How to capture innovation and solve the challenges of urbanization with hackathons?

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Abstract

Developing cities are facing the enormous challenge of urbanization and the digitalization of urban development. The advancements of new technologies and the exponential growth of available data offers numerous new opportunities to innovate and to solve some of the challenges developing cities are facing. However, developing cities often lack the know-how, money, competent workforce, collaboration between different stakeholders to realize this potential. This paper discusses how developing cities can solve these challenges with hackathons. We present through two case examples how hackathons can be utilized to develop and enhance urban development process in developing cities. We describe how hackathons could be used to increase transparency and collaboration in urban development, share knowledge and promote new technologies, produce new urban planning innovations, create new job opportunities in the field of urban development, and learn more agile and cost-effective development methods.

Key Words: Hackathon, Innovation, Spatial Data Infrastructure, Urban development, Urbanization

INTRODUCTION

This paper discusses how to tackle the challenges of urbanization with innovation and hackathons. Currently, over half of the world's population (54 percent) lives in urban areas. The urban population of the world has grown quickly since 1950, from 746 million to 3.9 billion in 2014. The continuing urbanization and population growth is projected to add 2.5 billion people to the world's urban population by 2050, with nearly 90 per cent of the increase concentrated in Asia and Africa. (United Nations, Department of Economic and Social Affairs, Population Division, 2015).

Developing cities are facing various challenges related to unplanned and rapid urbanization, e.g. climate change, pollution, natural disasters, diseases, environmental degradation, urban development, public transportation, large scale infrastructure and building projects. These challenges are threatening sustainable development, if necessary urban planning (spatial data) infrastructure and process are not implemented to support the population growth. Research has proven that geographic information systems (GIS) and the underlying spatial data infrastructures (SDI) offer significant benefits in managing urbanization in developing cities. In some circumstances, SDIs, spatial data, and urban planning processes already exist in these cities. However, the challenge is to break down the information silos between different organizations and help stakeholders discover, access and use the shared information to improve decision-making, business outcomes and customer services. (Bishop et al., 2000; FIG Commission 3, 2010).

The development of SDIs and urban planning processes is decelerated not only by money, but also by the lack of technological know-how, competent workforce, and collaboration between different stakeholders (FIG Commission 3, 2010). In addition, the experiences of the developed world in the digitalization of urban development have usually proven inadequate in developing countries, and new and innovative solutions are required to increase situation awareness and integrate the social, economic and environmental factors of urbanization to manage growth and change in developing cities (Bishop et al., 2000; FIG Commission 3, 2010). The digitalization of urban development means integrating digital technologies into urban planning and permitting, and city management processes ("Digitalization - Gartner IT Glossary").

In this article, we introduce a hackathon as a toolkit to tackle these problems and accelerate the digital transformation of urban development in developing cities. Although, hackathons are nowadays a popular

innovation approach, and hackahons in the urban development context have been arranged, there is not much previous research about the topic. In this article, we explain through two case examples how hackathons can be used as a collaborative innovation platform in the field of urban development. We present how hackathons can be utilized to increase collaboration, learn new work methods, open up data sources, introduce new technology trends, and produce new innovations and job opportunities in the field of urban development. The article examines two different hackathons, 3D City Model Hackathon and AEC Hackathon Helsinki, which were organized in Espoo, Finland in 2015. The topic of both hackathons was related to urban development. Although, both of these case hackathons took place in Finland, we believe that the same benefits can be achieved anywhere in the world.

The article is arranged as follows. The second chapter answers the question "what is a hackathon?". The third chapter focuses on the case hackathons. The chapter describes the characteristics of the case hackathons and the realized benefits and learnings. The fourth chapter discusses how hackathons could help developing cities to encounter the challenges of urbanization and the digitalization of urban development. The conclusions are presented in chapter six, and the acknowledgment is found in chapter seven.

HACKATHONS

A hackathon is a creative problem solving and innovation event where people from different fields collaborate intensively to create new ideas, services and applications around a pre-defined topic (Briscoe and Mulligan, 2014). Typically, a hackathon is constrained by time and space to create a distraction free environment to foster the innovation and implementation of new ideas. The length of a hackathon varies usually from a day to few days, but also shorter and longer versions exist. The location of a hackathon should be an isolated and inspiring environment, where the participants can stay throughout the event. Food, snacks and beverages are often offered to the participants during the hackathon to allow them to work without distractions. In addition, a continuous on-site support is essential to enable the participants to focus on innovation and implementation of their ideas without interruptions. (Raatikainen et al., 2013).

The aim of a hackathon is to develop concrete demonstrations of ideas. These demos and prototypes are often presented to other hackathon participants, organizers and judges in a demo session held at the end of the hackathon. At the demo sessions, the technical and commercial feasibility of demos are assessed by the judges, and the teams with best prototypes are often presented with prizes. The quality of the

hackathon demos can be increased by supporting the participants in ideation and preparation before the event, and by facilitating collaboration of people from different backgrounds. Team dynamics is essential for a successful hackathon, and it is beneficial that hackathon teams consist of people from different backgrounds. It has been proven that the high degree of diversity among participants will produce a wider range of solutions. And in order for software programs to build meaningful applications, there needs to be people who understand the challenges of the field. (Rosell et al., 2014).

The motivation to organize, and participate in a hackathon vary between companies, organizations, and students. For companies and organizations, hackathons are a great platform to learn, network, collaborate, attract talent, and innovate, test and market new products. For the participants, hackathons are great events for learning, socializing and networking. They offer the participants an environment to showcase their talents to companies through concrete projects, and a break from routines. (Rosell et al., 2014). The challenge of organizing is to generate adequate interest for the hackathon. Previous research has proven that some kind of reward structure is required in attracting participants (Tushmann, 1997). Although, according to Briscoe and Mullingan (2014) learning and networking are the top reason for attending (Briscoe and Mulligan, 2014). They argued that the value of hackathons is not in the immediate results but in the long-term development and the collaboration between the stakeholders that hackathons can foster to create. The further development of realized ideas after the event is one of the biggest challenges in organizing hackathons. In order for the further development to happen, the follow-up activities to support the long-term development ideas and collaboration should be planned before the hackathon, This could mean incubation programs, post hackathon meetings, and opportunities to engage with hackathon collaborators. (Shemie et al., 2012).

The innovation potential has made hackathons a popular platform for companies, government agencies and organizations to test new products and innovate new ideas, e.g. Facebook arranges hackathons to innovate new features to its social media platform (Burnham, 2012; Raatikainen et al. 2013; Rosell et al., 2014). The World Bank has experience in organizing hackathons, e.g., Water Hackathon, which was organized in 2011 simultaneously in ten cities around the world. Lessons learned from this event were that the hackathon offered "*a low-cost, high-reward opportunity to open up water sector challenges to the talent and creativity of the ICT design and development community*". The event also challenged the World bank to change its mindset towards greater openness, experimentation and tolerance of failure. The organizers of the Water Hackathon believe that other development sectors of the World bank could find hackathon as a useful tool. (Shemie et al., 2012).

CASE HACKATHONS

3D CITY MODEL HACKATHON

3D City Model Hackathon (3D City Model Hackathon - website) was organized by Aalto University, City of Espoo and Sito ltd. as a part of Energizing Urban Ecosystems (EUE) project. The event was organized at the Aalto Design Factory in the Aalto University Campus, Otaniemi, Espoo, on 9 - 11 October 2015. 3D City Model Hackathon lasted for approximately 48 hours, beginning on Friday afternoon with a kick off event and ending on Sunday afternoon with a demo session. The aim of the hackathon was to increase general awareness for open geospatial data and 3D city models and to bring together universities, companies, startups and cities to investigate what kind of new possibilities open data and 3D models could offer for Smart Cities and their citizen and companies. The event itself was a success with an energetic and collaborative atmosphere, new ideas and innovations, and 80 participants ranging from universities to research institutes, students, companies, such as Colossal Order, Elisa, Fira, Futurice, Gispo Ltd, IBM, Kone, Tietoa, Unity, virtualcitySYSTEMS , and organizations, such as Aalto University Campus & Real Estate (Aalto CRE), AEC Hackathon, Helsinki Regional Transport Authority (HRT), Slush, and Ultrahack, VTT Technical Research Centre of Finland Ltd (VTT), and the 3D City Model Project of Helsinki.

The participants of the hackathon were encouraged to create services and applications related to city planning, urban digitalization, living & environment, traffic & transportation, energy, gaming, internet of things or anything else that utilizes the 3D city model of Otaniemi, Espoo and other open geospatial data provided by the organizers. The organizer proposed six challenges to help the participants in the application ideation.

- How could the 3D city model serve as an open innovation platform for smart cities?
- How can the 3D city model and open data be utilized to support university campus and Otaniemi Area Restaurants, Cafes, Events and Facility Management?
- How to combine the 3D city model with real time energy, traffic, or mobile phone data?
- How could Internet of things benefits from 3D city models?
- How can 3D gaming technologies utilize 3D city models and data from the databases of the city?
- How to utilize open data and open interfaces in 3D city models?

In addition, the participating companies were given an opportunity to suggest their own challenges or ideas for the hackathon participants. For example, Aalto CRE encouraged the participants to combine the 3D city model, BIM models, and energy API. Elisa challenged the participants to study how social media could be used in urban planning together with 3D city models. However, the challenges of organizers and companies were only guidelines for innovation, and participants were allowed to create and develop their own ideas. The organizers' only wish was that the participants would use the provided data in their applications and ideas.

The organizers and companies provided data for the hackathon. City of Espoo provided the 3D City Model of Otaniemi (produced by Sito), and API for all the open data from the Espoo area. Aalto CRE provided the BIM models and energy consumption data of three buildings from the Otaniemi campus area. Kone provided People Flow API, which can be used to simulate elevators in buildings. HRT provided the open public transportation data of Helsinki region. Fira provided the BIM model of a building in Jätkäsaari, Helsinki and simulated energy data. The most of the data was published a couple weeks before the event took place, in order to allow the participants to familiarize themselves with the data and prepare for the event.

In addition to data and APIs, the organizers and companies provided tech to hack for the participants. The participants were encouraged to utilize the Unity game engine and the Cesium virtual globe on their applications. Sito provided support for the Unity and the 3D city model of Otaniemi. VirtualcitySYSTEMS provided support for the Cesium, and brought their virtualcitySYSTEMS Cesium tools to the hackathon. IBM brought their digital innovation platform IBM Bluemix to the hackathon. It is a cloud platform as a service (PaaS), which allows developers to integrate multiple datasource, infrastructures and services, easily scale existing services, and produce new solutions. Futurice provided their "Iot Service Kit", which is a co-creative tool for exploring user-centric interactive scenarios in service design. It was modified to work for the hackathon study area, Otaniemi Campus. Moreover, the Aalto university, Elisa, Espoo, IBM, Sito, Futurice, Fira, and Virtual City Systems offered their expertise for the hackathon teams to help with ideation of the applications, and to support with problems the teams encountered during the weekend.

The event kicked off with presentations by the organizers and the participating companies on friday afternoon. After the kick off, short speed networking and grouping session was held to form teams or find extra team members. Altogether, 9 teams were formed. During the weekend, all the organizers,

companies, and industry experts were given a possibility to give a presentation about their ideas about 3D City Models, future smart cities, and technology trends. For example, Helsinki City 3D City Model Project gave a presentation about the future of smart 3D city information models and CityGML. Futurice gave a presentation about open city data and ecosystems, and its benefits for application and service creation. Sito and Virtual City Systems showcased 3D city model applications develop with the Unity and the Cesium technologies.

The 3D City Model Hackathon ended with a demo session on sunday afternoon. The teams presented the applications that they had developed during the weekend to the other participants and the jury. The best applications were awarded in three categories: AEC Hackathon, Gaming and UltraHack. The winner of the AEC Hackathon category was Kauppi&Peltonen with a 3D city model user interface intended for mobile devices. Estia won the Gaming category with an application that tells the users about the status of a building by taking advantage of the BIM model and energy usage information. The UltraHack category had three winners. The winners of the category were Otamap's outdoor and indoor navigation application utilizing 3D models, HarmaaBeige's navigation application based on voice control, and Team 3DBrainström's city planning application that combined augmented reality and 3D printing.

AEC HACKATHON HELSINKI

AEC Hackathon (AEC Hackathon - website) is a rapidly growing global community which was founded in California in 2013. AEC stands for Architecture, Engineering and Construction but it includes all areas of the built environment. The aim of the hackathon is to give built environment professionals an opportunity to collaborate with cutting edge technology developers and programmers to develop new solutions to everyday problems. The community has spread all over the world by local active organizers and it was organized in Finland for the first time in November 6-8 2015 at Tekla HQ in Espoo. During the weekend 14 teams developed rapid prototypes related to virtual and augmented reality, building information modeling, 3D city models, internet of things sensors and open data. The event was a huge success with 150 participants from various organizations such as Aalto University, Tekla, City of Helsinki, Sweco, IndoorAtlas, Fira, YIT, A-insinöörit, M.A.D., RAKLI, Thingsee, AE Partners, Unity, UpCloud, Colossal Order, Augumenta, 720 Degrees, Proximi.io and Umbra.

The participants were given eight hack categories with awards a week before the event. The AEC Hackathon community had four fixed categories for the event:

- The best overall hack in the hackathon
- The best hack that solves a big AEC problem
- The best hack utilizing open source and open standards
- The best hack for 3D city models

In addition, the partner companies were able to give sponsored challenges which were:

- The best hack for innovative end user experience by Fira and YIT
- The best hack for smart buildings, smart cities and IoT in AEC by Thingsee
- The best hack for utilizing BIM in facilities management by City of Helsinki and Sweco
- The best hack for indoor navigation in AEC by IndoorAtlas and Proximi.io

The organizers and partner companies provided various datasets and APIs for the hack teams to use in the projects. Tekla provided the floor plans of the hackathon area. City of Helsinki provided its open city data and two IFC models from recently built buildings; a youth center and a kindergarten. IndoorAtlas mapped the whole hackathon area and the participants could use their API in indoor navigation applications. 720 Degrees installed their air quality and noise level sensors to various places in the hackathon area and provided an API for the teams to access the real-time data. Proximi.io installed beacons in the hackathon area and provided their API to access them for location-based applications. Finally, Fira and YIT provided supporting material for their end user experience challenge such as material packages and bathroom models. All the data was released for the participants on Friday when the hackathon started.

In addition to data sets and APIs, the organizers and partner companies also provided various technology for the hack teams. Thingsee provided their Thingsee One IoT sensor devices and their Creator platform for its easy utilization. Google provided Project Tango tablet devices with laser scanning abilities to be utilized in the projects. The organizers also provided HTC Vives, Oculus Rifts, Samsung Gear VR and Leap Motions to be used in virtual reality applications. In addition, a lot of software licences were provided such as Augumenta SDK, Unity Pro game engine, ArchiCAD, BIMcloud, Tekla BIMsight and Solibri Model Viewer. All the companies also provided their support over the weekend either online on physically at the venue.

The event kicked off on Friday evening with an introduction and a keynote speech. After that, there were lightning rounds where the partner companies could introduce shortly their challenges and already formed

teams could share what they were planning to work on during the weekend. After the lightning rounds there was an opportunity to form teams or find extra team members through facilitated matchmaking. Overall, 14 teams were formed and the rest of the Friday evening was all about planning the hacks and starting the projects. Saturday was all about hacking. There were also two tracks of workshops to inspire and help the participants; AEC and Tech workshops. In Tech workshops, the provided datasets and technology were quickly demonstrated to the participants. In AEC workshops, 10 distinguished AEC professionals gave inspirational talks about digital transformation of the built environment from different perspectives.

The hackathon ended with the team presentations on Sunday afternoon. In the end, the best teams were awarded in 9 categories; best hack, best indoor navigation sponsored by IndoorAtlas, best user experience sponsored by Fira & YIT, best IoT sponsored by Thingsee, best BIM for FM sponsored by city of Helsinki and Sweco, best 3D city, best Project Tango sponsored by Google, best 3D sponsored by Autodesk and best duct tape. Team Indoor Hackers, who developed a mobile app for indoor navigation with IndoorAtlas, Unity and IFC models, won the best hack and the best indoor navigation categories. Team Kitchenware, who developed a virtual reality application for kitchen renovation with HTC Vive, won the best user experience category. Team PlaceBIM, who integrated IoT data to visual IFC models for FM purposes, won the best IoT category. Team Lifelee, who developed an application to manage the air quality in buildings, won the best BIM for FM category. Team JCJ, who visualized different data sources on a 3D city map, won the best 3D city category. Team Backjump, who made an app for Project Tango to visualize IFCs in augmented reality, won both the best Project Tango and the best 3D by Autodesk categories. Finally, team ShowARoom, who developed an app with AR and VR for easier selection of furniture in your own home, won the best duct tape category which was created by the judges at the judging.

BENEFITS AND LESSONS LEARNED FROM ORGANIZING A HACKATHON

BENEFITS

In the both cases, the constraints of space and time together with participants' desire to learn and socialize created an isolated and inspiring environment, which fostered innovation and collaboration between different stakeholders. Both hackathons provided several benefits to their participants and organizers. Among the most notable were the socializing, networking, collaboration, learning, and sharing of

knowledge that took place during the hackathons. The presentations and challenges offered the organizers and participating companies a platform to promote new ideas, and market new products, e.g. in the 3D City Model Hackathon, City of Espoo was able to promote their open data and APIs to developers. In addition, the presentations and challenges together with teamwork done in both hackathons provided all the participants an opportunity to learn about future technology trends. The learning and sharing of knowledge was also supported by the wide range of participants with different kind backgrounds.

The 3D City Model Hackathon and AEC Hackathon proved that hackathons possess a huge innovation potential, if organized and managed properly. The proof of the innovation potential is the two startup companies, Teatime Research and VisuaLynk, which emerged from the AEC Hackathon. In addition, companies started new deep collaborations between startups and other organizations after the events. The birth of these new meaningful collaborations was enabled by the transparent atmosphere of the hackathons, which facilitated socializing, networking and collaborating. For example, after the 3D City Model Hackathon City of Espoo and Sito have further developed Elisa's hackathon challenge of combining social media with 3D city model. Moreover, several participating companies have held internal hackathons to facilitate collaboration between different departments and innovation in their companies after the hackathons. It was also noticed that the hackathons could teach new agile and collaborative working methods, and introduce an experimentation culture to their participants. Through iterative experimentation, collaboration and better utilization of resources, agile development methods can lead to better product quality and cost-efficiency in future development projects. For example, Sweco started using scrum as a project management method after the AEC Hackathon Helsinki (Heiskanen, 2016).

In addition, two of the realized benefits of the hackathons were the recruiting and finding of new job opportunities. The hackathons provided the companies and organizations a chance to look for and attract new talented employee candidates among the participants. And for the participants, the hackathons offered a platform to showcase their talents, network with companies, and find new job opportunities. For example, Sito, one of the organizers of 3D City Model Hackathon, discovered several competent employee prospects, and eventually ended up hiring one 3D-modelling specialist from the 3D City Model Hackathon.

LESSONS LEARNED

According to the previous research, the participants' preparation for a hackathon leads to a better quality in the applications developed during the hackathon (Rosell et al., 2014), and the follow-up activities to support the long-term development ideas and collaboration should be plan before the hackathon (Shemie et al., 2012). These challenges were also noticed by the organizers of the 3D City Model Hackathon and AEC Hackathon Helsinki. During the hackathons, it was perceived that one weekend is a really short time for innovating and building new meaningful prototypes. Therefore, we believe that the quality could be enhanced by artificially stretching the length of a hackathon, e.g. with pre and follow-up events. In the pre events, the organizers and participating companies could help teams to familiarize themselves with the hackathon topic, challenges, technologies, and support teams in ideation. The follow-up events could facilitate the further development of the best ideas. However, it is debatable, whether the organization of the follow-up activities should be the organizers' or participating companies' responsibility. We believe that this depends on the organizers' goals for the hackathon. If the aim of the organizers is to build a community around the digital transformation, then the hackathon events themselves serve that purpose and companies should take more responsibility in follow-up. On the other hand, if the aim is to provide new opportunities to partner companies, then the organizers could take more active role in follow-up activities. In addition, we learned that the public relations, and communicating should happen straight after the event to keep the news fresh and this requires planned resources.

Moreover, other lessons that we learned from the case hackathons were related to team formation, registration, marketing and logistics for the event. We believe that the threshold to participate could be decreased by supporting the team formation before the event, e.g. through a matchmaking platform. This could increase participation for a hackathon. It was also noticed during the case hackathons that all the registered participants didn't show up for the events. In 3D City Model Hackathon, the registration was free. The participating percentage of the hackathon followed the rule of Joshua Tauberer's hackathon organizing guide. According to Tauberer (2015), about 65 % of registered people actually show up for the event. AEC Hackathon Helsinki had a small registration fee, which led to a higher participation percentage with the registered people. However, we are not sure which registration method is better. We only know that when organizing hackathon the organizers should understand that all the registered people are not going to show up.

Finally, we want to emphasize that the organizers should comprehend how laborious tasks the marketing and the management of logistics (food, drinks and venue) during the hackathon are. The marketing is the biggest single workload when organizing a hackathon, and often determines whether a hackathon

succeeds or fails. We learned that marketing should be started at least two months before the event. Various social media channels work great in reaching the potential participants. With university students, a good way is to bundle a hackathon to a course so that students will earn credits from attendance. The management of logistics during the hackathon is also a time consuming task during a hackathon. There are numerous running errands during the hackathon, such as food, drinks, on-site support and presentations. And as mentioned in literature (Raatikainen et al., 2013), the logistics are essential in enabling participants to focus on innovation and implementation of their ideas.

DISCUSSION

Developing cities are facing an enormous challenge in the digital transformation of urban development. The rapid advancements of new technologies and the exponential growth of available data offers numerous new opportunities to innovate and to solve some of the challenges developing cities are facing. However, developing cities often lack the know-how to realize this potential, as declared in the call for submissions of the Annual World Bank Conference on Land and Poverty "*Developing country policy makers have often limited awareness of these possibilities and, as a consequence, may implement solutions that are no longer state of the art, preventing them from reaping potentially vast digital dividends and building local capacity in this critical area.*". (Land and Poverty Conference 2017: Responsible Land Governance-Towards an Evidence-Based Approach, 2017). In addition to the lack of technological know-how, developing cities are limited with money, competent workforce, and collaboration between different stakeholders (FIG Commission 3, 2010).

The Annual World Bank Conference on Land and Poverty Conference is one opportunity to improve the awareness of innovative new solutions among developing nations. However, we suggest that hackathons could be another great toolkit for the World Bank to assist developing cities to tackle the challenges of urbanization and accelerate the digital transformation of urban development on more grassroot level. We have shown through two case examples, 3D City Model Hackathon and AEC Hackathon Helsinki, how hackathons can be utilized in the field of urban development, and what kind of benefits they can foster. Hackathon can teach cost-effective agile project management and software development methods, share knowledge and facilitate collaboration between stakeholders. By focusing in hackathons to solve relevant urban development problems, e.g. the challenges of SDIs in developing nations, we believe that hackathons could be utilized to develop and enhance urban planning processes in developing nations and cities around the world.

Hackathons could be used as a platform to increase awareness about new technology trends and the benefits of open data in developing cities. They offer a low friction environment for people, companies and organizations from different background to participate, network, learn, collaborate and innovate. By colliding people from different background with new ideas and technology trends, hackathons possess a huge innovation potential. They can disclose problems and weaknesses in existing data and systems, and even give birth to new applications and startups, if the events are organized and managed properly. In addition, they can help developing cities to learn new collaborative and agile working methods, and lead to better quality and cost-efficiency in developed software. The previous research has also proved that hackathons have potential to bridge existing ICT skill gaps in developing communities (Coetzee, 2010).

For example through a hackathon series organized in different the World Bank target cities, the World Bank could facilitate creation of a global innovation network. Each hackathon could have a different theme focusing on a relevant problem in the host city. The learnings of the events would be carried through the series from a city to a next one. The hackathon series would allow the World Bank to introduce new technologies to developing cities, and establish an innovation community between different cities and stakeholders. The series would also provide a track to further develop the best innovations, and possibly refine them into startups or new business opportunities for incumbent companies.

CONCLUSIONS

3D City Model Hackathon and AEC Hackathon Helsinki proved that hackathons are a great tool for networking and collaborating with different stakeholders (students, universities, governmental organizations, companies, startups, etc.), promoting and exploring new ideas, and producing new innovations in a transparent environment. In addition, hackathons offer companies a recruiting platform, and students a possibility to showcase their talents and to find a job. We believe that transparent and collaborative events, such as 3D City Model Hackathon and AEC Hackathon Helsinki, could be utilized to develop and enhance urban planning processes in developing nations and cities around the world. Hackathons could increase transparency and collaboration in urban development, enable countries and cities to skip a few technological development stages in the digitalization of urban development processes, produce new urban planning innovations, and create new job opportunities in the field of urban development.

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