

HUNGARIAN SMART CITIES STRATEGIES TOWARDS INDUSTRY 4.0

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Abstract: *From the beginning of the 21st century the industrial activity and potential are key factors of urban development just like geographical location. The aim of this study is to analyse urban development strategies in the light of the fourth Industrial revolution. The first part presents the challenges the cities are facing, and the possible answers: introducing a concept to create Industry 4.0 "ready" urban environment and to build Smart Cities. In addition a theoretical framework of urban development strategies is also introduced. The second part is an analysis of the urban development strategies of two Hungarian automotive-industry cities Kecskemét and Győr based on the above mentioned criteria*

Keywords: SMART CITY, INDUSTRY 4.0, COMPETITIVENESS, RANKING

1 Introduction

1.1 Automotive Industry in Europe

Automotive plays an important role in European economy. 6.9% of the EU's entire GDP comes from this industry¹. 5.3% of the employees of the EU, approximately 12.9 million people work in this sector. 3 million of them are highly qualified manpower. On an annual basis, 16.2 million vehicles (cars, trucks and buses) are manufactured in the 290 vehicle factories in 25 countries of Europe. Automotive, with its investment in research and development amounting to EUR 32 billion, is the largest investor in this field. These companies – wherever they are present – have an effect on regional development, and the international corporations directly connect the towns of their sites to the global economy (Enyedi 1996).

1.2 The destiny of Győr and Kecskemét is strongly linked to the Audi and Mercedes factories operating there

In the third quarter of 2013, countrywide 620 automotive companies had more than 100 thousand employees. The production value the industry amounted EUR 15 billion, which makes up 10% of the Hungarian GDP, and one quarter of the entire export. Four-fifths of the manufactured engines and 90% of cars are exported. Besides the large vehicle manufacturers, out of the twenty largest vehicle industry suppliers, fifteen are present in Hungary².

The two key players of the sector are the Audi Hungaria Motor Kft. having its seat in Győr (Audi), and the Mercedes-Benz Manufacturing Hungary Kft. operating in Kecskemét (Mercedes). According to the publication of the Ranking Coface CEE top 500 companies, in 2015 the Audi was the seventh largest revenue producing company in the East-Central European region with an income of EUR 8.3 billion, while Mercedes is 23rd in the regional ranking, with its income of EUR 3.4 billion. In 2015 Audi, employed over 12,000 employees directly, while Mercedes had more than 3,700 employees³.

Both factories have a wide basis of suppliers, therefore the number of people employed indirectly is also significant. Taking the market demand generated by the family members and people affiliated with the factories as well, it can be stated that Audi and Mercedes are significant economic players in the towns of Győr and Kecskemét, therefore changes affecting the industry and especially the two companies have a great effect on the living conditions, income, and the current situation of the inhabitants of the towns, and through this the entire towns.

1.3 Revolutionary changes in the industry

Mary Barra, the Chief Executive Officer of General Motors said the following on the website of the World Economy Forum's publication titled car industry: Car industry is going to go through more changes in the next 10 years, than it had in the last 50 years⁴. Barra emphasises the following technological trends:

- Electromobility: Combustion engine cars are a thing of the past

- Connected Car: Cars "communicate with each other" – Continuous, automated data collection and mobile communication
- Autonomous car: Self-driving cars
- Car sharing: Instead of owning vehicles, a service providing model

The listed changes greatly rely on the exponential development of the infocommunication technologies. Besides many other studies, IBM's iX (Interactive Experience) department dealing with the topic of digital customer experience, compiled the current development directions of the vehicle industry in the summary titled Reinventing the Wheel, where the increasing role of IT technology solutions can be well traced in transport.

Not only the vehicle industry products depend increasingly on infocommunication technology. Nowadays 90% of the production processes are also supported by some kind of IT tool. The increasingly significant and inescapable role of IT applied at companies has changed the life and work conditions.

Miniaturization and the development of communication technologies make it possible for the physical and the virtual world to melt together, and a new, so called CPS – Cyber-Physical System is being created, in which physical space has an especially important and defining role. Industrial production can now be integrated into an intelligent environment, which is called smart factory.

Based on this technological approach, Germany announced the Industrie 4.0 vision, with its core element being the integration of CPS into the production and logistics systems, as well as the introduction of the network of tools and services in the production processes, influencing the value production, the business models, the organizational structures, decision making and communication mechanisms, creating a change of paradigm of such a degree which can rightly be called the fourth industrial revolution.

The fourth industrial revolution also means the new wave of automatizing. According to the study of the Institute for Economic and Enterprise Research of the Hungarian Chamber of Commerce on the effects of automatization on the labour market – District labour markets automatization exposure estimation⁵, 12% of Hungarian work places could be replaced by automatization technologies already used in practice in the world; which means 513 thousand jobs. According to the study, the largest portion - 33% - of replaceable jobs are in the industry.

1.4 Are we prepared?

Several initiatives have been launched at national level for the adjustment to the revolutionary changes taking place in the vehicle industry. One of them is the Irinyi plan⁶ – the publication of the strategic document on the definition of the directions of innovative industrial development and the creation of the Ipar 4.0 national technological platform. János Abonyi and Ferenc Mészlivetz wrote a monography⁷ titled In the point of intersection of networks – The

social challenges of the fourth industrial revolution; about the social and labour market consequences of the changes.

In the case of the two examined towns, in our opinion, the approaching changes hold both opportunities and threats. The new industrial revolution we are facing, although it mainly affects the industry, will have an effect on the actors of the regional economy and its processes too, just like the previous ones. If we accept that the industrial revolution is a kind of innovation, then we can study it based on the models already learned there. Successful innovation ecosystems are based on the cooperation between the various state, educational and civil actors. In our study, after reviewing the relevant literature, we are going to examine how the issue of the revolutionary change of the vehicle industry and its effect on the towns appear in the Integrated Settlement Development Strategy (ITS), and especially in its strategical objectives system and in the SWOT analyses.

1.5 Smart cities

From the end of the 2000's the expression "smart city" appeared in the relevant literature, the marketing communication of companies working in the field, and as a result, it became widespread as a term. Various definitions exist for the concept of smart city, most of them include the following elements.

- The innovative and wide-spread use of IT technologies
- Sustainable operation from both environmental, economic and social aspects
- A high living standard secured for the inhabitants of the city, favourable enterprise environment secured for the entrepreneurs

One of the leading European scientific centre of smart city researches is the Technical University of Vienna⁸ where the European smart city ranking is published on a regular basis, based on the system of indicators they choose. This assessment is designed based on the following dimensions.

- Smart Economy (Economy)
- Smart Governance (Governance)
- Smart Living (Living conditions)
- Smart People (Human resources)
- Smart Environment (Environment)
- Smart Mobility (Transportation)

In the creation and spreading of the concept of Smart City IBM played an important role. The company announced its „Smarter Planet” initiative in 2008, which is aimed at handling the social, environmental, economic problems on the system levels with the newest innovations of IT, such as handling traffic jams in mega cities, disaster management, or making the electricity supply more efficient and reliable. The three main characteristics of Smart Planet solutions, summarized with the 3 "I" initials are instrumented, interconnected, intelligent operation.

One of the elements of the Smart Planet framework is the Smart City theme, which expressly concentrates on the responses to challenges in the cities. The methodology of IBM's Smart City Assessment studies the operation of the city on three levels⁹:

- The mission and governance of the city
- The services used by the inhabitants and the enterprises operating in the city
- The infrastructure supporting the above

Based on this approach, the smart technologies are not viewed independently on their own, but from the aspect of how much they are in the support of the realization of the strategic objectives of a city, and how they serve the inhabitants of, and enterprises operating in the city.

The methodology takes the following indicators into consideration for the evaluation of the current situation:

- Preconditions

- Management
- "Smart" systems
- Results

The "smart" systems indicator is outstanding, since according to our interpretation, without the innovative application of infocommunication technologies, we cannot talk about smart city.

We can evaluate each aspect on all the levels of the above-mentioned city subsystems (city services, people, enterprises, communication, transportation, water management, energy

The study conducted as an assignment of the IBM Magyarország Kft. titled Smarter cities¹⁰ used the above methodology, and compared various Hungarian cities/towns to the international best practices and a few other cities of the region.

1.6 Knowledge-based economies

The latest manifestations of the Post-Fordist economies can also be called knowledge-based economies. The comparison of Fordism, or object-based economies and the knowledge-based economies appear in the works of Cséfalvy, Enyedi, Florida and Rechnitzer. It is clear from the following table that the concepts articulated in Industrie 4.0 are identical (horizontal integration, personalized mass products) with the attributes of the knowledge-based economy.

The knowledge creating region in fact is an ideal manifestation if the objectives articulated in Industrie 4.0, since company clusters, tight cooperation, demand for labour force able to fill R&D positions appear here. They are able to manufacture their products tailored to the individual needs but in mass production, utilizing the local characteristics. The active local governments and their development policies play a significant role in this.

1.7 City development strategies

The Leipzig Charter was searching for such solution, in which the leaders of the city, differently from the previous practice, can now design, shape the vision of their city in an integrated way, by articulating a uniformed Integrated City Development Strategy (ICS). The Charter also talks about the content items, related processes of the ICS, such as¹¹

- consistent vision of aims and vision
- technical plans of sectoral development of neighbourhoods
- opening way for the option of joint private and state financing
- cooperation between the city and its region
- importance of construction culture
- the involvement of local actors and the inhabitants into the preparation of the plans

The relevant Hungarian handbook was published in October 2007^{12,13}, following this numerous ICS's were prepared, most of them were published as the annexes of application materials.

2 Applied methodologies

During our research, we took the two cities Integrated City Development Strategy as a basis. Mostly we analysed the articulated objective system and the SWOT analyses which can be found in both documents, from the angle of how much they take into consideration the powerful connection of the cities to the vehicle industries operating there, do they take into consideration the opportunities and threats created by the revolutionary transformation of the industry, and what are their responses to them. We also analysed the two documents from the aspect of how many times and in which context certain keywords appear.

3 Comparison of city development strategies

3.1 SWOT analysis in the case of Győr

In the case of Győr the ICS¹⁴ includes SWOT analysis for the following areas:

- Human
- Economy
- Infrastructure

From the aspect of the subject matter of our research, some of the highlighted findings of the SWOT analysis:

Strength (Human)

- The mobility, qualification, level of education of the workers increased
- In the city, the corporate management having international experience is already available
- The labour force has significant production, activity experience

Strength (Economy)

- One-fifth of the companies in the Western Region of Hungary with the most significant revenues operate in Győr, the amount of investment is HUF 100 billion
- In the city, there is an industrial park, as well as a service house and an innovation technology centre
- The establishment of the R&D activities of some of the multinational companies has already started in the city

Strength (Infrastructure)

- Győr has an important multimodal transportation infrastructure, and is a logistics meeting point at the same time

Weakness (Human)

- The demographical processes (reproduction, migration) are unfavourable
- The structure of the secondary level education is not adequate

Weakness (Human)

- 43% of the town's jobs are made up of industrial jobs
- Opportunity (Human)
- The Szent István University is starting the process of becoming a regional knowledge centre

Opportunity (Economy)

- Expansion of logistics activities which are based on wide traditions and abilities

Threat (Human)

- 70% of the out-of-town employees have blue collar jobs, the percentage of employees with white collar jobs is increasing (currently 30%) The increasing migration to the green belt area may have an unfavourable effect on this ratio

Threat (Economy)

- No threat was identified

In the case of Győr, the most striking element of the SWOT analysis is that it does not identify any threats in the area of the economy, while it mentions among the weaknesses of the Human area that 43% of the jobs are in the industrial sector. In our opinion, the high ratio of industrial jobs is not a weakness on its own, but it can become one in case these workers are offered unfavourable working conditions or wages (usually this is not the case in Győr), or, if for some reason these jobs are endangered. The industry and employment system of Győr is extremely determined by the automotive industry, especially the performance of Audi. The 12,000 Audi employees constitute a very significant part of those with employment. Taking into consideration the revolutionary changes which are happening in the car industry, it would certainly be justified to mention them among the opportunities and threats of the economy as well. It is enough to mention that in Győr, Audi

mainly manufactures combustion engines, while the announced strategy of the Volkswagen concern is to increase the ratio of electric vehicles within its product range. The SWOT analysis considers the human resources of the town and the innovative abilities of the town to be strategic resources. At the same time among the opportunities in economy, only the topic of logistics is mentioned. We think that the appearance of the synergies of the industry and the IT sector is missing. The SWOT analysis does not explicitly name the vehicle industry as the significant industrial sector of the town.

3.2 SWOT analysis in the case of Kecskemét

In the case of Kecskemét the ICS¹⁵ includes SWOT analysis for the following areas:

- Human
- Economy
- Infrastructure

From the aspect of the subject matter of our research some of the highlighted findings of the SWOT analysis:

Strength (Human)

- Permanently and consistently increasing number of inhabitants of the town
- Birth-rate showing a stable level and natural reproduction
- Permanently positive migration balance
- Increasing educational level
- Civil activity covering various areas
- Workforce with appropriate production experience
- Appropriate working culture.

Strength (Economy)

- The strongest industrial potential of the region
- Strong entrepreneurship activity
- Relatively diversified economic structure
- One of the lowest industrial tax among the large town in the country
- The presence of the Mercedes-Benz Manufacturing Hungary Kft.
- The presence of some significant multinational companies, fit for supplier integration (Knorr- Bremse, Phoenix-Mecano, Thomas & Betts, Hilti, Bosch)
- Dynamically developing companies with Hungarian ownership (Univer, Bertrans, KÉSZ, Autoflex, Fornetti)
- Well-developed plastic- and printing industry
- Strong machine and vehicle industry and production of devices, instruments
- Operating incubator house
- Increasingly strong logistic role
- Improving touristic and hotel options

Strength (technical infrastructure and town management)

- Favourable telecommunication and IT situation;

Weakness (Human)

- The number and rate of those with a low educational level is high
- The profession-structure of both those with a secondary school degree and a higher education degree differ from the market demands;
- Low innovative and adaptive level within the population;

Weakness (Economy)

- The low number of high-quality business services;
- Narrow town-owned industrial park capacity
- The professional demand-difference between the demand and the supply on the labour market, increasing lack of professionals in the industrial sector
- Insufficient level of cooperation between the local government and the businesses, on the area of the improvement of the economic competitiveness

- Low level R&D and innovation activity, too few high-tech factories at the companies with Hungarian ownership;

Opportunity (Economy)

- Utilization of the educational values, cultural and artistic traditions of the town, and society- and town-development based on this;
- The increment of the social openness and inclusiveness of Kecskemét, new agricultural, industrial and service activities, as well as for the settling of cultural contents.

Opportunity (Economy)

- Increasing clusters in many activity areas (mechanical industry, plastics industry, agricultural and environmental industry);
- Logistic developments resulting from the favourable transportation-geographical situation of Kecskemét;
- Formation of new town-owned industrial and logistic areas

Opportunity (Infrastructure)

- The town's service providing role can become stronger with the further modernization if its IT network (formation of a symmetric network)

Threat (Human)

- The competition in the area of higher education creates an unfavourable situation at the College of Kecskemét, as a result the number of students continuously decreases
- Due to the low number of quality jobs and the attraction of the regional centres the migration of degree holders from the town increases

Threat (Economy)

- Failure to reform the education, the procrastination of vocational trainings, retraining in line with the labour market demands
- The secession of some of the companies from the town due to the lack of professional workforce, or the lack of settling of new ones
- The worsening of the position of the higher education of Kecskemét
- The worsening of the economic competitiveness of Kecskemét due to the more attractive economic environment of the Euroregional competitors
- Financial and economic crisis

In the case of Kecskemét, the SWOT analysis explicitly names the Mercedes, and many of the vehicle industry suppliers operating in the town, which is definitely justified taking their economic and social role into consideration. Among the threats, in the case of Kecskemét the potential worsening of the economic competitiveness is included, and in the analysis, the mechanical cluster is mentioned among the opportunities. The quality, composition of the workforce, and the attraction and retaining of qualified workers as an objective appears in a very articulated way. The question of the synergies of the industry and the IT sector, and the revolutionary changes in the car industry are also missing from this document.

3.3 Győr's long-term vision for the future

Győr identified its long-term vision for the future and the system of objectives for its town development strategy in the IDS long-term Town Development concept as follows: *In 2030, Győr is a city offering an outstanding living, enterprise and cultural environment both at national and Central-European level. The city maintains its previously obtained strong positions in the vehicle and mechanical industries, and besides developing them, it successfully diversifies its economy in the areas of the environment and the*

health industry, in sports economy, as well as in economic services. It provides an appropriate number and quality of jobs for the city and its surrounding area. The city's ability for continuous innovation is based on the tight cooperation between the economy and the R&D at the University, the qualifications of the inhabitants of Győr, their creativity, as well as on the outstanding quality of the services available in the city, which support sustainable development. The city reserves its built and natural environment's unique qualities and enriches them with further qualities. In Győr the cultural and artistic life is of a high standard, the city's touristic attractiveness is outstanding both at national and international level.¹⁴

The system of objectives mentions the already functioning and developing economy as one of the four priorities. Among the interventions, the establishment of a technological region of Győr is included. Among the sub-objectives, the document states, that in this it includes the creation of a vehicle industry career model, as well as the stimulation of the establishment of knowledge-intensive industrial sectors in the city. Besides the vehicle industry, the strategy strives to diversify the economy, which can also be advantageous from the viewpoint of the vehicle industry, since it is more and more in need of diversified sectorial knowledge besides the traditional mechanical industry knowledge. The "soft" economy development programs articulated in the strategy and listed below explicitly support the formation of an environment which also supports the innovation in the vehicle industry:

- identifying and developing companies and enterprises with economic potential
- identifying and developing scientific/research workshops that are based on market needs
- facilitating the establishment of excellency-related start-up and spin-off companies
- broadening the possibilities of joining international R+D+I activities

The steps listed above are clearly steps towards supporting a knowledge-based economy. The strong link between the city and the automotive industry could justify more specified recommendations, ones related explicitly to the development trends of the industry. Infocommunication is not a priority area.

3.4 Long term vision of Kecskemét

According to the Integrated Urban Development Strategy: *Kecskemét intends to become a city that has European values yet clearly expresses and is proud of its own identity, a city that can find the balance between economic development and community values, that thinks responsibly about the natural and the built environment, a city with an open, inclusive and innovative society.¹⁵*

The groups of urban development programs include the industrial park, innovation and technology service development program directly related to the current challenges of the automotive industry, and the human resource development and labour market matching program. The Integrated Urban Development Strategy explicitly mentions Mercedes in relation to the innovation and technology service and development program. The following elements of the program facilitate the development of the automotive industry-related knowledge economy:

- Building on existing technological education and culture and on the companies that are key to the fabric of the industry, the city intends to create the Kecskemét Creative Innovation Center in cooperation with the college, according to already existing preliminary plans. This can be based on three pillars, the materials industry, the automotive industry and the environment industry clusters.
- Kecskemét intends to enable and support the establishment of modern enterprises that fit in its economic vision – organizations involved in certification, research, development and innovation – with unique

urban development marketing and by expanding the areas of technology, industry and logistics.

This document does not treat the expected effects of the IT revolution as a priority either, and does not consider infocommunication as a priority industry

3.5 Keywords in the Integrated Urban Development Strategy of Győr and Kecskemét

Table 1: Keywords and their context in the Development Strategy of the two cities source: own compilation

Keyword	No. of appearances [pages]		Győr context (where relevant)	Kecskemét context (where relevant)
	Győr	Kecskemét		
SmartCity, Digital City	11	1	Energy efficient urban management	the term „SmartCity” is not used, Digital City program is planned, „smart” appears several times in relation to the keyword IT
Innovation	24	31	Competitiveness, Incubation, Culture, Higher education, Networking, Knowledge transfer, Automotive industry	Knowledge-based economy, Clusters, Skills to be developed, Industry, Environment, Energy, Incubation
IT (Computing)	5	27	Energy, Supporting the real estate strategy, Broadband infrastructure, Environment	Network infrastructure, Local ICT enterprises, Labour market demand, Education, training, Geographical information, Urban administration, Teleworking
Mercedes		32		Investment, Employment, Economic effect, Supplier, Strength of the city, Technology transfer, Industrial area, Related residential development, Education, Training, Strategic cooperation, Mercedes school,
Audi	11		Audi School, Industrial area development, Not mentioned as strategic	
Start-up	5	0		
Incubator, incubation	4	3		
Cooperation	27	29		
Future	18	59	Vision, Health, Culture, Innovation, Leisure time, Environment, Energy, Environmental sustainability, Innovation, Elderly-friendly local government, Transport, Noise pollution	Vision, Planning, Urban development, Jobs, Amount of credit, Financial planning, Social system, Environmental sustainability, Training, Digital City program, Green city, Environmental, economic and energy
Preparation	1	5	Urban Development Strategy	Climate change, EU grants

Table 1 shows the keywords analysed and their context in the Integrated Urban Development Strategy of the two cities.

The term "smart city" is mentioned on 11 pages in the Integrated Urban Development Strategy of Győr. In this document, the interpretation of this term narrows down to the topic of energy-efficient urban management. The terms "information technology / computer science" is mentioned on 5 pages in contexts related to environmental sustainability, GIS and broadband infrastructure. The Integrated Urban Development Strategy of Kecskemét does not include the "smart city" term, but on one page, the planned digital city program of Kecskemét is mentioned. In this document, the terms "information technology / computer science" is mentioned on 27 pages in contexts involving almost every level of urban operation. Both strategies aim for and describe in detail the environmental, economic and social sustainability, which is an

important element of the smart city approach; however, in the case of Győr, where the document describes the implementation of the objectives, the application of ICT tools are only mentioned in certain sub-areas. In contrast, the strategy of Kecskemét mentions the application of ICT tools in almost all of the urban subsystems.

The term "innovation" is mentioned on 24 pages in the case of Győr, and on 31 pages in the case of Kecskemét. It is a priority in both strategies to support the building of a knowledge-based economy, the cooperation of different industrial, academic, governmental and non-governmental persons and the R&D&I activities driven by industrial demand. The term "cooperation" is mentioned on 27 and 29 pages in both documents with strong emphasis. Both strategies include the creation of space that supports innovation and the creation of innovation centres and incubators. The term "start up" is mentioned on 5 pages in the case of Győr, but not once in the case of Kecskemét.

It is interesting to examine the appearance of the two major automotive manufacturers in the strategies of Győr and Kecskemét. The number of mentions differ (32 Mercedes and 11 Audi), and the context is also different. The term "Audi" only appears in connection with the development of industrial areas claimed by Audi school and factory, while the term "Mercedes" appears in a broad context including, inter alia, investment, employment, labour market, education, training, housing market, suppliers and technology transfer. The strategy of Kecskemét explicitly mentions Mercedes as the strategic partner of the city.

The terms "future" and "preparation" appear significantly more often in the case of Kecskemét. The Integrated Urban Development Strategy of Győr includes the term "future" mainly in the contexts of sustainability and the quality of life, while in the case of Kecskemét it expands with economy and labour market aspects, and the context of digital city also appears. In the case of Győr, the word "preparation" appears only on one page in relation with the implementation of city strategy, while in the case of Kecskemét, the word "preparation" is mentioned in the contexts of EU tenders and climate change. Neither of the documents mentions the term "preparation" in relation to the expected revolutionary changes in the automotive industry.

4 Summary

In conclusion, it can be stated that in both of the examined Integrated Urban Development Strategies it is a priority to support the building of a knowledge-based economy, the cooperation of different industrial, academic, governmental and non-governmental persons and the R&D&I activities driven by industrial demand, and both strategies consider the city's inhabitant's as strategic resources. Both Integrated Urban Development Strategies deal thoroughly and in detail with labour market, education, training and the quality of life offered by the cities. Both strategies aim for and describe in detail the environmental, economic and social sustainability, which is an important element of the smart city approach; however, in the case of Győr, where the document describes the implementation of the objectives, the application of ICT tools are only mentioned in certain sub-areas. In contrast, the strategy of Kecskemét mentions the application of ICT tools in almost all of the urban subsystems. The Integrated Urban Development Strategy of Győr mentions Audi, which fundamentally and dominantly determine the city's employment, economy and society, only in connection with the Audi School and the development of industrial areas, while the Integrated Urban Development Strategy of Kecskemét mentions Mercedes as a strategic partner. In the case of factors that determine the environment of the city, neither of the strategies analyzes the expected revolutionary changes in the automotive industry and their impact on the cities.

Recommendations:

- The analysis of the impact of automotive industry trends and industrial trends which affects the cities, and the development of action plans with special attention to the

topic of industrie 4.0 and the impact of automotive trends (electro mobility, connected car, autonomous car, car sharing) on the future production needs.

- In the case of Győr, treating Audi as a strategic partner and integrating its planned activities in the city's planning processes on the level of the Integrated Urban Development Strategy as well.
- Developing full range and formal smart city and digital city strategies.

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