Fifth-generation (5G) communication networks and sustainability: a research agenda

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Abstract

Communication networks hugely improved many fields during the past decades (i.e. education, healthcare, engineering sector, management, etc.). However, the new fifth-generation (5G) communication networks is expected to be able to bring new developments in this sector even faster than the past technologies. This will happen, not only, as the technology will be presented in the field as a new way of approaching data and services, but also, as there is more pressure exerted on 5G, due to the rising need of data that companies and individuals feel in everyday life. The paper suggests that emerging trends in this filed will also be able to create improvements for society, economy, management and environment. Better use of energy, information sharing and resource efficiency, in fact, are some of the main goals that the 5G and the sustainability approach are aiming to achieve. This shows that 5G and sustainability have several features in common that are yet not fully explored nor in theory nor in practice. Thus, proposing a research agenda, the paper aims at analysing this common characteristics, but also to highlight that the 5G can be considered a strategic tool that enables companies to be involved in boosting sustainable development.

Key words: sustainability, 5G, digital technology, innovation, sustainable development, economic growth.

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Sommario

I 5G communication network e la sostenibilità: un'agenda di ricerca

L'utilizzo dei network di comunicazione è riuscito a garantire importanti miglioramenti negli ultimi anni in diversi ambiti (specialmente nel campo della formazione, della medicina, dell'ingegneria, del management, ecc.). Per cui, c'è da aspettarsi che i nuovi fifth-generation communication (5G) networks riusciranno a sviluppare progressi persino più ampi rispetto a quelli raggiunti dalle passate tecnologie (4G e 3G).

Questo potrà accadere sia in quanto la nuova tecnologia si imporrà come un nuovo modo di fruire dati e servizi digitali, sia in quanto le pressioni esercitate sul 5G sono molto più forti, tanto da parte delle imprese che da parte dei singoli individui, i quali hanno sempre più necessità di accedere, nella vita di tutti i giorni ad un'enorme mole di dati in poco tempo.

Il paper suggerisce che i trend emergenti in questo campo saranno in grado di apportare cambiamenti favorevoli per la società, l'economia, il management e l'ambiente in ottica di sostenibilità. Utilizzare l'energia in modo efficace, condividere le informazioni e le risorse in modo efficiente, infatti, sono solo alcuni degli obiettivi che i 5G communication networks e l'approccio alla sostenibilità si propongono entrambi di raggiungere. Questo dimostra che il 5G e la sostenibilità hanno caratteristiche in comune che non sono state ancora esplorate né in teoria né in pratica. Per cui, grazie ad una ricca agenda di ricerca, il paper si propone di dimostrare che il 5G può essere considerato uno strumento capace di aiutare le imprese nell'intento di contribuire al raggiungimento di uno sviluppo sostenibile.

Parole chiave: sostenibilità, 5G, tecnologia digitale, innovazione, sviluppo sostenibile, crescita economica.

1. Introduction

Communications networks have played a huge role in changing current scenarios in the past years: starting from the first-generation system to the fourth-generation networks, many developments hugely affected the global communications and succeeded in strongly change the manners as to how individuals and companies in the contemporary society use, create, and share information among them (Andrew *et al*., 2014; Afolabi *et al.*, 2018). Presently, researchers and practitioners state that the era of Internet has being enriched by big data (Afzal *et al.*, 2018).

The huge demand for data traffic and the enormous number of applications involving big data rates have pushed forward the standards in the selected sector (Gupta & Jha, 2015). This involved the rise for the creation of

the next-generation of communication systems, which has to answer to a large amount of traffic request, to the sudden increase in the number of devices, and to the big variety of individual use and needs (Andrew s*et al.*, 2014).

In this scenery, the fifth-generation (5G) communications network emerged to deal with the opportunities and threats set by the enormous number of data traffic (Agiwal *et al.*, 2016; Dahlman *et al*., 2020).

The need to develop 5G communications networks is not only due to the rise in data volumes/rates, but also to the necessity of connecting at the same time billions of different devices used both by organisations and by individuals (for example, drones, surveillance cameras, smart-phones, smart-home devices, sensors) (Hossain & Hasan, 2015). In fact, 5G communication networks were born with the main aim of offering consistent connectivity between organisations, individuals, machines, and other devices, which are all playing a role in making real the era of the Internet of Things (IoT) (Gharaibeh *et al.*, 2017; Mistry *et al*., 2020).

In order to reach the goal, several issues have to be put into place: disruptive innovations and radical improvements need to be made in the network's features (Antonakoglou *et al.*, 2018).

On the other hand, it must be considered the fact that the growing attractiveness of wireless communication networks, has made information and communication technology a strong contributor to the carbon footprint (Xiang *et al.*, 2016). In fact, the rising amount of base stations and remote radio heads has caused wider operating expenditure due to the bigger energy utilization (Pervaiz *et al.*, 2018). This escalation can be imputed, as said before, not only to the increase of number of smart devices in developing and fully-developed economies, but also to the increase of other kind of online devices (Sharma, 2013).

These issues linked with the development of the 5G are those that are considered dangerous by several activists and individuals who think that the new communication network can cause more damages than opportunities (Alsharif *et al.*, 2019).

Thus, there is the need for the selected industry to create important improvements in terms of energy efficiency of network standards and infrastructure in order to balance the amplified energy demands set by the huge network growth. Actually, creating energy-efficient communication network and related systems is a real challenge for 5G, which nowadays assures to be able to deal with the substantial rise in use of smart devices and new wireless infrastructure (Agyapong *et al.*, 2014).

The so called fourth industrial revolution, based on Internet, digital items, nanotechnology, technology advances, robotics, artificial intelli-

gence, etc. has to be able to find several common points within the sustainability approach (Georgakopoulos *et al.*, 2016). This new era of the digital revolution, in fact, is affecting how people work, live, and communicate with each other and the same is happening in the managerial perspective (Andrew *et al.*, 2014). This sets the need, therefore, to see the development of unique digital applications and services (especially in the fields of smart cities, artificial intelligence, traffic management, drone-based delivery systems, smart home, smart design, autonomous vehicles, etc.) as strategic tool that can enable companies and individuals to boost the sustainable development.

The current co-existence of machine and human centric factors will modify future environments, as communication networks will mediate every facets of the society and generate a new multidimensional ecosystem based on information: in this background organisations have to be ready to be part of the game, leveraging on sustainability.

This paper thus contributes to the debate on sustainability by providing a research agenda and focussing of the characteristics of 5G that can help organisations to develop responsible efforts. This facilitates a comprehensive view of the whole sustainability approach in the current scenario. In fact, exploring how 5G creates sustainable items/initiatives entails investigating how sustainability can be assimilated into a value creation process that will surely be developed in the future settings.

From a practical standpoint, the paper highlights that the traditional business models need to be adapted in order to allow companies to make a deep impact on every aspect of stakeholder's digital life and work. For this reason, it is essential for managers to link 5G with sustainability, reassuring the general public opinion regarding the real risks and advantages connected with the new communication networks.

The structure of the paper is summarised as follows. In the first part of the paper we review both topics: the 5G and the sustainability. While the second part of the paper explores the specific applications of 5G. After presenting the subjects, we set a research agenda focussed on the potential implications of 5G in terms of sustainability and on how to attain possible avenues for future research.

2. The fifth-generation communication networks: features, definitions, challenges and drawbacks

Communication networks were categorized in generations (Andrew *et al.*, 2014):

– 1G communication network presents the concept of digital mobility,
– 2G introduces the issues linked with security through the SIM card and the capacity increase of higher frequency bands,
– 3G focussed on the development of mobile Internet and digital inclusion's bases,
– 4G highlights the rise of digital inclusion thanks to the mobile broadband features,
– 5G introduces mobile networks for sensor communication, industrial networks, etc. with the aim of boosting the level of digital inclusion.

Besides, 5G's development is also linked with the typical items of network integration, created with the main aim to react to the different requests in terms of: massive mobile broadband, millions of devices and ultra-reliable and ultra-low latency networks (Kachhavay & Thakare, 2014).

Therefore, from a customer standpoint, the bigger difference between all past generations and the current 5G is not only a technical issue but it involves something else that goes beyond the stronger characteristics of networks (Wong, 2017).

In fact, other needs that 5G aims to totally fulfil attain (Andrew *et al.*, 2014; Wu *et al.*, 2017):
– better coverage and high data rates accessible,
– various simultaneous data transfer paths,
– more security and attention for the privacy,
– higher system efficacy and efficiency,
– more importance give to artificial intelligent (as users are surrounded by artificial sensors which could communicate with other digital devices),
– more attention to users' healthcare,
– accessible fees due to low costs of infrastructures,
– high resolution and faster Internet access,
– wider volume data distribution,
– stability without delay,
– better data transfer technology,
– strong support to the development of virtual private spaces/networks,
– faster uploading and downloading speed,
– enhanced connectivity all round the world (especially for developing and under-developed countries).

All these features typical of 5G have more than one application in contemporary scenarios (Zakrzewska *et al.*, 2014). Some of them surely can be related to the field of sustainability and to digital inclusion (one of the pillar of the ethical approach that can create huge advantages not only for indi-

viduals but also for companies). Actually, the 5G applications involve (Zikria *et al.*, 2018):

– communication networks with few limits relating with access and zone matters,
– cognitive radio technology (i.e. smart radio),
– wearable devices with AI skills,
– a unique global standard,
– the possibility to be connected at the same time to different wireless access technologies and to move between these access following a multiple simultaneous data transfer pathway.

In sum, these applications, together with the featured considered before, show that 5G is expected to provide high speed, better reliability, fast response, and energy efficiency: leveraging on 5G communication network, users will finally be able to benefit of instant cloud services, Vehicle-to-Everything, Internet of Things, tactile internet, and robots/drones communication (Khalil & Abou El Kalam, 2018; Simsek *et al.*, 2016).

The applications and features of 5G can also be analysed taking into account the users' experience. This allows to see 5G services classified into five groups (Boccardi *et al.*, 2014): immersive 5G services, intelligent 5G services, omnipresent 5G services, autonomous 5G services, and public 5G services.

Table 1 presents the five service categories of 5G and new types of multimedia services that need 5G to be developed (i.e. augmented reality, drones, robots, virtual reality, etc.).

Tab. 1: Five service categories of 5G

Five service categories of 5G	*New types of multimedia services*
Immersive 5G services	virtual reality/augmented reality, huge contents streaming
Intelligent 5G services	user-centric computing, crowded area services
Omnipresent 5G services	Internet of things
Autonomous 5G services	smart transportation, drones, robots
Public 5G services	disaster monitoring, private security/public safety, emergency services

Source: Xiang *et al.*, 2016.

As many researchers highlighted in their studies about the possible advantages of 5G, digital inclusion is a recurrent topic in the field, and at the same time it has to be considered as essential for sustainable development and a central content of the SDGs (Zhang *et al.*, 2016; Zhang *et al.*, 2017). Even before, when 3G communication network was born, its claim "always online, always connected" was seen as one of the main element of this technology and was highlighted as one of the most relevant characteristics of these systems. Nevertheless, nowadays a huge number of individuals in developing and under-developed countries have no access to Internet and the digital society (Noll *et al.*, 2018; Ziegler *et al.*, 2019).

Starting from the analysis of the main features, definitions and applications of 5G, it is clear that the 5G will have to face different challenges in the current and future scenarios. 5G will be used to answer to different service needs in diverse facets of work, everyday life, leisure, healthcare, engineering, education and transportation (Sodhro & Fortino, 2017; Sodhro & Shah, 2017). 5G factors that will surely affect the users' service experiences are: cloud desktop, virtual reality, Internet of Things, edge cloud computing, augmented reality, and Internet of Everything (Dohler *et al.*, 2017; Sodhro *et al.*, 2018).

In order to meet diverse needs, 5G will be differently applied to diversified scenarios. In fact, it is expected that further items of this communication network will emerge, which are presently not predictable at all (Wu *et al.*, 2015).

On the other hand, it must be highlighted that the increase in terms of features and applications of 5G will also involve an enormous rise of use of data traffic that surely will strongly impact on infrastructure and energy consumption. This trend is already seen by public opinion as dangerous (Zikria *et al.*, 2018; Ziegler *et al.*, 2019). Due to the high level of pressure exerted by different kind of audiences, environmentally friendly and cost-effective solutions are more than needed while developing unexpected facets of 5G. This involves calling companies and individuals to create the most suitable set of factors for each specific digital context but also resorting to solutions like sustainability.

3. Sustainability: an overview

The concept of sustainability is growing noticeably as many companies, while using natural resources, and exploiting the workforce, must give a positive contribution to the development of the society in which they operate and promote the sustainable development (Matten *et al.* 2003; Matten &

Crane, 2005; Deigh *et al.*, 2016). As a result, those have the obligation to protect the environment, develop local communities, fight against corruption or improve human resource's skills (Vollero *et al.*, 2016; Vollero *et al.*, 2020). Due to this amplified request of morality, particularly in the perspective of digitalization, the concept of sustainability has appeared with the scope of assessing "(...) business activities as well as social and industrial development more generally (...)" (Matten & Crane, 2004, 21). The World Commission on Environment and Development stated that the "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). It highlights that sustainability entails environmental issues, social and economic features at the same time: therefore, sustainability has three souls (Crane & Matten, 2016). Elkington (1999) defined these three elements while presenting the triple bottom line (TBL) model: planet, people and profit.

Planet - The issues linked with the environmental safeguard have always been seen as the core feature of sustainability approach (Edwards, 2005; Willard, 2012). In this viewpoint, the organization and utilization of different kind of resources and their meticulous preservation for the future are crucial factors as resources are characterized by a restricted access (Hacking & Guthrie, 2008; Govindan *et al.*, 2013). Several business strategies do not take into account the natural background, badly affecting the well-being of future generations (Alhaddi, 2015). The 'planet' dimension of sustainability involves, thus, the assessment of the impact of processes, products/services on natural elements (Henriques, 2013). Setting this item as a basis for the corporate life means that a systematic resource intensive business conduct is any longer a choice available for an organisation (Slaper & Hall, 2011). Consequently, the environmental pillar of sustainability allows organisations to: embrace the environmental protection; avoid risks that can affect the ecosystem and the population; sustain the preservation of the environment through actions aimed at reducing the environmental impact of corporate strategies/tactics; follow high standards and obtain green certifications; protect the ecosystem, create environmentally friendly products; rationally use natural resources (Hussain *et al.*, 2018).

People - The social pillar of sustainability tries to prevent negative impacts of business strategies/tactics on people/societies/communities (Deigh *et al.*, 2016; Palazzo *et al.*, 2019; 2020). It deals with issues about the defence of health and security of employees, consumers and other kind of stakeholders, as well as, the accomplishment of main requests and expectations of different audiences. The social pillar of sustainability is linked,

firstly, to the manufacture of services/products that have to follow the requests of customers and other stakeholders (Jackson *et al.*, 2011).

Profit - The economic pillar of sustainability is based on indicators of profit and refers to the capability of the company to reach a suitable competitive position (Lee *et al.*, 2012). The profit pillar states that only strategies/tactics which have a long-standing economic commitment have to be set by sustainability-based organizations (Kucukvar & Tatari, 2013). This item is also linked to the main goal of every company: to create well-being and a satisfactory compensation for all shareholders (Palazzo, 2019; Vollero *et al.*, 2020).

The organisation, to attain economic scopes have to, however, work according to the present legislation about the defence of human rights and guarantee open competition. The dimension of profit, at last, is also firmly linked with sustaining social causes (Coffman & Umemoto, 2010). The economic pillar of sustainability hence involves the capability to build relationships with customers, suppliers and other stakeholders (Dhiman, 2008).

4. Sustainability and 5G scenarios

The explored features of 5G should help individuals, governments and organisations to achieve a sustainable development in different areas.

Table 2, in fact, shows that the five service categories of 5G and the new types of multimedia services can be usefully used to help different actors in attaining the very well known 17 Sustainable Development Goals, SDGs included in a UN Resolution known as Agenda 2030.

Tab. 2: Linking the 17 SDGs with the five service categories of 5G

Five service categories of 5G	*The 17 SDGs that can benefit of 5G*
Immersive 5G services (virtual reality/augmented reality, huge contents streaming)	(3) Good Health and Well-being, (4) Quality Education, (5) Gender Equality, (8) Decent Work and Economic Growth, (9) Industry, Innovation and Infrastructure, (10) Reducing Inequality, (11) Sustainable Cities and Communities, (16) Peace, Justice, and Strong Institutions, (17) Partnerships for the Goals.
Intelligent 5G services (user-centric computing, crowded area services)	(1) No Poverty, (2) Zero Hunger, (6) Clean Water and Sanitation, (7) Affordable and Clean Energy, (8) Decent Work and Economic Growth,

	(12) Responsible Consumption and Production, (13) Climate Action, (14) Life Below Water, (15) Life On Land,
Omnipresent 5G services (Internet of things)	(8) Decent Work and Economic Growth, (9) Industry, Innovation and Infrastructure, (10) Reducing Inequality, (16) Peace, Justice, and Strong Institutions, (17) Partnerships for the Goals.
Autonomous 5G services (smart transportation, drones, robots)	(1) No Poverty, (2) Zero Hunger, (3) Good Health and Well-being, (4) Quality Education, (5) Gender Equality, (8) Decent Work and Economic Growth, (9) Industry, Innovation and Infrastructure, (17) Partnerships for the Goals.
Public 5G services (disaster monitoring, private security/public safety, emergency services)	(6) Clean Water and Sanitation, (7) Affordable and Clean Energy, (8) Decent Work and Economic Growth, (9) Industry, Innovation and Infrastructure, (11) Sustainable Cities and Communities, (13) Climate Action, (14) Life Below Water, (15) Life On Land, (17) Partnerships for the Goals.

Source: author's elaboration.

Actually, several sustainability initiatives have already been analysed and put into practice thanks to the new 5G applications. They are offering important benefits especially in the field of: urbanisation and creation of smart cities; traffic management and smart building. As an example, some of the main advantages in these areas will be here briefly presented.

Urbanisation and creation of smart cities - Cities really need to benefit of 5G features as they are facing many sustainability issues due to indiscriminate urbanization (Rao & Prasad, 2018a, b). Thus, urban areas request digital applications that can aid with water consumption, air pollution, traffic management, building design management, etc. (Condoluci *et al.*, 2015). For them, in fact, it is essential to pay attention to: energy and utilities, public safety, citizen engagement, transportation and infrastructure. Several, organisations are now exploring solutions that will make smart cities able to foster large-scale carbon emissions savings and that will aid companies meeting their aims and at the same time reducing the carbon footprint of their operations. Thanks to new digital applications in automated driving area, the 5G will set the bases for better connectivity, systems of cloud-based storage, and other kind of online devices/services. For example, in the automotive sector, the 5G applications will offer safer vehicles that can be driven on the highway. This shows that 5G is not just a better

version of 3G and 4G, it is a total transformative ecosystem that helps people to live personalized and enhanced experiences whenever and wherever they want.

Traffic Management - Transportation is a field that needs to reach quality improvements thanks to digital technology (Ning *et al.*, 2019). For example, traffic lights nowadays don't have information on flow variations of the traffic. Digital technology, nevertheless, will create intelligent traffic signals with dynamic functioning, able to detect the actual traffic in real-time and adjust to it: this will improve the efficiency of traffic flows and in this manner protect the air quality.

Moreover, several digital apps help drivers to find the quickest traffic routes. Instead of having to presume where traffic congestion is, these applications aid individuals to know which street has to be avoided and which one is more suitable: this saves people time and help reducing the pollution in the atmosphere (Comşa *et al.*, 2018).

Similar benefits are available in the area of real-time mass transit guides and car sharing services. Several transportation organisations have promoted online their bus line or subway schedules: this has resulted in rising the appreciation of the users for public transport and in reducing their waiting time.

In addition, different apps aid drivers to find parking places in specific urban areas. In fact, sensors linked to parking spots communicate data that are then analysed and offered to users as points of a map which shows free parking spots. This allows drivers not to drive in circle trying to find a space but they can put their car directly in the right places: this enables energy savings, reduce carbon dioxide emissions and traffic congestion.

Smart Buildings – Building design, developed following the sustainable approach, involves paying attention to lighting, heating, and electrical systems (Fu *et al.*, 2018): they are the bases of smart building development. Using 5G and connected sensors in structuring lighting systems aids to make them more cost-effective (Maheswaran & Badidi, 2018). In fact, these technologies can be used inside the houses and in streets, to detect when no one is going to use them: this will result in reducing the energy consumption in modern buildings and cities.

Some locations have also smart trash bins that use 5G and typical sensors that indicate when they need to be cleaned (Agarwal *et al.*, 2010). On the same line, smart digital thermostats are used to increase the level of energy conservation. Individuals can remotely manage the temperature in a house and/or a room considering when they are going to be there. This kind of digital and dynamic system allows people to be comfortable when they are in the house and to save energy when they do not need it. For example,

this device can be very useful in office buildings (it will avoid to have light and thermostat always on when none is inside the office). Thus, these simple technologies show to individuals and organisations a simple way to live sustainably, gain efficiency and save money.

5. Limitations of the study and initial implications

The paper, in trying to develop a first attempt of linking 5G with the sustainability approach has briefly analysed 5G features and different linked concepts which require further analysis based on detailed theoretical and empirical research.

The main limits of the current study are due to the fact that the literature review of the topics is still circumscribed and very recent.

It must be said that practitioners and expert in the fields of engineering and ITC were more interested in analysing these subjects than scholars and researchers. This made difficult the attempt to link the two fields of study as they are in constant development nowadays. However, this relevant theoretical gap can be seen as an interesting opportunity for academics who would like to try to fulfil it opening a new area of research and exploring its potential practical implications in different realities.

Actually, as it is showed before, analysing the 5G in terms of sustainability could potentially have several interesting implications.

The result can be the creation – in the new digital world - of better-integrated strategies between organisations, individuals and governments; stronger relationships between organisations and their stakeholders, and, consequently, the potential for allowing companies that create their product and service leveraging on the 5G features within a specific sector to involve even more in the value creation process their customers.

In fact, the new technologies of 5G are going to take advantage of the huge database of information that are nowadays available for different kind of subjects. Many studies are now focused on the fact that these big datasets will create what is called the "digital twin": a digital person that totally reflects the main characteristic of every one of us (Tao *et al*., 2018). Dealing with the needs of the "digital twin" surely involves to take into account the sustainability approach, as companies, organisations and governments will know all aspects of the personality of customers, citizens and individuals in general (Qi *et al*., 2018).

From the company's point of view, the possibilities of exploiting in a sustainable way the requests of the "digital twins" of their customers involves to be able to create personalised products even before they are re-

quested by clients, facilities that are able to solve problems even before they appear, find specific solutions to problems that are not occurred yet.

Hence, these new trends have to be better explored in theory and in practice in order to be deeply understood and to be perceived as potential chances and not as intimidating threats.

6. Toward a conclusion: a research agenda

In this conceptual paper, a research agenda needs to be structured in order to find, explore and understand the next generation applications of 5G that are set to develop in a multiplatform environment where sustainability has to be seen as a core item. Accordingly, there is the need to:

- not underestimate the direct contribution that 5G technologies can offer in structuring the orientation of companies and organisations toward sustainability. Actually, it is essential not only to focus the orientation on main topics of the sustainability approach, but also to communicate the efforts that organisations do in this areas. Thus, there is the need to assess how 5G applications can help to spread the sustainability teachings among different actors and to evaluate how 5G can affect the communication of this specific item;
- explore the link between sustainability and Artificial Intelligence (AI). In fact, 5G applications will allow the development of artificial intelligent items that will make individuals surrounded by artificial sensors which can communicate with different kind of devices. Thus, there is the need to use the AI following a sustainable perspective;
- use 5G to structure plans of crisis management of communication systems. For example, this will be extremely important when natural disasters cause breakdown in communication systems. Nowadays, it takes long time to re-establish the use of communication system, but 5G is expected to face quickly this kind of problems, bringing essential benefits especially for people and organisations;
- use 5G to sustainably foster economic growth. The economic growth will be strongly sustained by 5G applications as the new digital changes allow customers and organisations to benefit from high-value data, content services and many other communication items that need to be managed following a sustainable approach. This relationship between sustainability and corporate economic growth had not yet been explicitly explored nor quantified yet, especially in the fields of education, healthcare, engineering and management, where the contribution of 5G to the sustainability approach practiced by the organisations belonging

to these sectors can make a huge difference creating unique key factors of success;

- reinvent education based on sustainable inclusion and boosted by 5G applications. All individuals who are attracted by lifelong education, will use 5G applications as a good opportunity to continue their education through online tools in a cost effective manner. Moreover, education will be available for people that were not able to easily access to educational content before;
- not underestimate the importance of security while exploiting 5G. This involves paying attention to authorization, establishment, encryption, authentication, and implementation of service policy agreement between the various actors that will benefit of 5G applications;
- to understand the role played by 5G in sustainably developing telemedicine. 5G allows remote health control of patients all round the world. With the new digital applications users will have no need to go to the hospital to meet doctors, instead patients can join videoconference assistance at anytime and anywhere. This will allow users to meet doctors who were difficult to be reached before, and maybe, it will also help people to have a wider access to healthcare, reducing costs and waiting lists;
- to reinvent travelling in a sustainable tourism perspective. Integrating the new phone apps, the use of Bluetooth & technology integrated smart phones in the traveller processes will have a huge impact on people, planet and profit. Digital technology is going to play a pivotal role in reordering the phases of travelling, allowing, for example, visitors to visit a place virtually before reaching it, or to share information live while they are travelling, suggesting others to avoid crowded or problematic destinations and re-directing travellers to other more sustainable locations;
- to develop virtual navigation. The 5G will offer users virtual navigation through which they access database of streets, universities, hospitals, etc. located in metropolis and big cities. Thanks to high speed data transmission, people will save time and money before reaching their destination as they will already know where they have to go.
- consider the sustainable side of the virtual presence. This means that 5G give individuals the possibility to access services at all times, even if they are off-site. Surely, it will benefit: (a) organisations that will increase the amount of services that they can offer (rising their profits), (b) people as they will have huge range of services available and (c) the environment as there will be no necessity for individuals to reach a certain place in a precise time to access the service (this will reduce the environmental impact).

Following the agenda, future research will address issues facing 5G growth and its important role in terms of sustainability. Moreover, recommendations for coordinating these two sides of the same coin will also be further presented.

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