3D City Governance: Towards an Integrated Sustainability

Zhixuan YANG, Arbind TULADHAR, Abbas RAJABIFARD
Email: zxyang@dufe.edu.cn, a.m.tuladhar@utwente.nl, abbas.r@unimelb.edu.au

Key words: City governance, 3D city, Sustainability, GIS, BIM, Cloud

SUMMARY

Cities, especially large cities, expand rapidly in China. Sustainable urban development as a critical issue calls for good governance. The traditional governance theory advocates the participation of communities in the process of decision-making while neglecting the inner-correlations among the eight different elements (participation, rule of law, transparency, responsiveness, consensus orientation, equity and inclusiveness, effectiveness and efficiency and accountability), causing inefficiency in its implementation. As the emergence of the requirement of an integrated sustainability, a new governmental form is in need. Under such background, 3D city governance provides novel approaches. Basing on 3D information technology, land and property information can be integrated into city models predominantly from the two semantic models CityGML and IFC. Besides, cloud technology provides another opportunity for multiuser cooperation in the city environment. Therefore, the paper proposes 3D city governance with "8+2" elements i.e. plus 3D information technology as transmission institution and resilience as supervision institution. With the clear framework, the inner-relationship amongst its implementation is combined. Effective 3D city governance will achieve the goal of an integrated sustainability.

1. INTRODUCTION

City numbers have expanded dramatically due to the high economic growth in China. By the end of the 1940s, China had 69 cities, while, in 2007, the number increased to 670 cities, almost ten times as many as it was in the 1940s. As such growth keeps growing, China has 61 super-large cities, 352 large cities and 385 median-large cities (WPR, 2015). Nowadays, more than half of Chinese live in cities with the urbanization rate of 54.77%. City growth in terms of size, density and complexity prevails not only horizontally but also vertically, changing the skyline of urban China. The city transition has boosted infrastructure construction as well as real estate development, particularly the latter one. Since the housing distribution system was abolished in 1998, the volume of real estate investment in urban areas has increased, rigorously stimulating the country's GDP growth. Real estate has been a key engine of China's rapid growth in the past decade. The investment in real estate grew rapidly from about 4 percent of GDP in 1997 to 15 percent of GDP in 2014 (Chivakul et al., 2015). Therefore, the real estate construction in the last few years kept agglomerating people into cities, increasing the cities' volume, changing the cities' configuration and the growth pattern. As the urban development is in the active administrative intervention, regulatory authorities are in the charge of land approval, housing development examination and urban planning in 2D paperwork. This situation leads to administrative compartmentalization segmentation regarding to information inconsistency during the processes of land use, housing erection and urban development. Meanwhile, local governments rely on land revenue to promote local economic growth, resulting in single and imbalanced city growth pattern. Such situation has

severely affected urban sustainability. Sustainability of some metropolitan cities, such as Beijing, Shanghai, Guangzhou and Shenzhen is reaching the limit in social and environmental aspects as the cities' GDP and population size grow (Sun, 2014) .

China is facing severe challenges in terms of urban sustainability, which requires a sustainable city governance method through 3D information technology through embedded platforms of land, building and geo-city environment information in three dimensions. With this background, the paper proposes the concept of 3D city governance as a useful tool for the city sustainability in the following manners. Firstly, the paper analyzes the need for an integrated sustainability in China that calls for good governance. The co-existing opportunities and challenges are researched for good governance. Secondly, the paper proposes 3D city governance is a useful and new governmental form with detailed analysis on the main concepts and extra benefits. The highlights of the benefits are the added-value of 3D information technology and the empowerment of the community through the 3D city model. Thirdly, an integrated 3D city model is analyzed in terms of the integration of CityGML and IFC. Besides, cloud concept is introduced for multi-user cooperation in 3D city model. Lastly, the paper defines the new governmental form, that is, "8+2" 3D city governance, which will drive cities towards an integrated sustainability.

2. GOOD GOVERNANCE FOR CITIES SUSTAINABILITY

2.1 Need of an integrated sustainability

Sustainability, in the domain of *sustainable development*, means "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Burton, 1987, Brundtland, 1987). Generally, among three pillars of sustainability, economic sustainability is influential to social and environmental sustainability. Because economic sustainability enables an efficient balance between maintaining environmental services and generating income, wealth and welfare (Bartelmus, 2012). However, the leading concept of the economy results in segregation of economy from society and environment, which causes severe social and environmental problems. The new focus of an integrated sustainability treats the three aspects as a holistic view relevant to land and property.

Land and property value can reflect economic growth in China. China Bureau of Statistics (CBS) shows that the total value of all land and property held in the title in China was approximately three times of GDP in 2011. The fact that the land and property market leveraged brisk Chinese economic growth in the past decade was proved not sustainable in the long run. The real estate market has been in the bust condition since 2012. With the engine power losing, the GDP growth slows down. As the massive consumption of natural resources and higher density of city living environment during the land and property development, city environment has been damaged dramatically, resulting in air pollution and water contamination. Noise and traffic congestion appears in the mean time, which ruins people's living conditions. Furthermore, overemphasized economic growth and excessive use of environment arouse social illness, such as housing affordability, social disputes and so on so forth. The focus of fast economic growth costs environmental resources and social stability, which has already been noticed by Chinese governments. The concept of an integrated sustainability is promoted for the long-run urban development. With the cooperation of Mckinsey Analysis, Urban China Initiative plays its role in evaluating Chinese city sustainability. The research involves 185 Tier 1 and Tier 2 cities and some county-level cities, extracting 23 Urban Sustainability Index (USI) indicators in the sustainable aspects of society, environment, economy and resources (Xiaopeng Li, 2014). The research pays attention to the society and environment as giving more weight to these two factors. The research result finds that Chinese urban

sustainability has the positive correlation with GDP per capita as well as population density. That means although society and environment are the major aspects of losing sustainability, economy is the key engine of providing the sustained power of city growth. Meanwhile, population density is the other key factor to influence people social conditions and living environment. Therefore, the attention to city sustainability transfers from the separate concerns of the economy, society and environment to the integrated sustainability. By means of the transition of economic growth structure and city configuration, good governance is a prerequisite for the integrated sustainability.

2.2 GOOD GOVERNANCE: OPPORTUNITIES AND CHALLENGES

Governance, in the school of social management, means "the process of decision-making and the process by which decisions are implemented (or not implemented)" (United Nations, 2009). Distributed governance power diverts from traditional centralized government power. It lies in public institutions (government), private organizations (industry associations and other non-governmental organizations), or both public and private sectors, requiring balance and decentralization. Meanwhile, governance theory advocates the interaction in the governmental process, encouraging the participation through mutual dialogue, coordination and cooperation. The goal is to establish common objectives, achieve maximum utilization of various resources, and ultimately reach a win-win management pattern through both top-down and bottom-up vertical management (Xidong, 2005; QianZhenming, 2006).

Two significant participations in the city governance process are the public sectors (e.g. government) and the private sectors (e.g. community). They co-exist and balance with each other in the city life cycle. Governments, particularly council, land authority and urban planning authority, play vital roles in 3D city governance, which keeps services updated and points out the future direction of city development. Meanwhile, the community who represents end users of the information conveys willingness and arguments to the public, which affects policy efficiency. It is important to establish the efficient communication path from government to community and vice versa.

The governance process determines the first and foremost emphasis is the communities' participation. Besides, other seven factors rule of law, transparency, responsiveness, consensus orientation, equity and inclusiveness, effectiveness and efficiency and accountability are recognized by the United Nations (United Nations, 2009). The eight elements are mainly from the perspective of governance implementation. Rule of law provides fair legal frameworks, deciding participation and responsiveness. Participation is a key cornerstone, relating to consensus orientation and equity and inclusiveness. Responsiveness is the other cornerstone determining effectiveness and efficiency. However, transparency and accountability are not linked directly to the legal framework and cornerstones, resulting in disconnection of the eight elements during the governance implementation, which undermines the efficiency of governance theory.

Meanwhile, as the city develops fast, the city growth pattern has changed from low-density agglomeration and flat-curve economic growth to the complex environment with rapid economic achievement, which challenges the traditional governance theory. Particularly, new concepts of eco-city, green-city, smart-city, e-city, and et al. illustrate requirements for updated managerial, technical and legal settlements. Traditional good city governance cannot fulfill the new requirements, which calls for 3D city governance as an integrated 3D information platform adds the value to good governance.

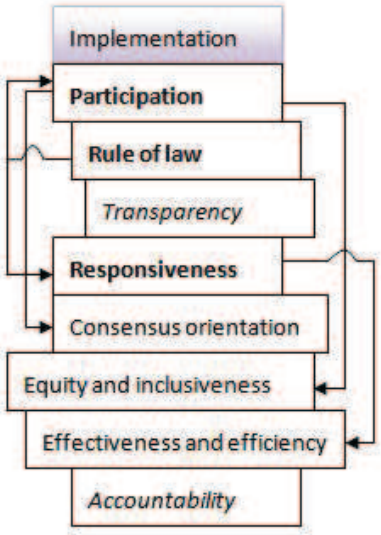

Fig. 1 Links and gaps in the governance implementation

It can be predicted that with the aid of 3D city platform, the government takes accountability to encourage the community to participate in the governance process actively through the platform, listen to the feedback of the governance policy, and identify and rectify the weakness transparently. The community reflects opinions, establish a link with government and evaluate policy efficiency basing on the platform resiliently.

3. 3D CITY GOVERNANCE AS A NEW GOVERNMENTAL FORM

3.1 Concepts

3D city governance leverages information technology-based solutions to maximize communities' role in decision-making process and enhance the quality of life while minimizing the sacrifice of resource and environment. 3D information technology is the foundation of city governance in processes of urban planning, resource management, infrastructure construction, building design and construction, transportation systems, security services, emergency management, and disaster response systems. The added-value can only be realized through an integrated platform for those capabilities. For example, emerging "city dashboard" solutions provide governments and communities with real-time comprehensive situational state of cities. The data is integrated through a broad range of sources distributed throughout the city, monitoring critical infrastructures such as transportation and power and water supplies. Dashboards also provide modeling and simulation activities that can help communities to understand the city growth. Meanwhile, through smartphones or other smart devices, communities can get access to the city portal at any location anytime. With well connections, feedbacks go to the platform interactively, aiding the construction of good governance (Council, 2012).

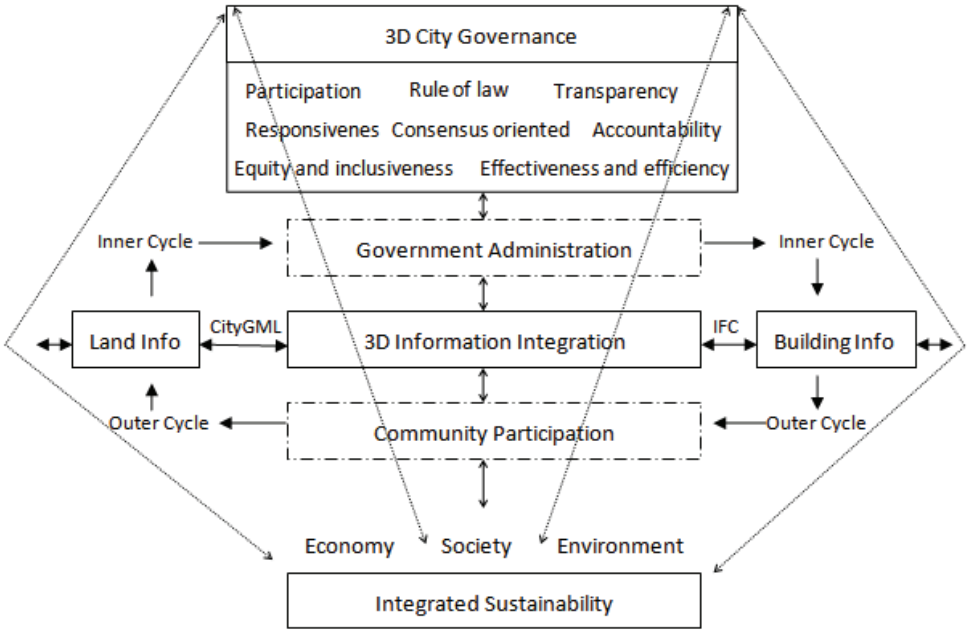

Fig.2 Concept of 3D city governance

3.2 Benefits

There are major two extra benefits from 3D city governance that are the add-value of 3D information technology and the empowerment of the community through the 3D city model apart from contributions to sustainable city development.

3.2.1 Added-value of 3D information technology

City governments are believed to ensure the equitable use of land without diminishing the future generations' need. Decisions amongst a diverse set of users should support the sustainable development of land, as a valuable and finite resource, for appropriate assessment. "This can only be achieved if the decision makers, both governments and communities, have access to consistent and integrated information about land and property" (FIG, 2010). An essential element in providing the consistent and integrated information is the 3D city model accessible through web portal. It provides the institutional arrangements about land and property in the city range for good city governance.

The requirement of the city model needs to be participatory, consensus oriented, accountable, transparent, responsive, effective and efficient, equitable and inclusive and the rule-of-law abeyant. Thus, an integrated information platform with land, building and city-regions is required. Building Information Modeling (BIM) and Geo Information System (GIS) are the two major information models meeting the requirements.

The ideal city model links significant governance aspects in terms of housing affordability, the environmental friendly environment, sustainable industry growth, community survivability and livability and social sustainability in the following manners. Through the platform, 3D city governance recognizes housing value in three dimensions and evaluates its impact on housing affordability, industry development and urban economic growth, which aids economic sustainability in urban planning process. Environmental friendly neighbourhood

reflects communities' survivability and livability and has a direct relationship with transportation, energy and waste, water contamination, and property rights, which, of course, has an influence on social sustainability. At the same time, social sustainability is reflected by community choice in terms of factors mentioned above. Through 3D city governance, all the factors can be recognized and calculated reasonably by collecting cloud data from massive consumers and end users. An integrated information communication platform combines three sustainability perspectives and leads 3D city governance beneficial to urban development.

3.2.2 Empowerment of the community through the 3D city model

The spread of 3D information technology enables community's unprecedented capability to participate in the governance process in new ways (Council, 2012). The conventional way to access to information has been replaced by PC and mobile phone, which faces the emerging replacement of smartphones. The fast mobility and good connection of information facilitate networked movements, information crowdsourcing and cloud sourcing, which influences community's daily life. For the industries, the shift to cloud planning, architecture, construction and maintenance improves the efficiency of output, requiring the change for resilient management skills. 3D information technology plays an increasing role in the social world. Therefore, the government needs to take steps to facilitate the governance through an integrated information model.
A successful example can be found in the European region. According to the INSPIRE (the Norwegian NSDI) principles, at least 210,000 reference and 50,000 standardized spatial thematic data set are available on a geoportal , involving more than 600 partners and 100 operational web map services (WMS). The reference data covers "topographic data, hydrography, roads and other infrastructure, land-use, buildings and cadastral information, elevation and bathymetry, and orthophoto layer". Thematic data supported by national institutions and municipalities includes profound information of almost every aspect of daily life. Through the geoportal, government provides transparent and simple information for the community, securing the future welfare. The communities can find relevant public services on "My Page", which keeps the interaction of the government and the community (FIG, 2010).
The online service encouraged the community to participate in the online portal and forums, affecting the societies and governance. And the connective network in terms of governance will provide governments both authoritarian and democratic devices for administrating the community (Council, 2012).

4. AN INTEGRATED 3D CITY MODEL

For the purpose of sustainability maximization, an integrated 3D city model provides novel approaches to city governance. In the view of city governance in terms of the land and property, there are two major semantic models for 3D representations (El-Mekawy et al., 2012b). One is building orientation with BIM/IFC format focusing on building design, construction and maintenance; the other one is urban environment orientation with GIS/CityGML format focusing on the land use process. The new technological trends are merging IFC and CityGML in an embedded platform and conversing the two classes of standards. It is a crucial driver for 3D city governance as the need of integrated 3D information in city life cycle. Through Building Information Modeling (BIM) and Geospatial Information System (GIS), the city model provides city planning tools with efficient 3D information, which facilitates industry boom and productive 3D city governance.
Several attentions to 3D city model have been paid in terms of land and building information integration. Firstly, 3D visualization is regarded as a graphical way to identify spatial connections in a complex city environment. Alexandra Ribeiro et al. (2014) examined CityEngine as a visualization tool for 3D cadastre

through cadastral requirements, visualization requirement and non-functional requirements (Alexandra Ribeiro, 2014). With the procedural modeling approach and Computer Generated Architecture (CGA), CityEngine facilitates the efficient creation of 3D city models (Kolbe et al., 2005). Besides, Safe Software develops FME to support 3D city visualization by integrating IFC and CityGML information. Secondly, 3D data analysis function is a new direction of 3D city models. Noise analysis, shadow projection, energy consumption are beyond the simple visualization requirements, which enforces the integrated city model for both land and building. CityGML and IFC are the two typical model standards in the area of visualization and data analysis. They have shared attributes but different format due to diverting functions.

4.1 CityGML v.s. IFC

CityGML is an open geospatial model standard with attributes of geometric as well as entities and non-spatial relationships among entities. It is prevalently used as an application schema for Geography Markup Language3 (GML3) which is developed and issued by the Open Geospatial Consortium (OGC) as an extensible international exchange standard. CityGML describes city environment with modules, including Core, Appearance, Building, CityFurniture, CityObjectGroup, Relief, Transportation, Vegetation, WaterBody, TextureedSurface, LandUse, Generics. Besides, CityGML represents city environment with five Level of Details (LoD) (Kolbe et al., 2005). From the coarsest level LoD0 to the finest level LoD4.
In the building industry, BIM is predominantly influential for information integration and interoperability (IAI). The Industry Foundation Classes (IFC) has been developed to facilitate the research as a reference model standard (Peachavanish et al., 2006; El-Mekawy et al., 2012b). IFC is an object-oriented format by the International Alliance for Interoperability (IAI), representing not only building components, but also supporting advanced process for data analysis among the components. IFC provides a very detailed semantic model for 3D building (Thomas H. Kolbe) with Level-of-Development (LOD, capital letter O to differentiate LoD mentioned in CityGML) to indicate the state of development from conceptual phase (level 100) to as-built phase (level 500) (Donkers, 2013; Donkers et al., 2015).
As the merging trend in geomatics and architecture recently, researchers in both of the fields of BIM and GIS put efforts in the 3D information integration and interoperability, establishing possible city models standards.

4.2 Integration of CityGML and IFC

The integration of IFC and CityGML is seen today as a necessary step for getting a complete picture of 3D city modeling at different levels of details. Recent research efforts are mainly in the following three categories, CityGML ADE Extension (Edvardsson, 2013; Van Berlo et al., 2013; Cheng et al., 2013; Alexandra Ribeiro, 2014), IFC Extension and Conversion (Donkers, 2013; El-Mekawy et al., 2012a; Sz-Cheng Yu) and Unified Building Modeling (UBM) method (El-Mekawy et al., 2012b). The significant research attention is on standard conversion from IFC to CityGML LoD3 & LoD4, and transformation from CityGML LoD3 to LoD2 & LoD1 for the purpose of getting semantic-rich CityGML models. Therefore, the difficulties in terms of coordinate system, a combination of boundary representation and semantic-rich models are being conquered. Some of the models have been published for 3D city visualization and data analysis, such as CityEngine by ESRI, Revit, and Infraswork by Autodesk, and FME by Safe Software.

4.3 Cloud concept for multi-user cooperation

The cloud technology is another driver for 3D city modeling, which has been developed in BIM fields. The BIM bases on cloud concept i.e. storage, viewing and sharing through cloud platform to achieve the goal of multi-user shared project management through shared users rights and multi-project sharing control. Recent information technology has progressed in the field of information integration of land and building in 3D. New-developed applications even can realize cloud network anytime, anywhere and anyone e.g. Autodesk 360 series (A360) (Fig 3).
The basic concept of the cloud is the easy collaborations amongst partners through cloud disk basing on a project. Easy upload and download project files anywhere is another thought of cloud idea. Therefore, the mobility is required for different characters of the project, including architecture, engineer, and other end users. Basing on the thought, APP on mobile end is developed on site, which enables engineers to examine the project easily by holding an IPad and realize the co-work process with other colleagues. Under the cloud cooperation, stakeholders share workflow from office to site seamlessly. The concept is now extending its use from building to the urban environment. Before long, a semantic-rich 3D city model will be developed for use. In all, the cloud concept facilitates the integrated cooperation amongst diverse end users, which provides a brilliant future for the 3D city platform collaborations.

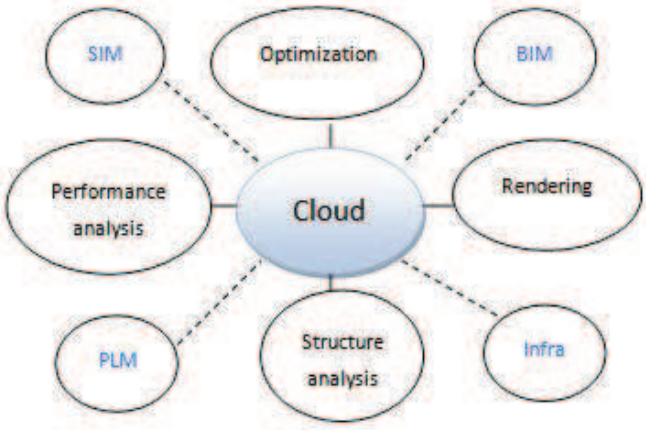

Fig. 3 Autodesk 360 product design concept

5. "8+2" 3D CITY GOVERNANCE TOWARDS AN INTEGRATED SUSTAINABILITY

As mentioned above, good governance consists of eight predominant elements which is not sufficient for the requirement of 3D city governance as the gap existing amongst the elements. 3D information technology is a fundamental requirement facilitating the information transparency from governments and communities. Besides, resilience is an influential factor in responsiveness and accountability. Therefore, the research advocates to plus these two factors to the eight-factor model, forming the new ten-element model. The inner-relations among the ten elements are described in the Fig. 4.

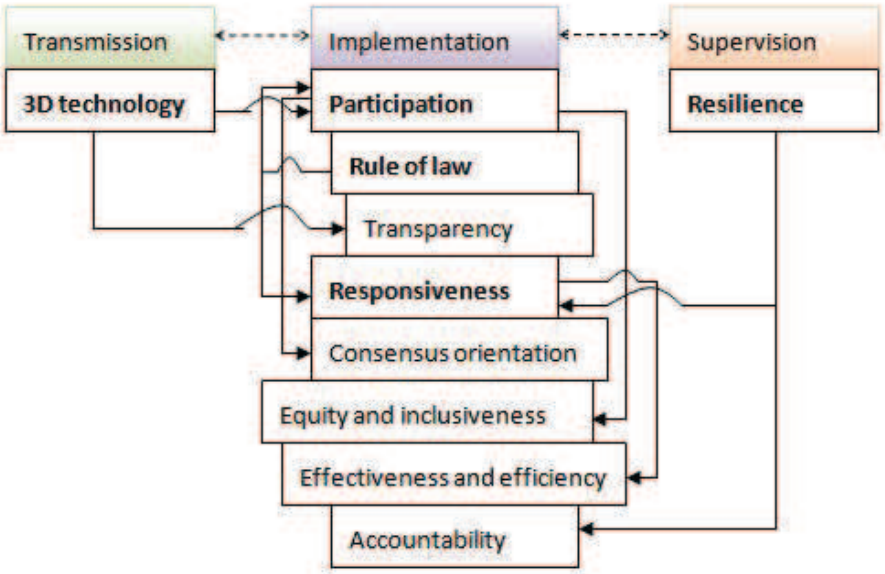

Fig. 4 Improved model of 3D city governance

The lack of information transmission and supervision institution causes implementation failure due to unconnected governance implementation processes. Through adding information transmission and supervision institutions, the disconnection in the implementation institution disappears, complementing the absence of horizontal integration. 3D technology and resilience facilitate the implementation process better connect one another. The core elements of the improved model are participation, rule of law and responsiveness, 3D technology and resilience as they transit the flow route to the other factors.

3D city governance determines the rule of law in new governance manners, promotes the participation of both the government and community in decision-making process through an integrated information platform. This helps to regulate city issues relevant to land and property including land use, housing affordability, water resources, transportation, waste management and disaster responsiveness etc., which interacts with economic, social and environmental sustainability with fast resilience and responsiveness. Undoubtedly, 3D city governance drives the city towards an integrated sustainability.

6. CONCLUSION

Cities expand in terms of size, density and complexity not only horizontally but also vertically. With the evolution of information communication technology, city governance drives city towards an integrated sustainability through 3D information integration of land and property, which forms the concept of 3D city governance.

An integrated sustainability includes three perspectives that are economic, social and environmental. They impact on one another and play vital roles in 3D city governance. However, the leading concept of economy growth results in the segregation of economy from society and environment, which causes severe social and environmental problems. The new focus of an integrated sustainability treats the three aspects as a holistic view relevant to land and property.

The eight elements consists the domain of good governance while the disconnections amongst one another cause inefficiency in terms of governance implementation. 3D city governance as a new governmental form adds the other two predominant elements i.e. 3D information technology and resilience to the governance

theory benefiting the governance process by added-value of 3D information technology and engagement of the community.
An integrated 3D city model is a vital premise to establish good 3D city governance. With the integration of CityGML and IFC, the integration can be realized in three ways that are CityGML ADE Extension, IFC Extension and Conversion and Unified Building Modeling (UBM). Besides, the cloud technology provides an updated method for multi-user cooperation, which is being explored in the use of city environment. With the aid of 3D city model, an integrated sustainability will be realized through a new governance concept of "8+2" 3D city governance.
The future research direction is to design an integrated 3D city governance model on the 3D information platform in the environment of Chinese cities.

ACKOWLEDGEMENTS

The authors would like to thank the supports from colleagues in Dongbei University of Finance and Economics, CSDILA, the University of Melbourne and ITC, University of Twente. Particularly, thanks to the aid from the Ministry of Education, Humanities and Social Sciences Research Youth Foundation, Project Number 15YJC630158 [教育部人文社会科学研究青年基金项目，项目批准号 15YJC630158].

REFERENCES

WPR, W. P. R. 2015. *Major Cities in China Population 2015* [Online]. Available: http://worldpopulationreview.com/countries/china-population/major-cities-in-china/ [Accessed 27 Aug. 2015].

ALEXANDRA RIBEIRO, J.-P. D. D. A., PORTUGAL AND CLAIRE ELLUL 2014. Exploring CityEngine as a Visualisation Tool for 3D Cadastre *4th International Workshop on FIG 3D Cadastres* Dubai, United Arab Emirates.

BARTELMUS, P. 2012. *Sustainability economics: an introduction*, Routledge.

BRUNDTLAND, G. H. 1987. *Report of the World Commission on environment and development:" our common future."*, UN.

BURTON, I. 1987. Report on reports: Our common future: The world commission on environment and development. *Environment: Science and Policy for Sustainable Development,* 29**,** 25-29.

CHENG, J., DENG, Y. & DU, Q. Mapping between BIM models and 3D GIS city models of different levels of detail. 13th international conference on construction applications of virtual reality, London, 2013. 30-31.

CHIVAKUL, M., LAM, M. R. W., LIU, X., MALISZEWSKI, W. & SCHIPKE, M. A. 2015. *Understanding Residential Real Estate in China*, International Monetary Fund.

COUNCIL, N. I. 2012. GLOBAL TRENDS 2030: ALTERNATIVE WORLDS.

DONKERS, S. 2013. *Automatic generation of CityGML LoD3 building models from IFC models.* TU Delft, Delft University of Technology.

DONKERS, S., LEDOUX, H., ZHAO, J. & STOTER, J. 2015. Automatic conversion of IFC datasets to geometrically and semantically correct CityGML LOD3 buildings. *Transactions in GIS*.

EDVARDSSON, K. N. 2013. 3D GIS modelling using ESRI's CityEngine: a case study from the University Jaume I in Castellon de la Plana Spain.

EL-MEKAWY, M., ÖSTMAN, A. & HIJAZI, I. 2012a. An evaluation of IFC-CityGML unidirectional conversion. *International Journal of Advanced Computer Science and Applications,* 3**,** 159-171.

EL-MEKAWY, M., ÖSTMAN, A. & HIJAZI, I. 2012b. A unified building model for 3D urban GIS. *ISPRS International Journal of Geo-Information,* 1**,** 120-145.

FIG 2010. Rapid Urbanization and Mega Cities: The Need for Spatial Information Management. Online.

IAI. IFC Model Documentation Webpage. International Alliance for Interoperability. Available: http://www.buildingsmart-tech.org/specifications/ifc-releases/summary [Accessed 10 July, 2012].

KOLBE, T. H., GR GER, G. & PL MER, L. 2005. CityGML: Interoperable access to 3D city models. *Geo-information for disaster management.* Springer.

PEACHAVANISH, R., KARIMI, H. A., AKINCI, B. & BOUKAMP, F. 2006. An ontological engineering approach for integrating CAD and GIS in support of infrastructure management. *Advanced Engineering Informatics,* 20**,** 71-88.

QIANZHENMING, Q. 2006. Good City Governance: Chinese city governance transformation analysis, goal and path. *Journal of Jianghai Academic,* 3.

SUN, C. 2014. Sustainability reaching its limit in top Chinese cities. *Globla Economy*, 17 April, 2014.

SZ-CHENG YU, T.-A. T. THE GENERALIZATION OF BIM/IFC MODEL FOR MULTI-SCALE 3D GIS/CITYGML MODELS. Available: http://www.a-a-r-s.org/acrs/administrator/components/com_jresearch/files/publications/OS-006%20THE%20GENERALIZATION%20OF%20BIM%20IFC%20MODEL%20FOR%20MULTI-SCALE%203D%20GIS%20CITYGML%20MODELS.pdf [Accessed 27 Aug, 2015].

UNITED NATIONS, E. A. S. C. F. A. A. T. P. 2009.What is Good Governance? Available: http://www.unescap.org/sites/default/files/good-governance.pdf [Accessed 27 Aug, 2015].

VAN BERLO, L., DIJKMANS, T. & STOTER, J. Experiment for inegrating Dutch 3D spatial planning and BIM for checking building permits. 8th 3DGeoInfo Conference & WG II/2 Workshop, Istanbul, Turkey, 27–29 November 2013, ISPRS Archives Volume II-2/W1, 2013. ISPRS.

XIAOPENG LI, X. L., JONATHAN WOETZEL, GENGTIAN ZHANG, YINGJIE ZHANG. 2014. The China Urban Sustainability Index 2013. Available: http://www.mckinseychina.com/wp-content/uploads/2014/04/china-urban-sustainability-index-2013.pdf?5c8e08 [Accessed 27 Aug, 2015].

XIDONG, T. 2005. Urban governance in China: theory, problem and strategy. *Journal of East China University of Science and Technology (SOCIAL SCIENCE EDITION),* 3**,** 95-97.

CONTACTS

Dr. Zhixuan Yang
School of Investment and Construction Management
Dongbei University of Finance and Economics, China
217 Jianshan Street, Shahekou District
Dalian
CHINA
Tel. +86 1370 494 8946
Email: zhixuan_yang@126.com; zxyang@dufe.edu.cn
Web site: www.dufe.edu.cn