Anthropomorphic Walking Robots Integration in Smart Green Systems

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Abstract: The article presents aspects of integrating Anthropomorphic Walking Robots (AWRs) into Smart Green city systems. Through the interaction of physical systems assisted by artificial intelligence, it is estimated that environmental pollution risks are reduced by manufacturing processes; improving the pace of citizens' lives by efficiently managing the travel time between different regions of the city; increasing the quality of social life, ensuring a greater degree of independence of the elderly or disabled people etc. In order to achieve the above mentioned, the paper highlights some aspects of research on detection, monitoring, control and navigation of AWRs, as well as elements of standardization of intelligent urban processes and actions.

1 INTRODUCTION

The smart city is not an exclusive city, it is the city where living beings, objects and processes are in intense transformation and continuous evolution and where local services are provided for a long period of time, which simultaneously satisfy a number of fundamental conditions. Equitable access to education and healthy, safe living in an unpolluted environment that includes a strong infrastructure, alternative resources and connection is provided.

Robotics and autonomous systems can help the smart city, but only under certain conditions: the existence of national and international strategies with permanent connection between suburbs, cities and countries; strong political engagement needed to set the legislative framework of priorities; research projects to identify causes, influences, and validate solutions. In the smart city, all components and intelligent physical systems interact continuously, anticipating possible challenges and indicating solutions to avoid situations that pose a danger; the sustainability of the actions being mainly dependent on a few key elements, such as: collection and processing of data and information, technological means used and education of citizens.

Urban demographic expansion in the near future requires local authorities to take urgent measures such as increasing the surface of the locality by adding land in the immediate vicinity, building a new, intelligent general infrastructure, interconnecting of intelligent elements of strict necessity, preventing ecosystem and environment deterioration, ensuring well-being for its citizens, a civilized and dignified life.

The efficiency of manufacturing systems, which are embedded in the industry concept 4.0, is becoming increasingly important, especially from the point of view of protecting the environment and reducing the devastating effects of climate change, which are so obvious lately (Barreto et al., 2017).
The causes-effect diagram, presented in figure 1, shows the potential areas and basic causes that influence the appearance of the smart city under specified conditions. All the causes shown graphically are concurrent sources of variational character and have been grouped by categories.

AWRs can perform permanent 24-hour missions to measure deviations of phenomenon parameters, detect unpredictable events that can cause injuries or harming people, data transmission, information, pictures and videos from the site of abnormal occurrences, the collection and real-time transmission of information to traffic participants on

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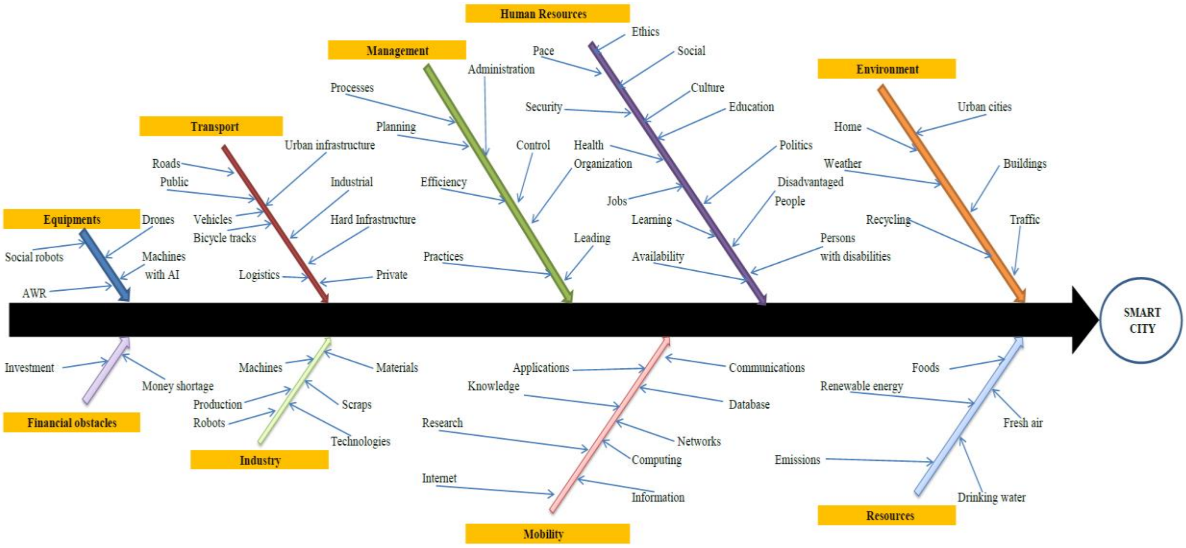


Figure 1: Diagram causes-efect for smart city.

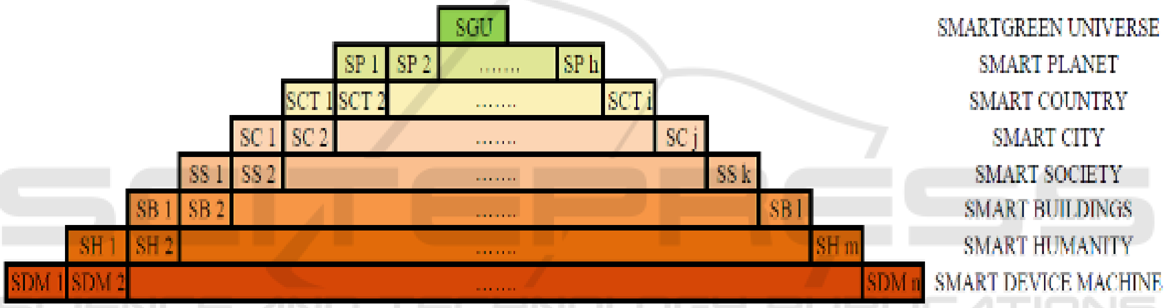


Figure 2: Macro SmartGreen Universe (MSCU).

the existence of unlicensed routes, the failure of some intelligent systems installations, the violation pictures and videos from the site of abnormal occurrences, the collection and real-time transmission of information to traffic participants on the existence of unlicensed routes, the failure of some intelligent systems installations, the violation of legal provisions, the analysis of situations and their exemption from normality, the establishment of guilty situations, various information to pedestrians etc.

Scientists and researchers are invited to offer solutions that include robots of all kinds to meet macro targets, as we see in figure 2 below.

Today, there are a large number of complex programs and projects in the world that are being developed in order to transform many cities into smart cities. Everything is done step by step, gradually on several plans that correspond to the socio-economic fields. Such a project is carried out by the University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania, through the Research Center for the Study of Quality Agricultural Products - HORTINVEST (figure 3), a modern, intelligent, ecological building for the activities of research in the fields of agriculture and food industry.

The HORTINVEST building is equipped with smart installations and equipment that optimizes the consumptions of utilities and reduces the risks of environmental pollution.

Figure 3: Smart building HORTINVEST.

2 INTEGRATION OF AWRs IN THE SMART CITY

The urban framework of smart cities has several key directions that define this concept. In order to achieve this goal, concerted actions of all categories of human resources (local authorities, citizens, politicians, scientists etc.) together with technical resources must collect data and information in order to make medium and long-term decisions, but also to develop viable and sustainable projects that include proactive solutions.

Urbanization, management, infrastructure and networks, civic education, public and private transport, public lighting, public services and social facilities offered to its citizens, drinking water supply, sewerage, power supply, security, sanitation, waste collection and recycling, the environment, the economic environment, culture, entertainment, are just a few of the key areas and issues of the smart green city concept - see figure 4.

Urban management and urban services for smart cities are areas of great importance. Monitoring the essential qualitative parameters through the sensors installed in the city allows the people to control the changes quickly and efficiently. AWRs also help to measure and monitor the size of the urban macrosystem, performing routine, boring activities for people. Their use streamlines services related to the environment, social environment, street and home security, real-time information on infrastructure, but also unexpected events and incidents.

The main topical issues that need to be solved in smart green city include: increasing office and office space, adapting existing infrastructure, satisfying and optimizing the increasing demand for resources (electricity, drinking water, land, food), increasing the share of renewable energies consumer protection, public safety and defence of the population against natural disasters, food safety management, waste recycling, logistics and mobility services, increased demands for healthcare and social care, new environmental standards, incorporation of new digital technologies, reduction of greenhouse effect gas emissions, climate change mitigation, upgrading, support for actions initiated by commercial applications.

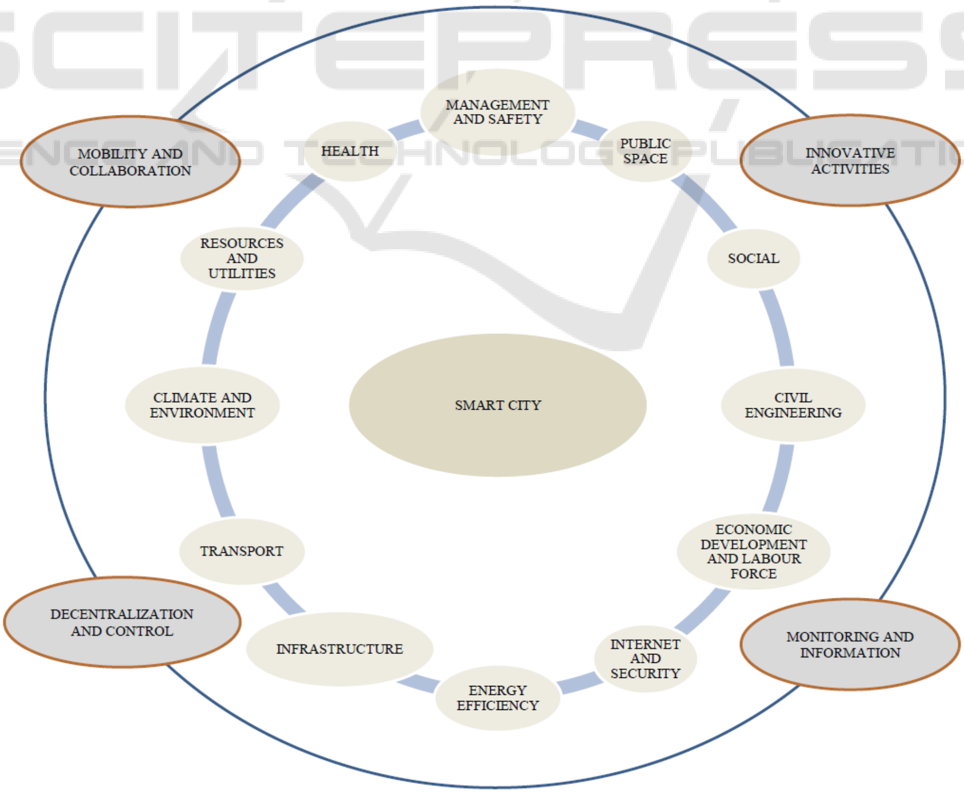


Figure 4: Main areas and directions for the smart city.

To monitor and control the unevenness or sudden variation in resources or the quality of the environment, for example, in the city it is suitable to have fixedly sensors and robots, whether they are anthropomorphic or mobile pessimists; they are observed, monitored and connected to the IoT network by transmitting in real time information for possible emergency intervention or to solve a particular problem.

Our research refers to the intelligent city and proposes a concept with the new infrastructure, called the Macro SmartGreen Universe (MSGU), figure 2, for which were taken into account only social services, social assistance, street and home care needed for elderly people in the context of AWRs involvement in their lives. This versatile, scalable and flexible structure integrates into the smart green city platform via the IoT internet network with all the other smart systems and platforms so that final decisions are quickly redirected to implementation deployments.

2.1 Sustainable Development of Social Systems and Citizen Safety Aided by AWRs

The concept of a smart city can't exist without the inclusion of robots in the urban project and detailed plans of the socio-economic domains as they are progressing with citizens enhancing their well-being and service efficiency.

Social assistance is targeted at people or communities of people in distress, such as elderly people, people with various disabilities, single-parent families, families in disadvantaged geographical areas who are entitled to well-being on the part of society - see figure 5.

Smart Devices Machines (SDM - figure 2), include AWRs in the smart world, requiring equipment with super-developed senses. They can be especially useful in indoor or outdoor environments to perform missions that are characterized by mobility, performance and precision.

The analysis elements of the smart city concept include problems and challenges, influence factors, ideas and modern solutions. Such, (Silva et al., 2018) proposes a verifiable architectural model of the concept of smart sustainable city, while (Riffat et al., 2016) proposes innovative models for the control of urbanization, excessive industrialization and cultural change through planning and flexibility, economic and social stability, prosperity and superior quality of the citizens life and energy optimization, starting from the territorial administrative division of the neighbourhood type. (Serbanica and Constantin, 2017) studies the importance and role of strategic actions well planned in the legal and institutional framework, economic and social environment, environmental and cultural environment, and (Mora et al., 2018) formulates a set of strategic principles needed to be pursued for the smart development of the city on the basis of the set of dichotomies adopted by several european cities. (Yigitcanlar et al., 2019) analyses the possibility for the future smart city to exist without being sustainable, i.e. without a controlled balance between the elements of the triad economic growth, environmental protection and discovery of alternative resources. The smart house is a necessity of the smart city concept where resources are efficiently managed, waste and pollutant emissions are reduced in order to improve the quality of life in the human habitat environment. Proposals for ideas, strategies, methods and solutions by (Wilson et al., 2018) exist in means of mobile robots with detection functions and drawing up zoning topographical plans in order to fulfil the daily activities.

Social and welfare area through social assistance (Grieco et al., 2014), (Wachaja et al., 2017), (Wilson et al., 2018), elderly care (Wachaja et al., 2017) and health-care applications (Grieco et al., 2014) (Wilson et al., 2018) represent an important direction with a major impact on society. The study conducted by (Shishehgar et al., 2018) represents a wide scientific analysis of the necessity of integrating artificial intelligence and robots into elderly people life, avoiding the risk of social exclusion and ensuring a decent and dignified living, and (Wachaja et al., 2017) presents a practical solution for moving people with walking and/or vision impairments through the sensors; also for the external environment, (Grieco et al., 2014) proposed a customized solution for the assistance services offered by robots in an airport. (Liu, 2018) presents the advantages of interdependence between IoT and ecological transport on the bike in the smart city, contributing to the conservation and protection of the environment, as well as to the sustainable development of the city. Electricity field (Iliescu et al., 2016), (Iliescu et al., 2018), (Kavitha and Geetha, 2017), (Liu, 2018), (Riffat et al., 2016) raises the interest of many researchers by developing sustainable strategies and increased efficiency. (Iliescu et al., 2016) offers a new, innovative, complex and complete solution (design, manufacture and validation of results in the real environment) for the energy field, applicable to solar and photovoltaic cells, with precise reference to the obtaining of solar cells of type Perovskite by modern, intelligent advanced methods.

Article written by (Kavitha and Geetha, 2017) presents an effective managerial solution that optimizes the consumption of electricity at the level of the individual dwelling located in the smart city using the grid technology.

Waste recovery, an activity of the smart city, stands at the base of studies conducted by (Esmaeilian et al., 2018), which proposes a conceptual, sustainable and centralized systemic framework, interconnected through the IoT network, for gathering information on the life cycle of products and pursuing any resulting waste.

Study of technical elements, sensors (Esmaeilian et al., 2018), (Kavitha and Geetha, 2017), (Liu, 2018), (Rehman et al., 2018), (Wachaja et al., 2017), (Wilson et al., 2018) and robots (Grieco et al., 2014), (Rehman et al., 2018), (Wachaja et al., 2017), (Wilson et al., 2018), helps to integrate smart devices and machines into the realization of smart city. The rapid transmission of precise, punctual, permanently updated information about the environment, traffic, special events etc. is done by connecting smart objects to the IoT internet network (Esmaeilian et al., 2018), (Grieco et al., 2014), (Kavitha and Geetha, 2017), (Liu, 2018), (Wilson et al., 2018) of the smart city. The cost optimization is an integral part of the decision-making system and cannot lack in the management of smart city development directions, being found in articles such as (Kavitha and Geetha, 2017), (Liu, 2018), (Rehman et al., 2018).

Poisonous areas are: construction sites, cement factories and metal poles, stone quarries, car boulevards, people houses, which can be monitored by fixedly sensors and measuring stations, only that pollution spreads rapidly in areas in which there are no such sensors installed, and AWRs are extremely useful for signalling imminent danger areas. The rapid knowledge and analysis of alarming situations, those in which the maximum permissible values of particles, nanomaterials and toxic powders have been exceeded, require a rapid reaction in real time and solutions that by immediate implementation diminish and prevent disasters.

Mobility AWRs is of great help in indoor / outdoor environments for wheelchair disabled people, blind people who want to cross the street or travel on a particular route, for example, by pushing / emitting the voice command for the green colour of the traffic light and stopping the car traffic, or by analysing the parameters of the environment in the areas in which the construction works take place.

A companion robot for an elder person can call the emergency service when he observes something unnatural or can announce the family, recall

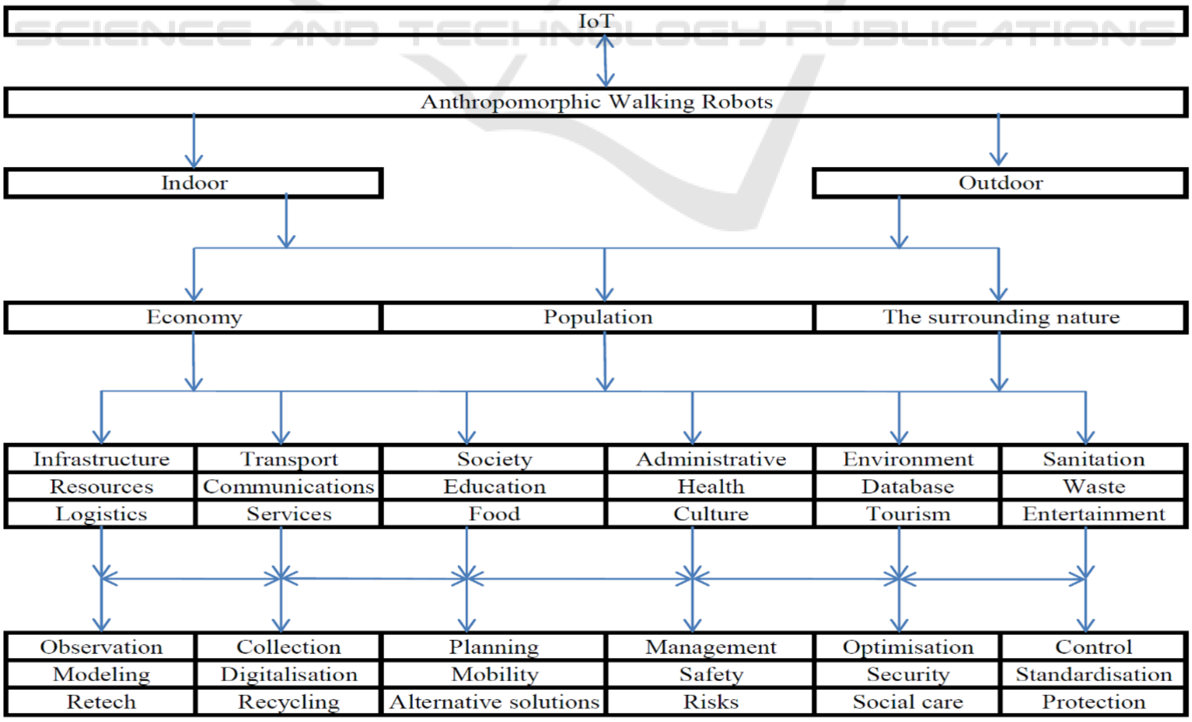


Figure 5: Sustainable development for social systems and citizen safety aided by AWRs.

various daily activities previously scheduled, announce a life-threatening event, recite lyrics, can work with the psyche of the afflicted, can render self-confidence, apply to specialized service platforms, collect and transmit data and information etc. The person who has access to the services of such a robot must feel safe and do not have to worry about intimacy.

2.2 Detection, Monitoring, Control and Navigation

AWR is structurally an open cinematic chain and includes in its architecture subsystems and components absolutely necessary that performs walking, observation / detection, monitoring, planning, communication, control and navigation functions. Moving AWR's mechanical legs does not give him as much control, stability, speed and safety as in the case of human beings' movement. Maintaining the trajectory, reducing the constraints and effects of disturbing factors, optimizing the motion parameters, represent the actions necessary to carry out the tasks.

Positioning AWR involves determining the location, but also its orientation, relative to a coordinate axis system. Along with the position, sometimes speed and acceleration, force or moment parameters are required. Navigation is the ability to set motion safely, as simple as so complex, from one place to another in relation to workspace landmarks. Controllers give the platforms versatility, flexibility and high-level interactivity to meet a growing payload, where external disturbances are an integral part of system equations.

Sensational feedback for efficient control is a major desideratum, and is due to the number, type, positioning, errors, calibration, and exploration through sensor interpolation.

An example of AWR's integration into the social assistance system is shown in figure 6. The focus is on identifying important needs for an elderly or impaired person, so that its life gets closer to the normal one and is fit for, both indoor and outdoor AWR assistance. The schema block used to identify the needs of a person is shown in figure 6. This can be used in indoor and outdoor environments.

In the smart city equation, AWRs continuously interact with the other intelligent mobile systems providing a new dimension of urban space, observing phenomena, moving to dangerous places, anticipating possible risks and indicating solutions to avoid them, so they help to restore the balance of the environment progressively and provide real benefits

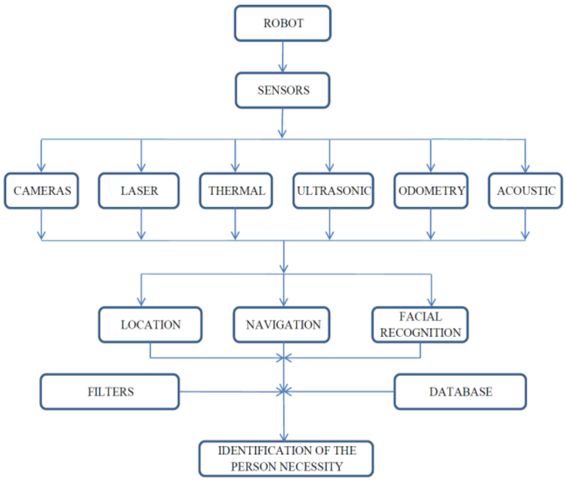
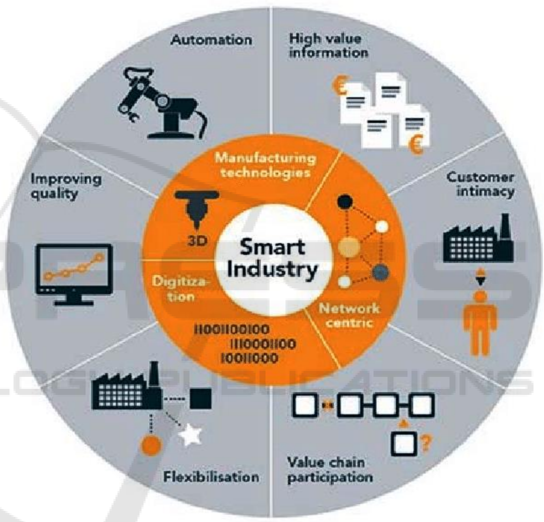
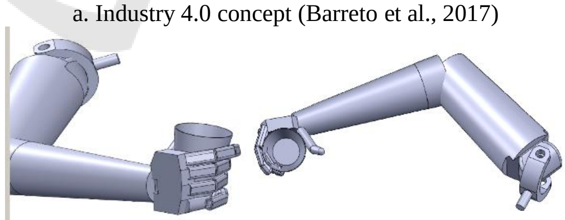


Figure 6: Schema block to identify personal needs.



a. Industry 4.0 concept (Barreto et al., 2017)



b. AWR arm

Figure 7: AWR integration in industry 4.0 manufacturing system (a. and b.).

to the citizens.

Another example of AWRs integration is that of green manufacturing systems, especially the ones based on industry 4.0 concepts (Barreto et al., 2017). When it is rather difficult and dangerous for humans to manipulate any materials, and when common grippers do not ensure correct materials handling, special designed robotic hand (similar to human arm) could be used – see figure 7. This robotic hand is aimed to be mounted on AWR body so that, required position, precision and gripping forces to be available for the manufacture process stage.

3 STANDARDIZATION OF SMART URBAN PROCESSES AND ACTIONS

Specific ISO standards (ISO, 2017) on sustainable cities and communities (ISO 37100 / ISO 37120, ISO 26000 Guidance on Social Responsibility) have already been developed for the specific needs of the smart city, Energy Efficiency (ISO 17742), Road Traffic Safety (ISO 39001), Health and Safety at Work (ISO 45001 Occupational Health and Safety), Safety of Persons (ISO 22395 Security and resilience – Community resilience), Smart community infrastructures (ISO 37152 / ISO 37157) and are in the process of formulating standards that complete the feature definition table tors.

Figure 8 comprises some of the ISO standards regulating the specifications, predominant attributes and qualities necessary for the smart city.

In addition to existing international ISO standards, the smart city urgently needs good practice guides and precise regulations to complement those available to provide a framework for sustainable socio-economic development. Only in this way can the vocabulary, the objectives, the characteristics, the structures, the control tools and the parameters of the domains involved in this ample process, as well as their interconnection, and the cities between them can be defined. Experts, scientists and researchers have the responsibility to make sustained efforts to provide strategies and methods for raising the community to a smart city rank.

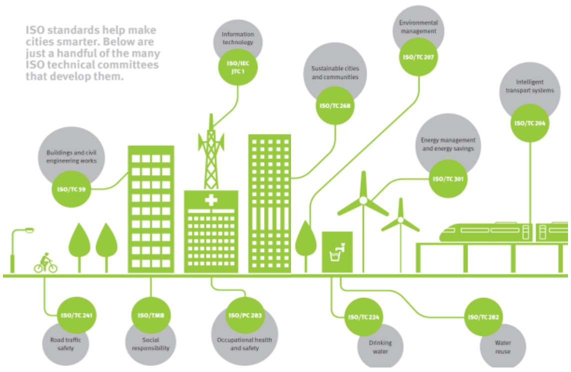


Figure 8: ISO standards for smarter cities (ISO, 2017).

Much of the necessary and sufficient actions to provide the status of a smart city to an urban settlement include: increasing the degree of political and economic stability, a favourable climate for the business environment, optimizing the degree of territorial occupancy, increasing the citizens' health, increasing the level of social assistance and welfare (water, electricity etc.), ensuring intelligent transport in safety, poverty alleviation, sanitation, food security, collection, analysis and processing data, communications and connectivity, cyber security, environmental protection.

4 CONCLUSIONS

The primordial smart city equation is social, economic and environmental and requires permanent energy-controlled transformations. In order to exert force and provide a suitable environment for people in need of support, the phenomenon of the smart city comprises an extensive paradigm plan, which contains innovative, plurivalent concepts, part of the concept proposed by us in this article – Macro SmartGreen Universe and from which there are also AWRs. Social community and citizen safety can have real benefits by including AWRs in smart city life.

Despite the statements of some scientists, we are convinced that AWRs will always be with their creators, rewarding their efforts.

This article discusses the life of the smart city and the compulsory integration in an accelerated pace of AWRs for social assistance services and citizenship safety. Systems modelling, increased mobility, as well as their implementation in the paradigm plan of the smart city, will emanate strength and ensure a suitable environment for people in need of support.

In the future, we intend to simulate AWRs navigation and stability control in order to support blind people both in the urban environment and in the living space.

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