Artificial Intelligence in the Telecommunication Sector: Exploratory Analysis of 6G's Potential for Organizational Agility

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Abstract:

6G (sixth generation of mobile communications) is one of the least understood future technologies from a management perspective, although the dynamics associated with it, like the internet of things (IoT), open service-based architecture (SBA) and Artificial Intelligence (AI) are increasingly visible in telecommunications sector. 6G envisions a highly interconnected future world where mobile connectivity is aimed at enhancing societal well-being and sustainability if managed properly. 6G will also considerably impact the agility of the organizations involved in providing different digital services by offering them an economical route to share and integrate various platforms, although it increases the management complexity of these platforms. To address this management complexity, AI has been referred to as the most viable tool for organizations to navigate the range of complex issues linked with platform sharing and integration, due to its potential for developing agility in both large and small organizations. Research on 6G started only a couple of years ago, and so far, most of the research on 6G has been undertaken from a technical perspective, with some recent studies analyzing some of the regulatory and business dynamics. To the best of our knowledge, no prior work (conceptual or empirical) has specifically attempted to untangle the link between AI and organizational agility development in the specific context of 6G. Our chapter is in response to these clear gaps in the literature, where we aim to undertake an exploratory analysis of 6G's potential for the development of organizational agility in the telecommunications industry. Moreover, it is a pioneering work that future business and management scholars can build on while analyzing 6G's management and implications in micro and macro settings.

Key Words: 6G, Agility, Artificial Intelligence, and Telecommunications sector

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1. Introduction

It is an established fact that modern life's economic and social aspects are increasingly data-driven, where continuous connectivity is a need globally (e.g., Pentland, 2013; Loukissas, 2019). Some scholars have gone even further in this context by arguing that near-instant and unlimited wireless connectivity is needed across physical, biological, and digital worlds (e.g., Mahmood *et al.*, 2020). Specifically, the sixth-generation (6G here onwards) mobile communication network, aiming at deployment in the 2030s, has been referred to as a general-purpose platform that will utilize novel technology enablers such as man-machine interfaces, distributed computing, and artificial intelligence at the local clouds, multisensory precision sensing and data fusion, and actuation to control the physical world (e.g., Yrjola *et al.*, 2020). In this context, it is important to highlight that developing products, applications, and services for the future digitized society in the 6G era requires a multidisciplinary approach and a re-imagining of how we create, deliver, and consume network resources, data, and services.

The need for 6G is increasingly becoming visible because the monolithic telecommunications infrastructure of today that is based on proprietary hardware and closed architectures do not provide the flexibility, scalability, and degree of automation that the telecommunication industry needs to stay competitive and profitable (e.g., Yrjola *et al.*, 2020). Moreover, converging digitalization across physical industries is increasing customer demand for high-performance networks, with trends towards open interfaces, virtualization, and cloud-native software. This technological development is expected to transform mobile business beyond connectivity towards cloud-based delivery, network-as-a-service business models, and software-led value creation across telecommunication, internet, enterprise, and industrial domains (e.g., Yrjola, 2020).

Technical studies done on 6G networks have highlighted that this network model will be designed, deployed, managed, and put into the market not only by the traditional mobile network operators but new stakeholders like local micro-operators, cloud operators, and resource brokers (e.g., Yrjola, 2020; Yrjola *et al.*, 2020). It is essential to highlight that as the evolution of the economy and society continues towards data and service-driven networks, the importance of non-technical aspects like trust is expected to increase further in this context (e.g., Steedman *et al.*, 2020). It has further been stressed that for the 6G network, communication service providers and relevant enterprises will require not only that all products and services are designed to be secure and private from the start, but also that vendors are to be trusted (Mocanu *et al.*, 2020). The role of governments and other regulatory bodies (including the European Union) in ensuring this trust and data security is also critical to consider as it would significantly impact the development and application of 6G network. Moreover, stemming from these discussions, ensuring national sovereignty has gained importance as a driver for 6G development and its adoption (Moerel & Timmers, 2021).

A key peculiarity of 6G is the increased visibility and importance of artificial intelligence (AI), which is linked to cloud-native computing, resulting in superior performance and flexibility (e.g., Shafin *et al.*, 2020). Three principles can be used to understand advanced technologies: combining, recursiveness, and phenomena (Arthur, 2009). In 6G, AI will be combined in several functional domains. Creating a system that transforms how data is collected, shared, and analyzed in real-time will create strong drivers for future value creation and capture and introduce novel stakeholder roles that transform businesses. AI also exhibits modular structures that may be developed independently, potentially contributing to system-internal conflicts between modules that have different design objectives, thereby creating recursiveness that may influence perceived user value and produce serious privacy and ethical concerns, e.g., over the sources, location, and use of big and small data. Consequently, in the future 6G context, the ubiquitous near real-time wireless connectivity will be shaped by the growing societal requirements for inclusivity, sustainability, and transparency (Hexa-X, 2021; Yrjölä *et al.*, 2020). The data-driven learning at the heart of AI utilization for creating services will have its impact on the phenomena emerging, especially from big data collected from various 6G-enabled systems, platforms, mobile devices, things, and open data. 6G will be able to utilize big data, meaning large volumes of data that is transmitted at high velocity from a variety of data sources (McAfee & Brynjolfsson, 2012). For the combination of big data and AI, the challenge is to ensure the veracity so that the 6G data sources represent the reality (Baesens *et al.*, 2016). The pervasive influence of service-driven logic in 6G means to meet the diverse needs and preferences of each user or specialized 6G sub-network, whether human, physical machine, or digital twin. Thus, avoiding any data biases or challenges of representativeness in creating a learning 6G system is crucial.

Up to date, the majority of all 6G research has been with a technology focus. Keeping in view the scant available research on 6G's potential for the larger society, our chapter undertakes an exploratory assessment by focusing on different dimensions and aspects of the 6G networks from a multidisciplinary viewpoint. It is one of the first studies to undertake such an analysis (at least to our knowledge) and hence, contributes to multiple literature streams, including 6G and AI research from business and technological perspectives, as well as futuristic entrepreneurship in this sector linked to agility. As 6G is envisioned as the connectivity backbone for future digital society, its impact potentially resonates with overall digital businesses. Our chapter is also the first study to link 6G to sustainability dynamics as well as geopolitics in this context. Hence, the current chapter is expected to be a pioneering work on which future business and management scholars can build on while analyzing 6G's management and implications in both micro and macro settings.

The rest of the chapter is organized so that the next section offers a discussion linking organizational agility and artificial intelligence. After that specific discussion on the practical manifestation of these aspects in 6G context is presented. The chapter concludes with the presentation of implications, limitations, and future research directions.

2. Artificial Intelligence and Organizational Agility

There are different definitions and conceptualizations of AI in different streams of literature. However, in simple words, AI combines the science and engineering of making intelligent machines that significantly influence organizations, their performance, and the economy at large (e.g., Balas *et al.*, 2020). Scholars have stressed that AI results in developing intelligent machines (including robots) that can understand the environment in which they operate and take required actions rationally (e.g., Marwala and Hurwitz, 2017; Balas *et al.*, 2020). There are multidisciplinary roots of AI as a research field, and it has been argued that the fundamental disciplines important in this context are engineering, philosophy, mathematics, cognitive science, economics, neurosciences, and linguistics (Solomonoff, 1985; Helo and Hao, 2021). A key goal of AI systems is to mimic human behavioral patterns and solve real-world problems (Davenport and Ronanki, 2018). In order to develop these mimicking capabilities, philosophy contributes to the main component of how a machine or a physical system can learn and operate based on a set of rules (e.g., Joshi, 2020). In this context, mathematics provides a formal representation of these rules designed based on algorithms and probability, while cognitive science includes studies of how humans think and act, and when applied in AI, it shows how computers think and learns different things (e.g., Skansi, 2018). Linguistics focuses on how language and thinking are related, while neuroscience provides the study of brain functioning and how brains and computers can be similar or dissimilar (e.g., Guoveia, 2020). From an engineering and computing perspective, AI represents a significant departure from the traditional human-machine (computer) interaction, where a machine (including) computer did what it was told to do (e.g., Helo and Hao, 2021). AI-driven machines can be trained and have the ability to learn from a massive amount of given historical data (i.e., big data analytics) and find a pattern on their own, define goals (Birkinshaw, 2020), and then make decisions and find solutions that appear rational to the machine's understanding, similar to a human worker (e.g., Jarrahi, 2018). Consequently, the ethics of quantification (Sareen *et al*., 2020) and ethics of AI (c.f., Jobin *et al*., 2019) have emerged as novel topics to add value to all fields relevant to developing and employing AI (Dignum, 2018).

One of the key tenets of AI is that it enables solving complex problems relatively quickly and dynamically enhances innovation (Adams and Hamm, 2010; Jarrahi, 2018; Joshi, 2020). It has a wide range of applications, such as driverless cars, business processes, security, manufacturing, and trade (Davenport *et al.*, 2020). As such, it is a key overarching technology that drives new innovations and provides large-scale solutions to problems that seemed unfathomable in past decades. As such, the profound potential of AI has widely been studied, and strong arguments in its role in the future of businesses and societies have been discussed (e.g., Davenport *et al.*, 2020; Di Vaio, Palladino *et al.*, 2020; Ming-Hui and Roland, 2018; Nica *et al.*, 2019).

In turn, organizational agility is defined as the organizational capability to efficiently and effectively redeploy/redirect its resources to value-creating and capturing activities in response to external change (Teece *et al.*, 2016). As such, organizational agility is particularly relevant in times of unprecedented pace of change within and across organizational boundaries (Bouguerra, Gölgeci, Gligor, & Tatoglu, 2019). It enables firms to prosper in hypercompetitive environments and amid unprecedented levels of technological change (Overby *et al.*, 2006). Key dimensions of organizational agility are alertness, responsiveness, flexibility, and speed (Gligor *et al.*, 2013; Golgeci *et al.*, 2019).

In the context of organizational agility, task automation enabled by AI could speed up organizational processes and enhance organizational agility (Davenport *et al.*, 2020). AI also reduces the cost and the time span of forecasting processes (Agrawal *et al.*, 2018), which could foster alertness and responsiveness dimensions of agility (Gligor *et al.*, 2013). Furthermore, AI's critical role in processing and leveraging big data and integrating organizational functions (Davenport & Ronanki, 2018) could bolster organizational visibility that underlies key agile capabilities in the organization (Gligor *et al.*, 2019). Likewise, AI speeds up organizational learning and decision-making (Mnih *et al.*, 2015) and can support managers to be resolute in their decision-making and implementation that are found to be further enablers of agility (Gligor *et al.*, 2013). Thus, AI may serve an assisting (improving efficiency), augmenting (enabling otherwise impossible tasks), or autonomous (creating and deploying systems that act on their own) role for organizational agility (Garbuio & Lin, 2019).

Kaplan and Haenlein (2019) identified three levels of AI maturity. The first level of maturity is based on machine learning (ML), meaning that its impact on organizations is limited to specific application areas since machine learning cannot easily be replicated to new areas of application without significant changes to the algorithms. The second maturity level extends AI to several application areas, thereby bringing in simple reasoning without human intervention. The third level includes a fully self-conscious system that interconnects creativity and general wisdom, making humans redundant. Beyond redundancy, AI has been attributed to create a technological singularity in the future: "*after the intelligence of AI passes the human-level, its entire future will be perceived as a single point, since it will be beyond our comprehension*." (Wang, Liu, & Dougherty, 2018). While AI may unsettle organizational procedures at the initial stages of its adoption and play an episodic obstructing role in organizational agility, it is likely to improve organizational agility in the long run, given the potential benefits mentioned above. Accordingly, we expect, at an overall level, AI to have a positive association with organizational agility.

3. Practical manifestation of AI and Organizational Agility in 6G Context

To explore and make sense of AI's role in 6G, and the possible impact of this combination on organizational agility, it is important to notice that the 6G mobile communications platform will not be developed in isolation, but as a continuation from 5G where the current enhanced mobile broadband (eMBB) services will be further extended. For 6G, the work on defining new service classes is only about to start in the future, but already now, they can be expected to continue having features evolving from the 5G services (eMBB, URLLC, and mMTC). For example, these developments could include mobile broadband reliable low latency communications (MBRLLC) to converge eMBB and URLLC for providing, e.g., extended mixed reality services; massive ultra-reliable low latency communications (mURLLC) to converge URLLC and mMTC for smart factories' robots and cobots (collaborative robots); human-centric services (HCS) for facilitating empathic and haptic communications; and multi-purpose services (MPS) that comprise control, location, sensing, and specific performance requirements of, e.g., the energy systems of the future (Saad et al, 2020).

The world's first 6G White Paper identifies sustainability as a key driver for 6G development and highlights merging different services, such as sensing, imaging, and positioning, with the communication service to provide totally new applications (Latva-aho *et al*., 2019). Similarly, the European Hexa-X project envisions the "*unification of the physical, digital and human worlds*" (Hexa-X, 2021, p. 29) and that in 6G, communications, positioning, imaging, and sensing will converge, also with ML and AI. This envisioned unification and convergence point out the challenges of mapping the relevant scale and scope for our exploratory analysis. Thus, while the research on 6G is still in early phases aiming at first network deployments around the year 2030, two major drivers are already clear (Latva-aho *et al*., 2019): sustainability (Matinmikko-Blue *et al*., 2020) and AI (Ali *et al*., 2020).

3.1. United Nations' Social Development Goals driving 6G development

There is global consensus in the 6G research and development community that the United Nations Sustainable Development Goals (UN SDGs) should be taken as the starting point for defining the future 6G networks as both are aiming at the same year 2030 (Latva-aho et al. 2019; Matinmikko-Blue et al. 2020). Existing and future wireless systems including 6G will play a major role in helping various vertical sectors, such as industry, energy, health, and their public sector counterparts such as smart cities, meet the individual targets defined in the UN SDG framework. In parallel, the sustainability of the wireless networks themselves needs to be a key design criterion in developing these systems. This calls for the development of new key performance indicators (KPIs) that take into account sustainability factors in future mobile communication networks. Consequently, KPIs related to 6G networks are being extended to consider value-related aspects, resulting in new key-value indicators (KVI), the definitions of which are still at an early stage.

The UN SDGs and 6G influence each other in a multitude of ways. Authors in (Matinmikko-Blue et al. 2020) identified a threefold role for 6G as 1) a provider of services to help in achieving the UN SDGs, 2) an enabler of measuring tools for data collection to help with the reporting of indicators, and 3) a reinforcer of a new ecosystem to be developed in line with the UN SDGs. The UN SDGs influence 6G by design by driving the development of future 6G networks to be the backbone of future society to help in meeting the specific targets of the UN SDG framework as defined by the existing indicators. The UN SDGs influence 6G in design by making the 6G networks a measuring tool to collect data for the reporting on the achievement of the sustainability targets through their indicators. The UN SDGs also influence 6G for design through the development of the 6G systems in accordance with the UN SDGs, covering the societal, environmental, and economic sustainability perspectives.

3.2 The impact of AI on organizational agility via 6G use cases

Traditionally the context of mobile communications has been approached from regulatory, technological, and business perspectives, keeping the mobile network operator as the focal player (Ahokangas *et al.*, 2013). In this approach, regulation has been considered as the delimiting factor, technology as the enabling factor, and business as the realizing factor. However, as 5G is already an enabling technology that has been considered to disrupt the telecommunications sector; 6G is expected to bring further radical changes (Iansiti & Lakhani, 2020). To start with, we argue that 6G and AI can be considered as closely related general-purpose technologies (Bresnahan & Trajtenberg, 1995) characterized by their pervasiveness, technological dynamism, and innovation complementarities; radiating their impact on downstream and upstream sectors (Bekar *et al.*, 2018); and having a transformational effect on the society at large (Hogendorn & Frischmann, 2020).

As with all emerging technologies, there are numerous enabling technologies connected to 6G and AI that may impact organizational agility. Although there is little point to enlist them all, some of them include human-machine interfaces that allow for novel ways of interacting; virtual, augmented, and extended mixed reality that facilitate extreme user-experience; and ubiquitous distributed computing that refers to bringing cloud services to the edges of the mobile network. Also, distributed ledger technologies that enhance the security and privacy of communications; and context-aware things and systems that may support in achieving environmental or societal sustainability— are some other associated facets. However, a more fruitful approach is to look for use cases that can be identified for future AI-assisted, AI-augmented, and AI-autonomous 6G as *antecedents for organizational agility* (Saad *et al*, 2020; Viswanathan & Mogensen, 2020; Yrjölä *et al*., 2020; Hexa-X, 2021). The following list of use cases shows some examples or these antecedents but cannot be considered exhaustive:

- The convergence of increasingly maturing AI and 6G, i.e*., the cost-efficient sustainable ubiquitous near-instant unlimited mobile connectivity* aimed to be reached by 6G, encapsulates the generic characteristics potentially impacting organizational agility via new services—such as various AI-agents and assistants—that help humans in fundamental ways in all sectors and at all levels of analysis.
- Up to the early stages of 5G, humans have been by far the largest user group of mobile communications services. However, a growing number of *increasingly more autonomous things*, robots, cobots (collaborative robots), vehicles, and drones—also swarms of them—and communities can be considered as the users of novel 6G services. As the service needs of different types of users in different sectors of society vary, 6G needs to become more versatile and adaptable, e.g., for the needs of different verticals such as industry, logistics, or agriculture. It has been claimed that the true growth potential of 6G lies not in consumer services, but in 6G's capabilities to serve industries and thereby boost network effects and novel productivity gains at the societal level.
- For humans, *multisensory applications and services* such as virtual, augmented, or extended mixed reality (VR, AR, and XR, respectively), are leading the way to holographic communications and immersive telepresence. These provide novel ways of working that connect the physical, digital, and virtual worlds by 6G. Also, at the other end of the communications continuum, haptic and empathic communications may enable AI-enabled work in radically new ways in augmenting human abilities to perform tasks and interact with others. A general observation from this continuum is the diminishing role of smartphones

when communications will be embedded with different systems and artifacts such as wearables.

- The value of *privacy, security, and safety* is increasing not only for humans in daily communications but also for ensuring that things, robots, and autonomous vehicles can be used safely and those critical infrastructures are secured. For ensured privacy, security, and protection against malicious cyber-attacks and -crime, 6G may offer (local) trust zones for homes, communities, smart factories, healthcare, smart cities, and different kinds of smart environments (e.g., roads for autonomous vehicles), even related to smart communication surfaces of the future.
- 6G facilitates *massive dynamic twinning*, meaning the creation and existence of online and real-time digital twins (DT) of the physical reality in cases such as industrial design, smart factories or smart cities. It is expected that in the future, digital twins will be used, e.g., for environmental management and supporting the creation of situational awareness.
- Climate change and biodiversity are two of the drivers emphasizing *sustainable development*, both societally and environmentally. In the societal context, trustworthy e-health services and institutional, local mobile coverage in schools and hospitals are examples of sustainable 6G services. In the environmental context, harnessing 6G to monitor the earth via bio-friendly and energy-harvesting sensors over 6G connectivity could help to create systems that monitor the status of the environment.
- The first steps of *transhumanism* have already been taken, and in the future, 6G connectivity and body-area networks can be used to communicate and connect implanted biosensors that help to merge humans and machines together, providing humans with new capabilities. The digital (twin of) me, enabled by 6G, is one of the future visions that may impact all organizational levels.

Technically, the 6G system will employ AI/ML in the air interface and optimization of radios, cognitive spectrum use, and context awareness. Zero human touch network optimization based on the traffic pattern will be applied extensively. In addition to radio applications, AI/ML will become essential for the end-to-end network automation allowing for dynamic orchestration and adaptation of network resources according to changing service requests. This will reduce the deployment time of new services and mitigate of failures while significantly reducing operational expenditures.

3.3 The impact of AI and 6G on organizational agility at different levels of analysis

The antecedents of organizational agility listed above evidence of the technological convergence, divergence, and emergence envisioned for 6G. In parallel, these use cases indicate a move from the exploitation of technology to exploration with new technologies, potentially changing the way how organizational agility will be achieved and managed (Fountaine *et al*., 2019). This raises the question what are the levels or units of analysis that we should pay attention to when looking at 6G's outcomes and impact on organizational agility. Yrjölä *et al*., (2020) provide a generic framework that comprises *user*, *business*, *sustainability*, and *geopolitical* levels of analysis on organizations. The following discussion builds primarily on inputs from Yrjölä *et al*., (2020), Saad *et al*., (2020), and Hexa-X, 2021) visions.

User-level impacts

At the user level, the impact of AI in 6G on organizational agility can be considered as an enabling factor. For humans, the 6G services will enable new working processes that connect the physical, digital, and human worlds, enabling remote work to extend beyond the current digital-only work content. Extreme experience built on virtual, augmented, and extended reality will be possible anywhere; telepresence may become the norm instead of the pre-COVID-19 "in real life" approach, supporting thus the distributed organization, learning, collaboration, and teamwork. Merged cyber-physical work contexts, mixed reality co-design and collaboration, experience before prototyping, and all kinds of immersive experiments, e.g., via haptic and affective/empathic communications, will enable using new senses and feeling, experiencing, and manipulating objects remotely. New human-machine interfaces, brain-computer interaction, embedded and wearable devices and intelligent surfaces will be used to enable the new work content and the extension of the work context. Also, the extended work context may support creating a safe and efficient work environment. All these examples contribute especially to environmental and societal sustainability that are expected to be the core values driving work but also consuming of services by the prosumers of the future.

The starting point for the future 6G- and AI-enhanced work and organizational agility will be trust and trustworthy communications that also enable the inclusion of AI-assistants, robots/cobots. Moreover, different kinds of autonomous machines—including vehicles and drones, will also enhance organizational agility. Privacy, security, and safety as human rights need to be highlighted in future AI-enabled 6G, as there is also the risk of loss of privacy and the emergence of a control society. As a new phenomenon, autonomous AI-assistants, robots/cobots, and vehicles and drones and communities can be considered as new types of users of 6G. The key question for the emergence of this kind of new ecosystem of users will be how the control of these new users is organized in a human-centric way as the big, and small data required, consumed, and generated in future 6G may be owned, governed, and regulated differently depending on country or business sector.

Business-level impacts

The pervasive nature of AI and 6G has the potential to change businesses fundamentally in all sectors of the economy. However, different industry verticals with decentralized manufacturing are currently seen as the primary beneficiary of the novel flexibility, efficiency, and quality improvements that AI and 6G may bring about, especially when ubiquitous, unlimited, and near-instant connectivity is available for things, machines, and robots applying circular and sharing economy principles in digital twins. In addition, Industry 5.0 facilitates the long tail of mass customization, localization, and closer interaction with the users. Digital Trust, enabled by quantum computing and distributed ledger technologies like blockchain and smart contracts, will provide businesses a secure and predictable basis for digital society with world-class cybersecurity, public safety, and fintech. In addition, when the user-level impacts are harnessed in various business domains, we may expect businesses to gain benefits following the 4C-paradigm of mobile communications: changes in *connectivity* services enable improvements in data *content* services and *context* awareness services, creating a *commerce* platform ecosystem in which different business models and business ecosystem roles transcend.

The focal point in that expected change of businesses is the new 6G connectivity provided by future mobile network operators and especially local private network operators, the number of which is expected to grow fast. Currently, there are typically a handful of mobile operators (providing 2G-5G services and IoT network services) per country, but based on a trend started already in 5G, it is expected that in 6G millions of private local small scale operators will emerge in the future to serve the specific needs of industries, smart cities, communities (e.g., in the context of future smart grids) and different kind of campuses such as hospitals or universities. This trend toward localization in mobile communications will facilitate the convergence of different connectivity and data platforms (Ahokangas *et al*., 2021) and the emergence of new kinds of edge cloud and service/resource broker and integrator roles in the future business ecosystems. Also, the over-the-top (OTT) internet content providers and various cloud infrastructure providers will play a role in this localization of services.

The fundamental first-order changes in the value creation and capture processes and corresponding value configurations—i.e., business models—in platform ecosystems comprising connectivity, content, context, and commerce services discussed above will have a second-order impact on all sectors relying on digitalization. The challenge will be to ensure that customers in different locations, served possibly by millions of different operators, can consume the services offered. For platform owners, the question will be how to open the platforms, and with what kind of business models, easily for complementing actors (complementors). The question for complementors will be how to utilize all kinds of platforms flexibly in parallel, and with what kinds of business models, in service provisioning toward extreme customer experiences. Consequently, from a business model perspective answering the questions of *scalability* to deal with the dynamism of the businesses, *replicability* to deal with entries to new markets or the creation of new markets, and economic, environmental, and societal *sustainability* of services will become crucial. Thus, the change from closed business models toward more open and mixed business models will continue, highlighting the role of competition, ecosystems-thinking instead of traditional supply- and demand-based platforms, and sharing economy strategies instead of traditional competition.

The key challenge at the business level will be how to achieve legitimacy for the combination of AI and 6G. Disruptive innovations frequently suffer from low legitimation, exhibiting a low legitimation level due to associated high uncertainty (Snihur *et al*., 2021). At the same time, legitimation of the innovations is necessary to be able to create and capture value from the innovations (Biloslavo *et al*., 2020), and innovation-related disruptions have been found to cause regulatory, incumbent, and social pushbacks, calling for ecosystem-level activities to ensure successful commercialization across different segments and markets.

Sustainability-level impacts

The United Nations' Societal Development Goals (UN SDGs) have emerged as the key source of impact for developing future 6G (Matinmikko-Blue *et al*., 2021). However, in different markets, the starting points for using UN SDGs' are different. Traditionally, in addition to the economic aspect, the environmental aspect has been considered in the development of telecommunications in the form of energy and resource efficiency (Zhang *et al*., 2020) as green radios. Increasingly, societal values have also been considered relevant for the 6G debate (Matinmikko-Blue *et al*., 2020). The different sustainability perspectives in 6G and AI should be considered in parallel as balanced and uncompromised by the developers and users of future 6G: environmental sustainability should not sacrifice economic and societal progress, societal values should not compromise economic and environmental sustainability, and economic sustainability should not cause negative societal or environmental consequences (Miceli *et al*., 2021). The types of sustainability should be considered over the lifecycle of all future mobile communications technologies from their development to their deployment. In the deployment phase, the sharing economy principles will increasingly be applied in the domains of the spectrum, infrastructure, and resource sharing. Also, it has been expected that AI-enabled 6G will increasingly be used to monitor the natural environment.

From the perspective of integrated sustainable development, the emerging, enabling, and embedding nature of technology will be increasingly more important to consider (Kapoor & Teece, 2021). There will be several initial variations of the 6G technology; therefore their lifecycle needs to be considered from the beginning to deal with the uncertainties associated with them. As 6G and AI technologies will be commercialized as general-purpose technologies in multiple application domains, they might lead to significant societal outcomes and be placed with requirements for complementarity and extendibility. Thus, in developing these technologies, the business models and business ecosystems where these technologies will be commercialized need to be carefully considered to deal with the potential variations stemming from the use of 6G for various purposes.

Geopolitics

Geopolitical developments have been recognized influencing future telecommunications from economic, societal, and environmental perspectives. At the national level, concerns over sovereignty regarding digital technologies have already become an issue (Moerel & Timmers, 2021), especially in the context of critical infrastructures. The global competition of the US, China, and Europe in the AI and 6G contexts may lead to the creation of technology blocks (Yrjölä et al., 2020; Feijóo et al., 2020) that may negatively influence the scalability, replicability, and internationalization of the AI-based 6G services due to technological fragmentation, compartmented innovation ecosystems, techno-nationalism, and market protection.

Although all the three key geopolitical groups will be faced with the consequences of COVID-19 pandemic and eventually climate change, they run different policies. The market approach of the US, the rights-framework approach of the EU, and the government-push policy of China (Feijóo et al., 2020) are backed by differing values and legislations, influencing not only the traditional spectrum allocation, regulation, and harmonization decisions but also competition and innovation policies and especially the privacy, security, and consumer rights related decisions. In the same vein, international standardization of the 6G technologies may also slow down. The international spillover effect risk of data and service colonialism is already a reality in many consumer services and may in the future extend to services offered to different industrial verticals. Therefore, organizations participating in the development of AI and 6G will need to consider and foresight emerging geopolitical trends and risks carefully.

4. Implications, Limitations, and Future Research Directions

As the above discussion indicates, frameworks needed for making sense of the complexities of how 6G and AI impact organizational agility are just evolving. From the research perspective, six themes may be recognized to influence organization agility at large: trust and legitimation at the core of interaction, profiting from innovation, APIfication and rise of the developer, sustainability, and the technological and economic singularity as the potential outcome of the implementation of AI.

Creating *trust* in the context of 6G and AI can be considered a bottom-up approach strategy to achieving *legitimacy*. To achieve legitimacy, i.e., be considered appropriate and become accepted (Suchman, 1995) in its context, the developers, users, and regulators of future 6G must consider it trustworthy. Innovations in general suffer from low legitimacy (Snihur *et al*., 2021) and the combination of AI and 6G doubly so as the combination may potentially raise ethical questions related to their data sources, access, ownership, and usage. A research gap identified in this is the poorly understood legitimacy of algorithms, especially AI. As AI is capable of learning from the data, improving the creation and capture of value on the platform, making decisions, and acting based on the data, the question arises whether AI, and not only the designers and users of it, can be held accountable for its actions and how legitimate these actions are in the first place (Gregory *et al*., 2020). Also, extant research claims that the relationship between a platform's AI capability and perceived value is moderated by platform legitimation, data-stewardship and user-centric design, indicating that a wider perspective is needed for understanding legitimacy and the processes of legitimation in 6G. Thereby directing attention to combination possibilities stemming from different technologies (AI included), recursiveness stemming from tensions between different technology modules being developed independently, and phenomena emerging from data (Gregory *et al*., 2020), is critical.

A new trend recognized within telecommunications is the "APIfication and rise of the developer". "API-fication" (application programming interface) paradigm refers to the confluence of a few different trends. First, software is becoming ubiquitous. Second, the role of cloud computing and microservices is increasing in importance. With APIs, software functionality becomes like modular – stacking software modules together becomes easy, enabling to quickly build new software solutions. APIs allow to effortlessly continue to develop a solution by adding, changing, or removing bricks. This enables more agility and productivity than traditional, monolithic applications have provided. APIs allow to rethink the "theory of the firm" – the nature and structure of a company – including how the company is organized internally and the boundaries between the company and the market. APIfication breaks economies of scale and end-to-end platforms, which will be more easily replaced by best-of-breed solutions. APIs change how software is consumed by removing the need for us. On the other hand, it changes how software is developed by allowing companies to mix internal and third party components when creating an offering. It is the key driver for platform play and decentralization. Stemming from APIfication, digitalization and converging 6G and IA, the role of the developer becomes increasingly important. Development talent is a scarce resource – most companies are struggling to attract the talent they need. Shift to the cloud has changed how enterprises purchase software. Developers have more control than before over what is being purchased. Developers are increasingly getting a seat at the table in major technology decisions. This has made developers a key target for sales efforts: many companies build their product to make it easy for developers to try them out. Once they try and get hooked, the commercial discussion is elevated to decision-makers. Building a developer ecosystem is a pre-requisite for success for many businesses, and they are shifting their expensive top-down go-to-market motion to bottom-up product-led growth, where customers can try out the product easily and expand usage over time.

Although sustainability has already been raised as a key driver for 6G (e.g., Matinmikko *et al*., 2021), future research is needed on multiple perspectives that link 6G, AI and related environmental and societal sustainability aspects. For example, research on the KPIs and KPIs role for developing and utilizing future 6G are urgently called for. The sense of community created by 6G technology and the ability to directly collaborate with others enables humans to participate and act in society in an unprecedented way. Co-evolution of human capabilities and intelligent 6G and AI technologies and how people participate and collaborate in the shaping and co-creation of the digital futures is taking place as part of their everyday lives and practices at work and leisure time. To make this possible, it is essential to consider whether users have real access to these services: that they have the needed devices and know how to use those and the available services. Furthermore, there is a serious need to consider also non-users and the reasons for exclusion, by their own choice or , e.g., for an external reason. A deeper understanding of technologies and related development and experimenting skills such as programming also further enhances the users' possibilities to take an active role in the ecosystem and make and shape technologies for their personal needs. This enables the users to evaluate and reflect on the technologies and their role in the user's own life as well as more widely in the society: Who benefits from technology or service use, and how? Who experiences value? What is the real price and is it worth paying?

Finally, whether 6G and AI can be considered as general-purpose technologies, remains an open question. The differentiation between discrete, enabling, and general-purpose technologies helps clarify how to profit from technological innovations and their combinations, both privately and societally (Hogendorn & Frischmann, 2020). How firms can profit from enabling and general-purpose technologies is considered different from that of profiting from more narrowly applicable technologies (Gambardella *et al*., 2021)—broad applicability leads to difficulties in value capture for the innovators and raises concerns regarding the dominant designs for up-and downstream sectors, the strength of the appropriability regime to protect intellectual property rights in these sectors, and the availability of complementary resources. However, the question emerges how general-purpose technologies commercialization and business models in the combined context or 6G and AI could be. Of specific importance in this regard may become the tethering logics applied to these technologies as 6G provides opportunities to bring new resources into the domain of continuous network connection on both demand and supply sides of 6G services. This tethering may be of physical (via the infrastructure/platform), virtual (via devices or data), or legal nature (Hogendorn & Frischmann, 2020). Tethering also raises the question of regulation, as without regulation, different stakeholders may discriminate against each other in competitive situations. As the consequence of the convergence of data and connectivity platforms in the future, regulatory challenges will become complicated.

During recent years, discussions on whether AI's utilization leads to technological and economic singularity and the redundancy of humans in value creations and capture have been raised as AI matures and develops from mere calculation via computerized control and production toward computerized innovation (Nordhaus, 2021). However, AI needs 6G connectivity to reach the efficiency improvements, immersion and rapid technological change envisioned for the singularity. Both demand and supply-side “tests” have been developed to evaluate whether singularity is really approaching, also using data from the telecommunications sector as evidence. These discussions resonate with the profiting from innovation research with their focus on both demand and supply-side phenomena and having reflections on both down- and upstream sectors around 6G and AI. Although being at least to some degree speculative, these pieces of research point out to look at the phenomena around 6G and AI from multidisciplinary perspectives.

Our chapter has limitations as well like any other academic work. Firstly, it is a descriptive piece, where the discussion is based on existing research and secondary sources. Therefore, lack of primary data can be considered a limitation. However, keeping in view the lack of research on this topic and its newness, our chapter has the bases to offer a starting point for future studies to explore different aspects highlighted here in detail in different empirical settings. Another limitation can be the diversity of topics discussed in the chapter while referring to digital business and entrepreneurial possibilities. However, due to the current chapter being a pioneering work describing the potential of 6G for organizational agility, it was necessary to refer to all these aspects. The future studies can build on our chapter and analyze both macro and micro business dynamics associated with 6G, in detail, and in different contexts.

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