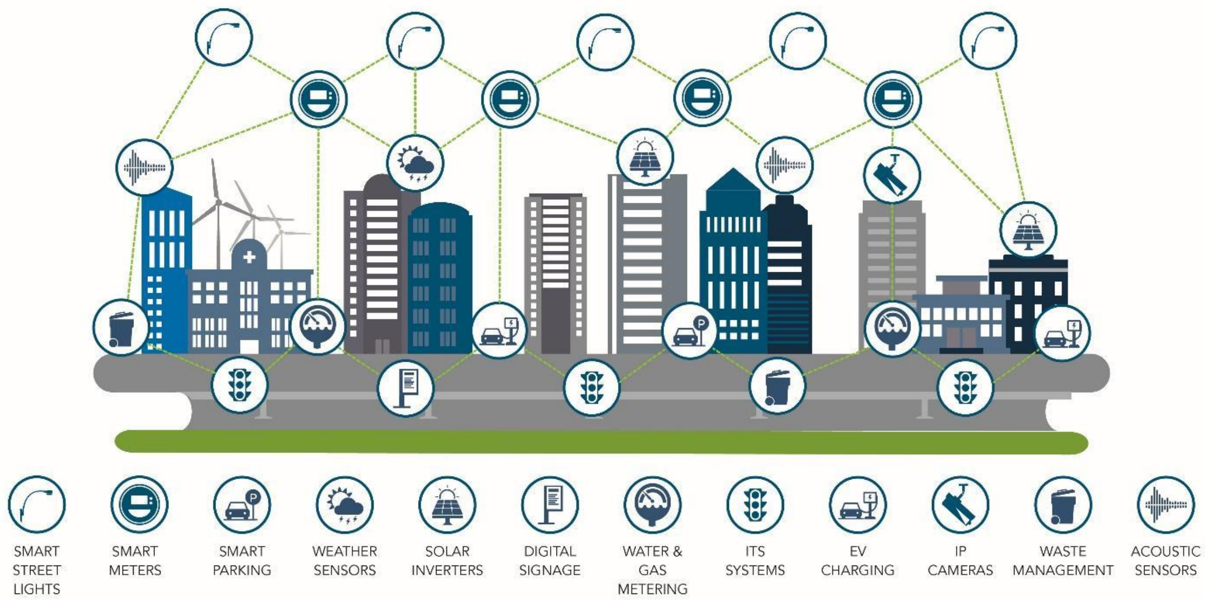
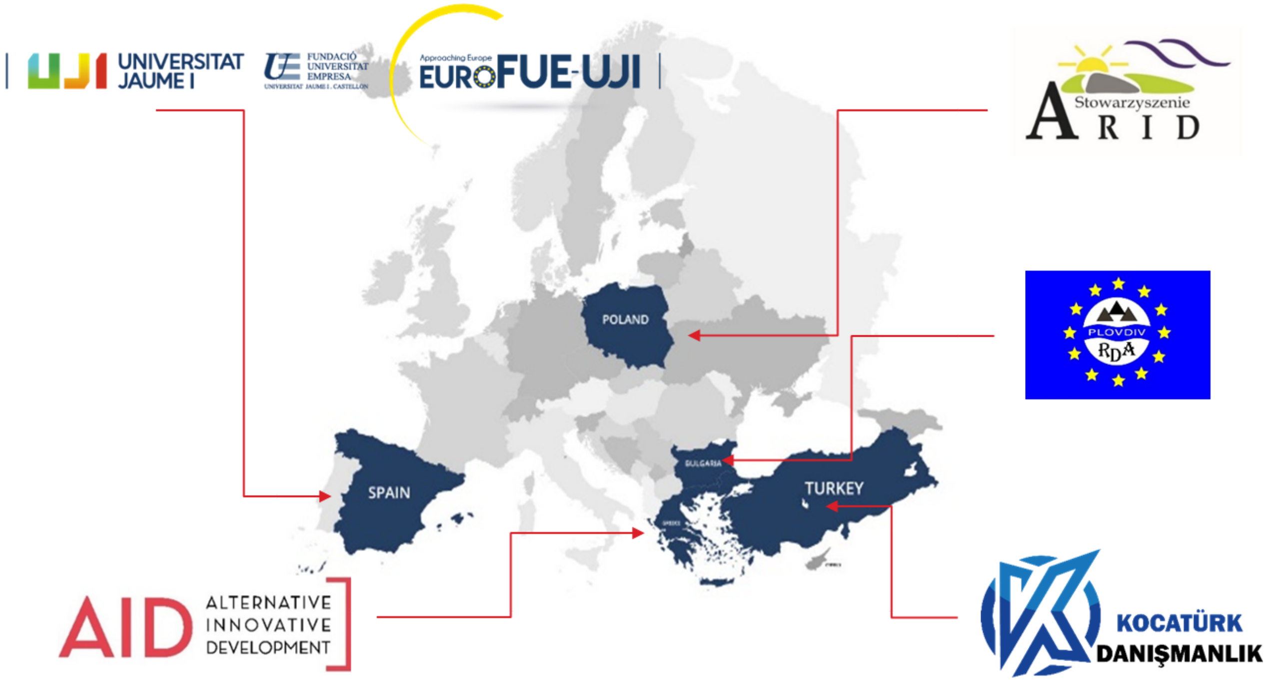
Co-funded by the Erasmus+ Programme of the European Union

MODULE 5

SMART LIFE





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PRODUCED BY: START-UP PROJECT PARTNERSHIP

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CONTENT MAP:

ANNOTATION AND LEARNING GOALS:

Digital services and applications of informatics have become a new way of life and interaction between individuals, society, and government. The blending of technology with human resources has led to the emergence of a smart life moving, at an accelerated pace and easily in the style and form, characterized by the ease, speed, and accuracy in the delivery of public services and business. This module is going to focus on smart life which is considered as one of the six components of a smart city. Other five modules include:

- smart people,
- smart mobility,
- smart economy,
- smart environment, and
- smart government.

All smart living activities also have these six components integrated with the smart city system. Cities have their own characteristics based on the size whether it is a metropolis, megacity, meta city or small or very big continental settlement. It is easily understood that smart living as a trend, involves improved standards in several aspects of day-to-day life, ranging from domiciles, workplaces and the way people are transported within cities. Within the context of construction of buildings, the trend can be identified through the growing existence of innovative, quicker, cheaper, and more efficient construction technologies, materials, processes and concepts.

EXPECTED LEARNING OUTCOMES:

By the end of this module, the learner should be able to argue and discuss several aspects of Smart Life Concept such as Smart Home, Smart Health, Smart Building, Smart Devices and so on. This module will help learners to understand the dimensions of smart living, and the elements that compose the smart living in today's modern life. This module requires self-learning with the materials, the assessments, as well as the training activities. The main purpose for the trainees is to learn by reading, exercising, applying, and evaluating their knowledge. Moreover, the module uses theory, case studies and examples, and presents several smart and innovative technologies. Finally, by the end of the module, there is a list with several additional resources to facilitate the learners during the reading process.

At the end of the study of the module and after having carried out the activities included in it, the student will be able to acquire the following knowledge, skills and competences:

Knowledge:

- Identify the core dimensions of smart living
- Know smart life things and learn how to make use of them.
- Gain a deep understanding of the nature of smart cities in terms of smart life.
- Understand potential applications of the materials relevant to smart living learned in this module.

Skills:

- Recognize and interpret the concept of smart life.
- Assess the significance of smart living in their daily lives.
- Discuss and Share Smart Living Aspects and Terms

Competences:

- Ability to share the obtained knowledge to peers and interested individuals with the topic of smart living
- Raise awareness relevant to smart life and its proper management and use
- Professional competences to use the acquired knowledge in their own daily life

FORMS AND METHODS OF WORK

The methods used in this module are those recommended by the project coordinating group.

The working methods are:

- Lecture with discussion (online/offline)
- Training seminars (online/offline)
- Self-study (online/offline)
- Interactive activities
- Case study

GENERAL MODULE OVERVIEW

Digital services and applications of informatics have become a new way of life and interaction between individuals, society, and government. The blending of technology with human resources has led to the emergence of a smart life moving, at an accelerated pace and easily in the style and form, characterized by the ease, speed, and accuracy in the delivery of public services and business. This module is going to focus on smart life which is considered as one of the six components of a smart city. Other five modules include:

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UNIT 1. OVERVIEW

1.1. Short Description

In today's modern world, it is a fact that cities are dealing with a series of new challenges, along with new opportunities, which derive from a constantly changing environment. Cities need to clearly understand that environment, so they are ready to deal with these challenges and opportunities and take advantage in the best and most effective way, contributing thus to their upgrade and quality of life. Cities, today, are called smart, as it has been already mentioned at the previous modules, and they have been transformed from a traditional place to a more modern and efficient one, with the use of digital and telecommunication technologies and applications for the benefit of its inhabitants and businesses. According to literature, most of the scholars have adopted the smart city framework developed by Giffinger et al. (2007), in which it demonstrates 6 main dimension which are:

- smart economy,
- smart people,
- smart governance,
- smart mobility,
- smart environment
- smart living.

As society grows ever more connected, the promise of smart home technologies and smart living continue to motivate research interest across diverse disciplines such as computer science, engineering, social science, design, and relevant health-oriented clinical sciences (e.g., gerontology). Across these domains, research goals may vary from advancing technological innovation, to exploring a specific application domain, to investigating a particular user population. Despite these differences, however, scholars and researchers contend that the creation and/or consumption of knowledge about the problems, needs, and experiences of intended users is shared by all. We believe an untapped opportunity exists for the exchange of rich knowledge and methodological expertise – both in research and design – in the study and design of user-centered smart home (living) technologies.

Therefore, for the purposes of this module, we will focus on the last dimension that refers to smart life. More precisely, the first unit pursues to outline the definition of smart life, providing examples, good practices, videos and relevant images and visual material.

1.2. "Smart Life" Term Definitions

While there may be different standards and definitions when it comes to a good quality of living, a smart city should be able to cater the needs for people of all sections of society through the provision of high-quality affordable housing as well as the different facilities and functions a city has (Govada et al., 2020). People should be able to live in affordable quality housing regardless of their social status or income, be inclusive and not be discriminated against members of society. People should be living in a safe urban environment with quality public open space, accessible to education, employment, and health facilities. Cities should offer choices for people to live comfortably in a nurturing environment that allows them to thrive and achieve their aspirations along with a happy and healthy lifestyle (Govada et al., 2020).

A smart life definition must include information technology and computer systems that positively impact individuals' way of living. Smart life comes from placing people in the foreground and the quality of their lives. The city can provide and offer various parameters that, related to natural resources and infrastructure, are to offer better options of occupation and, consequently, better quality of life. Many scholars, researchers and practitioners have also referred to smart living. Smart Living, as a trend, involves improved standards in several aspects of day-to-day life, ranging from homes and residencies to workplaces, even the way people are transported within cities. In particular, smart life uses software and the Internet of Things (IoTs) to simplify and improve many daily activities and life planning. Interchangeably "smart life" term is used also as smart living.

Smart Living is a trend encompassing advancements that give people the opportunity to benefit from new ways of living. It involves original and innovative solutions aimed at making life more efficient, more controllable, economical, productive, integrated, and sustainable. This is a trend that covers all the aspects of day-to-day life, from domiciles and workplaces to the manner in which people are transported within cities. In short, Smart Living involves improved standards in several aspects of life, whilst striving for efficiency, economy, and reduction of the carbon footprint.

More precisely, ***Smart Living*** focuses on the following aspects:

- High Quality of Life
- Provision of Affordable Quality Housing at Minimum Standard of Living
- Inclusive Society and Social Cohesion
- Promotes Social Equity and Equality
- Security and Sense of Safety

Table 1. Smart Living Aspects

1.3. Examples of Smart Life

1.3.1. Smart Buildings

In terms of building construction, the trend can be identified through the growing existence of innovative, quicker, cheaper, and more efficient construction technologies, materials, processes, and concepts. To construct a smart building is to apply information technology and intelligent systems to achieve efficiency, comfort to users and sustainability in the project, construction and operation phases of the building lifecycle. Smart buildings and infrastructure also describe the implementation of inter-connected technologies in infrastructure and the equipment they interact with. Furthermore, in terms of home buildings, a Smart Home incorporates advanced automation systems to provide the inhabitants with elaborated monitoring and control over the building's functions.

Compile orders for food needed (coordinated with diet, meal planning, and schedule of invited guests). In a smart building such orders could be bundled and send to a store for a collective delivery scheduled at a time of low traffic, as determined from the city's smart traffic system.

Another example refers to keeping track of the contents of a refrigerator and other food storage through reading IDs of all things put in and taken out. The system could also use the data, for instance, on school day endings to tell a parent when he or she needs to leave to pick up their child considering present traffic conditions.

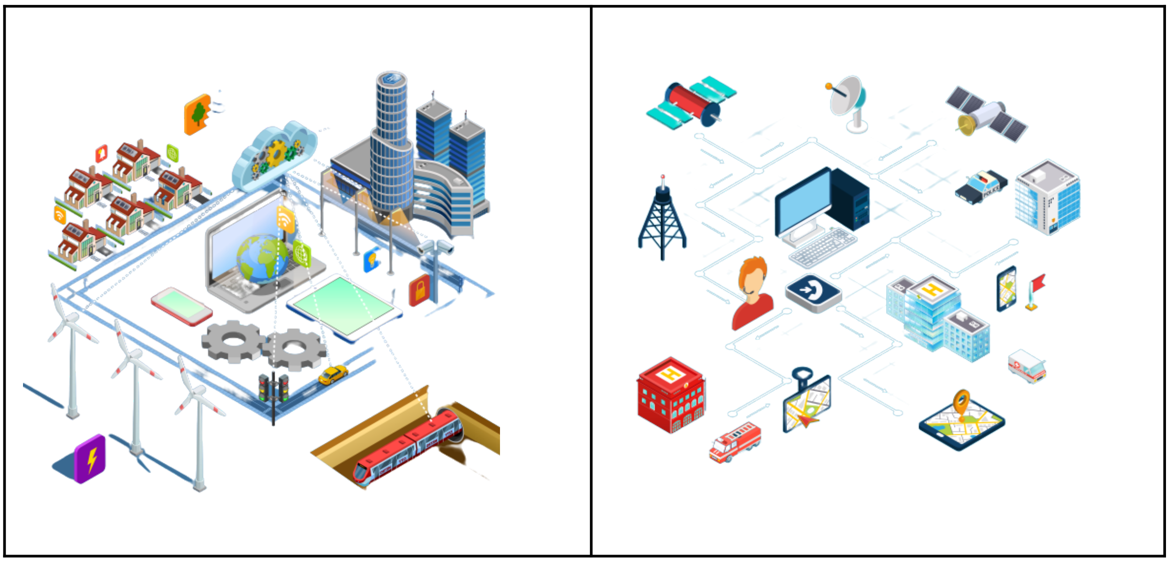

Image 1. Examples of smart buildings and smart infrastructures

1.3.2. Smart Home

The immensity and diversity of attention that Smart Home (or Smart Living) developments and market has received (and will receive) has caused an ever-growing, yet dispersed, body of literature. Although the concept has the unanimous goal of promoting comfort, convenience, security and entertainment of home residents, the burgeoning literature on Smart Home is utterly incoherent. In addition, the few well-structured review publications with the aim of representing the Smart Home body of knowledge either focus on specific technology aspect or on sector-specific developments. Examples are reviews on assistive technologies, e-health projects, design requirements, laboratories, technologies for ageing societies, energy management, location-based systems and user studies in healthy Smart Home.

A Smart Home (Aldrich, 2003) can be defined as a residence equipped with computing and information technology which anticipates and responds to the needs of the occupants, working to promote their comfort, convenience, security, and entertainment through the management of technology within the home and connections to the world beyond. In particular, in terms of safety and security, we refer to smart homes when monitoring the lifestyle of the inhabitants reveals that a dangerous situation is going to happen. In terms of comfort, we refer to the case in which smart homes provide information when the room temperature is adjusted automatically for the inhabitant.

The part definition, “connection to the world beyond”, stresses the notion of the ‘informational’ home, where existing and new information services are interactively connected to the outside world, rather than the mere ‘automation’ of home appliances. The notion that Smarts applications are not limited to the dwelling or home as such makes it clear that the term Smart Home is limited, and that the term Smart Living may be more accurate, indicating that smart applications serve and focus on an intelligent living instead of a home environment.

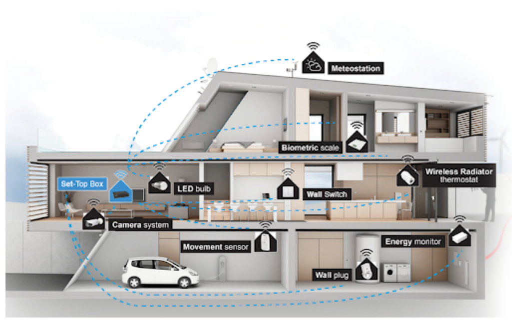

Image 2. Examples of smart homes

1.3.3. The smart vacuum robot case

A smart vacuum robot is autonomous and can be remotely controlled. More specifically, Autonomous motion occurs by using IR sensor mechanism and manually controlled via GUI controls. It has dirt sensors, obstacle sensors (the distance of the obstacles is likely to be detected using ultrasonic sensors), rapid incline/decline sensors (this infrared can be used to detect the stairs and steep inclines, when there is a sudden changed on the height from where the sensor is mounted to the floor), mapping sensors. It also includes a battery indicator in order to indicate the voltage of the battery. The smart vacuum robot is initiated through application by connecting to the Wi-Fi access point and entering port number. After initiating the robot, three ultrasonic sensors, motor driver are initiated, and the robot is navigated according to the logic.

1.3.4. Smart Governance

“Governance” is the exercise of political, economic, and administrative authority to manage a nation's affairs. It is the complex mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights and obligations, and mediate their differences”. Smart governance aims towards a performance improvement of administration topics, to enhance accountability and transparency. It includes e-government, the efficiency agenda and mobile working scenarios. In the same way smart governance is about the future of the public services in the cities. The main objective of smart governance is about greater efficiency, community leadership, mobile working, good infrastructure, and continuous improvement through innovation. Smart Governance is basically about using technology to facilitate and support better planning and decision making in the metropolitan or smart cities. It is about improving democratic processes and transforming the ways that public services are delivered effectively and efficiently.

1.3.5. Smart Things

Having made a deeper investigation, it has been found that there has been particular emphasis on smart things, under the framework, that smart things are able to make it easy to connect the things in your physical world to the Internet. Smart things place the world of connected things at individuals' fingertips. Smart Things are more convenient, secure, safe and efficient. For instance, smart things could include an intelligent calendar connected with a system that schedules meetings, considering transportation time if necessary. Smart Things can make things more intelligent, automate, monitor, and control. We call smart any physical object connected to the web with some sensing capabilities. They are:

- Detect users and the social connections between them
- Access user' s data
- Infer social context according to user's network topology, preferences & features
- Infer social goals according to the social context and the user model
- Coordinate their behavior
- Provide a context driven output.

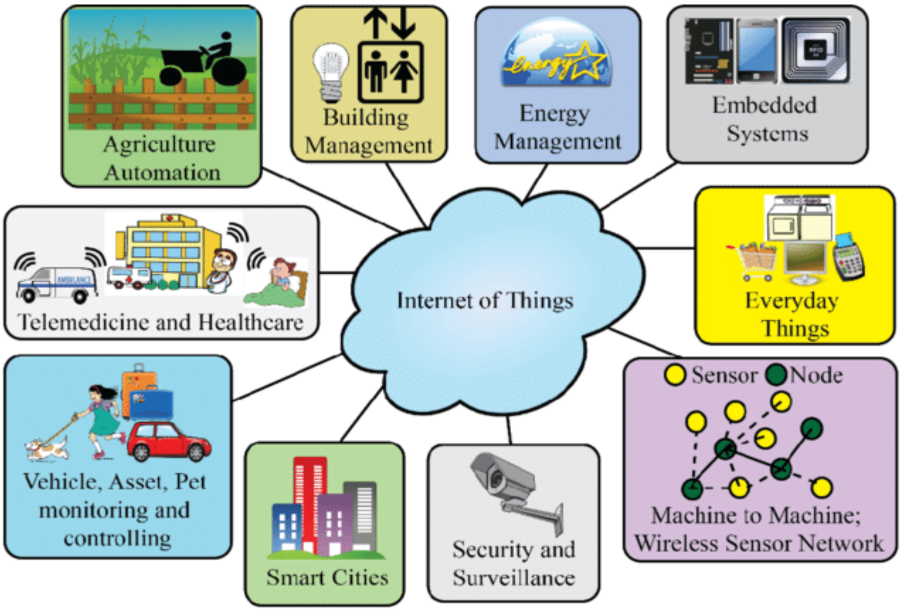

Image 3. Examples of smart things

1.3.6. Smart Medicine (Health)

Smart medicine includes such things as applying precision medicine to daily life, diet, and exercise. Internet of things (more will be explained at the following sections) can be really beneficial for health care applications. People can use sensors, which can measure and monitor various medical parameters in their human body. These applications can aim at monitoring a patient's health when they are not in hospital or when they are alone. Subsequently, they can provide real time feedback to the doctor, relatives, or the patient. McGrath and Scanaill (2014) have described in detail the different sensors that can be worn on the body for monitoring a person's health.

There are many wearable sensing devices available in the market. They are equipped with medical sensors that are capable of measuring different parameters such as the heart rate, pulse, blood pressure, body temperature, respiration rate, and blood glucose levels. These wearables include smart watches, wristbands, monitoring patches, and smart textiles.

Image 4. Examples of smart medical applications

1.3.7. Smart life for smarter regions

Cities and regions will change more in the future. A well-thought-out use of digital possible solutions to network different actors can help configure the smarter but above all more worth living. Smart cities set their strategy in accordance with specific priorities such as saving time and money, to offer a better quality to individuals' lives, to reduce negative environmental impacts through the use of ICT technologies, innovative processes, and the support of a long-term systematic search for optimal solutions in partnership with relevant stakeholders.

By working together to develop a strategy that is shared by all parties involved such as municipalities and the community, a common line towards a smart region can be achieved. Smart regions employ modern technology to save time and money for people who live there. Smart Region is understood as a region that solves tasks and challenges by wisely applying e.g., new technologies, by organizing processes otherwise or by making wise, future-proof decisions.

1.3.8. Case Study: Greece tests drone drug delivery for remote regions

The most recent example of smart things, smart living and IoT benefits and application took place in Greece. More precisely, the city of Trikala, on Tuesday tested a drone to deliver medicines to isolated places in an environmentally friendly way, sending the unmanned vehicle to a 200-person village.

The red drone with four rotor blades took off from the northwestern Greek city of Trikala and flew 3 kilometers (0.5 miles) to Leptokarya. It made two stops, landing outside a pharmacy and in a farmer's field. A pharmacy staff member unloaded the medicine from a storage compartment on the drone, and it took off again.

For more information and photograph material, you can visit the link:

https://www.reuters.com/business/healthcare-pharmaceuticals/greece-tests-drone-drug-delivery-remote-regions-2021-09-21

UNIT 2: Need of Smart Life

2.1. Smart life nowadays

Urbanization is a non-ending phenomenon. Today, 54% of people worldwide live-in cities, a proportion that's expected to reach 66% by 2050. With the overall population growth, urbanization will add another 2.5 billion people to cities over the next three decades. Environmental, social, and economic sustainability is a must to keep pace with this rapid expansion taxing our cities' resources. One hundred ninety-three countries agreed upon the Sustainable Development Goals (SDGs) agenda in September 2015 at the United Nations. However, citizens and local authorities are certainly more agile to launch swift initiatives, and smart city technology is paramount to success and meeting these goals.

Moreover, today's changing, and diversifying lifestyles and values are transforming consumer needs in the areas of home appliance products and lifestyle services. Advances in digital technology are also leading to the appearance of new lifestyle services that were previously impossible. On the other hand, aging populations, food loss, and other societal challenges that affect daily life are appearing around the world.

Growing demand for digital areas may be fueled by the on-demand nature of these areas that allows them to deliver whatever users want at any time. So, along with the appearance of various lifestyle services, consumer needs, lifestyles and values are changing. The focus is shifting from things to experiences, from ownership to use, and toward a sharing economy and on-demand services. The conventional ways of providing products will no longer be enough.

Understanding consumers is the starting point for achieving the Smart Life vision, and the use of digital technologies plays a crucial role here. Connected appliances with functions for exchanging data with the Internet or smartphones can identify increasing laundry load sizes and other housework-related changes largely unnoticed by users.

These fully showcase the latest achievements made in cutting-edge technologies such as 5G, AI, IoT, big data and cloud computing, their integration with the home appliance and consumer electronics industry, as well as the evolution of the tech-powered industry ecology.

2.2. Smart Living Overview

A few researchers have developed a vision for the construction of a smart city. Su et al. (2011) visualizes the smart city construction in three layers:

- The first layer being the "Perception Layer", in which different data are collected from various data sources such as cameras, GPS, Sensor network.
- The second layer refers to "Network Layer" is responsible for transmitting data, collected from layer 1 to data storage center, and
- The third layer 3 is dubbed, "Application Layer" containing applications for analyzing and processing the massive data residing in the data storage center.

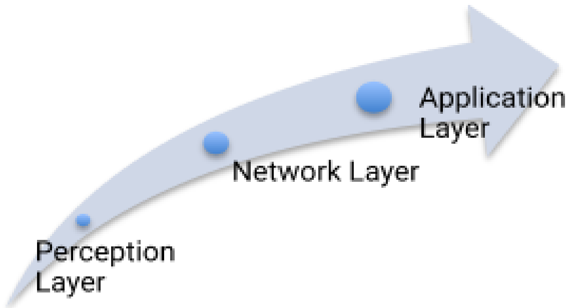

Figure 1. Smart city construction in three layers

By 2020, a quarter of Europeans will be over 60 years of age and this will impact on our health care, economy, and social security systems. According to EC, Europe is already spending nearly 10% GDP on **healthcare** due to the EU ageing population. As a result, the EU Health 2020 aims to: "significantly improve the health and well-being of populations, reduce health inequalities, strengthen public health and ensure people-centered health systems that are universal, equitable, sustainable and of high quality".

Smart Home is the basic building block for Smart Cities, and the establishment of Smart Cities is a core enabler for the rapid global urbanization. By 2050, 66% of the world population will be living in urban areas while the number of "mega-cities" with 10 million inhabitants or more is expanding at the same pace. A people centric design approach is adopted in **building Smart Cities** in order to share resources effectively and intelligently, however, provision of tailor-made services to individual inhabitants is difficult without collecting and learning personal behavior in public spaces such as smart offices, smart factories, and public transport. **Smart home** is the best venue assisting Smart Cities to gain personal data when privacy protection is properly implemented.

While it is believed that more requirements will be revealed in the future when smart home becomes more mature, the major requirements derived from this research are found to be:

- Heterogeneity
- Self-configurable
- Extensibility
- Context Awareness
- Usability
- Security and Privacy Protection
- Intelligence

2.3. Technology, smart things, and human beings

The relationship between human behavior and technology can be viewed from different perspectives. For example, from the sociological perspective, one looks at the use of technology and its effects on society (Poole & DeSanctis, 1990), from the social-psychological perspective, one mainly looks at explanatory factors of technology use at the individual level, in the socio-cultural perspective, social constructivism plays a major role and people and technology co-construct, and from the philosophical perspective, human-technology relationships are examined. All these perspectives provide a specific and valuable contribution to our understanding of the relationship between human behavior and technology.

Individuals may be wary and reluctant to trust and use the new technology and innovations. More precisely, there is a specific sequence.

2.3.1. Adoption

Diffusion of innovations theory (Rogers, 1995; Valente, 1994), describes the process of diffusion of a new innovation (an object, idea, practice or service) within a social system from a sociological perspective. New innovations entail uncertainties because the outcomes of the adopted innovation are not known in advance. As a result, people are motivated to search for both objective and subjective information about this innovation.

2.3.2. Acceptance

Technology acceptance covers the process that begins with becoming aware of a new technology and ends with incorporating the use of that technology in one's daily life. This implies the acceptance process is wider and includes multiple phases instead of only the adoption process. In addition, it is not only related to the phases of adoption, but also to the phases of implementation, the use and the effects.

2.3.3. Appropriation

When technology acceptance has taken place, the actual use of the technology may cause people to start using the technology differently than was intended by the designers. This is a reconstruction of the technology. Appropriation of new technology starts with a positive adoption process that results in an implementation process in which (long-term) use of that technology produces certain effects that, in turn, impact the different contexts in which an individual moves.

2.4. The example of Smartphones

Smartphones are smart things. Smartphones have many types of sensors embedded in it. In specific, the smartphone is a very handy and user-friendly device that has a host of built-in communication and data processing features. With the increasing popularity of smartphones among people, researchers are showing interest in building smart IoT solutions using smartphones because of the embedded sensors. Some additional sensors can also be used depending upon the requirements. Applications can be built on the smartphone that uses sensor data to produce meaningful results. Some of the sensors inside a modern smartphone are as follows.

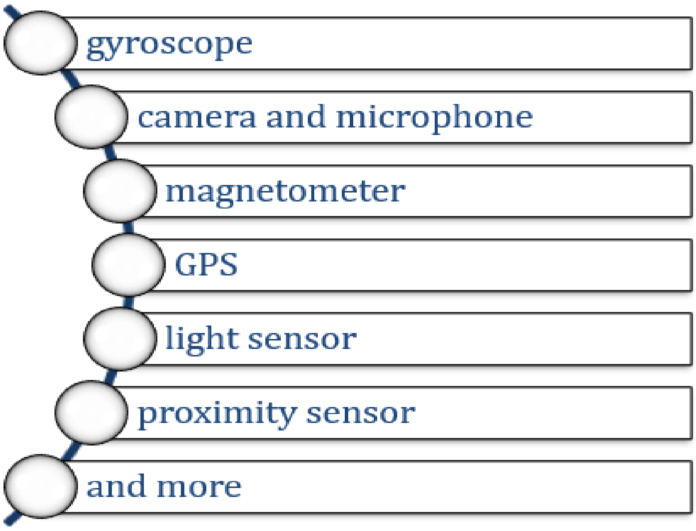

Table 2. Smartphone applications for use

(1) The gyroscope detects the orientation of the phone very precisely. Orientation is measured using capacitive changes when a seismic mass moves in a particular direction.

(2) The camera and microphone are very powerful sensors since they capture visual and audio information, which can then be analyzed and processed to

detect various types of contextual information. For example, we can infer users' current environment and the interactions that they are having. To make sense of the audio data, technologies such as voice recognition and acoustic features can be exploited.

(3) The magnetometer detects magnetic fields. This can be used as a digital compass and in applications to detect the presence of metals.

(4) The GPS (Global Positioning System) detects the location of the phone, which is one of the most important pieces of contextual information for smart applications.

(5) The light sensor detects the intensity of ambient light. It can be used for setting the brightness of the screen and other applications in which some action is to be taken depending on the intensity of ambient light. For example, we can control the lights in a room.

(6) The proximity sensor uses an infrared (IR) LED, which emits IR rays. These rays bounce back when they strike some object. For example, we can use it to determine when the phone is close to the face while talking. It can also be used in applications in which we have to trigger some event when an object approaches the phone.

Some smartphones also have a thermometer, barometer, and humidity sensor to measure the temperature, atmospheric pressure, and humidity, respectively.

2.5. Smart Devices

2.5.1. Smart watch

Smartwatches can do much more than just showing time, and can potentially support numerous other applications, like contextual updates, NFC (Near Field Communication), mobile money, navigation, health, and fitness, and so on. First of all, questions come to mind regarding what smartphones exactly are.

The smartwatch is one of many types of smart wearable devices. A wearable device is an electronic computing device embedded in the personal space of a user that can be worn, carried, or attached to the body (Giri & Srivatsa, 2018) then the collected data of the user can be transferred and analyzed on a different device (Chuah et al., 2016). Smartwatches come equipped with many wireless sensors that can provide value-added features. Some of the sensors can:

- record activity,
- heart rate,
- oxygen rate in the blood, and
- sleep quality.

Most of them have a touchscreen and support wireless communication technology, such as Bluetooth, GPS, and Wi-Fi, and GSM card so the device can have a connection to the internet by themselves when they are not paired with a smartphone as a standalone smartwatch (Fred & Luximon, 2016). Smartwatches are both useful and trendy. A smartwatch with built in network, GPS and other sensors would cater to many use cases and potentially eat market share of some of the existing gadgets, like fitness wearables.

Smartwatches can provide:

- **Useful information when you need it most**: Individuals are able to receive the latest posts and updates from your favorite social apps, chats from your preferred messaging apps, notifications from shopping, news, and photography apps, and more.
- **Straight answers to spoken questions**: Just say “Ok Google” to ask questions, like how many calories are in an avocado, what time your flight leaves, and the score of the game. Or say “Ok Google” to get stuff done, like calling a taxi, sending a text, making a restaurant reservation or setting an alarm.
- **The ability to better monitor your health and fitness**: It is also worth standing the fact that smart watches are rapidly penetrating the health informatics research space. Fitness apps can give you real-time speed, distance, and time information on your wrist for your run, cycle or walk.
- **Your key to a multiscreen world**: They provide access and control other devices. For example, individuals can fire up a music playlist on their phone or cast their favorite movie to TV.

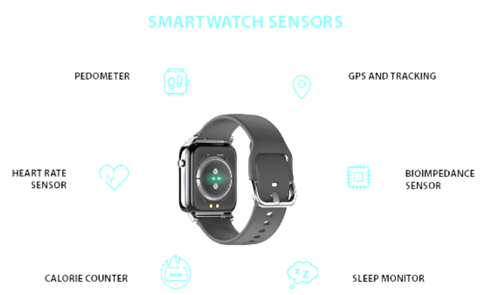

Image 5. Smartwatches and functions

2.5.2. Smart car

Due to the growing interest in problems such as global warming and energy constraints, automobile manufacturers are being called upon to make greater improvements in fuel efficiency than ever before and to reduce the transportation sector's dependence on oil in order to achieve a low-carbon society. Thus, they are introducing Electric Vehicles (EVs) and Plug-in Hybrid Electric Vehicles (PHEVs) that are powered by electric motors. The industry trend globally is toward the development of next-generation vehicles known as **smart cars**, which will be made highly intelligent by integrating new information and communication technologies into the vehicles. New models of EVs, PHEVs and conventional types of vehicles that up until now **have been operationally independent** of other traffic are predicted to soon be mutually interlinked to Intelligent Transport System (ITS) infrastructures. They will be plugged into Long Term Evolution (LTE) links and other forms of wireless high-speed data communication. Such connectivity measures will enable individual cars and trucks to communicate back and forth with other smart vehicles, elements of roadway infrastructures and smart communities.

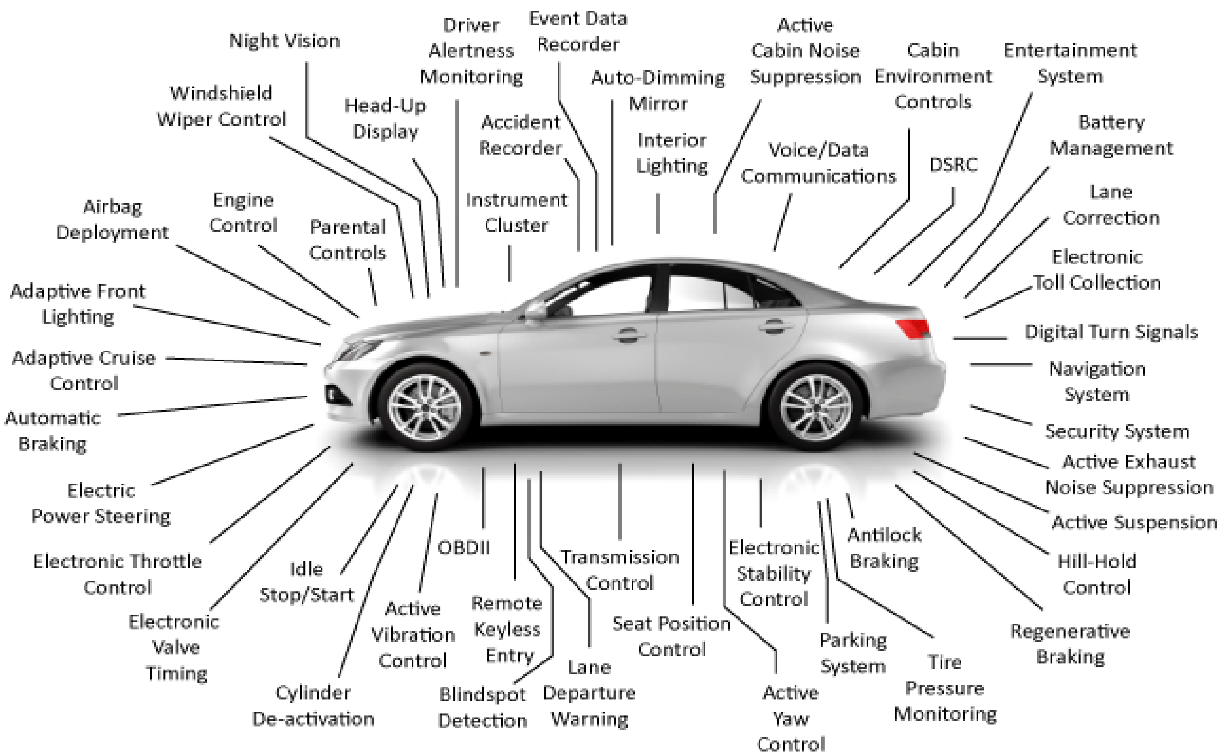

Image 6. An example of Smart Cars

2.5.3. The TESLA Case

Tesla effectively uses its data from all of its vehicles as well as their drivers, with internal as well as external sensors which can pick up information about a driver's hand placement on the instruments and how they are operating them. Researchers at McKinsey and Co estimate that the market for vehicle-gathered data will be worth $750 billion a year by 2030.

The data is used to highly generate data-dense maps showing everything from the average increase in traffic speed over a stretch of road, to the location of hazards which cause drivers to act. Machine learning in the cloud takes care of educating the entire fleet, while at an individual car level, edge computing decides what action the car needs to take right now. A third level of decision-making also exists, with cars able to form networks with other Tesla vehicles nearby in order to share local information and insights. In a near future scenario where autonomous cars are widespread, these networks will most likely also interface with cars from other manufacturers as well as other systems such as traffic cameras, road-based sensors or mobile phones.

The Good Things About Smart Cars

#1 – Smart cars are not as noisy as normal sized cars. Noise pollution is one of the bigger problems of living in an urban sprawl, so being able to drive a car that does not contribute to noise pollution is definitely a plus.

#2 – They take up much less space when it comes to parking. In fact, some Smart cars can be parked perpendicularly, rather than having to parallel park. Some are even light enough to be lifted into a tight spot if need be!

#3 – They add less chemical pollution to the air. One of the reasons for this is that they don't use as much fuel as regular sized cars. In fact, they use far less. In addition, some of these micro cars are hybrid cars, or even electric.

Some Of the Downsides of the Smart Cars

#3 – Smart cars may be crushed upon impact in an accident. may not be safe if you get into a crash with a larger, heavier vehicle. While supposedly the tridion frame of the Smart car will protect passengers, according to Adrian Lund of the Insurance Institute for Highway Safety, *all* car manufacturers say they have the state of the art technology on car design that makes their cars the safest to drive. Therefore, these claims should be taken with a grain of salt.

UNIT 3: Internet of Things

3.1. The new era

In the digital age, a growing number of formerly non-digitized, industrial-age products, so-called things, are being equipped with ICT–hardware and software–to offer novel functions and possibilities to interact as so-called smart things (Fortino and Trunfio, 2014). Their development is favored through the cost-effective miniaturization of hardware and the increasing power of processors (Serpanos and Wolf, 2018). The terms smart thing and smart device are often used synonymously. The term smart product presupposes that the smart thing is offered as a product or service. Smart products can either be product-like or a platform. Summarizing several authors, Beverungen et al. (2019) argue that from a technological standpoint most smart products comprise a unique identifier, a positioning device (e.g., GPS), connectivity, sensors, a data store, an own processor or embedded computer, actuators as well as multimodal interfaces. Further, they summarize those smart products may be invisible to the consumer and only be detectable if necessary or through malfunction. Püschel et al. (2016) systematize general smart product capabilities by differentiating four dimensions containing characteristics such as of main purpose and offline functionality; data usage and data source; interaction compatibility, partner, multiplicity, and direction as well as acting and sensing capabilities.

The Internet of Things (IoT) describes the general interplay of these smart products (Atzori et al., 2010; Serpanos and Wolf, 2018). The IoT hallmarks "the digitization and Internet-enabled integration of physical objects into the networked society" (Kees et al.2015). It can be regarded as "*a global infrastructure [...], enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving, interoperable information and communication technologies*" (International Telecommunication Union, 2012). The IoTs have been a topic of research on technologies for networking, communication, power storing, security, and signals from an IT perspective as well as on types of business models. It is a much-discussed multi-disciplinary topic in telecommunications, informatics, electronics, and social science (Atzori et al., 2010).

3.2. Theory and Internet of things (IoTs)

The idea of IoT has evolved over time and has undergone succeeding transformations that will predictably still continue over the next years with the advent of new enabling technologies. For instance, the advent of the new concepts, such as cloud computing, information centric net-working, big data, social networking, have already partially impacted and still are impacting the IoT idea and novel futuristic paradigms are already in the horizon (Akyildiz & Jornet, 2010)

Depending on who people talk to, the Internet of Things (IoT) is defined in different ways, and it encompasses many aspects of life. In particular, from connected homes and cities to connected cars and roads to devices that track an individual's behavior and use the data collected for "push" services (Karimi & Atkinson, (white paper)).

The IoT grew out of sensor networks and monitoring which developed quickly into a broader interest for networked devices and infrastructures. While the term Internet of Things is now more and more broadly used, there is no common definition or understanding today of what the IoT actually encompasses (Wortmann & Fluchter, 2015).

3.3. IoTs: what is it?

A definition for the IoT would be as follows: ***"a group of infrastructures interconnecting connected objects and allowing their management, data mining and the access to the data they generate"***

(Dorsemaine et al., 2015)

From the other hand, The International Telecommunication Union (ITU) for instance, defines the Internet of Things as ***"a global infrastructure for the Information Society, enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable in-formation and communication technologies"***

(ITU, 2012)

Along the same line, it is considered that the best definition for the IoT would be: ***"An open and comprehensive network of intelligent objects that have the capacity to auto-organize, share information, data and resources, reacting and acting in face of situations and changes in the environment"***

(Madakam, Ramaswamy, & Tripathi, 2015)

As one can understand, at the same time, a multitude of alternative definitions has been proposed. Some of these definitions exhibit an emphasis on the things which become connected in the IoT. Other definitions focus on Internet-related aspects of the IoT, such as Internet protocols and network technology. And a third type centers on semantic challenges in the IoT relating to, e.g., the storage, search, and organization of large volumes of information (Atzori et al., 2010).

The phrase "Internet of Things" was coined some 10 years ago by the founders of the original MIT Auto-ID Center, with special mention to Kevin Ashton in 1999 and David L. Brock in 2001.

3.4. Examples IoTs

As a result of the IoTs, we are said to be on the verge of a new era—an era that features a dizzying array of so-called smart objects or smart things, e.g., smart dust, smart TVs, smart cars, smart buildings, smart cities, smart appliances, smart clothes, and so on. Components of IoTs are already being deployed. There is a series of examples as follows:

Consumers are increasingly using web-enabled mobile phones equipped with cameras and/or employing Near-Field Communication. These phones allow users to access additional information regarding products such as allergen information.

Pharmaceutical products supported by bar-codes, enabling the verification of each product before it reaches the patient. This reduces counterfeiting, reimbursement fraud and dispensing errors. A similar approach taken on the traceability of consumer products in general would improve Europe's ability to tackle counterfeiting and to take measures against unsafe products.

Several utility companies in the energy sector have started deploying smart electrical metering systems which provide consumption information to consumers in real time and allow electricity providers to monitor electrical appliances remotely. Within traditional industries, such as logistics, manufacturing20 and retail, 'intelligent objects' facilitate the exchange of information and increase the effectiveness of the production cycle.

3.5. Additional Resources and Videos

Here, learner can find a list of several videos for further learning and information

1. https://youtu.be/OAlhfvud9ts
2. https://youtu.be/m45SshJqOP4
3. https://youtu.be/POHYyP4EbzE
4. https://youtu.be/ipdTLJcIkWI
5. https://youtu.be/VyBkLzBuKsw
6. A Simple Way to Make Buildings Smart is a Simple Way to Attract Smart Investors (https://www.wipro.com/blogs/wipro-insights/my-future-_-a-smart-life/)

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