank, TUDelft, Kadaster, UN-GGIM, GLTN, Royal Institute of Chartered Surveyors (RICS), and others

ISO/TC 211, in collaboration with the OGC and FIG, has initiated the review of ISO 19152 Land Administration Domain Model (LADM). The review will also take into account the requirements from the United Nations Division for the Ocean Affairs and the Law of the Sea (UN-DOALOS) and IHO. The use of Blockchain technology with geospatial information continues to strengthen, therefore ISO/TC 211 has established a liaison with ISO/TC 307 Blockchain and Electronic Distributed Ledger Technologies"

4.2 Geospatial data and Reference architecture of DLT for SDG agenda

Geospatial data is core to the 2030 Sustainable Development Agenda. It is in this context Surveyors could contribute to creating that link of accessibility through digital Identity linked to Geographical information.
A typical geospatial data looks as follows directly linked to a centralized database. It involves - data storage as spatial databases / repositories, data distribution as web services / download data processing query / analyse big data sets on large DB / services. (as shown in Figure 1)

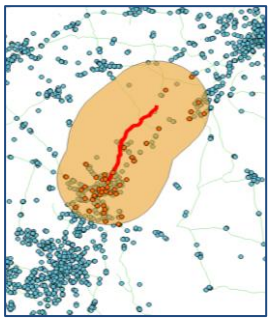


Figure 1 : Geospatial data depiction based on the dataset

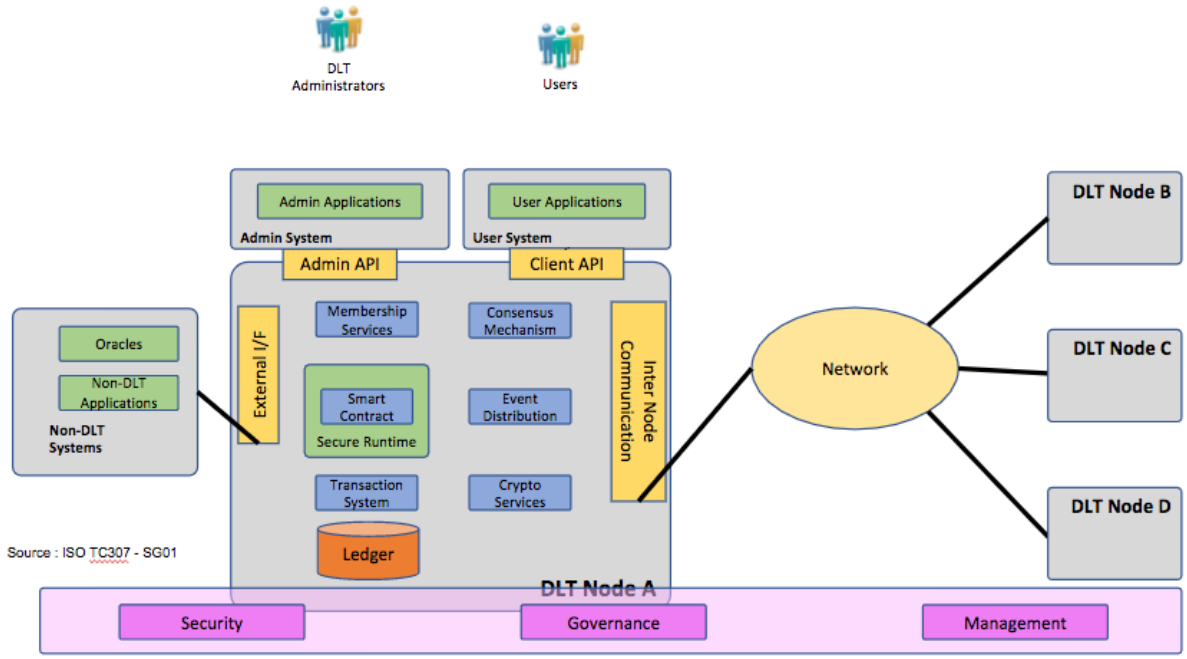


Figure 2 : Reference architecture and smart contracts with Blockchain/Distributed ledger technology. (source : ISO TC 307 draft terminology)

Blockchain and DLT's can enable people to build systems where the data is inherently public, no one controls it, anyone can access it, and anyone can review the full history of contributions to the data. Distributed peer-to-peer systems, they could be cheaper and give their users full control of their data.

Complex and high-resolution geometries could be grid aligned and can represent any piece of land. It allows creating for more than a passive registry of entries or transactions. Each property right could be linked to a digital identity. Most of the significant data (personal data or else) should be stored off the chain, in asset repositories (Cloud, or any Database). Therefore, any personal information change will impact only the database's contents. The blockchain can bear pointers (that may be hashes as example) leading to the actual data (birth certificate, marriage

certificate, death certificate, etc, or any so-called Breeder Document, see CEN/TC 224/WG 19 and ORIGINS or FIDELITY EU projects). The access to asset repositories shall be permissioned so that when a Right to be Forgotten is exerted , only the permission pointing onto some specific data will be switched off.

As an example of implementation in several countries like Georgia - The 4-month statistical data shows sharp increase of registration number and interest of citizens is growing daily. Up to date over 90 thousand applications have been filed for land registration. It is expected to receive approximately 360,000 applications per year. Its implementation will significantly speed up full coverage of the country with high quality registration and cadastral data, which is a prerequisite for sustainable land administration system and land market development. Several other countries that involved in using blockchain for real estate management are - Sweden, Ghana, Georgia, Honduras, Kenya etc. Reference architecture of Blockchain that could form the basis for real estate management and land administration. As shown in Figure 2 and 3 - a draft reference architecture has been proposed on observing current implementations across the globe.

For inter-governmental project implementations using blockchain the reference architecture forms the basis for refining the real estate management process. Before starting to think about more difficult to standardize blockchain protocols and interoperability standards, a common language and terminology needs to be established. We need a clear definition of distributed ledger technology and blockchain, including which features (properties, functions, etc.)determine them and which elements they comprise, and how to call them. We also need clear definitions of all related concepts and terms, e.g. smart contracts, protocol, transaction, wallet, asset, token, permissions, private vs. public blockchain, etc., just to give some examples.

The European Union together with the OECD and the World Bank also launched this commitment to develop a global people based definition of cities and settlements during Habitat III in Quito in 2016. This commitment was also joined by FAO. There is the continuing need to advocate policies that promote - i) affordable access to the basic geospatial data set, ii) avoid duplication particularly in mapping iii) quality, iv) timeliness, v) data sharing and vi) interoperability and standards. so a population focused GI data could be possible through VGI thinking.

4.3 Industrial revolution 4.0 and Smart contracts

Some of the features of 4th industrial revolution and cities growth are featured as :

1. The 4th Industrial revolution flourishes in Cities, in particular in advanced countries
2. Space-based platform will be more essential for the 4th Industrial revolution
3. To support better, spatial community focus on paradigm changes by providing practical framework and collective solutions

4. As a step, paradigm change is more possible through building Spatial Ecosystem, equivalent to IT Ecosystem.
5. Long journey with collective actions for the 4th IR and sustainable development through Spatial Ecosystem

"Developing and accelerating electronic merchant payments at the broader level can help countries advance financial access and financial inclusion. The three foundational enablers are also highly relevant levers for helping to improve the usage and adoption of electronic payments by merchants" (WorldBank, 2016). Ultimately, people will be able to use their mobile devices to register a plot of land with GPS accuracy, file a claim, register a dispute, sell or purchase land. As well as the transparent and immutable nature of the blockchain, OpenLedger allows smart contracts. This removes the need for trust, so that microloans can be issued and government contracts fulfilled on a platform that tracks progress and distributes funds accordingly.

5. SMART CONTRACTS & SUSTAINABLE DEVELOPMENT OF REAL ESTATE & MANAGEMENT

RICS in its 3rd edition on Real estate management lists in the glossary - Real estate management: any person who, in the course of a business (including a business in which he or she is employed), is instructed to manage an interest in real estate on behalf of the owner of the interest.

"Blockchain has a positive correlation to financial inclusion in case of providing access to credit even in case of unregistered land" (Velpuri et al 2017). In earlier research from Velpuri et al 2017, the access to credit framework for blockchain was presented. Distributed ledger transactions could be from large properties sale, legal contracts for services or small and simple micro-payment services. The blockchain technology could remove barriers of access to data, improve efficiency in handling access to the data, and the ability to manage a vast volume of

transactions, potentially means cost reductions to the end-user micropayments that for all intents and purposes removes licence costs

Figure 3 : Real estate management

Smart Contracts are blockchain-based solutions first applied on Bitcoin's virtual currency. With Smart Contract, complex transactions can be processed: contracting, contract processing, government and court inputs, and those complete automated. The blockchain technology will support the achievement of the sustainable development goals, the SDGs immense. The UN applies the blockchain technology as one of the tools to generate "smart contracts" to accelerate the creation of Public Partnerships (SDG 17) and for the achievement of SDG 16 by focussing on a variety of areas related to transparent government and fair justice systems. Smart contracts is implementable in all the interdependencies (Figure 9) of the real estate management.

5.1 Oracles and Smart contracts

While recognising there is likely to be a need for some subjectivity, certain subjective elements could be replaced by determinations of third-party oracles.

To execute automatically, smart contracts need to be able to interface with data in the wider world. For example, a piece of conditional logic that depends on whether a particular stock price has reached a certain level would require the smart contract to be able to ascertain that stock price. To do this, it can look up the stock price from a separate data source, typically known in the distributed ledger community as an 'oracle'.

Legal to Technical interlinkage :

With the internal model, the code element of the smart contract becomes an inextricable part of the legal contract. There is no possibility of difference between the code and the relevant part of the written contract because they are one and the same.

However, there are two other potential areas of difference (or translation error) that are normally raised as potential issues:

• The first is illustrated by the question: “how do I know the code as written in the contract reflects my intentions if I cannot read it?”

• The second potential area of difference is illustrated by the question: “how do I know the effect of the code, when executed by a machine, will be what I intend?”

In other words, simulations can be run to observe whether the code produces the expected outputs. It is worth noting that the risk of a glitch somewhere in the programming exists in the use of any computer program. A different angle on the same question is whether the code has captured all the different permutations it needs to provide for.

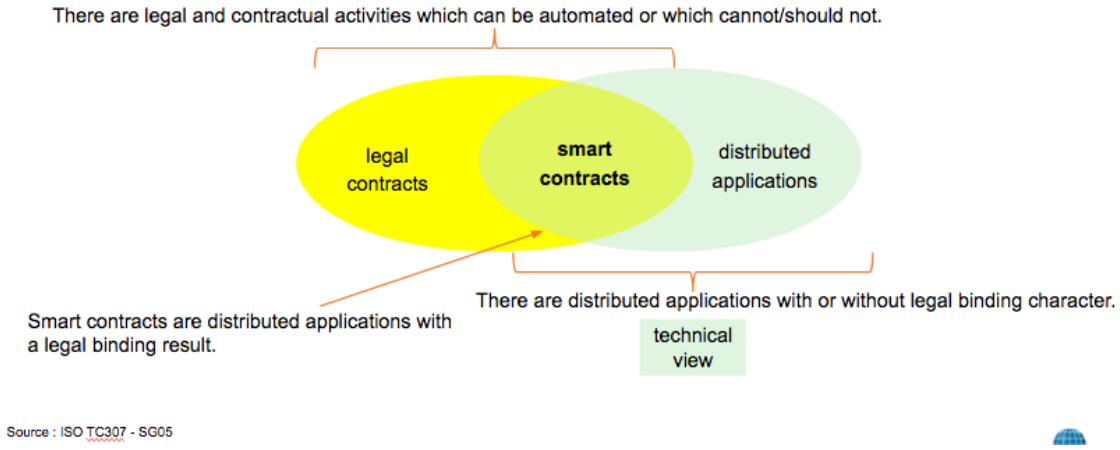
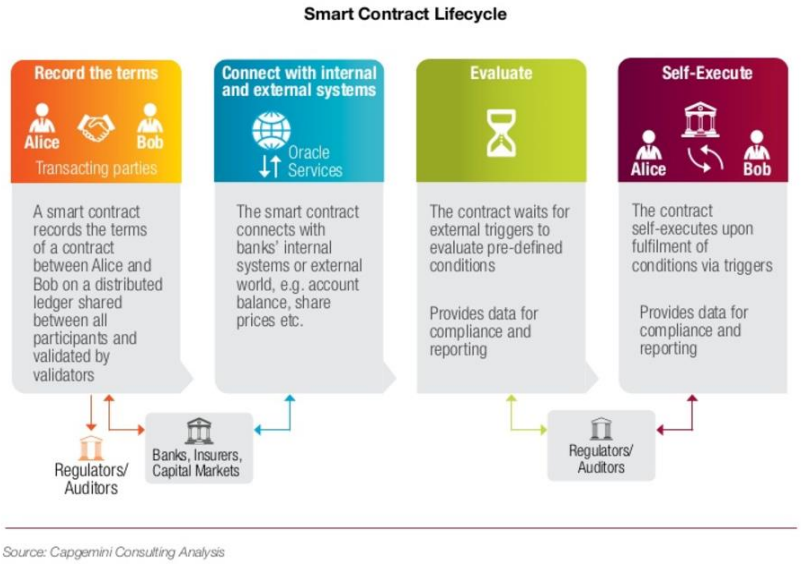


Figure 4: Smart contracts interpretation - legal in fusion with distributed applications.

5.2 Technical language as Lawyers legal draft - Formal representation :

The multiplicity of programming languages used in practice may make it unpalatable to pick any one language. In addition, it may be difficult for the average lawyer to pick up a piece of code in a programming language and understand exactly what it is seeking to do. Even if a lawyer is prepared to learn the programming language, these have not been designed with legal drafting in mind, which would make it difficult for a lawyer to translate a traditional drafting approach into code. One way to solve these issues would be for a new programming language to be devised (perhaps based on extensions to a current language) that is designed to more intuitively follow the flow and terms of legal drafting. Figure 5: Smart contract life cycle.



Lawyers would need to learn this programming language to be able to draft smart contracts. There are current examples of languages that have been devised to facilitate smart contract code (such as Ethereum's Solidity), but these are not the most intuitive for lawyers and are also often closely associated with actions on a particular DLT rather than being interoperable across many DLTs. However, it must be recognised that most live instances of smart contracts (or at least, smart contract code) use these specific languages, and these have a certain amount of traction. Whether they can evolve to facilitate smart legal contracts in a manner that meets the needs of the legal community remains to be seen. An alternative approach would be for the more formal representation to be a bridge that attempts to straddle the natural language legal drafting that lawyers use, and the strict formalism and full syntax of a programming language.

5.3 Need for Smart contracts and cost-benefit over life cycle.

Urban populations have grown significantly over the past two centuries, from 3% in 1800 to 14% in 1900 and 47% in 2000. Based on a UN estimate, 61% of world's population (up to 5 billion people) will live in urban areas by year 2030 (Frej, Peiser 2004). It is in this context automation research enabled contracts like smart contracts could make available the resources for better real estate management. The smart contract life cycle involved four major steps and are intertwined with all the aspects of real estate management. One of the key features of the smart contracts is the ease of business it may provide for in the cost savings in the entire real estate management life cycle. The access to credit is the most impacted part of the property markets due to the use of smart contracts. It is supplemented by identity management using smart keys. Only the one with the private key has the control of a resource. A private key can

be converted into a public key, but a public key cannot be converted back into a private key because the math only works one way.

The reference to originator of term “smart contract can be traced back to Nick Szabo in early 1996 in the magazine Extropy. “The idea of smart contracts”. Szabo Wrote briefly “automation of contracts”, but referred to it in the text as “automation of contract clauses”, which clarifies his intention. It was originally not meant as automation of “contracting” and “contract fulfilment/enforcement”. Szabo defined a contract as being “a set of promises agreed to in a meeting of the minds [which] is the traditional way to formalize a relationship.” Smart contracts would improve execution of the four basic contract objectives - observability, verifiability, privity and enforceability.

With an increase in the use of smart contracts, it is possible to embed smart contracts into our physical property hence named as “smart property.” These embedded smart contracts would automatically grant access to the rightful owner of the property, depending on the parameters of the contract.

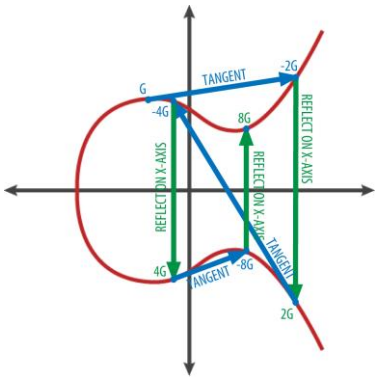


Figure 6 : Security keys used in blockchain and math.

6. ENABLING POLICIES FOR FINTECH

There are several countries that are in the process of improving the geospatial policy globally. China’s geospatial policy is in parliament for approval and USA has submitted a National geospatial bill (2018) in the parliament with higher maturity. The countries that have geospatial policies that are already in place are - USA, Canada, European Union (Norway, The Netherlands (Spatial planning and Environmental protection Act), Finland, Sweden), Thailand, South Korea, New zealand, Philippines, Nigeria and Ghana, while countries like - Japan, Indonesia, Switzerland, Germany and Russia with geospatial legislation/rules and regulations that could be aiming for more maturity. (Sanjay 2017) . UK has announced for Geospatial Data commission in 2017. India has two draft bills - 1) ISRO’s draft space activities bill 2017, 2) Draft Geospatial information regulation bill 2016. Malaysia has proposed for a National Geospatial Master plan 2018. These policies are the enablers to improve and expand the business value chains and/or facilitate the impact of SDG’s and scale up the operations of the SDG communities. The private sector network of UNGGIMannounced ts observations at the High level political forum of Mexico (Nov 2017) that - 64% of the countries largely are in need of policies which promote public private partnership for enhancing commercial adoption of geospatial information and technology for economic growth.

6.1. Global development policy framework

Global development policy framework				
The 2030 agenda for SD	**Sendai Framework for Disaster risk reduction 2015-2030**	**SIDS accelerated modalities of action (SAMAO) pathway**	**Paris agreement on climate change**	**Habitat III Urban agenda**

Table 1 : Global development policy framework

Property transactions are taking place in every market irrespective of the market size and even if the market is informal. While many developing markets are still largely cash-based, international investment and financing continues to grow as investors seek new markets and higher returns.

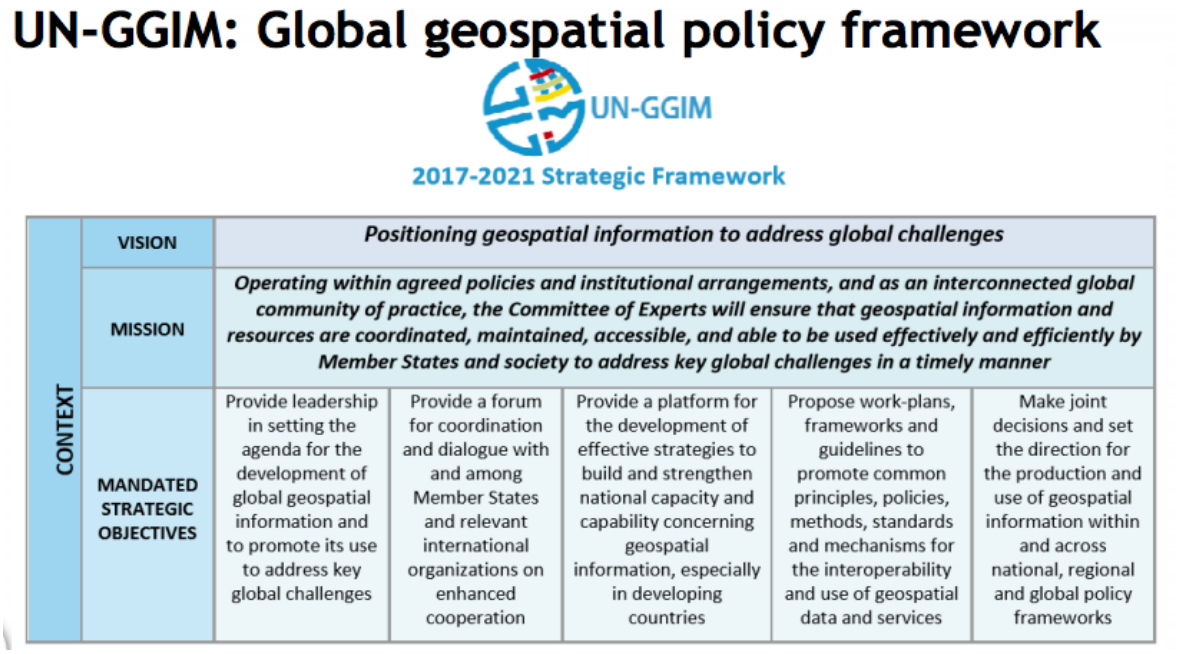


Figure 7 : Strategic framework for UNGGIM : Global geospatial policy.
Source : http://en.nasg.gov.cn/kunmingforum/Presentation_Materials/201702/W020170522389753944785.pdf

The strategic framework was presented during the UNGGIM's Kunming forum in May 2017. The mandated strategic objectives are from the period 2017-2021.

6.2 Habitat III

The use of digital platforms and tools, including geospatial information systems, will be encouraged to improve long-term integrated urban and territorial planning and design, land administration and management, and access to urban and metropolitan services.

6.3 SDG platform by 2020

As part of the strategic framework, the following proposal for an SDG platform by 2020 has been presented. The Global SDG database has been built upon the national development indicators and after validation of data produced by the international organisations. Global SDG database will be the source for country SDG implementation. The Global SDG database will lead to the formation of SDG platform by 2020.

National information systems includes

- Earth observations and monitoring
- National spatial data infrastructure
- National statistics, accounts, administrative registers, demographics
- Other sources of Data, incl BigData

National information systems and Data sources will be validated, disaggregated and Harmonized to National development indicators. National development indicators will through the coordinated effort of International organisations will feed to Global Indicators (Source : Greg Scott, UNGGIM, Kunming forum 2017)

6.4. GEO and SDG's

GEO is the group on earth observations. As satellite data is crucial for defining the SDG indicator framework. Establishing partnership with non-space communities are relevant to pull the data from different sources to form that platform of GI data. The non-space communities could be JICA, JST, WB, ADB, UNSC, WGGI, NSO.

The Features of the data that could fit to quantify SDG's must be characterised by -

- Scale and continuity
- Long time series with consistency
- Comparability and complementarity with traditional statistics.
- Free and open data with diversity of measurements

SDG's provide guidance for planning and monitoring city development. Space-based Earth observation has great potentials to contribute to implementation of various SDG Indicators for cities and solving its issues.

The UK Government Science Adviser (2016) - " two sets of rules or codes are involved in fintech applications. The first is the traditional code of law. The second set is broadly termed

as ‘technical code’ and includes the set of rules that regulate how software behaves in mission-critical applications in information-intensive industries”

1) Enabling ‘Technical Code’
2) Enabling Open Data Policies
3) Policies Enabling Network Trust and Interoperability - Interoperability of DLT is being studies in the SG07 of ISO TC307 along side to SG06 - Governance group ISO TC 307
4) Enabling Policies of Embracing Blockchain Regulatory Co-benefits : Regulators are naturally cautious given the role played by lightly regulated ‘shadow banking’ in the global financial crisis of 2008-09
5) Public Sector Taking a Leadership Role
6) Enabling ‘Hands-off Regulatory Approach’ to Market Creation and Innovation - World Bank proposes a framework for choosing the right approach of regulation according to the level of digital transformation of each country/sector. Their framework segments the level of digital transformation into three types: “emerging”, “transitioning” and “transforming”

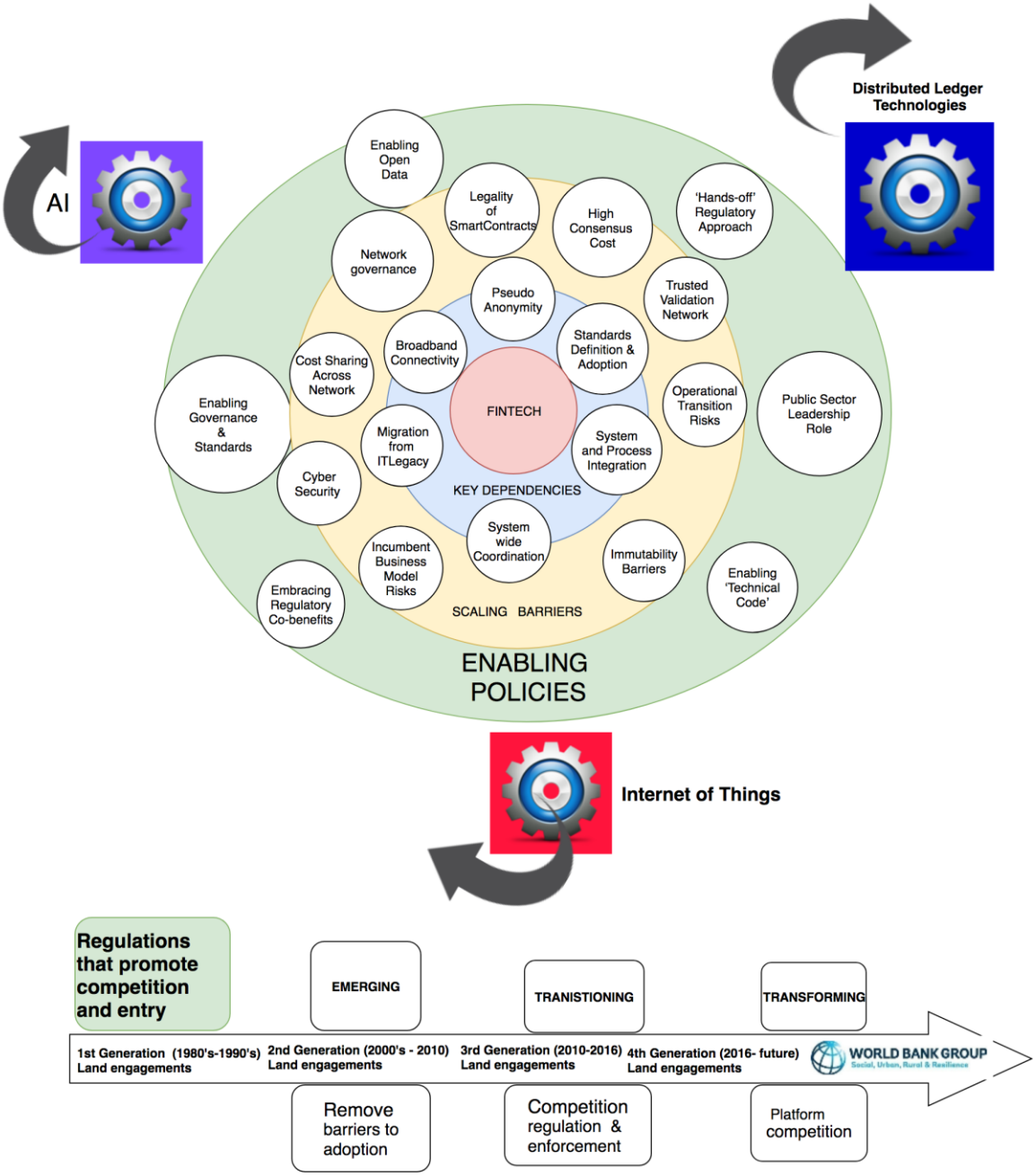


Figure 8 : Enabling policies of Fintech - Barriers and key experiences (Modified version Source : UNEP 2016, World bank 2016)

"Embracing our smart world where the continents connect: enhancing the geospatial maturity of societies" finds its meaning in the joint effort for the "Geospatial Transformation of the World" and is aligned with the above definition of "geospatial maturity" of societies. From 20 to 21 June 2018 the international community will gather in Vienna for UNISPACE+50, a

special segment of the 61st session of the Committee on the Peaceful Uses of Outer Space (COPUOS). The shared goal for UNISPACE+50 is to build, together with all stakeholders, a comprehensive Space-2030 agenda for the contribution of space activities to the achievement of the Sustainable Development Goals, addressing overarching, long-term development concerns, and which is based on the peaceful exploration and uses of outer space.

6.5 Fintech in EO and share economy of space and Challenges.

Spatial information is crucial to derive patterns not readily apparent to the observer by using Geospatial Information System and Technology (GIST). "Location is seen as the fundamental element of single logical geographical view of the world. Unlike sharing the data using digital maps the new 'data driven' future will have machines rather than people as primary consumers of our data which require explicit references to objects mandating a new way to deliver data"(Giacomo Brambilla, 2016)
Location and statisticians are aware that the harmonisation of statistics, location and boundary delineation could affect sampling and therefore their analysis and results.Spatial analysis is important not just for national statistics, it provides a structure for collecting, collating, processing, storing, aggregating, generalising, disseminating and analysing operational and business data. The costs of EO data provided by satellites will be fast changing due to private start-ups, nanosats, space robotics. Even the security of the data is reinforced due to adoption of Quantum Key Distribution (QKD) which enable communication between two parties on Earth more secure as Privacy becomes something to protect..

Shared economy of space is possible by confluence of new technologies in space as DLT/BC provide low cost, assured trust in the integrity of data and transactions, own, share and sell services from this exploding new sensing and communication infrastructure. Satellites tracking the movements of the citizens or property and sharing that information becomes more and more relevant to effectively work through the technical, political and regulatory challenges.

By integrating geospatial and statistical data and processing the data via spatial analysis, it facilitated the building of complex multidimensional location-based information resources. This could potentially generate unique visualisation, insightful spatial analysis and valuable predictive modelling results in the form of a map. Blockchain-enabled "smart contracts" or formally verified code in "Trusted Execution Environments" can lead to autonomous negotiation and complete transactions based on pre-set criteria such as the price a customer is willing to pay for a certain image or data set.

- Regulating the infrastructure, addressing the barriers to nanosat deployment and or satellite lifecycle management
- Funding to promote sharing economy in space.
- Data ownership amongst the EO and addressing private ownership.
- Effective counters and balance to legitimate commercial, privacy and public data handling to space based observation.

7. CONCLUSIONS and Future works

Especially at times when the GI data is to be used for quantifying the SDG's it makes more relevance to position that data on distributed ledgers. Blockchain and DLT's can enable people to build systems where the data is inherently public, no one controls it, anyone can access it, and anyone can review the full history of contributions to the data. Distributed peer-to-peer systems, they could be cheaper and give their users full control of their data. With access to truly publicly distributed data as described above, such apps would be even more reliable and cheaper to run. This could be possible only if the Identity is linked to GI data (a people centric definition of GI data).

Protecting the satellite data and the transactions governing their creation and use, blockchain technology creates the potential for many granular, decentralized markets for the rental, lending and sharing of satellites. Satellite data could form the basis for quantifying the SDG indicators. Potential need for standing documents that take European legislation such as GDPR into consideration.

Again distributed peer-to-peer apps could cut out the middleman and reliance on third parties for their navigation and other geospatial components. Further using geodesic grids of discrete cells to register land ownership on a blockchain. Such cells can be shaped and each cell has a unique identifier. In a traditional cadastral system, parcels are represented with flexible polygons, which allows users to register any possible shape of a parcel. Although a grid of discrete cells doesn't allow such flexible polygons it can allow a crypto token to represent one unique cell of a grid and hence can be used for landowners to own a private encryption key that controls it. Complex and high resolution geometries could be grid aligned and can represent any piece of land. It allows to create for more than a passive registry of entries or transactions. Illustrative use cases which comprise values important to the EU and region specificity, such as giving IP owners control over their data may be relevant. Identity management use cases across border to manage refugees as well as to prevent social welfare fraud.

Flexible, low-cost satellites secured by blockchains will give access to broadband connectivity and sensor data insights from orbit and thereby lead to Technology Convergence and Sharing Economy in Space A space-based, shared infrastructure connecting physical, digital and biological spheres for the 4th industrial revolution on a truly global scale could be possible by innovation through blockchain on Earth observatory operations. The existence of a financial infrastructure encourage investment in commercial multiple terrestrial economies, particularly as a standardized valuation of space resources is developed. Given a common space currency and valuation methods and a methodology is developed to value space resources and the legal framework exists to recognize a claim, then space resources, could become the basis for financing the development and also aid in terrestrial resource development for financing development of the resource itself.

7.1 Future works : World Geospatial industrial council.

A proposal for the Geospatial industrial council will be to be setup with a vision - to advance the geospatial industry globally. The objectives are

1) to create collective shared value for entire ecosystem and network
2) Co-create and strengthen the geospatial value by partnership with governments, regional entities and civil society
3) Think laterally, position consciously and grow collectively to advance the role of geospatial industry.

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Appendix - I

Table 1 : Goals and Indicators - custodian agencies (source: Chu Ishida, 2017)

Goals	**Indicators**	**Tier**	**Custodian agency**	**Domestic Ministry**
Goal 3. Health	3.9.1 Mortality rate attributed to household and ambient air pollution	**I**	**WHO**	**MHLW**
Goal 6. Water	6.4.2 Level of water stress 6.5.1 Degree of integrated water resource management implementation	**II** **I**	**FAO** **FAO**	**MLIT** **MLIT**
Goal 7. Energy	7.1.1 Population with access to electricity	**I**	**WB**	**METI**
Goal 9. Infrastructure, Industry	9.4.1 CO2 emission per unit of value added	**I**	**UNIDO, IEA**	**MOE, CAO, METI, MLT**

Goal 11. Cities	11.1.1 Urban population living in slums, informal settlements or inadequate housing	**III**	**UN-Habitat**	**MHLW**
	11.2.1 Population that has convenient access to public transport	**II**	**UN-Habitat**	**MIC MLIT**
	11.3.1 Ratio of land consumption rate to population growth rate	**II**	**UN-Habitat**	**MLIT MAFF**
	11.5.2 Direct disaster economic loss in relation to global GDP	**II**	**UNISDR**	**CAO, FDMA, MLIT**
	11.6.2 Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities	**I**	**WHO**	**MOE**
	11.7.1 Average share of the built-up area of cities that is open space for public use	**III**	**UN-Habitat**	**MLIT**
Goal 13 Climate change	13.1.1 Number of countries with national and local disaster risk reduction strategies	**II**	**UNISDR**	**CAO**

BIOGRAPHICAL NOTES

Prof Manohar Velpuri works as the Secretary for Commission 9: Valuation and Management of Real estate, FIG office (Denmark) and was a member of UNGGIM Private sector network. Prof. Velpuri is a certified business operation professional and has been working in financial consulting over ten years as a certified Fintech-Commerce specialist from MIT. Dr Velpuri was also representative of COP23 , UNFCC - UNEP in 2017 and in private networks of UN systems.

Surya Bhamidipati is currently working as a Director in TLF consortium and has been actively involved in product design using geographical information datasets. With 20 over years of experience in quality management and data analysis using elasticsearch Mr. Bhamidipati is versatile entrepreneur with focus in data management.

Dr Madhu Aman Sharma work as the Director, CEO of K2A Management Incorporated is a certified lead Auditor for various management standards with industry experience of over 30 years. Dr Madhu is also certified ISO 9001/ISO14000/ISO27000/ISO22000 and risk assessor globally and has managed many training programs and certification audits.

Dr Chetan Maringanti works as a Operational Risk manager at Credit Suisse. As a certified FRM, and CFA , Dr Chetan has vast experience in risk management strategies and future technologies.

Chin Yee Hoong is the director for TLF consortium in Singapore. Mr. Chin is a Chartered Accountant (NZ) by training and an MIT certified fintech specialist. He has been working in financial consulting in various sectors for the past twenty years. He is also passionate in the geography and recently earned him a degree from University of London.

Jyothsna Velpuri works for IBM and is a member of the ISO - TC 307 working groups and has been actively contributing to the Terminology works groups led by several experts from IBM.

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