Chapter 2
How Technology Devices Can Help or Harm Vulnerable Communities in Technocene. Issues for Designers, Architects, and Policy Makers

Emanuele Giorgi (iD)

2.1 Introduction

Due to the effectiveness with which it indicates the contemporary relationship between humanity and the environment, the term Anthropocene has been at the center of the scientific debate for years. It is used to describe a new historical moment (a geological era) in which humanity finds itself (1) able to count on immense capacity to modify the global ecosystem and (2) at the same time, having to rethink many of the certainties that have characterized the social evolution up to this moment. In recent decades, in fact, humanity had to face new challenges, anxieties, and uncertainties that never had been placed on the path of human evolution and which directly depend on the unprecedented power that it has reached, with incredible repercussions on the responsibilities that this entails, in terms of ecological impact and social relations.

This relationship between technical power, human responsibility, and impact on the environment has been discussed extensively throughout the history of thought and religions. Technical capacity and responsibility, for example, were fundamental aspects in forging the basic concepts of the great Western religions and for Greek thinkers.

For Ancient Greek thought, in fact, in a world governed by the category of *ananke*, namely "compulsion" or "necessity," human responsibility was relegated exclusively to the city. Thus, in the outside world, the "power of man" could do nothing. Famous is the passage of Sophocles' *Antigone* (Sophocles, ca. 441 B.C./2001), which describes, in fact, the nature that is recomposed after the passage of human technology: both the earth that covers the furrow dug by a plow, and the surface of the sea that closes the wake left by ships. Even more famous is

E. Giorgi (✉)
Tecnologico de Monterrey, Escuela de Arquitectura, Arte y Diseño, Chihuahua, Mexico
e-mail: egiorgi@tec.mx

the story of Prometheus who delivers fire to humanity, a symbol of technical knowledge. In the tragedy *Prometheus Bound* by Aeschylus (Aeschylus, ca. 460 B.C./1996): to the doubts raised by the choir whether the new technical knowledge does imply future damage to the harmony of nature, Prometheus replies that the environment, governed by *ananke*, is so perfect that it does not have to fear technical capacity of people. The limited technological power of that time dictated this conclusion and precisely for this reason it is very interesting to observe how the relationship between technical power (although limited) and the environment was already the subject of profound reflection for the Greeks.

Similarly, the Jewish-Christian conception of this relationship between humanity and nature is even more relevant, whereby God, once he created man and breathed the vital breath of *nishmat-hajjîm*, made him master and responsible for creation. This conception of ownership and responsibility for the environment has therefore characterized the relationship between man and the environment for the whole of Western society (Ravasi, 2009).

Up to a century ago, human actions in a more than millennial history certainly changed nature (creating barriers, artificial dams, or sea canals, for example) and led to the extinction of some species, but after all, the quality of the relationship between humanity and the environment did not change enormously. In fact, there was an insufficient power to transform human actions from an intervention internal to a substantially balanced system, to a threat that could break the equilibrium of the whole system. Today, instead, as the sixth report of the Intergovernmental Panel on Climate Change (IPCC) shows, the impact of human actions on the environment has been catastrophic, so that it is assumed that the effects of climate change cannot be eliminated anymore (IPCC_AR6_WGI_Full_Report.Pdf, n.d.).

In fact, as widely discussed by the scientific community, the last century human activities (from the economic-productive to the political level) had consequences not only on local subsystems but profoundly distorted the global ecosystem at different scales, from the nano-metric dimension of genetics to the mega-metric dimension of the atmosphere. If this worries a lot (at least the scientific community), it should worry even more the fact that nowadays humanity does not know how to regain control of the situation, putting into practice effective actions and truly regenerating a new balance for this relationship: a new balance, not a return to a *status quo ante*, which is already impossible to restore.

2.1.1   *Technological Development and Society*

In this complex scenario of the Anthropocene (Steffen, Grinevald, et al., 2011), it clearly emerges that it is the development of technological capabilities that closely accompanied humanity along in these changes and allowed it to have this impact on the planet. Without knowledge and technological means, humanity could never have changed the environment as much as it has done in recent decades (Steffen, Persson, et al., 2011). Moreover, the technological development and the scientific revolution,

which underlies it deeply, contributed in changing the way humanity perceives the environment: "*not like a schoolboy who believes everything the teacher tells to him, but as a judge who forces the suspect to answer his questions,*" says Galimberti (Galimberti, 2009; Galimberti, 2012) to express this change.

If the scientific and technical vision of the world has changed the relationship between humanity and the environment, even more shocking is the transformation that is taking place in the management of this relationship. Before it was the human will (the political system) to indicate, with choices and decisions, which actions to undertake and which direction development should have, now the technological system imposes (to an extent never seen in previous historical phases) the direction towards which humanity must move. As Galimebrti affirms, today humanity is a co-historian of the technological system: "we have become co-historians: history is made by technical rationality and we take part in this history, waiting to become a-historians [...] History is no longer made by man but by technical-scientific rationality, with respect to which we are co-historians" (Boncinelli & Galimberti, 2000).

Technological development changed the production of goods and services, as well the social relations and the way people relate to their cities and territories. The firm position of numerous authors is that this unbridled technological development is the cause of an overall bewilderment of our society, the generator of the strong individualism with which we face every day, as well as the main force that promotes the constant increase of innovation and change. Technological development is, by its nature, a force driven by the need for constant change, also to resolve crises and changes in the environment. As pointed out by Marvin Harris in *Cannibals and Kings* (Harris, 1977), technical and technological evolution is often due to external crises and changes. Thus, for example, the transition from hunting with spears to hunting with bows is due to the reduction in preys' size, while the transition from hunting to agriculture would be due to important changes in the environment, which pushed populations to reduce migrations.

The speed of contemporary changes, however, entails enormous ethical and moral problems, which are widely debated (Brey, 2012) (Shrader-Frechette & Westra, 1997) (Belk, 2020) (Sharma & Chaturvedi, 2020) and highlights the urgent need to reformulate the role and responsibility of humanity. We need, therefore, to reflect on contemporaneity and on the new technological system that leads the development and aims at self-empowering, marginalizing the human will.

For this reason, to encourage a deep discussion on contemporary phenomena, it is useful to introduce the term *Technocene*, which quotes the famous term "Anthropocene"adding considerations on the role of technology (Giorgi, 2020d). In fact, alongside the indispensable considerations on the *Anthropocene* and its challenges for society, environment, and design, it is equally essential to reflect and understand the role that the technological system assumes in this global scenario. Hence, the term *Technocene* wants to highlight how all the events of the Anthropocene are taking place in a contemporaneity in which events and history are led mainly by the technological development and not totally controlled by human will. As it will

be deeply discussed along this chapter, this idea has important consequences for vulnerable communities and for design strategies.

2.1.2   Market of Technological Development

In addition to these implications on an ethical and moral level, there is a more easily visible and understandable dimension: the market[1]. In fact, since the technological one is a system in constant change and renewal, it has an incredible impact on the market. In recent years, the size of the market for technology products has increased considerably and will increase even more soon. To represent this scenario, data presented by the United Nations "Technology and Innovation Report, 2021" are considered (Technology and Innovation Report 2021, 2021). The report refers to the 11 "digital frontiers," protagonists of the so-called *Industry 4.0*. They are technologies that are rapidly developing and emerging as the technologies that will change the world in the coming years, improving the quality of life and production: artificial intelligence (AI), Internet of things (IoT), big data, blockchain, 5G, 3D printing, robotics, drones, gene editing, nanotechnology, and solar photovoltaic (Solar PV).

Making predictions about the future of the technological system is difficult (Quinn, 1967), because predictions are difficult by themselves and because the technological system, by its very essence, does not respond to decisions or human needs, but is developed according to processes of continuous improvement that do not necessarily align with the needs of the market or of people.

Nevertheless, in the short term, we can define some directions in which the world of technology is heading. On one side there are macro trends, on the other side there are well-defined fields which, unless significant changes, can be considered as the next areas of development: precisely the "11 digital frontiers." These eleven technologies alone represented a $350-billion market in 2018, and this same market will grow to over $3.2 trillion by 2025. This means growth of nearly $3 trillion in just 7 years (Technology and Innovation Report 2021, 2021). Another interesting data about technological development, for example, concerns the diffusion of the Internet, which increased by 1331.9% between 2000 and 2021 (World Internet Users Statistics and 2021 World Population Stats, n.d.).

Nevertheless, when a phenomenon undergoes a significant quantitative change, as in this case, the same phenomenon undergoes also a significant qualitative change. In fact, based on this principle, the relationship people have with technology and how they use it to relate with the environment changed. Humanity entered

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[1] Although technological development is still driven by a capitalist economic system, often oriented to the exclusive pursuit of profit, and the cause of many contemporary problems, this dimension is omitted in this work because the research aims to focus exclusively on the Technological System, which is self- develops independently of social control, representing an unprecedented phenomenon in history.

the fourth industrial revolution, in which the physical and digital dimensions are combined with the biological one (and this is the first time this happened). The transformation, therefore, is deep: it concerns both the context, but also the human being and the life itself. Elon Musk's company "Neuralink," with its goal to increase the potentialities of human intellect by installing neural implant in the brain, is perhaps the best example of these efforts that are being made in recent years to physically unite the digital and biological worlds (Gordon et al., 2018; Gupta et al., 2018; Kim et al., 2018).

Anyway, it is not only with digital grafts in the body that the human being is changing. Continuous exposure to the technological dimension profoundly changes the person so much that the terms "digital beings"(The Circle: A Novel by Dave Eggers) or "analog being in a digital environment" (Bailey, n.d.) start to be used, questioning the evolution of the species itself[2].

The environment has changed radically: the tools with which people live are all connected (or potentially all connected) in the IoT, allowing new information transmission that is ever faster, more effective, and richer in data. Furthermore, the IoT, combined with Big Data and AI, can easily allow effective predictions of the scenarios that can arise. The impact in this field is so great that today, the IoT and Big Data represent the largest business investment sector and the greatest demand for qualified personnel. In a virtuous circle, technological development improves the cost-effectiveness of the product, in turn allowing greater demand from the market and further technological improvements. The lowering of production costs and data retention should also allow for a massive democratization of the use of data, allowing more and more people to benefit from this phenomenon.

At the same time, the availability of a lot of data also changes their quality and the quality of the work that can be done with them. In this way, new IT opportunities that impact the lives of people, communities, and society are generated. There is talk of personalized and preventive medicine, of prediction of natural disasters (floods, droughts, etc.), or of social phenomena (poverty, terrorism, crime, etc.).

Data takes on an incredible value because they are more and more easily processed by the machines; thus, the "technology drives data, data catalyzes knowledge, and knowledge enables empowerment" process will assume unprecedented importance. This constantly strengthening technological system has significant consequences for the economic and political-administrative system: as the CEOs of a company make decisions based on the calculations and forecasts offered by a Big Data and AI system, the administrators of a city will be able to make decisions based on forecasts of the social phenomena that will affect a city. Data processing and forecasts can therefore be put at the service of society, for the well-being of vulnerable communities too. However, much remains to be done in the public and social sector, which has not yet fully exploited the potential offered by big data, IoT and AI and which could thus solve many of the problems that most afflict vulnerable

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[2] As reported in Future Shocks, "the current pandemic has shown us is how important technology is for maintaining and facilitating communication - not simply for work purposes, but for building real emotional connections" (Future Shocks, n.d.).

communities. The World Economic Forum is convinced of this, for which the use of this technology will certainly bring many benefits in achieving the SDGs (Why Tech Will Be Key in Our Quest to Hit the SDGs, n.d.; How 5G Can Advance the SDGs, n.d.). Anyway, to meet these new scenarios without losing the "human dimension" of development, a cultural revolution is necessary, so to understand how the potential of these new technologies can be made available to society and in particular to the most vulnerable populations (Giorgi, 2020c).

2.2 Vulnerable Communities in Technocene

Undoubtedly, vulnerability has always been a very complex issue, whose characteristics could be defined in a variable way, on the basis of the geographical, cultural, and social context, and of the historical moment of reference as well (Brooks, 2003) (Schroeder & Gefenas, 2009). Although complex, the concept of vulnerability, however, has a very interesting feature, namely that of being able to highlight some aspects that go beyond a purely quantitative evaluation of a phenomenon. In fact, "vulnerability" differs from "risk" because of its ability to highlight aspects that are not only quantitative, which instead are very suitable for measuring "risk," and it is in this quantitative dimension that the success of risk concept lies (Martin, 1996). That is, alongside the more "easily" measurable evaluations of "risk," the concept of "vulnerability" allows to highlight the qualitative nuances that characterize contemporary territories, bringing to light those aspects of daily life, made up of dreams, hopes, and necessities that at times do not adapt to quantitative analytical structures.

In addition to this aspect of opportunity between qualitative or quantitative analyzes, it is appropriate to reflect how the concept of vulnerability is very up-to-date. In the past, in fact, repeating themselves almost identical from generation to generation, the challenges to society were clearly defined and, consequently, the aspects linked to the vulnerability of a population were much more easily defined. Today, on the contrary, the infinity of new challenges that contemporaneity launches to humanity requires a much deeper reflection on the issues that are involved in the definition of a vulnerable population, in order to be able to define, study, understand, and resolve them. The covid-19 pandemic has highlighted how some sectors of the population are more vulnerable than others, being able to react in a limited way to sudden crisis situations that will increasingly impact humanity (Abedi et al., 2021). Precisely the pandemic has shown how the most vulnerable populations have experienced more than others the impossibility of following the indications for social distancing, the impossibility of acquiring the necessary protection measures (masks, antibacterial gel, etc.), as well as the limitations to access health services in the appropriate times and ways. All these limitations have been added to the problems related to job insecurity and the restriction for not having access to information, or not to know how to react to information. Finally, the pandemic has shown how in the most vulnerable populations, the lack of technological means and knowledge has implied a decrease in access to education for more than a year for the youngest. This last

example is a clear demonstration of how the different distribution of technological possibilities impacts a community, creating an even greater difference between those students from non-vulnerable communities, able to continue their lessons online, and students from vulnerable communities who, due to lack of opportunities, have had to stop school for more than a year (Masonbrink & Hurley, 2020).

2.2.1 Vulnerabilities in the Technocene?

Contemporary technological development is creating new and unprecedented challenges for society, contributing to enrich incredibly the complexity of the concept of vulnerability. Furthermore, technological development itself has always contributed creating important inequalities: from the first industrial revolution, and so for all the other revolutions driven by technical-scientific innovations. Whenever there was a significant change in technological development, there was also an increase in inequalities both within individual countries, as well as between countries and geographical macro-areas, and between the epicenter of technological revolutions (the western world) and the "periphery" (all other countries) (Technology and innovation report 2021, 2021).

However, despite this, in some way, humanity has always been able to face the new conditions, adapting to the changes imposed by technological evolution. In fact, albeit with difficulty, societies adapted to the new demands imposed by technology: skills changed, as production needs and, consequently, job opportunities did. The changes imposed by technological development had such a slowness to allow societies to react and ensure that the jobs that were lost could be recovered in some other way, thanks to the new technologies.

Today, on the contrary, according to the United Nations, this scenario is no longer plausible, since future technological revolutions will have such an impact and speed that the changes generated will be so strong and fast and it will be difficult to understand how society can react to these transformations (Technology and Innovation Report 2021, 2021). Consequently, it can be imagined that the next technological transformations will have an even greater impact on society and will create even stronger inequalities than the previous ones.

This prospect of ever more rapid and invasive future revolutions, with which humanity will not be able to keep up, is not limited only to the workplace but will have implications in many more areas of daily life. This will make even more complex and difficult being able to define the concept of vulnerability in the future: therefore limiting, as is often wrongly done, the new vulnerability to productive implications is dangerously deceptive. Vulnerability in the *Technocene* era thus takes on a much broader and more complex meaning. The aspect that summarizes this complexity could be recognized in the fact of not being able to access to technological tools (for shortage or disinterest). This barrier means the impossibility of being able to use technological platforms that will be increasingly indispensable to face everyday life and to get out from situations of vulnerabilities.

Often, when referring to the relationship between technology and vulnerable communities, attention is focused mainly on two cases:

- environmental emergency situations, in which a technological solution is adopted to respond to a situation of vulnerability suddenly created. This is very easily seen with the implementation of geo-spatial models that can help to organize responses in case of important events (Bazemore et al., 2011; Krstikj et al., 2021), in the use of drones as the first technological tool to understand the intensity of a disaster (Zwęgliński, 2020), in the use of big data for emergency forecast, management, and response (Song et al., 2020), or the more generic use of technological innovations and mathematical models to solve crisis or emergency situations (Chui & Ko, 2020; Srivastava, 2009; Sun & Yamori, 2018).
- attention to vulnerable groups (people with physical or psychological limitations, minorities, etc.) to whom technology can offer solutions to reduce vulnerability or facilitate their participation in social life. Examples are AR/VR projects designed to generate empathy towards the most vulnerable or applications that allow for solutions to facilitate access to goods and services by these groups (Merriam, 2009) (Ludert, 2018) (Chuah, 2019).

However, when referring to the impact of technology on the vulnerability of communities, the mention is to communities made up of people with different characteristics, dreams, and needs, who experience a state of vulnerability distributed over a period of time (a day, a week or a particularly cold season) and not just during an emergency event.

Although some authors highlight how the cohesion of a neighborhood can be associated with the "mechanism of cumulative advantage" (Méndez et al., 2021), community has always been an indispensable element for the well-being of society: a protective dimension for the individual, both in moments of calmness (Giorgi, 2020a) and in moments of crisis (Giorgi et al., 2021; Palgi & Getz, 2014), demonstrating that the communitarian dimension must be rediscovered in the contemporary world to allow society to overcome the challenges of the future (Giorgi, 2020b).

Therefore, the purpose of this research is precisely to open a reflection on how the ideas of vulnerabilities must change in the "Technocene," an era in which history is dictated by technological development that inserts powerful and unprecedented variables in society. The research aims to understand how technology can increase or decrease the vulnerability of populations and what the consideration urban-architectural designers should contemplate in these new environments: how the processes, methodologies, and objectives of design should eventually change.

2.2.2   Scenarios

Relating technological development and vulnerability mainly implies reflecting on two levels: the very essence of technology and the environment it creates (Martin, 1996). Leaving aside the implications that technological development can have for

society as a whole, which would require analyzing the optimistic and pessimistic positions (in daily life respectively represented by the positions of Mark Zuckemberg and Elon Musk), there are two main scenarios that can be pre-figure and that interest the research at this level of discussion on vulnerable communities. On one hand, technological development is highlighting various possible practical applications, which, if well applied to vulnerable realities, could reduce the vulnerability of people and facilitate the transition to a much more equitable and emancipated society, capable of achieving in time the ambitious SDGs. On the other hand, a worrying scenario is envisaged, in which the inability to incorporate technological innovations leads vulnerable communities to be even more vulnerable and to fall into a state of immobility. This would make even more difficult (than it is already now) to reduce the gap that separates the most vulnerable communities from the whole society, thus creating an increasingly unjust, unequal, and unsustainable society.

2.3   Dangers and Negative Scenarios for Vulnerable Communities

2.3.1   Technology Illiteracy

Without a doubt, illiteracy is considered one of the main problems of contemporary society and the fight against it is among the priorities of both the United Nations (Goal 4|Department of Economic and Social Affairs, n.d.) and most individual countries. Even if the actions carried out in the last decades in this direction are certainly giving results that allow us to hope for a better future (SDG Indicators, n.d.), much remains to do, in particular due to the numerous crises humanity is going through, including the Covid pandemic (Freitag, 2021) and the technological development (Selfe, 1999) (Yienger, 2016) (Donovan, 2015).

Thus, how important the "traditional" literacy is, that is reading, understanding, and writing, just as important is and will increasingly be the "digital" literacy. It will be increasingly necessary to know how to move with critical skills in the immensity of the technological world and to be able to use (optimally) the technological resources that are becoming more and more prevalent in everyday life. Undoubtedly, just as "traditional" literacy brings with it numerous benefits (6 Benefits of Literacy in the Fight against Poverty|Con-cern Worldwide US, n.d.) (Post, 2016), so too digital literacy will bring positive effects (Mudra, 2020). According to the World Economic Forum, technology literacy could help in closing the skills gap: digital technologies applied to education can contribute to lower the cost and improve the quality (WEF—New Vision for Education_Report2015.Pdf, n.d.). In particular, education in the use of technology can allow improvement in the required skills for XXI century (Spires et al., 2019). We are used to assuming that our daily technological experience is common to all, but the reality is quite different. First, by cost or interest, access to technological means is limited in various parts of the world, as well as the infrastructure necessary to allow the effective use of digital media and the knowledge necessary to use technology too.

Currently (March 2021) Internet Usage Statistics estimates as 5,168,780,607 internet Users, which represent the 65.6% of global population, with a big disparity between North America users (93.9%) and Africa users (43.2%) (World Internet Users Statistics and 2021 World Population Stats, n.d.). The differences in the use of technology between countries, therefore, are very high, as well as within the same countries, and the level of digital literacy is very different, highlighting precisely the most vulnerable communities which, in terms of digitalization, also suffer for gender inequalities (Antonio & Tuffley, n.d.; Ong, n.d.). The danger is that "digital inequality" becomes a risk for "digital literacy". If this gap between genders, communities and countries were to continue to increase, it would become a problem both for the most vulnerable communities (limited in their ability to use technological resources) and for the whole local and global societies (O'Toole, n.d.). This would push away the possibility to reach the goals of sustainable and equitable development.

2.3.2 Data Production and its Density

Data are and will increasingly be a huge source of information and, consequently, of wealth. Technological development is moving in the direction of making the production, storage, and interpretation of data one of its priorities. As people who live in the duality of the physical and digital world, we are a continuous source of data that we—more or less consciously—transmit to companies so that they can process them and, in the best of cases, give us useful information. The more obvious example concerns traffic applications, in which users receive information on the circulation situation thanks to information shared in real time by other users.

This immense data management, called "Big data," opens the doors to make important reflections on the dimensions of the digital world that is becoming ever more immensely large[3] and the importance that data production is having. Those who produce data, which can be used by companies, receive something in return: services (as in the case of traffic apps), economic payments or, more generally, special attention. Therefore, the problem arises for those who do not have the economic, infrastructural, or numerical strength to generate large amounts of data. This means that an urban community will receive more attention from businesses than a rural community, where the connection capacities are more limited, the network slower and the quantity of devices capable of transmitting data is less. The density of data production will therefore be lower in vulnerable communities and consequently the interest of companies in them will be lower. An interesting project, in an area of a Biosphere Reserve in the Mexican Sierra Gorda, studies about design strategies to implement community participation, social sustainability, and local development, based on digital platforms (Cobreros et al., 2019).

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[3] It was estimated that in 2020, 1.7 MB of data were created every second for every person on earth.

2.3.3 Exclusion

A further danger that, in particular as designers, we have to consider is the exclusion of the most vulnerable population from the generation of services and technological products. Technological platforms are now conceived, designed, and developed in a uniform way. While various platforms already think of vulnerable communities as primary users, it is very rare that people from these communities have participated in the design stages of the platform. This is a very big problem because culture is making the mistake of excluding the users from the design, of thinking that all users have the same needs and that an application can have the same effects for different contexts and users.

As in architecture, designers try to integrate residents in the design of buildings and urban spaces with participatory processes, so it is necessary to think about the design of these new digital spaces in which users are destined to entrust important aspects of their lives. The lack of shared planning, in addition to limiting the impacts of a digital resource, could also lead to unexpected processes of discrimination or segregation. For this reason, the development of new technologies will have to be increasingly contextualized, making the solutions tailored to communities' challenges.

2.4 Opportunities and Positive Scenarios for Vulnerable Communities

2.4.1 Reduction in Distances

To explain the importance of willpower, a story that is often used is the one of the Indian Dashrath Manjhi who lost his wife for not being able to reach the nearest hospital in a short time, from which only an impassable mountain separated them. Determined to change the situation, Manjhi dug a passage in this mountain for the next 22 years, reducing the distance between his village and the hospital from forty to a few kilometers. This story shows very clearly an aspect that characterizes the life of people in vulnerable communities: the impotence to face the lack of services or the impossibility of reaching them in adequate times.

Beyond to improve the infrastructures, as Manjhi did "artisanally," our society must absolutely take into consideration all those possibilities to offer better services in a homogeneous way throughout the territory. Technology undoubtedly offers this possibility and allows improvements in an innumerable number of fields. To name a few of them:

- *Telemedicine*: Certainly, a field that will develop considerably in the future is that of telemedicine, which makes it possible to carry out diagnostic tests and (potentially) interventions in vulnerable communities in remote areas. The pandemic

has shown how, albeit still with important limitations, it has been possible to start offering online medical visits for virtual consultations and remote monitoring (Ajibade et al., 2020). It will be even more interesting to be able to count with surgical operations carried out by surgeons who operate miles away by means of a robot with results almost equal to or better than traditional surgery (Bakalar, 2021) (Morrell et al., 2021).

- *Online teaching*: As already discussed above, the pandemic has forced to experiment on a large scale those technologies supporting online teaching. This has highlighted the problems in terms of vulnerability and access to resources but, at the same time, it has allowed us to understand how much this technology can be relevant to standardize the educational offer in a territory in the near future, enabling to access information offers without the need to move. This means access to education without the consequences of commuting, renting, quitting a job, abandoning a family in difficulty, etc. If this is valid for a manager who from New York can follow a course given by the University of California, it is even more important and relevant for a Raramuri girl who, from her village in the Sierra Tarahumara, can follow the elementary class transmitted by her teacher 40 km away, without the necessity to commute every week along a dangerous route. Moreover, interesting studies, as the one by Krstikj, show how combination between technological devices and social innovation can turn students in agents of social change (Krstikj, 2021).
- *Counseling*: Being able to access consultancy from a remote community with an expert to solve practical problems, such as repairing an agricultural machine, improving welding techniques (Lai et al., 2020), or receiving advice on how to improve sales strategies. Benefits that residents of vulnerable communities can count on today thanks to the diffusion of technological products.

2.4.2   Self-production

Another aspect that characterizes the vulnerability of many communities, especially the isolated ones, is the impossibility of being able to obtain adequate supplies. Whether it is a need for everyday life or for emergencies, the difficulty in being reached by the production and supply chain can be a very serious problem. To these needs, technologies related to 3d printing are giving solid and effective answers. There are numerous cases of isolated communities that can print some necessary goods reducing thus their vulnerability dictated by the procurement of goods. Obydenkova et al., for example, report a case of 3d printing technology used to improve the work of a remote community of reindeer herders: printing of ear-tags, electric fence components, and lasso accessories (Obydenkova et al., 2018). Their research states that this technology can reduce production costs by up to 63% thanks to reduced costs of raw materials and transport, as well as being able to offer greater freedom in production. Another of the many examples about the benefits of 3D printing for vulnerable communities is described by King et al. that present two

open-source mobile digital manufacturing facilities powered with solar photovoltaics capable of printing customizable Open Source Appropriate Technology (OSAT) in any community with access to sunlight (King et al., 2014). Therefore, 3d printers technologies can be used to produce customized goods in remote areas and to democratize production, leading to the rebirth of craftsmanship in a "digital" form.

2.4.3   Transportation

Furthermore, vulnerable communities can count, for all that cannot be produced locally by self-production techniques, on more effective and accessible transportation systems, which, both for goods and people, will be soon revolutionized thanks to technological innovations ('5 Advancements in Transportation Technology', 2018). Of course, the most vulnerable communities could benefit from them.

Relatively "simple" services such as Uber have already shown how much they can upset the transport market and how much they can affect users' changing habits. Important revolutions such as those that lie ahead in this field, especially in terms of autonomous cars, could have important positive effects. In fact, the efficiency of autonomous vehicles can reduce the costs of the service, thus making it more accessible and efficient (Automated Vehicles Comprehensive Plan | US Department of Transportation, n.d.).

Furthermore, the development of technologies related to drones could provide important benefits in terms of the transport of goods and people. Being able to deliver quickly, based on unplanned or unexpected needs, medicines or essential products is envisaged as something with a potentially very positive impact for vulnerable communities that today can hardly access emergency goods quickly. Examples are the projects of the World Food Programme implemented thanks to Unmanned Aircraft Systems (UAS) drone technologies (World Food Programme, 2020).

Certainly, all these technologies relating to means of transport depend very much on associated technologies such as the use of big data, artificial intelligence, GPS devices, research on sustainable and economic fuels, etc. but the impact that these changes will have on cities and territories will be impressive and the most vulnerable communities cannot stay out of them. A closing observation on this issue comes from a research by Sochor and Nikitas according to which vulnerable populations are not homogeneous when expressing attitudes towards transport technologies, but their assessment criteria tend to be "pro-social" as they usually consider that the social benefits outweigh the personal ones (Sochor & Nikitas, 2016). This highlights how improvements of transport means in vulnerable communities can have an even stronger impact on the social and community level.

2.4.4   Monitoring and Mitigation

We cannot forget how the concept of vulnerability is closely associated with the more quantitative concept of risk and how both of them become fundamental to highlight potentially dangerous situations or any changes that can suddenly impact a vulnerable community. For this reason, technology can help with the development of more efficient monitoring and mitigation systems: drones and earth observation technologies already demonstrate how equipment can be used to monitor all those situations of potential danger for vulnerable communities (Jayson-Quashigah et al., 2019; Brito et al., 2020, p. 19). As the case of Nanning, studied by Zhong et al., proves, technology and science improvements can also have higher relevance than social-economic or built-environment improvements in mitigating urban hazards (Zhong et al., 2020). Furthermore, as demonstrate by the UNICEF's experience in Uganda, Real Time Monitoring (RTM) can help in receiving data and transmitting information from and to vulnerable communities. Rapid SMS technology (mTrac and U-report) helps youths in vulnerable communities to participate in surveys and to receive information, allowing the agency to reduce costs, map in real-time, and provide better support (Cummins & Huddleston, 2013). Also, the research by Eyrich-Garg and Moss, about surveying homeless individuals, shows how technology devices can support in better understand social and urban phenomena involving vulnerable individuals (Eyrich-Garg & Moss, 2017). Technology therefore makes possible to map natural and social risks more easily than traditional systems, often limited to manual data collections in the most vulnerable areas (An et al., 2019). As Galer also states: "We have the intelligent data to help vulnerable communities" (Galer, n.d.).

2.4.5   Engagement (in Particular, Youth) with Global Issues

A last relevant aspect when talking about the benefits that technological development can bring to these communities regards the possibility of developing interesting forms of engagement between the community and global issues that, otherwise, can hardly enter the sensitivity of the most marginalized people. AR/VR, AI, new programs, and technological devices can bring important thoughts on global issues at the local level, in vulnerable communities, thus allowing residents to be aware of both the risks that their community could run in the coming years, and of the responsibility that everyone has in reducing the factors that increase the risks. As argued by Napawan, benefits in implementing technological devices are particularly visible in engaging youth with global and local problems (Napawan et al., 2017). This engagement can range from environmental issues, such as pollution or climate change, to social, health, or local production issues: various sectors can benefit from reaching these vulnerable communities by technologies that facilitate the commitment on local and global issues.

2.5 Policies, Strategies, Implementation, and Benefits

This contrast between potentially negative (Technology illiteracy, Data production and exclusion) and positive (distance reduction, self-production, transportation, monitoring and engagement) effects of technological development must be strongly considered at the moment to imagine the future of a vulnerable community (Fig. 2.1). Combined with institutional and political wise strategies, the development of technological devices can empower communitarian resilience everywhere, from urban "first-world" contexts to rural "third-world" (Shiferaw et al., 2014).

The empowerment of communitarian resilience can be particularly significant if it's addressed to face the crisis, related to climate change and forecasted environments (Yan & Roggema, 2019). There is no doubt that these considerations must be made by designers who are called to intervene in vulnerable communities because, as we have seen, the reality of Technocene and the dimension of the technological apparatus are increasingly gaining a role of protagonist in defining the destinies of a community. In these contexts, in addition to the skills and sensitivity of the designers, other factors are also important, such as public policies, education, infrastructures, and the market. The research presents some considerations about the importance of each of these factors.

2.5.1 Public Policies and Engagement

Even if, as the theoretical basis of this chapter, the research has taken the idea that technology is the historical actor of our contemporaneity and the system that defines historical processes, the role that public policies have in supporting the diffusion of technological tools is still fundamental. Indeed, bringing technological innovations
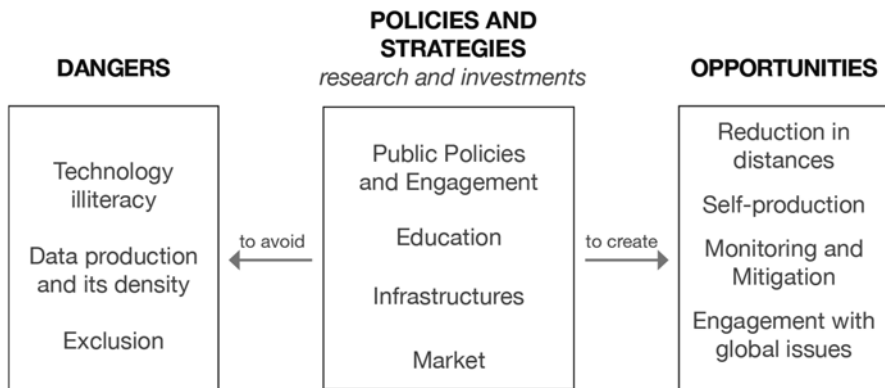

Fig. 2.1 Impacts of Policies and Strategies in Opportunities and Dangers of Technological Development in Vulnerable Communities (scheme by the Author)

to vulnerable communities is a political choice that requires severe efforts—on one hand, there is the need to plan interventions and investments, and on the other hand, the need to foster the participation of the population in these initiatives. The ability to develop public-private partnerships plays a fundamental role so that these efforts also do not end in providing technological resources that make vulnerable communities' residents mere users, but they have to be occasions to generate production and economic opportunities. As argued by Sianipar et al., bringing technological services to vulnerable communities requires a clearer understanding to empower people rather than only giving technology (Sianipar et al., 2014). Moreover, without any doubt, merging the digital environment with the social participation can bring important benefits in terms of social well-being, reducing conflicts and strengthening democratic participation. This is particularly true when referring to important urban transformation as those described by Falcón and Fuentes (2019). An important challenge for the next few years, in vulnerable communities, will be the ability to guarantee equitable access to the use and the management of resources, above all the technological ones that with their ability to provide fast, personalized, and efficient solutions are among the most relevant for adaptation to climate change.

Finally, with regard to public policies, a significant problem to consider is the lack of regulation of the ways in which technology can support vulnerable communities, with reference to moral values, norms, and commitments.

(Wang, 2019).

2.5.2   Education

Alongside public policies and community engagement, it is essential to encourage digital education in vulnerable communities in order that the most population can take advantage of the development of technological systems.

Bringing digital infrastructure and technology to vulnerable communities implies at the same time sensitizing them, because, by developing digital skills, residents can see the potential of these tools and understand how to apply best them to their daily life, not just as users, but also as protagonists. Programs that promote courses for education and awareness of digital skills must necessarily address the whole community to prevent inequalities and disparities. Programs must be inclusive and accessible to all, presenting the potential of new technologies in a friendly and easily understandable way. Technology-based workshops have to contribute to technology transfer: increasing skills and individual confidence and promoting the creation of a community of practice able to teach the skills, as demonstrated with the case of digital participatory mapping techniques in Mazvihwa, Zimbabwe, by Eitzel et al. (2018). Design shifted from the previous concerns about the material world to gradually expanding to nonmaterial areas. The objects of design extended too: from symbols to objects, to activities, to relationships, to services and processes, to systems, environments, and mechanisms. Real innovation is often learning by doing (Ni & Cattaneo, 2019).

2.5.3 Infrastructures

Even if the cost of technology and data is constantly decreasing, for a private individual entering the technological world can be an important problem from an economic point of view, especially for the most vulnerable populations. Furthermore, as we have seen, the most remote areas are unattractive for private enterprise. For this reason, it is necessary to develop joint efforts between private and public initiative to allow all citizens to be able to count with the basic technological resources to face the digital challenges of contemporaneity and take advantage of digital resources to reduce the state of vulnerability wherever they are. Public policies, educational and awareness-raising efforts will have limited impact if not followed by effective applications that are possible only if the population can effectively rely on technological resources in their daily lives. Furthermore, it is precisely in being able to provide a network of structures and infrastructures suitable for the massive use of technology that the inequalities of gender, generation, purchasing power and access to education or health can be reduced.

2.5.4 Market

We should consider that technological solutions do not reach everyone uniformly. Different accesses to technological devices, different levels of e-literacy, and overall capacities to access to technology limit the effectiveness of strategies based on the use of such devices (Van Winkle et al., 2017). Of course, as stated by Van Winkle with a focus on healthcare sector, several solutions can be implemented to facilitate the usefulness of these technologies: design for different levels of e-literacy, role of the health workers as liaisons with patients, analytics and customer relationship management tools to provide the appropriate interventions (Van Winkle et al., 2017). According to Nabben K. and Gardner-Stephen P., design of technology systems, in particular for crisis contexts, must be focused on "S4" (simple, secure and survivable systems) principles, trying to solve the problem and to support end user communities (Nabben & Gardner-Stephen, 2020).

2.6 Results, Benefits, and Conclusions

Several benefits, observed up to here, certainly satisfy many of the United Nations Sustainable Development Goals (SDGs): (3) good health and well-being, (4) quality education, (5) gender equality, (8) decent work and economic growth, (9) industry, innovation, and infrastructure, (10) reduced inequalities, (11) sustainable cities and communities, (12) responsible consumption and production, (16) peace, justice, and strong institutions, and (17) partnership for goals. These goals are undoubtedly the

direct object of the benefits that technological development can bring. Furthermore, as we have seen, many other SDGs benefit indirectly from technological development.

All these goals, and in particular the improvement of living conditions and equality in vulnerable communities, however, could never be achieved if effective inclusion strategies are not developed, allowing to collaborate with individuals and groups who are the main users of these new technologies: vulnerable people must be the co-authors of technological development. They must be the protagonists and authors of technological progress too. We might say that technology along with a humanistic design is the starting point for complete sustainability both in social and environmental terms (Giorgi et al., 2020).

There is no doubt that the complexity so far represents a further challenge for the designer who provides sustainable solutions for vulnerable communities as the impacts at a local level cannot be overlooked. Moreover, these considerations are more relevant, as the role of the designer, especially of those who deal with vulnerable communities, is rapidly evolving to meet the contemporary needs. In fact, the designer involved in difficult urban or rural situations has to play the role of accompaniment in processes of self-production or participatory design.

Designing for a sustainable environment begins and ends with a deep knowledge of the particular place, complete with its unique characteristics of climate, type of soil, native species, and patterns of living, technology along with participation can enhance the comprehension of a place (Cattaneo et al., 2019).

In this scenario, proposing design choices that allow the community to adopt easily technological solutions is fundamental. For example, developing design solutions that allow women living in a vulnerable community, isolated and characterized by male emigration, to access the knowledge offered online or to receive practical training to solve domestic problems, can be a turning point element. Empowering the use of technology among young people means allowing practical or academic training in vulnerable communities, promoting an increase in social capital and in the territory development and a decrease in migration. Technology will change the way we live in our communities, our cities, and our territories. Being aware of this will allow us to take full advantage of its positive effects: (1) empower local communities, (2) initiate community-based entrepreneurship, (3) maintain the continuity of technological changes (Sianipar et al., 2014), and (4) reduce global inequalities.

This research aimed to highlight the effects that the development and diffusion of frontier technologies can generate in vulnerable communities. Clearly, a limitation lies in the fact that the focus and point of view is not from a technology field but from architecture and urban design. The technologies were therefore analyzed on the basis of their potential impact on communities, cities, and territories and with a mainly philosophical theoretical basis to have a general and holistic vision of the phenomenon. After this first look at the technological landscape, however, a further interdisciplinary study will be necessary. Furthermore, a more in-depth field research represents the subsequent development of this reflection to analyze the limitations and the potential in order to adopt technological tools in some vulnerable communities where the author and his colleagues are already working.

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