Investigating Artificial Intelligence Applications Towards Future Smart Cities using a Fuzzy DEMATEL Method

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Introduction

- Smart cities vastly integrate technologies and support the innovations regarding the ability to provide sustainable urban socio-economic development.

- The growing rate of urbanization and "Metropolises" with more than 8 million inhabitants such as Tehran, cause difficulties to develop a sustainable and cost-effective environment and a high-quality life for the citizens.

- The cutting-edge Artificial Intelligence (AI) techniques are required to to deal with this limitation, boosting information and communication technologies (ICTs) solutions and implicitly enhancing the competitiveness of cities.

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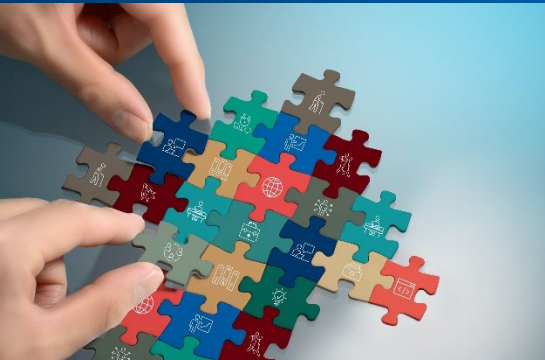
Smart People, Smart ICTs and Smart Cities

- AI provides possibilities to replace the human being in complex and dangerous activities.

- But, smart cities start from smart human capital, as merely smart people can create smart ICTs equipped with AI (Figure 1).
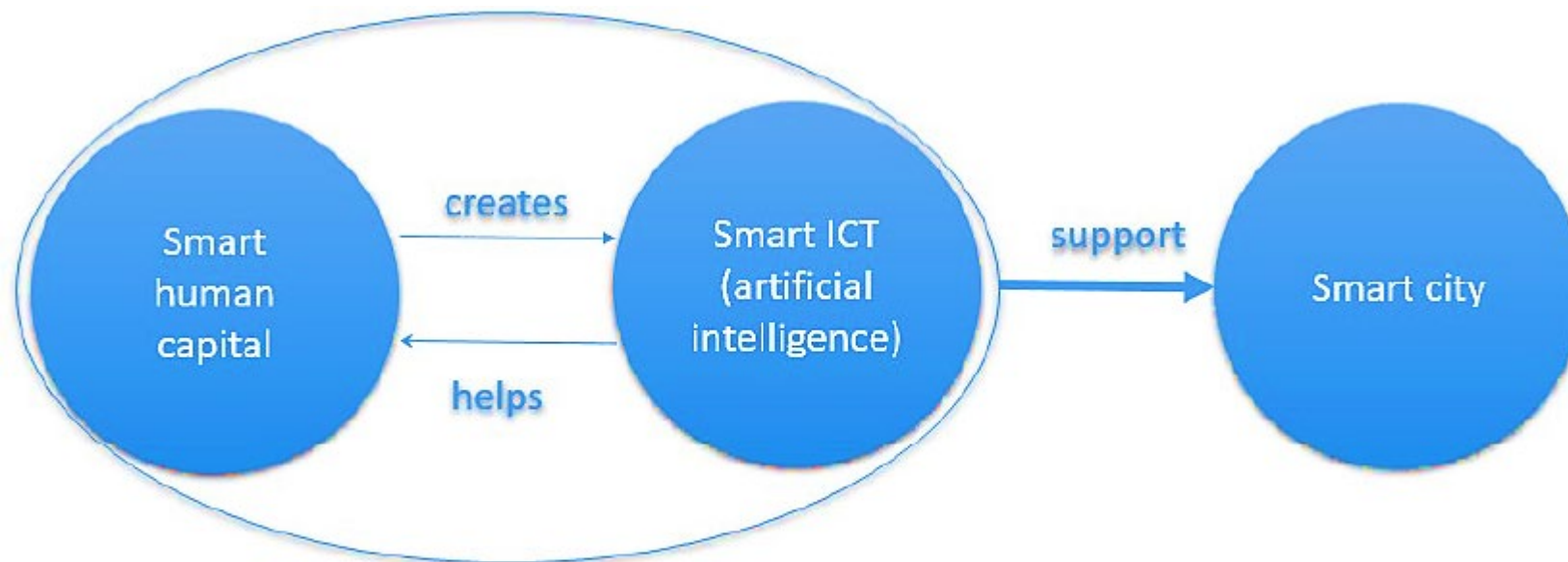

Figure 1. Smart people, smart ICTs and smart cities (Voda & Radu, 2018).

Smart City: Soft Dimensions

- The urban development is based on six 'soft dimensions': *smart economy, smart people, smart governance, smart mobility, smart environment and smart living* (Giffinger & Gudrun, 2010).

- These dimensions and factors are the components of the framework for evaluating a city's performance as a smart city (Table 1).
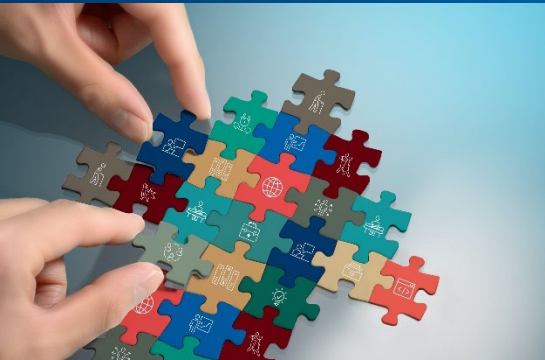
Table 1. Smart city complex system factors (Voda & Radu, 2018).

Smart Economy	Innovative spirit	Entrepreneurship		Economic image and trademarks	Productivity		Flexibility of labour market	International embeddedness	Ability to transform
Smart People	Level of qualification	Affinity to lifelong learning	Social and ethnic plurality	Flexibility		Creativity	Cosmopolitanism/open-mindedness		Participation in public life
Smart Governance	Participation in decision making	Public and social services			Transparent governance		Political strategies and perspectives		
Smart Mobility	Local accessibility	(Inter-) national access		Availability of ICT-infrastructure		Sustainable, innovative and safe transport systems			
Smart Environment	Pollution	Environmental protection		Attractively of natural conditions			Sustainable resource management		
Smart Living	Cultural facilities	Health conditions	Individual safety	Housing quality	Education facilities		Touristic attractiveness	Social cohesion	

- Due to the constantly increasing migration from rural to urban areas, concerns about economic restructuring, environmental protection, government and mobility issues must be dealt with in a smarter approach.
- According to Batty (2014), the answer to these challenges will be provided by data mining and new forms of AI.
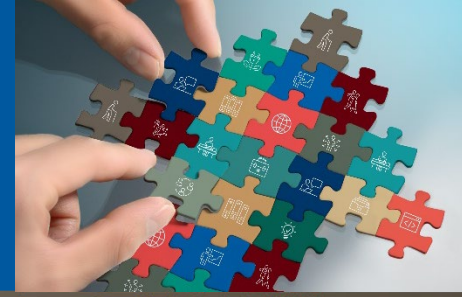
1) **Self-driving cars:**

- Self-driving vehicles equipped with a variety of proximity sensors and driving programs;

- Over 3 million miles self-driven.

2) **Autonomous Learning Agents:**

- Autonomous agents (e. g. drones) that though different algorithms collect and exchange information;

- Exchange of information would allow for strategies to be refined actively and improved;

- Developed for serving in the line of defense;

3) AI Assistance Systems:

- Virtual assistance programs which allow huge raw data processing (e. g. stock trades) in short amount of time and can make predictions. In case of errors, the system can learn from the mistake and adjust based of the shifting dynamics in the market and broader economy;

- AI helps monitoring around 30 factors that can affect the system performance (e. g. price-earnings ratios, interest rate).

4) Robot Patrol Vehicle:

- Vehicle patrol robot equipped with advanced sensors, which rides though predetermined paths.

- The Mobile Detection Assessment Response incorporated systems allow the AI Robot to detect intrusions and alert the persons in charge of any perimeter violations;

- Estimated savings of more than $6 million in infrastructure costs (e. g. no cameras or lights or towers utilisations, etc.) and $1 million due to eliminating the need for equipment maintenance and protective force costs.

- A Fuzzy DEMATEL method
  - (R): effectiveness of variables;
  - (D): influence of variables;
  - (R+D): importance of variables, and
  - (R-D): classifies criteria into a cause and effect group.
- A paired comparison questionnaire (seven tables)
- 15 experts of the Plan and Budget Organization of Iran participated (Table 2)

Table 2. Demographic statistics of the respondents

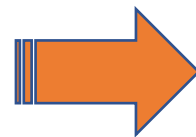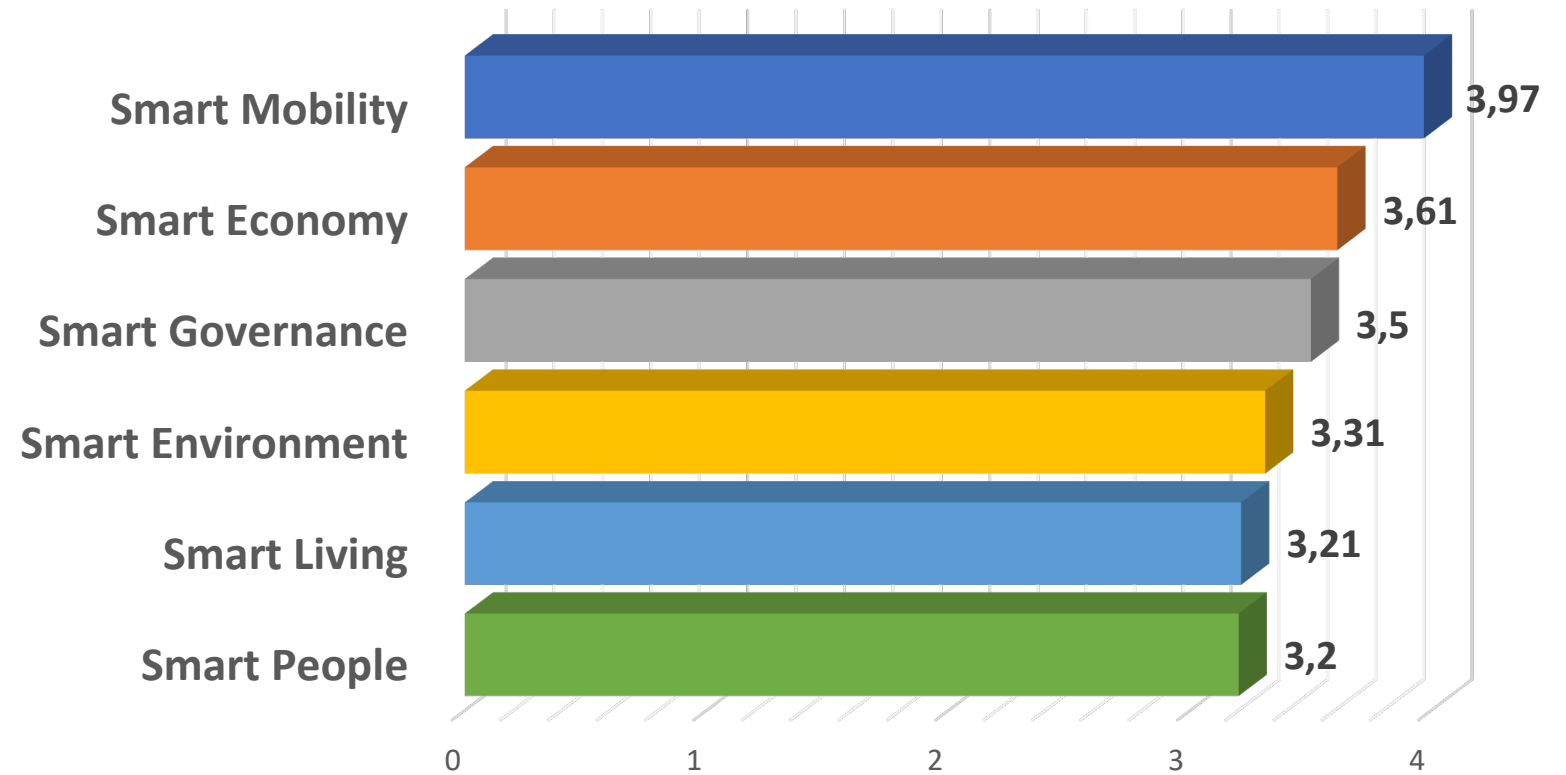| Gender		Age (year)			Education			Experience (year)			
Male	Female	30-40	40-50	over 50	BA	MA	PhD	5-10	10-15	15-20	over 20
11	4	4	6	5	3	7	5	2	5	3	5
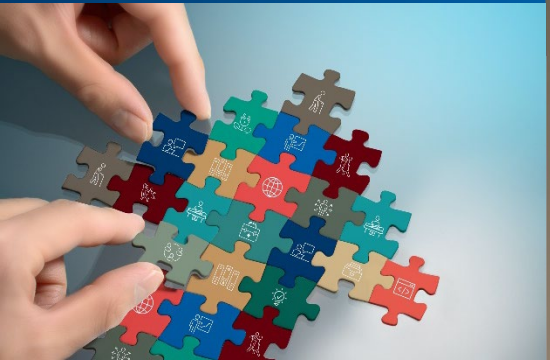
Results

The interrelationships among Smart City factors (Fuzzy DEMATEL)

Factors	Smart People	Smart Economy	Smart Mobility	Smart Governance	Smart Environment	Smart Living
R	1.7	1.97	2.18	1.66	1.51	1.44
D	1.51	1.63	1.79	1.84	1.8	1.77
R+D	3.2	3.61	3.97	3.5	3.31	3.21
R-D	0.19	0.34	0.4	-0.18	-0.29	-0.33

Results

Ranking based on the importance of Smart Cities Factors

Factor	Value
Smart Mobility	3,97
Smart Economy	3,61
Smart Governance	3,5
Smart Environment	3,31
Smart Living	3,21
Smart People	3,2

The main beneficiary of AI facilities: Smart Mobility

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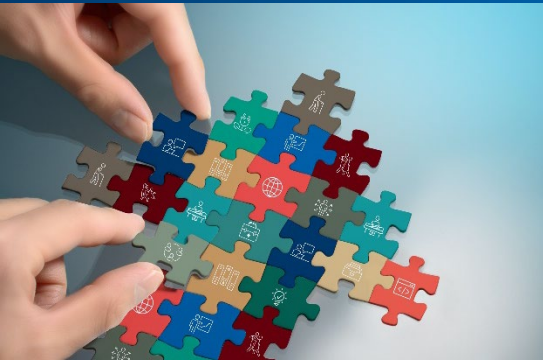
Results

Cause and Effect Diagram for Smart City complex system factors as **beneficiaries of AI facilities**
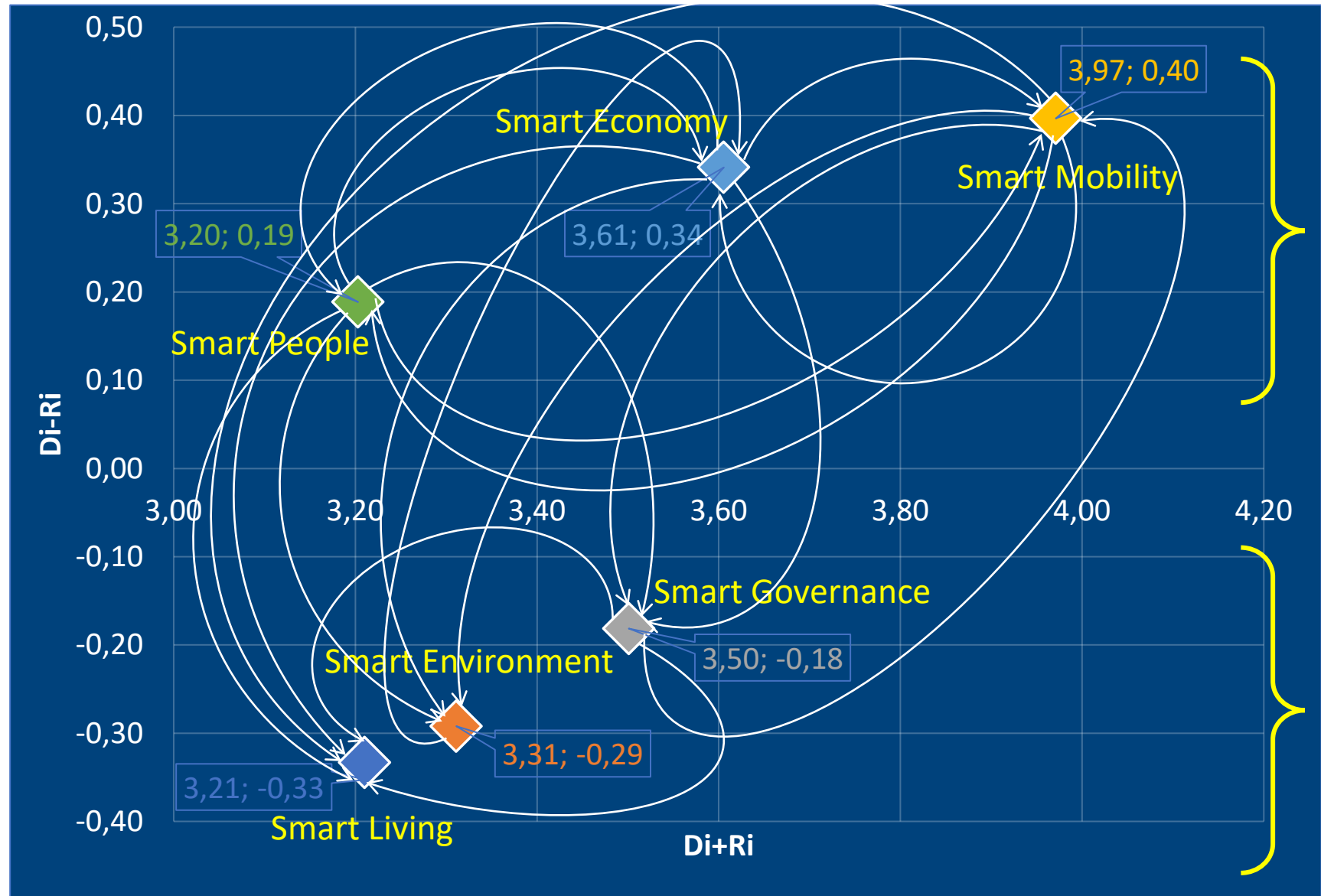
Conclusions

- From the results we could observe that experts in Plan and Budget Organization of Iran perceive AI as a very important factor in the development of smart cities.

- Based on the ranking of smart cities factors by Fuzzy DEMATEL method, The experts' score higher assuming that Smart Mobility will be the main beneficiary of AI facilities.

- Cause and Effect Diagram indicates that:
  - ✓ Smart Mobility, Smart Economy, and Smart People causes <u>all factors</u>.
  - ✓ Smart Living causes <u>no factor</u>.

  Therefore: 1) Smart Living is independently a beneficiary of AI facilities.

  2) Smart Mobility, Smart Economy, and Smart People have interrelationships
     with all factors as successors of AI facilities.

Study Limitations

- Our findings are in line with other studies (Katz, 2014; Schermerhorn et al., 2008; Loffredo & Tavakkoli, 2016; Voda & Radu, 2018).

- Some limitations associated with this research include the selected sample experts, so our results are limited and cannot be generalized.

- Further, additional factors may be included in the analysis for a more complex overview and analysis.

Thank you for your attention

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Any Question?