Review and critical assessment on the interaction of urban spaces and technology.
The case of the urban road.

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Abstract – *The road traditionally accommodated traffic but also leisure activities, social activities and even work. However, technology has dynamically entered our lives, enabling us to replicate activities in public that used to be private. It is considered that the lines between public space and private territory, human interaction and human alienation are becoming more and more blurred. The more interaction between digital and physical environments is increasing, the more our cities are changing. This paper intends to explore how urbanisation and spatial hierarchies are redefined by technological transitions. The first part of this research is a literature review, on the studies that concern the interrelation among three key components: people, space and ICT. The second part of this research highlights the proven consequences of technological progress in the shape and structure of the city by studying the evolution and interaction of the urban road and transport technologies (automobiles, highways). This research aims to map the current knowledge concerning the interaction between people, public space and ICT.*

Keywords— **public space, urban road, ICT,transport technology,social cohesion**

I. INTRODUCTION

Throughout the 20th century, the road, that used to be a space to meet, play games even work, turned into a car traffic channel. However, as technology during recent years has entered dynamically in people's lives, enabling them to replicate activities in public that used to be private, it is considered that the lines between public space and private territory, human interaction and human alienation are becoming more and more blurred. As the interaction between digital and physical environments is increasing, the more our cities are changing. It is considered that spatial hierarchies and "definitions" are re-established by technological transitions. This procedure consists of three key components: people, space and technology.

In this study that focuses in cities, the term "people" refers to the residents of urban settlements. They consist of the majority of the population of the planet. In the first part of this paper, the term technology includes all Information Communication Technologies (ICTs). In the second part, the transportation technologies (automobiles) and infrastructure technologies (highways) are examined.

Regarding the 'public', Iveson [1] highlights the multiple meanings of this term: "it can refer specifically to the state, in distinction to the 'private' market. It can refer to all things

beyond the 'privacy' of the home. People might be spoken of collectively as 'the public'. Getting 'publicity' describes the process of bringing an event or person to the notice of this 'public'." In this paper a public space is considered to be any open space accessible to all people that enhances social interaction. The road is a linear public space in close interaction with built space. As Low et al. [2] believe "A truly public space brings people from diverse backgrounds and classes into contact". Calhoun [3] also supports this opinion stating that "one of the most important social characteristics of cities is the provision of public spaces in which relative strangers can interact and observe each other, debate and learn politically, and grow psychologically from diverse contacts". Public spaces are usually identified as parks, squares, roads, markets, pedestrian areas. Lynch [4] in his attempt to understanding how people see their city, identified five parameters that helped people establish their "image of the city". One of them was the "paths" that represent streets, sidewalks and other spaces of movement. Our research focuses on studying the urban road through reviewing the impacts of transportation technologies (automobiles) and construction technologies on its shape and function.

II. LITERATURE REVIEW

Due to the car, it is argued that the road is changing and is becoming inconsistent to its original use and function. Regarding the public spaces, there are concerns that they are losing their predominant role in urban life [5]. Also Madanipour [6] research on several cities around the globe, also verifies that perception. Across the centuries and through its arious transformations, public space, enhanced by commercial activities, used to represent the main place of communication and source of information and politics. By the explosive growth of ICT, information became easily accessible from home, via the Internet. Sojourning and shopping tend to be partially replaced by online shopping and live communication is often replaced by online forums. At the same time, activities that used to be performed in the private sphere migrated into the public realm. Souza e Silva and Frith [7] reveal that as ICT allowed people to bring traditionally private activities to the public spaces, like chatting or listening to music, the traditional perception of "public" has changed. People began developing a feeling of control and familiarity with public spaces typically associated with private space.

The digital and physical interaction of environments is based on three key components: people, public space and technology. The increasingly strong and complex relation of these, have drawn the attention of several authors that have tried to set light on it, by their own point of view ([7], [8], [9], [10]). A lot or researchers have accused technology of being responsible for not only changing the form of the city but also for the isolation and removal of people from public spaces ([5], [12], [13], [14], [15]).

Technology made building easier and faster than ever, and gave the opportunity for increased control, surveillance and privatisation according to de Souza e Silva and Frith [7] and Iveson [16]. Shaw [17] also agrees with that perception and also adds the

parameter of "digitally collecting, storing, retrieving, classifying, and sorting very large amounts of information" that creates an additional threat to personal privacy.

Meier [18] viewed the city as a place where intense communication processes take place. Under that scope, he claimed that enhanced telecommunications will undermine the cohesion of the city. Stadler [19] points out how the Internet made some activities easily accessible from home, reducing those that take place in the public realm. Although, Hampton and Gupta [20] highlighted "that internet use amplifies the existing trend toward privatism" based on their earliest evidence, but conclude that internet use, generally, reinforces the overall communication.

In the new era of the proliferation of broadband wireless Internet, Hatuka and Toch [21] underlines how technology influences, among other aspects of our life, the use of public space as new behaviors and needs emerge. Riether [22] argues that mobile devices do not favor interaction between people or between people and space, instead facilitate the users' separation from the physical public space. Also the mobile phone, makes a public space less public by enabling people "spending time in private while in public" ([23], [24]). However, having a totally different point of view Hampton and Gupta [20] believe that establishing wireless internet access in public spaces will help tackling privatism.

Stadler [19] also points out that public space can host a wide spectrum of activities by turning the internet into a mobile service and exploring the possibility of using ICT as a tool to increase the attractiveness and quality of public space. Hatuka and Toch [21] conceptualised the "portable private-personal territory (PPPT), a personal space that individuals develop and that is characterised by a multi-dimensional set of social and spatial relationships". It is a combination of digital and material personal space, which does not follow spatial constraints and modifies the role and function of the public space by "enhancing multiple forms of exchange simultaneously". They argue that mobile technologies are not about isolation but about providing traditional public space with communication rituals that were not possible before.

Although the increased interaction with technology has allegedly resulted in increased privatism and individualism, it has also generated, a significant outcome: it increased the gender equity [25]. Women are spending much more time out of home than in the past [26] and as a result they have more opportunities to engage with public spaces.

Literature shows that technological advancements throughout the years have continuously altered space and people's view towards it. Nowadays, wireless internet, cheap data and mobile devices are redefining the social dynamics of public spaces. As a result the lines between virtual and material space are not very clear.

III. THE CASE OF THE URBAN ROAD

During the 20th century, technology has shaped cities through the tech advancements in different sectors. The innovations in agricultural mechanisation led to significant decreases

of agricultural labor that resulted in intense and continuous migration from rural to urban areas. The construction of highways spurred growth in less developed areas. Technology made livable some inhospitable (due to the climate) areas and permitted industries to have more location freedom. Urban sprawl occurred due to the increase of urban populations and to the car and highways. The transportation technologies of automobiles and airplanes are responsible for reshaping cities and regions and for connecting remote settlements/agglomerations with central areas. Car originally created settlements away from urban cores, but its wide-spread use led to the creation of agglomerations such as the dormitory suburbs. Air travel, train and truck transport reformed regional relationships that allowed extended spread of large-scale urban developments. The development of air conditioning made it possible to live in areas that used to be impossible to live in, i.e. large sections of the south and west of the US. The improved infrastructure of the city (water, sewage and electric systems, highways, telephone) all enabled the reduction of the time people spend in public. Cars enabled a crossing of the public space of the road in an isolated private sphere.

A. Cities for cars

"The cities everyone wants to live in would be clean and safe, possess efficient public services, support a dynamic economy, provide cultural stimulation, and help heal society's divisions of race, class, and ethnicity. These are not the cities we live in." [5]

The car is undeniably one of the most important inventions of all time. It changed the relevance of distances and made accessible areas that were before difficult to reach. Theoretically, every land use could be situated anywhere. The city embraced the automobile and sacrificed to it their form. They became more diffused. Being less dense jeopardised their social cohesion.

Modernism was the movement responsible for shaping cities since the beginning of the 20th century. One of the main principles of modernism was that the form should follow the function, and thus planners ignored the shape of the historical city and concentrated their efforts on facilitating the movement of cars. Moses R., influenced by, and a true believer of, modernism, described accurately the spirit of the time: "Cities are created by and for traffic. A city without traffic is a ghost town..." [27]. In North America, the development pattern was dominated by urban sprawl, strict separation of land uses, single family houses and strong reliance on automobile. The European cities, thanks to their historical legacy, were more resistant towards the car but finally many of them gave up. After the Second World War, and especially during the 1950s and 1960s, European cities started gradually being filled with cars. Highways connected the suburbs with the city center. The life in the city centers downgraded and many residents that preferred living in a detached house and under healthier environmental conditions moved to the suburbs. City centers ended up being crowded during the day and abandoned in the evening when commuters returned to the dormitory suburbs. Public spaces (streets and squares) were transformed into parking lots, new highways were planned, existing roads were widened and through traffic increased.

Urban roads were always considered an essential part of a city's public life: "the street is the river of life of the city, the place where we come together, the pathway to the center." [28]. In the past, roads fulfilled several functions for different groups, such as pedestrians strolling, vehicles moving, children playing and socialising. As Natrasony and Alexander [29] described, "streets became conduits for cars and not people." Expressways were built instead of promenades which were considered by Jacobs [30] as "sacking of cities". She also added that "not TV or illegal drugs but the automobile has been the chief destroyer of American communities" [31].

In this process, much was lost: "the city of memory, of desire, of spirit; the importance of place and the art of place-making" [32]. Cars became dominant of urban life as they occupied the cities. Public spaces turned into corridors dedicated to transport. Transport planning was addressed as a road capacity issue alone. Engineers planned more and more roads in order to respond to the ever increasing demand for car use. As a new road generates new traffic the consequences of this vicious circle are congestion, urban sprawl, accidents, pollution and noise.

Sidewalks shrank, cycling was expelled from the city and pedestrians started feeling unsafe. Intersections, places where normally pedestrians meet, were considered as obstacles for traffic [29]. Sidewalks were narrowed in order to accomplish more vehicle capacity. In the case of existing roads, the carriageway was widened so as to satisfy the need to accommodate more cars. Sidewalks hampered this vision, so in some cases they almost disappeared. The number of intersections for pedestrians was decreased. These interventions increased the number of cars, their speed and removed pedestrians. A vivid example is noted by Natrasony and Alexander [29] who describes the evolution of the city of Surrey, Canada where the "city center has witnessed a dramatic increase in road capacity, and there remains a perception that more expansion is required." In other cases, such as Athens and Krakow, the parked cars occupied even the sidewalks. In Cyprus, the angles of the building blocks became curved in order for the car to turn more easily. No attention was payed to the safety needs of pedestrians. Public spaces turned into parking spaces. During the time that traffic grew into city centers, many cities decided to provide more roads and more parking places. Public spaces turned into parking lots and traffic areas at the expense of pedestrians and Copenhagen was one of the few exceptions to decide to limit car access, by taking away traffic lanes and reducing parking.

B. Cities for people

"For decades the human dimension has been overlooked and haphazardly addressed urban planning topic, while many other issues such as accommodating the rocketing rise in car traffic have come more strongly into focus" [33]. Over the last few years though, the shape of the city has changed and a new vision is dominating urban mobility, as new needs emerge: residents seek not to use their private car for commuting. They use public transport, shared cars, shared bikes and rely more and more on the real-time data provided by their smartphones. In this context, it is expected that pollution, accidents, noise, stress

will decrease and public spaces will regain their identity. This is a vision for the cities for people. A vision enabled by technological advancements.

The road

During the 20th century, for many cities "public spaces" were mainly parks and few other spaces. Roads were neglected and in some cases it was considered absurd to think of them as public spaces as they were surrendered to traffic. This situation resulted in unbearable conditions for the citizens. Thus, many cities started getting away from this narrow perception of "streets as conduits for cars" and "transit stops as simply places to wait" and started paying attention to streets as livable places to stand, sit, communicate and socialise.

Transport planning as well as the shape of streets and roads, including parking lots, sidewalks, transit stops, cycling and bus lanes, road medians, etc., began to be reconceptualised according to the needs of pedestrians and cyclists. Devillers [34] highlighted that the process of designing road space is the process of giving back space to users who were until then excluded. Sidewalks as the "place we come together" [28] should be lively places, well designed and in humane dimensions.

Communities gradually changed their vision towards public space. Transport planning stopped addressing the vehicle capacity issue alone but aimed at making cities accessible and creating favorable conditions to achieve economic productivity and social engagement.

Roads are meant to be for all: lively shared spaces that accommodate vehicles, elderly, children, cyclists, parking, etc. Jacobs [35] describes that a Great Street is "markedly superior in character or quality", comfortable, safe and visited frequently by people and contributes to community feeling, encourages participation, is remembered as a landmark and is representative of a community.

Designing roads for all means creating open spaces, tackling social isolation, supporting transport equity and connecting communities to public spaces. It is proved by the examples that follow that well designed roads can reduce a family's dependency on the automobile, as children can safely walk to school. They connect commercial districts to neighborhoods, and they contribute in building a healthier lifestyle by increasing the potential to walk or cycle. Widening sidewalks is considered a transport solution that decreases speed and greatly enhances activities in the public realm. La Rambla is "a street clearly designed for people to be on, to walk, to meet, to talk" [35]. The transformation of Times Square aims at providing additional public space for pedestrians and events, and transforming it into a world-class "piazza". Praça do Comércio, the waterfront of Lisbon, used to be a parking lot but has recently been renovated and given to the public. There is no parking or traffic, except for trolleys, trams and taxis. The river banks of Lyon have undergone a transformation that turned the parking space along the Rhône to a public space for relaxation and socialising that encourages residents to use sustainable transport options. Streets are gradually unlocking big potential and technology could enhance them, through technology

enhanced urban furniture, in order to give citizens the opportunity to deal with the city itself in a closer range.

The means of transport

During the last two decades, proliferation of digital tools has changed the way people meet, get information, access knowledge and navigate (Figure 1). These technologies rely on networks, sensors, mobile communication, and real-time information. They only now begin to influence urban space. Actually artificial intelligence is increasingly suffusing our cities. It is possible to collect real-time information, seamlessly, on every dimension of urban life. It is considered that digital information is the fuel for a new vision for mobility.

It is possible to collect real-time information seamlessly and on every dimension of urban life. It is considered that digital information is the fuel for the new vision for mobility. This new vision of intelligent transport systems, in effect, consists of intelligent public transport systems, car-sharing and bike-sharing facilities, ride-sharing and self-driving cars. Intelligent transport systems (ITS) point out the integration of ICT with vehicles and transport infra-structure to improve environmental sustainability, economic performance, safety and accessibility.
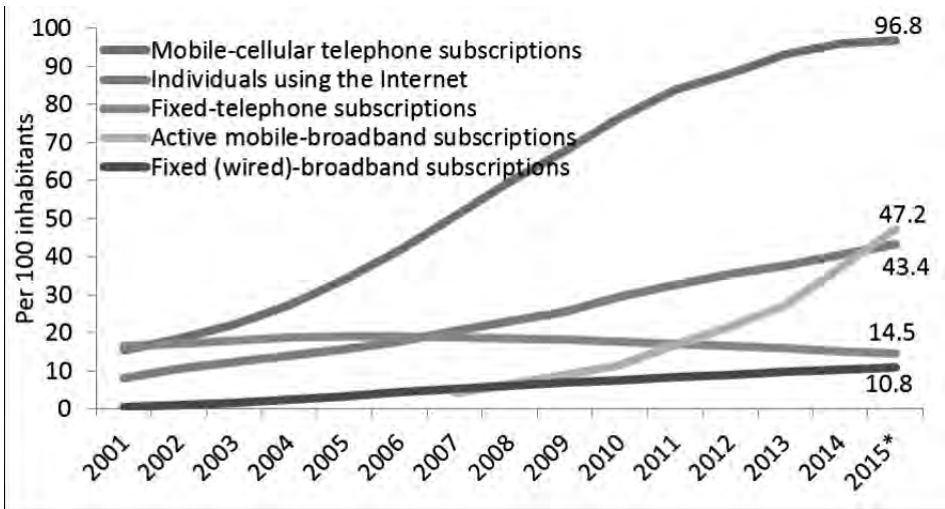
Figure 1: ICT developments per 100 inhabitants (*estimated) *Source: ITU World Telecommunication /ICT Indicators database (2015)*

Intelligent Public Transport Systems (IPTS) aim to provide passengers with smooth transportation, efficient time management and easy access to services. IPTS control public transport networks, assess their performance and provide users with updated (or even real time information) about trips, routes, timetables and traffic disruptions. Mobile services facilitate purchasing tickets and managing journeys.

Car-sharing, bike-sharing

The car/bike a person uses for a ride to work in the morning, would then give a lift to a university student or a group of tourists or to anyone else. People will not own a vehicle but they will share one, whenever needed.

Car-sharing: People spend a great amount of time on the roads, in traffic jams and looking for a place to park. Owning a car requires public space sacrifices that cities have accepted for decades, such as parking spaces at home, at work, at all destinations and space for roadways. Car-Sharing supplements the sustainable transport modes of walking, cycling and public transport – thus providing an alternative to car ownership without restricting individual mobility. With Car-Sharing as a market-based service, transport can be organised more rationally and more resource efficiently, reducing the parking needs [36]. The proliferation of wireless internet and mobile devices enabled the bloom of car-sharing companies through real-time GPS tracking and sharing.

Bike-sharing is considered to be an excellent last mile solution but they are also beneficial for cities trying to introduce cycling. Indeed, in many cities, the use of private bikes has increased significantly after the introduction of a bike sharing system. This positive result improves if the connection between public transport, public bicycles and private bicycles offers a complete and comfortable transport chain for the user's destinations. It is note-worthy that BSS increases public awareness and the acceptance of cycling as a mode of daily transport [37]. Moving from the 2nd to the 3rd generation of bike sharing systems was triggered by technological advancements: use of mobile phones, magnetic striped card and smartcards. The next generation (4th) is being even more tech dependent: stationless (free-floating) bicycles with GPS that can be detected and unlocked through smartphones.

Self-driving cars

The networked era has just begun, showing its potential by launching the self-driving car. Although various aspects of these cars (adaptive cruise control, automatic parallel parking, and collision warnings) are already used in a wide spectrum of conventional cars, it is the first time that these technologies are entering/influencing urban space so dynamically. As it was mentioned before, real time information can be collected seamlessly and thus sensors inside the car can catch drivers' stress, fatigue, sleepiness, and galvanic skin ([38], [39]). Radar, cameras and laser scanners overview the environment outside the car and act accordingly. Self-driving cars also combine the positive aspects of carsharing with those of carpooling as one car will be able to give a lift to multiple persons. Autonomous vehicles used in everyday life are seen mostly in the context of challenging the very notion of car ownership. Private cars, although they offer the convenience of having access to them whenever you need, are too expensive for the society if we take account that they stand idle, on average, 96% of the time [40]. A recent study proves that "under a ride-sharing configuration supported by high-capacity public transport and modelled over a 24-hour weekday, 90% of vehicles could be removed from the streets while still delivering nearly

the same level of mobility as before in terms of travel origins, destinations and length of trip" [41]. On the other hand there are those who are being skeptical towards self-driving cars, either for reasons of interest or due to a different point of view: a resurgence of urban sprawl, traffic jams, increased parking space requirements [42]. The big challenge is whether self-driving cars will be shared or private. The first scenario will be beneficial for the vision of the sustainable city and the second one disastrous.

IV. CONCLUSIONS

Regarding the future of cities, research has tried to propose answers as it concerns the technological impacts in urban life. There are researchers who are afraid that technology will tear the cities apart and those who can see hope in favoring a shift towards increased communication in the public realm. We can also consider three periods of thinking determined by the technological developments: the one prior to the internet, the internet era and the wireless network and, thirdly, the mobile devices era. The wireless network era can be branched in two subcategories according to the price of data.

Considering the pillars of the review it is difficult to fully address and explore their constantly changing relationship. It is difficult to predict how it is going to evolve as it would be equally difficult to predict in the 1930s or 1940s how cities might lose their traditional structure due to the automobile. Although, it is often indicated in the literature that due to technology people are detached from public space, there is evidence that communication still exists and expands, it is just based in new ways of interacting that is different to the traditional, socio-spatial representations. As new needs and possibilities emerge due to technology, isolation is the first layer of interpretation that studies provide. A second, more profound concept, is understood when conceptualising communication and interaction with no spatial constraints but with multiple simultaneous layers

Concerning the case of the road, cars provoked radical changes in employment patterns, social interactions, infrastructures and goods distribution. Streets became thruways to and from the workplace. This occupation by cars and negligence for people resulted a city with noise and air pollution, no green spaces, no social cohesion, with citizens with obesity, health problems, high rates of accidental death, with urban sprawl and decay. On the one hand, these new technologies drove the emergence of more dispersed cities having consequences on the urban and human environment but, on the other hand, spurred growth in less developed regions.

The new vehicles' technology is supposed to reshape transportation and land consumption in cities. Many questions and challenges arise regarding the implications: what will become of public transport? Is ride-sharing and car-sharing driverless cars a new form of mass transit? Should investment in public transport infrastructure be halted? Will the new system work for people with disabilities or those on low incomes? What are the implications for property owners, construction and planning? What will become the land now used for parking? Can the legislative framework correspond to the upcoming changes (planning

laws, vehicle insurance laws, etc.)? What will be the shape of the city of tomorrow? Who will benefit and who will lose? Do all these changes contribute making the cities more socially homogeneous and livable?

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CyberParks Project, funded by the European Cooperation in Science and Technology Programme | COST TU 1306 - www.cost.eu/COST_Actions/tud/TU1306), is a collaborative research platform for knowledge and experiences exchange on the role of Information and Communication Technologies (ICTs) to promote participatory urban design processes and the production of inclusive public open spaces. CyberParks is devoted to explore the contribution of ICTs to transform our cities into more social environments, rather than just more high-tech.

In April 2016 CyberParks organised the mid-term research event **ICiTy - Enhancing places through technology**, in Valletta, Malta, focused on the opportunities and challenges to public spaces brought about by the advancements of ICTs. The conference provided an excellent opportunity to synthesise the current 'state of the art', which is now reflected in this collection. It presents interdisciplinary perspectives, analysis of new methodologies, new theoretical or conceptual models for the digital era, as well as preliminary studies of peoples' use of, and engagement with, technology in public spaces.

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