Artificial Intelligence and the Future of Smart Cities

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Abstract

Smart cities integrate a wide variety of technologies and support those innovations capable of delivering sustainable socio-economic development of cities. They are complex environments that are shaped by their innovation capacity, information and communication technologies (ICTs) development and adoption, living standards, residents' readiness, and, last but not least, the willingness to invest. Higher urbanization rates and "mega-cities" with 10 million inhabitants or more make difficult to create a sustainable and cost-effective environment and a high quality of life for the citizens. To overcome this shortcoming, the latest Artificial Intelligence (AI) techniques are needed to increase ICTs solutions and implicitly, to augment the cities competitiveness. Our paper objective is to analyse the public attitude regarding the influence of AI on smart cities characteristics and to identify if there are significant differences in their perspective by gender and by age group. The statistical data analysis was performed using two-way measure analysis of variance (ANOVA). The differences between groups were analysed using inferential statistics. This paper contributes to the understanding of the importance of AI techniques in improving urban living.

Keywords: smart cities, Artificial Intelligence (AI), competitiveness.

1. Introduction

Smart cities are urban regions very advanced in terms of technology, where people and organizations are ultra-connected. They are systems of intelligent subsystems. All components work as an integrated system that provides real-time access to quality services and products in an economic and social environment characterized by sustainable development. This system involves the use of information and communication technologies (ICTs) to stimulate economic growth and improving the quality of life and, at the same time, the integration of all hardware and software technologies to improve urban management (Kitchin, 2015). The expression "smart city" is not unique for this new city "which often link together technological informational transformations with economic, political and socio-cultural change" (Hollands, 2008). Some authors use expressions like digital city, intelligent city, ubiquitous city, knowledge city, green city, sustainable city and so on, according to their field of interest. Nam and Pardo (2011) studied the difference between these concepts. From the technological perspective, smart cities are cities with ubiquitous ICTs applied to critical infrastructure components and services (Washburn et al., 2010; Albino et al., 2015). These ICTs are more advanced. According to Klein and Kaefer (2008), they permeate into intelligent-acting products and services, artificial intelligence (AI), and thinking machines. The smart cities dimensions have evolved from industry, education, participation, and technical infrastructure (Giffinger et al., 2007) to smart economy, smart people, smart governance, smart mobility, smart living and smart environment (Giffinger & Gudrun, 2010). All these components have to support the sustainable development of human society. It is estimated that by 2050 about 70% of the world's population will live in the urban area (Gupta et al., 2015). This demographic pressure along with global warming issues and the significant reduction of certain categories of non-renewable natural resources led to the search for alternative solutions. According to other authors "water, sewer, transportation, electricity, telecommunications, housing, healthcare, education — all of these functions—will have to be built from the ground up" (Glasmeier & Christopherson, 2015). This search is facilitated by the evolution of ICTs in general and of AI in particular. AI offers possibilities to replace the human being in complex and dangerous activities. But, smart cities start from smart human capital (Shapiro, 2006; Holland, 2008), because only smart people can create smart ICTs equipped with AI (Figure 1). These people and technologies will solve, by creativity and cooperation, problems associated with urban agglomerations, pollution, the depletion of some natural resources etc.

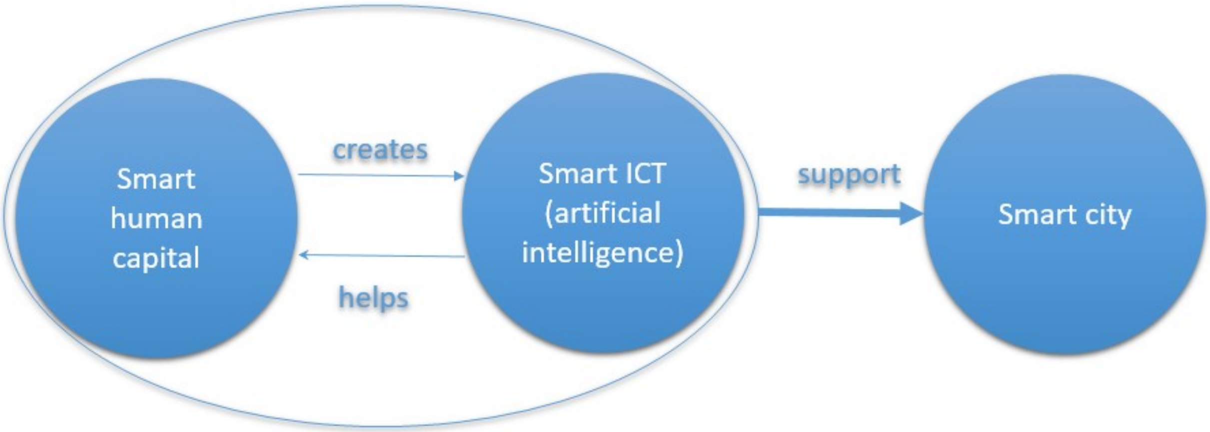

Figure 1. Smart people, smart ICTs and smart cities

The goal of this study aims to examine the potential of AI in smart cities development. The rest of this paper is organized as follows. In the next section, the definition and current status with some characteristics of smart cities and AI are given in brief. Therefore, according to our research objective, the results of a survey on public attitude regarding the influence of AI on smart cities characteristics and the significant differences in their perspective, by gender and by age group, are identified in the methodology and results sections. The last section is used for concluding remarks and study limitations.

2. Literature review

Smart cities are complex systems designed by using highly advanced integrated technologies which include millions of sensors and devices which are linked to computerized systems comprised of databases, tracking and decision-making algorithms (Bowerman et al., 2000). Due to its complex nature, the concept of 'smart city' is difficult to define. Most authors in their attempt to offer a representative and comprehensive definition focus either on people or citizens or on their quality of life (Caragliu, 2009; Giffinger et al., 2007). Just a few recall the importance of public and private institutions in improving the quality of life, while others pay attention to the environmental impact of urban activities (Dameri, 2013) or the use of infrastructures (especially ICTs) (Su et al., 2011). From the specialized literature, we selected Caragliu (2009) definition which encapsulates most of the above elements, and according to which "a city to be smart when investments in human and social capital and traditional (transport) and modern (ICTs) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance". This holistic definition integrates different economic and social demands, and also focuses on the urban development needs which are subordinated to sustainable development principles. It also emphasizes the ICTs based infrastructures for enhancing both the competitive profile of a city and people' quality of life.

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). 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.

Table 1. Smart city complex system factors

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

Source: Author's adaptation after smart-cities.eu, 2015

2.1. Smart city complex system factors

The greatest successes achieved in various component tasks such as speech recognition, autonomous vehicles, image classification, machine translation and question-answering systems can be attributed to a large degree of integration and mixture of ideas between AI, neuroscience, machine learning, and other interdisciplinary fields. Our society progress is achieved not only by making AI more capable, but also by maximizing its societal benefits.

Figure 2 underlines the importance of traditional production factors such as capital and labour in achieving and driving growth which arises when either stock of capital or labour increase or they are more effectively used. Total factor productivity (TFP) represents the growth enhanced by the use of technology and innovation. Besides these traditional factors, Purdy and Daugherty (2016) consider that AI can be seen as a new production factor, a capital-labour hybrid that will lead to significant growth opportunities. This is due to the advancement made in AI, which allows nowadays to replicate some labour activities at a greater and faster scale than humans (e.g. virtual text assistance, self-learning machines) (Purdy and Daugherty, 2016).

Figure 2. Traditional growth model vs. adapted growth model
Source: Adapted after Purdy & Daugherty, 2016

In our days AI is already present in various fields of activity, in economic and social life. In table 2 are presented some examples of AI application and their benefits for human and environment.

Table 2. Examples of AI applications

		Description	User	Author (Year)
AI applications	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.	Nevada National Security Site, USA	Shachtman (2010)
	Artificial Intelligent 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).	Wall Street	Patterson (2010)
	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 defence;	Disaster rescue situation management	Adams et al. (2008)
	Self-driving cars	• Self-driving vehicles equipped with a variety of proximity sensors and driving programs; • Over 3 million miles self-driven.	USA	Google (2009) and Waymo (2016)

2.1. Artificial intelligence and Smart cities

As we previously saw, AI can be used in different areas from security purposes, stock market, to rescue management and transportation. When regard to smart cities development, complex factors such as economic restructuring, environmental protection, government, and mobility issues arise. In the following section, our analysis is focused on the importance of AI for the development of smart cities.

For instance, AI can be used to achieve sustainable development of intelligent buildings. This is possible by using electronic devices, software driven systems or other advanced technologies in the form of AI, which perceive the building environment and take action to improve/ optimize the system performance (Adio-Moses & Asaolu, 2016).

Agarwal et al. (2015) underline the importance of AI for the development of a more efficient Intelligent Transport System in smart cities. The authors reveal that AI is not only a viable and convenient solution for design, construction, maintenance and time scheduling of transport system, but can also be used for resolving complex transport system problems at a faster and more efficient scale (e.g. huge amount of data processing). Integrating AI is also useful because it helps proving real-time report(s) on traffic accidents or predicting traffic conditions. In other words, AI application for development of Intelligent Transport Systems is essential because can solve many of the smart city's problems like traffic congestion, overcrowding, environmental degradation and so further (Agarwal et al., 2015). Nowadays, increase traffic flows represent an important issue for most smart cities around the world and its managing requires physical infrastructure complemented by new ways of thinking and advanced technologies. In line with these, Hawi et al (2015) emphases the need for new and advanced technologies such as intelligent control and AI to make traffic routine decisions in order to resolve increased traffic congestion from most urban areas. For instance, through the Twende-Twende project developed by IBM in partnered with a Kenyan Internet service provider, individuals were able to receive information and advises on their phones about driving routes and estimates on traffic congestion (Hawi et. al, 2015). Other authors like Patel & Ranganathan (2001) also presented an ANN (Artificial Neural Network) based on 83 neural nodes system that develops its decisions on the received inputs and selects the most suitable solution for the traffic situation. Environment Observation Method based on Artificial Neural Networks Controller represents another neural network of supervising urban traffic. Using different mathematical methodologies, the system makes time plans for intersections in order to prevent traffic congestions (De Oliveira & Neto, 2013).

The use of AI is not limited to smart buildings or transportation. It covers a wide range of application from medical diagnosis, to robot control and virtual assistance scientific tools. Nowadays, AI can be encountered in many services such as: cars speech recognitions, industrial robots, intelligent vacuum cleaners or fridges and so further. It can also be used in smart homes which permits by using hundreds or even thousands of sensors to provide services according to our preferences such as: ambient assisted living, energy saving etc. According to Skouby et al. (2014), AI also can be utilized in smart homes by adding personalized features in form of context awareness which allows AI to move beyond automation level. These authors designed a four-layer pyramid which encases the ICTs based infrastructure for future smart cites (Figure 3).

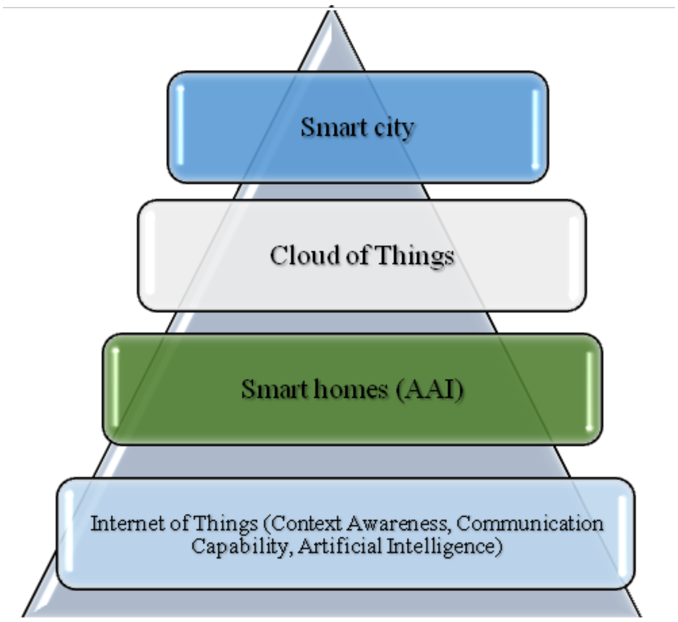

Figure 3. ICT-based infrastructure and its four layers
Source: adapted after Skouby et al., 2014

At the bottom layer we have a collection of IoT who interacts directly with the users. The contextual information gathered by smart home systems is used to "learn" and predicts individual preferences and behaviour (layer 2). Based on a mixture of the contextual system findings and AI utilization a new category of services can be provided such as: intelligent lighting and heating or other ambient assisted living, intelligent supervising system security, environmental monitoring for children or seniors etc., which are tailor-made for the user. The combination of all the four layers creates a smart city ICT based infrastructure, which supplies "advantages in the smart city areas", "environment, energy and water", "government, administration and public safety", and "social programs and healthcare" (Skouby et al., 2014).

2. Methodology and data

In literature, many studies focus on gender and age differences in attitude towards robots (Katz, 2014; Schermerhorn et al.; 2008, Loffredo & Tavakkoli, 2016). Starting from this premise, our paper objective is to analyse the influence of AI on smart cities characteristics and to identify if there are significant differences in public attitude by gender and by age group. The statistical data analysis was performed using two-way measure analysis of variance (ANOVA). The differences between groups were analysed using inferential statistics. Tests and modelling were performed using Statistical Package for Social Science (SPSS) software, SPSS 21.0 and Gretl.

In order to analyse the public perception on the influence of AI on smart cities characteristics, we have developed a survey which was completed during a four months period. The questionnaire-based survey was divided into two main parts: the first one contains some demographic questions such as gender, age, employment status and type, and field of activity. In the second part, in order to underline the relationship between AI and smart cities, we have developed several questions, in which respondents were asked to indicate the extent to which they agreed or disagreed with each item. In order to capture the importance and benefits of AI we used an online survey which was sent to 150 respondents, during August to November 2017 (Table 3). Different data sources were used to achieve more accuracy in the study (Table 4). From this total amount, only 112 were completed and remained in the analysis.

Table 3. Used data and sample

Variable name	Percentage
Age of the respondent	
18-25 years	31.3%
26-30 years	6.3%
31-40 years	50%
41-50 years	12.4%
+51 years	-
Gender of the respondent	
Male	68.8%
Female	31.2%
Employment status	
Yes	93.8%
No	6.2%
Industry currently employed	
SMEs	66.7%
Large private-sector corporation	6.7%
State enterprise/ Public administration	6.7%
University/ Research Institute	20%
Other institution	-
Field of activity	
IT/Software	66.7%
Accounting	6.7%
Advertising / Marketing / Public Relations	6.7%
Education – research	20%
Others fields of activity	-

Table 3 shows the demographic data used for our survey. The majority of the respondents were male and employed. We encompass a widely range of age groups ranging from 18-25 years old to +50 years old.

Half of the respondents were between 31 and 40 years old, while just a few were between 26-30 years old (6.3%). The majority of the respondents were employed in Small and Medium Enterprises (SMEs) and work in IT/software field or education and research.

Public attitude on the influence of AI on smart cities characteristics was measured using the following items described in Table 4. For each question we test if there are significant differences in the public attitude by gender and by age group (except question 15 due to the answering type).

Table 4. Survey questions

No.	Item	Question scale	Source
Q6.	Generally speaking, how do you assess the influence of AI in the development of intelligent cities?	Likert Scale recoded: 1 (not important) to 5 (very important)	-
Q7	Which of following features of smart cities would benefit the most from AI input:	Likert Scale recoded: 1 (strongly disagree) to 5 (strongly agree)	Source: adapted after Giffinger et al. (2007)
Q7.1	*Smart Economy (creative, innovation, entrepreneurship)*		
Q7.2	*Smart Governance (e-government, e-democracy)*		
Q7.3	*Smart Mobility (logistics and infrastructure)*		
Q7.4	*Smart Environment (environmental protection, sustainable development)*		
Q7.5	*Smart people (education, ICT skills)*		
Q7.6	*Smart living (security and quality of life)*		
Q8	On a scale of 1 to 5 (1 being "not important" and 5 being "critical for survival"), how important do you think will be the AI for your business or your industry (or for the one you are preparing for) in the next 10 years?	Likert Scale recoded: 1 (not important) to 5 (critical for survival)	Source: A. T. Kearney (2016)
Q9	Which of the following job functions will AI impact the most over the next 10 years?	Likert Scale recoded: 1 (not at all) to 5 (very much)	Source: A. T. Kearney (2016)
Q9.1	*General management (e.g. HR/people management).*		
Q9.2	*Product design and development (e.g. new product, ideation, development and introduction).*		
Q9.3	*Marketing (e.g. intelligent customer targeting, planning and executing marketing campaigns).*		
Q9.4	*Finance (e.g. robotic financial advisors, automated corporate financial analysis).*		
Q9.5	*Customer services (e.g. 100 % automated problem resolution, product or service delivery through automated driving).*		
Q9.6	*Health (e.g. consultation and diagnosis, surgery).*		
Q10	How likely is the use of AI in the following city-specific management scenarios?	Likert Scale recoded: 1 (impossible) to 5 (surely it will be).	Source: adapted after Stone et al. (2016) and Giffinger et al. (2007)
Q10.1	*Automatic waste selection via ubiquitous devices (e.g. RFID tag) on products.*		
Q10.2	*Automatic traffic management.*		
Q10.3	*Management and control of energy consumption in buildings and in the public space.*		
Q10.4	*Consultancy in the field of public services.*		
Q10.5	*Management of health services through biometric identification systems.*		
Q10.6	*Tourist assistance.*		
Q.11	On a scale of 1 to 5 (1 being "totally unimportant" and 5 being "very important"), how do you consider that the influence of AI on individual safety will be?	Likert Scale recoded: 1 (totally unimportant) to 5 (very important)	Source: adapted after Stone et al. (2016)
Q12	In your opinion, AI will be present in education through:	Likert Scale recoded: 1 (impossible) to 5 (surely it will be done).	Source: adapted after Stone et al. (2016)
Q12.1	*Evaluation process.*		
Q12.2	*Adaptation of information to the needs of each person.*		
Q12.3	*Robots to teach basic elements.*		
Q12.4	*Customize courses for each student.*		
Q12.5	*A better management of learning through successive attempts (the fear of failure disappears).*		
Q12.6	*Supporting continuous, personalized learning that can be done anywhere.*		

No.	Item	Question scale	Source
Q12.7	*Reduces costs (fewer teachers, fewer schools).*		
Q13	In your opinion, AI influence the environment through:	Likert Scale recoded: 1 (totally disagree) to 5 (totally agree)	Source: adapted after European Green City Index (Economist Intelligence Unit, 2012)
Q13.1	*Increase in energy consumption.*		
Q13.2	*Increasing the volume of electronic waste.*		
Q13.3	*Better information for citizens.*		
Q13.4	*Attracting community members to environmental actions.*		
Q13.5	*Increase in CO_2 emissions.*		
Q14	In your opinion how would you feel if the following activities could be done by robots:	Likert Scale recoded: 1 (totally disagree) to 5 (totally agree)	Adapted after European Commission Report (2017)
Q14.1	*Performing medical surgeries.*		
Q14.2	*Child Care.*		
Q14.3	*Supply of consumer goods.*		
Q14.4	*Driving a car.*		
Q14.5	*Assistance in performing tasks at work.*		
Q14.6	*Cleaning.*		
Q15	Which of the following domains is compatible with the use of AI (Max 3 answers):	Max 3 answers from 10 possible	Adapted after European Commission Report (2017)
	Manufacturing.		
	Healthcare.		
	Education.		
	Care of children, elderly, and the disabled.		
	Domestic use, such as cleaning.		
	Military and security.		
	Space exploration.		
	Informing citizens.		
	Transport / Logistics.		
	Environmental monitoring.		

4. Results and interpretation

Survey Question 6

Respondents were asked to indicate how they evaluate the influence of AI in the development of intelligent cities. In order to fully understand the concept of smart cities, the definition of smart city given by Caragliu (2009) was given to the respondents. It is presented in section 2. On question 6 two-way analysis was used to determine the difference by age and gender. There was no statistically significant interaction between groups as determined by two-way ANOVA $F(3, 106) = 8.675$, p value>0.05 (p=.387). The *assumption of homogeneity of variance* was tested using the *Brown-Forsythe Test*. There were statistically significant differences by gender (F=2.169, p<0.05) and by age (F=30.885, p<0.05). More than 9 in ten (almost 94%) consider AI to be important (50%) or very important (43.8%) while just a few (6.2%) recall a moderate importance for smart cities development. Female participants scored significantly higher (M=4.60, SD=.49) than male participants (M=4.27, SD=.62) on question 6 „Generally speaking, how do you assess the influence of AI in the development of intelligent cities". At the same question: the 41-50 age group scored the highest score followed by the 18-25 age group (M=4.40, SD=.49). The 26-30 age group scored lower than the 18-25 age group (M=4.37, SD=.48) and significantly higher than the 31-40 age group (Figure 4).

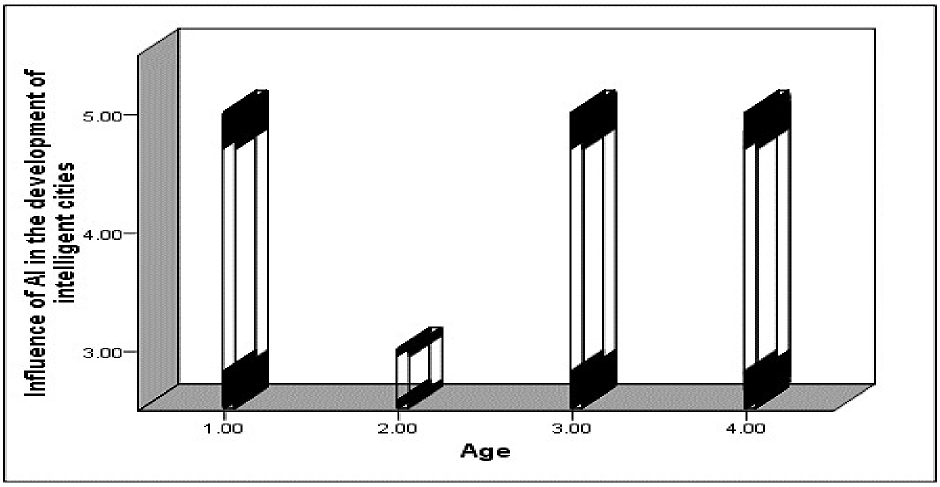

Figure 4. Influence of AI in the development of smart cities by respondents age

Survey Question 7

Question 7 was used to estimate the characteristics of smart cities that will be the main beneficiaries of AI facilities. The respondents were asked to indicate which of the following features of smart cities would benefit most from AI input. Their answers were evaluated using a Likert Scale: 1 means strongly disagree and 5 strongly agree. There were used the six characteristics identified by Giffinger et al. (2007). The results are presented in table 5 per total and by gender. No statistical interaction between age and gender F (3, 108) = 1.97, p=.17) was found for 7.1, neither for 7.2 (F=1.052, p=.329), 7.3 (F=5.063, p=.058), 7.4 (F=.405, p=.539), 7.5 (F=0.16, p>0.05) and 7.6 (F=.483, p>0.05). The *assumption of homogeneity of variance* was tested using the *Brown-Forsythe Test*. In this situations the homogeneity assumption was violated. For 7.1 we found statistically significant differences by gender (F=7.639, p=0.007) and by age (F=4.373, p<0.05) and also for 7.3 by both gender (F=7.419, p=0.021) and age (F=1.996, p=0.017). For 7.2, 7.4, 7.5 and 7.6 no statistically significant differences were found either by gender (p>0.05) or age (p>0.05). In the analysis only the statically significant differences by gender and age were interpreted. The female participants' score higher assuming that Smart Economy will be the main beneficiary of AI facilities. On the other hand, male respondents consider that logistics and infrastructure (Smart Mobility) as the main beneficiary of AI (Table 5).

Table 5. Means and standard deviations per total respondents and by gender

Item	Fields of interest	Total	Females	Males
Q7.1	**Smart Economy**	**(M=4.06, SD=.75)**	**(M=4.60, SD=.49)**	**(M=3.80, SD=.75)**
Q7.2	Smart Governance	(M=3.62, SD=.78)	(M=3.60, SD=.49)	(M=3.40, SD=.81)
Q7.3	**Smart Mobility**	**(M=4.43, SD=.61)**	**(M=4.00, SD=.64)**	**(M=4.40, SD=.81)**
Q7.4	Smart Environment	(M=4.25, SD=.75)	(M=4.60, SD=.49)	(M=4.20 SD=.75)
Q7.5	Smart People	(M=3.87, SD=.99)	(M=4.00, SD=.64)	(M=4.60, SD=.81)
Q7.6	Smart Living	(M=4.12, SD=.93)	(M=3.60, SD=.49)	(M=4.20, SD=1.18)

The majority of the respondents who found the smart features to be the main beneficiaries of AI facilities were ranging between 31-40 years old and +41 age old, followed by the 18-25 age group (M=3.80, SD =0.75), 26-30 (MD=4.0, SD =.75) (Figure 5).

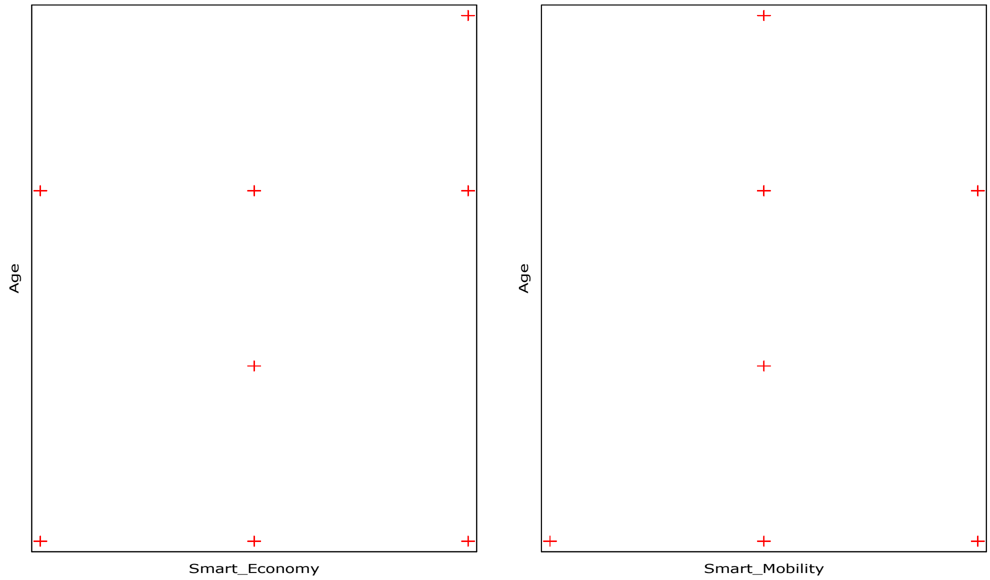

Figure 5. Smart features as the main beneficiaries of AI in terms of the respondent's age *(statistically significant differences only for 7.1 and 7.3)*

Survey Question 8

On question 8 respondents have to indicate on a scale of 1 to 5 (1 being "not important" and 5 being "critical for survival"), how important they think the AI will be for their business or industry (or for the one they are preparing for) in the next 10 years? No statistical interaction was found between age and gender F (3, 108) = .174, p>0.05). There were statistically significant differences by gender F (1, 108) = 50.261, p<0.05 and age, F (3, 108) = 9.298, p<0.05. Female participants scored significantly higher (M=4.60, SD=.49) than male participants (M=3.36, SD=.88) on question 8 about the importance of AI for the fields of activity of the participants (or for those they are preparing for) in the next 10 years. At the same question: the 26-30 age group scored the highest followed by the 18-25 age group (M=3.80, SD=1.18); the 31-40 age group scored lower than the 18-25 age group (M=3.50, SD=.87); the 31-40 age group scored also lower than the 18-25 age group (M=3.50, SD=.51) (Figure 6).

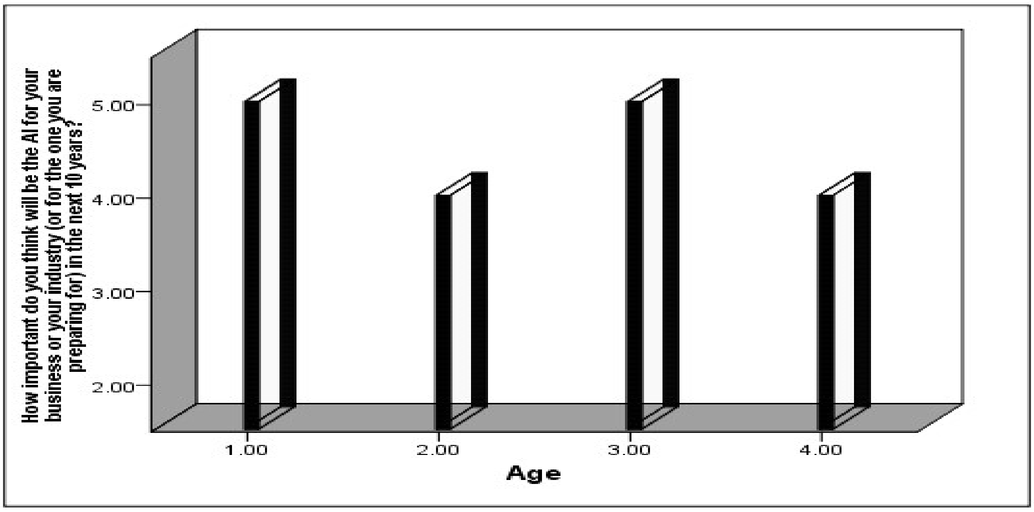

Figure 6. Importance of AI for respondents business or industry by respondent's age

Survey Question 9

On question 9 a two-way analysis of variance shows that no statistical interaction was found between age and gender for 9.1 (F=.621, p>0.05), 9.2 (F=1.383, p=.242), 9.3 (F=.75, p=.54), 9.4 (F=.23, p>0.05), 9.5 (F=.952, p=0.33) and 9.6 (F=.47, p>0.05). There were no statistically significant differences by gender and age for 9.1 (F=.383, p>0.05 for age and F=1.217, p>0.05 for gender) and 9.2 (F=.1.467 p>0.05 for age and F=1.383 p>0.05 for gender). For 9.3, 9.4, 9.5 and 9.6 we found statistically significant differences by gender and by age (9.3 - F=.75, p<0.05 for age and F=5.217 and p=0.045 for gender; 9.4 where F=5.309, p=0.019, for age and F=19.247 and p=0.001 for gender; on 9.5 where F=2.638, p=0.05 for age and F=6.437 and p=0.013 for gender; and for 9.6, F=15.967, p<0.05 by age and F=23.361 and p<0.05 by gender). In the analysis only the statically significant differences by gender and age were interpreted. The analysis reveals that people perceive that AI will have a greater impact over the next 10 years on marketing (for example, intelligent customer targeting, planning and executing marketing campaigns) scored significantly higher (M=4.37, SD=.69) than on finance (for example, robotic financial advisors, automated corporate financial analysis) (M=3.87, SD=.60) (Figure 7). For the same question customer services scored significantly higher (M=3.75, SD=.83) than health (e.g. consultation and diagnosis, surgery) (M=3.25, SD=.83). For the same question, the analyses by gender reveals that the majority of female participants scored significantly higher (M=3.40, SD=.81) than male participants (M=3.18, SD=.57) and those aged in the second group.

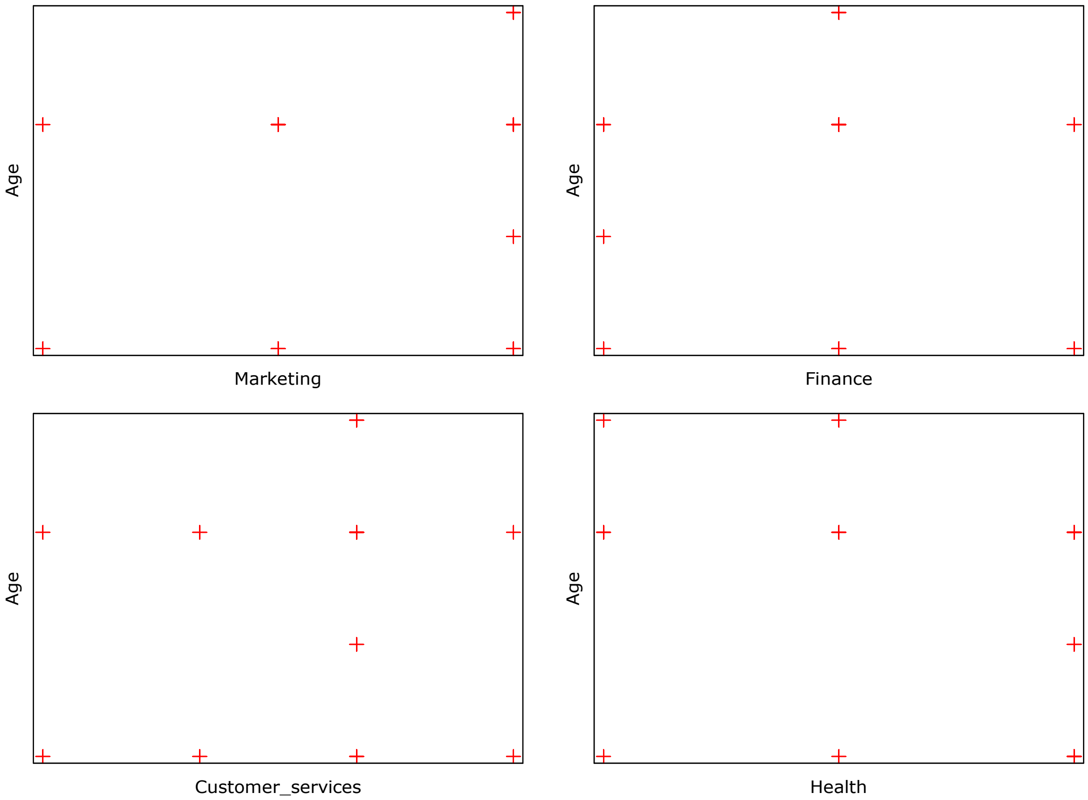

Figure 7. Q.9.Which of the following job functions will AI impact the most over the next 10 years? (Statistically significant differences by age for 9.3, 9.4, 9.5 and 9.6)

Survey Question 10

On question 10 a two-way analysis of variance was used to identify the fields with higher probabilities of AI use in smart cities management. On question 10 the analysis of variance shows that no statistical interaction was found between age and gender for 10.1 (F=1.013, p>0.05), 10.2 (F=3.545, p=.062), 10.3 (F=.32, p>0.05), 10.4 (F=2.836, p>0.05), 10.5 (F=2.939 p>0.05) and 10.6 (F=3.019, p>0.05). For 10.1 we found statistically significant differences by gender (F=12.917, p<0.05) and by age (F=7.997, p<0.05) also for 10.2 (by gender F=23.967, p<0.05 and by age F=6.208. p<0.05) and 10.3 (by age F=.384 and p=0.252). For 10.4, 10.5 and 10.6 no statistically significant differences were found either by gender or age (10.4: F=1.318, p>0.05 by age and F=2.836, p=.123 by gender; 10.5: F=.396, p>0.05 by age and F=.435, p=.123 for gender; 10.6: F=.793, p>0.05 by age and F=.932, p>0.05 by gender). In the analysis only the statically significant differences by gender and by age were interpreted. From questions Q10.1, Q10.2 and Q10.3 were we found statistically significant differences by gender and by age the analysis shows that female respondents consider much more that AI will be used in the following city specific management scenarios: management and control of energy consumption in buildings and in the public space and automatic traffic management (Table 6). The 26-30 age group scored significantly higher (M=3.60, SD=.93) than the other groups.

Table 6. Means and standard deviations by gender

Item	Fields of interest	Females	Males
Q10.1	**Automatic waste selection via ubiquitous devices on products.**	**(M=3.80, SD=1.18)**	**(M=3.09, SD=1.24)**
Q10.2	**Automatic traffic management.**	**(M=4.20, SD=1.18)**	**(M=3.72, SD=.75)**
Q10.3	**Management and control of energy consumption in buildings and in the public space.**	**(M=4.80, SD=.40)**	**(M=3.63, SD=.98)**
Q10.4	Consultancy in the field of public services	(M=3.00, SD=1.43)	(M=2.54, SD=.78)
Q10.5	Management of health services through biometric identification systems	(M=3.00, SD=.90)	(M=2.81, SD=.83)
Q10.6	Tourist assistance	(M=3.60, SD=1.03)	(M=3.45, SD=.78)

Survey Question 11

On question 11 respondents were asked to consider the influence of AI on individual safety using a 5 points Likert Scale ranging from 1 being "totally unimportant" and 5 being "very important". The analysis of variance was used to determine the differences by age group and by gender. The analysis shows that no statistical interaction was found between age and gender F=3.081, p=0.08. We found statistically significant differences by gender F=7.639, p<0.05 and age F=6.318, p=.001). Female participants scored significantly higher (M=4.40, SD=.81) than male participants (M=4.00, SD=.60) on question 11 about the influence of AI on individual safety. At the same question: the 41-50 age group scored the highest (M=4.50, SD=.51), followed by the 18-25 age group (M=4.40, SD=.81); the 26-30 age group scored lower than the 18-25 age group and significantly higher than the 31-40 age group (M=3.87, SD=.60) (Figure 8).

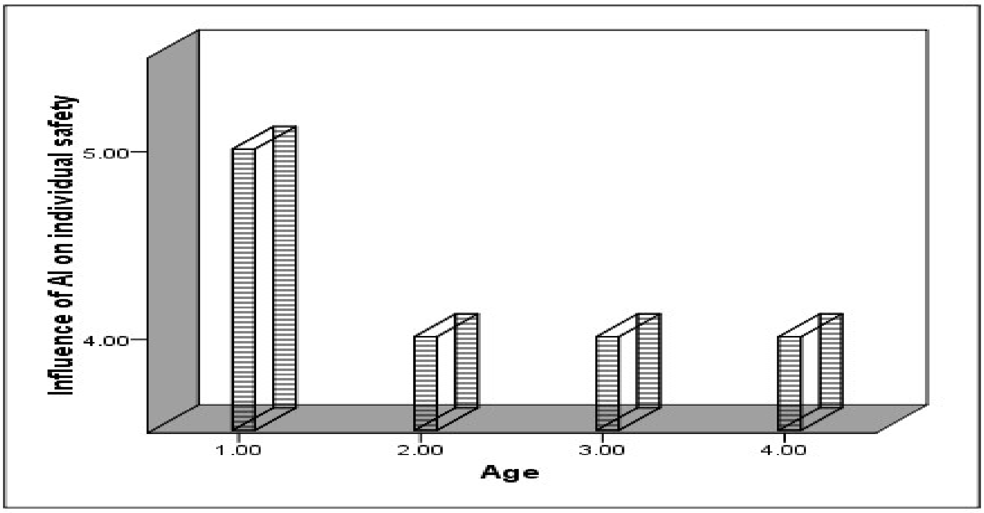

Figure 8. Influence of AI on individual safety by respondents age

Survey Question 12

On survey question 12, the respondents were asked to indicate if they consider that AI will be present in education though the following six categories of activities: 12.1 Evaluation process; 12.2 Adaptation of information to the needs of each person; 12.3 Robots to teach basic elements; 12.4 Customize courses for each student; 12.5 A better management of learning through successive attempts (the fear of failure disappears); 12.6 Supporting continuous, personalized learning that can be done anywhere and 12.7 Reduces costs (fewer teachers, fewer schools). The respondent's answers were evaluated using a 5 Likert Scale. The two-way analysis of variance shows that no statistical interaction was found between age and gender for Q12.1 (F=2.391, p=0.153); Q12.2 (F=.907, p=.363); Q12.3 (F=3.771, p=.055), Q12.4 (F=3.094, p=.525), Q12.5 (F=1.266, p=.263) or Q12.6. (F=.282, p>0.05). We found statistically significant differences by gender and age for questions Q12.3, Q12.4 and Q12.5 where all p values are lower than 0.05. For Q12.1, Q12.2 and Q12.6 no statistical differences were found. In table 7 are presented the results of the analysis per total and by gender for each category of activity. The 26-30 age group score significantly lower than the other age groups.

Table 7. Means and standard deviations per total respondents and by gender

	Fields of interest	Total	Females	Males
Q12.1	Evaluation Process	(M=3.81, SD=.95)	(M=4.60, SD=.49)	(M=3.45, SD=.89)
Q12.2	Adaptation of information to the needs of each person	(M=3.75, SD=.90)	(M=4.40, SD=.49)	(M=3.45, SD=.89)
Q12.3	**Robots to teach basic elements**	**(M=3.62, SD=1.05)**	**(M=4.60, SD=.81)**	**(M=3.18, SD=.83)**
Q12.4	**Customize courses for each student**	**(M=3.18, SD=.95)**	**(M=4.00, SD=.64)**	**(M=2.81 SD=.83)**
Q12.5	**A better management of learning through successive attempts**	**(M=3.68, SD=.98)**	**(M=4.80, SD=.40)**	**(M=3.18, SD=.72)**
Q12.6	Supporting continuous, personalized learning.	(M=3.93, SD=.97)	(M=4.80, SD=.40)	(M=3.54, SD=.89)
Q12.7	Reduces costs	(M=3.68, SD=1.04)	(M=4.80, SD=.64)	(M=3.54, SD=1.16)

Survey Question 13

On question 13, a two-way analysis of variance was used to evaluate the respondents' opinions about the influence of AI on the environment. The two-way analysis of variance shows that no statistical interaction was found between age and gender for Q13.1 (F=2.150, p=.173); Q13.2 (F=2.269, p=.135); Q13.3 (F=1.744, p>0.05) and Q13.4 (F=2.894, p=.092). Statistically significant differences by gender and age were found for questions Q13.2 (F=14.181 and p<0.05 by gender and F=12.731 and p<0.05 by age) and Q13.4 (F=15.755 and p<0.05 by gender and F=5.882 and p<0.05 by age).

The participants consider that AI development will increase the energy consumption and e-waste (M=3.60, SD=1.03), but will improve also the level of citizens' information on the environmental changes (M=3.60, SD=.49). The contribution to CO_2 emissions is on the fourth places (M=3.40, SD=.49), followed by the attracting of the community members to environmental actions (M=3.00, SD=.64). In the analysis of the statically significant differences by gender, female participants scored significantly higher (M=4.00, SD=.64) than male participants (M=3.63, SD=.77) in the case of the information of citizens on the environmental changes (M=3.80, SD=.75 vs. M=3.72, SD=.75) and the attracting of community members to environmental actions (M=3.00, SD=.90 vs. M=2.63, SD=.88). The analysis on age category, the results revealed that the 26-30 age group scored the highest at both questions (Figure 9).

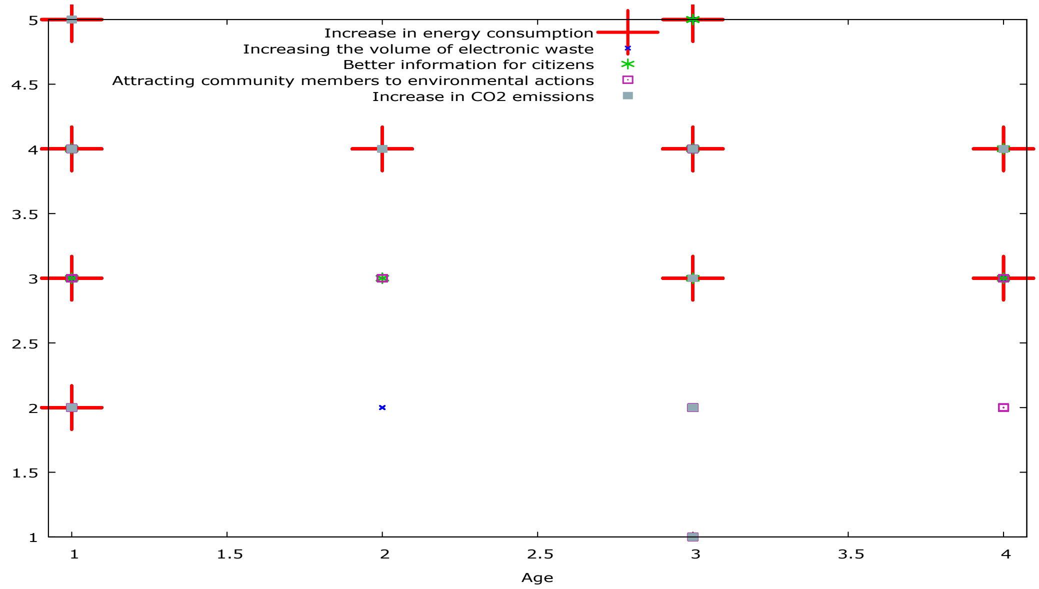

Figure 9. AI influence on the environment

Survey Question 14

Question 14 was used to evaluate the respondents' opinions about the use of robots in the following activities: performing medical surgeries, child care, supply of consumer goods, driving a car, assistance in performing tasks at work and cleaning (Figure 10). The respondents feel most confident and safe to use robots for cleaning (M=4.18, SD=1.07) and for assistance in performing tasks at work (M=4.12, SD=1.05) and less confident and safe to use robots for driving a car (M=3.87, SD=1.11), for supply of consumer goods (M=3.81, SD=.81) and performing medical surgeries (M=3.68, SD=.92) The child care obtained the lower score (M=2.00, SD=86).

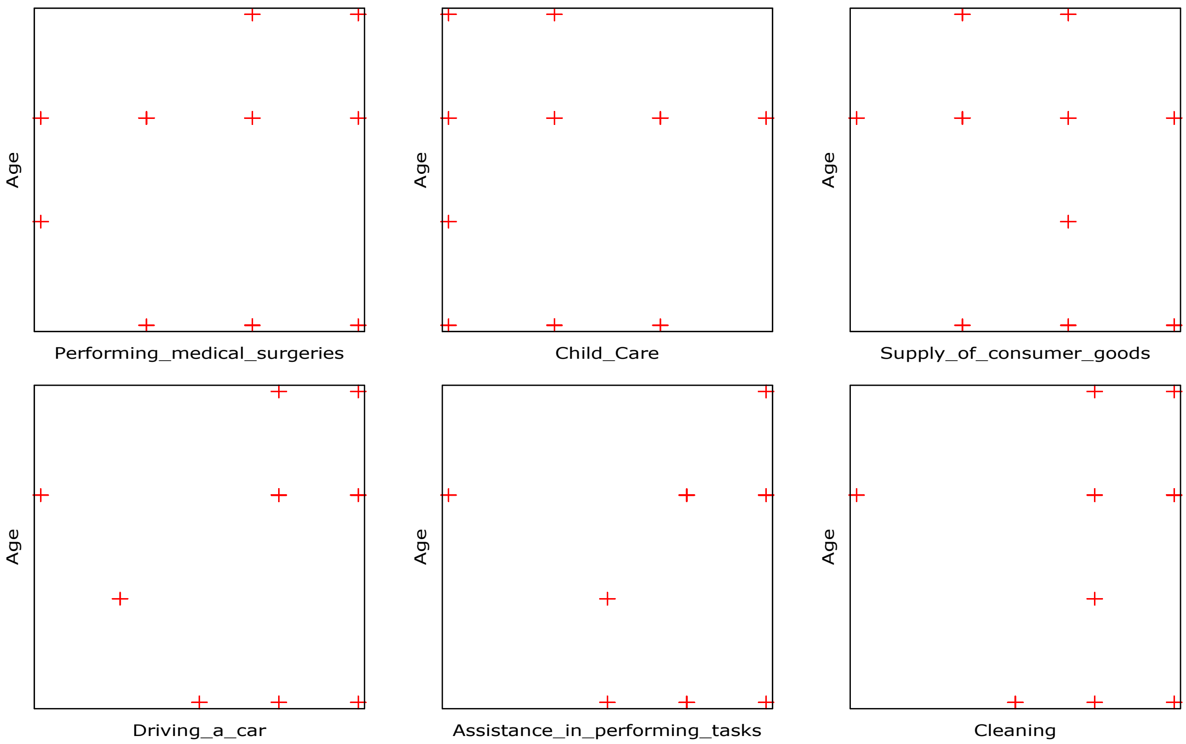

Figure 10. Respondents' opinions about the use of robots in different activities (grouped by age)

In the analysis on gender, female participants scored significantly higher (M=4.20, SD=1.61) than male participants (M=4.09, SD=.67) for the case of assistance in performing tasks at work, for the case of driving a car (M=3.40, SD=.81 vs. M=4.00, SD=.74) and for the case of performing medical surgeries (M=3.80, SD=.75 vs. M=3.63, SD=.98). The male participants scored significantly higher (M=4.36, SD=.77) than female participants for the cleaning (M=3.80, SD=1.49) and for supply of consumer goods (M=4.00, SD=.74 vs. M=3.40, SD=.81). The child care obtained the lower score for both categories of participants: female (M=2.00, SD=1.11) and male (M=2.00, SD=.74).

No statistical interaction was found between age and gender for Q14.2 (F=11.919, p>0.05), Q14.2 (F=.220, p>0.05), Q14.4 (F=2.328, p=.130) and Q14.6 (F=3.849, p=.078). Statistically significant differences by gender and age were found for questions Q14.1 (by gender F=18.093 and p<0.05 and by age, F=24.981, p<0.05); Q14.3 (by gender F=8.030 and p=.006 and by age, F=4.755 and p=.004) and Q14.5 (by gender F=11.105 and p=.001 and by age F=3.686 and p=.004).

Survey Question 15

On question 15 were presented ten fields for evaluation corresponding with the six dimensions of smart cities. According to the respondents' answers, AI will be most used on in space exploring (Smart People) and environmental protection (Smart Environment). The analysis of variance was excluded because the respondents have to choose three-word answers.

5. Conclusion and study limitations

From question 6 we could observe that people perceive AI as a very important factor in the development of smart cities. Significant differences were observed among both gender and age. For female participants, AI influence on the development of smart cities is more important than for male respondents. The 18-25 and 41-50 age groups scored the highest on this question.

Significant differences were both by age and gender were found for 7.1 and 7.3. The female participants' score higher assuming that Smart Economy will be the main beneficiary of AI facilities. On the other hand, male respondents consider that logistics and infrastructure (Smart Mobility) as the main beneficiary of AI. The age group between 31-40 years old score the highest at this question.

For question 8 significant differences were found by gender and by age. Female participants consider AI to be more important for their business or industry or for the one they are preparing for in the next 10 years, than male participants. By age, the 26-30 old group score the highest.

Question 9 also reveals significant differences by gender and by age (9.3, 9.4, 9.5 and 9.6). The analyses by gender show that the majority of female participants scored significantly higher than male participants and those aged in the second group. From those the analysis reveals that respondents consider that AI in 10 years will influence the most the marketing field, followed by finance, customer service and health.

The fields where we found statistically significant differences by gender and age were: automatic waste selection via ubiquitous devices on products, automatic traffic management and management and control of energy consumption in buildings and in the public space (Q.10). Female participants scored significantly higher than male participants. The 26-30 age group scored significantly higher than the other groups.

On question 11 respondents were asked to consider the influence of AI on individual safety. We found statically significant differences by gender and by age. Female participant's score higher than men and also those aged 18-25 and 41-50 score higher than the rest of the age groups. For question 12 we also found significant differences by gender (Q12.3, Q12.4 and Q12.5) and by age (Q12.3, Q12.4 and Q12.5). Female participants scored higher than men respondents. The 26-30 age group score significantly lower than the other age groups.

On questions Q13.2 and Q13.4 we found significant differences by gender and age. Female score significantly higher than men at both questions. In the age category, the once group between 26-30 score the highest at both questions.

The respondents feel most confident and safe to use robots for cleaning and for assistance in performing tasks at work and less confident and safe to use robots for driving a car, for the supply of consumer goods and performing medical surgeries (Q.14). Significant differences by gender and by age were found for three of the activities that could be done by robots: medical surgeries, supply of goods and task assistance.

Our study demonstrates that respondents perceive AI as an important aspect that influences smart cities development. Also, the paper shows that gender and age group influence public attitudes, findings which are in line with other studies (Katz, 2014; Schermerhorn et al., 2008; Loffredo & Tavakkoli, 2016). Some limitations associated with this research include the selected sample region, so our results are limited and cannot be generalized. Also, additional questions may be included in the analysis for a more complex overview and analysis.

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