



Survey of Global Efforts to Fight Covid-19: Standardization, Territorial Intelligence, AI and Countries' Experiences

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Abstract. The development of transportation and communication means and the opening up of the world due to the industrial, economic and social revolutions and the emergence of advanced urbanization have resulted in an acceleration of globalization, worldwide supply chains dependencies and greater openness of the world's ecosystems. At present, the world is experiencing an unparalleled health crisis due to the SARS 2 or covid-19 pandemic, which has given rise to socio-economic crises across the world. In the absence of a vaccine, countries are being forced to revolutionize their response and preparedness policies to health emergencies and compel themselves to the new global dynamic. Our paper, based on feedback from countries, proposed artificial intelligence solutions, the capitalization of standards-based knowledge in the face of covid-19 impacts and the concept of territorial intelligence, contributes to this global effort by proposing sustainable, smart and generic solutions against the current pandemic.

Keywords: Covid-19 · Artificial intelligence · Territorial intelligence · Standardization · Preparedness and response policies

1 Introduction

The world is currently in the midst of the most ferocious health crisis in its history. This pandemic belonging to the family of corona viruses and named by the scientific committee SARS 2 in reference to Severe Acute Respiratory Syndrome and more widely known by the public as Covid-19 began in December 2019 in China in the province of Wuhan and it has caused so far more than 894 342 deaths worldwide and 27 374 682 cases of infection [1]. Globalization, rapid urban development and the evolution of transportation, telecommunications and information technologies have reinforced the spread of the virus throughout the world in comparison to previous pandemics, thus giving way to a new double economic and social crisis [2]. Against the rapid and relentless

changes that the world is witnessing, all the actors of the socio-economical, scientific, industrial and governmental ecosystems are mobilized.

To date, more than 13 600 indexed papers were published by different research communities around pandemic facets across the world [3]. In addition, numerous inventions, technologies and policies that are in line with the evolution of the digital transformation have emerged, involving smart cooperation of human, intellectual and technological capital worldwide, with the aim to unveil the multi-dimensional feature of this new virus [4]. Through this paper we explored global efforts being made against the pandemic according to four different dimensions. The first section presents the role that standardization plays in meeting the emerging challenges of the virus and capitalizes on the knowledge gained from these efforts by proposing a continuous and cross-cutting improvement plan to address pandemic risks world widely. The second section introduces the concept of territorial intelligence and its importance in countering the impacts of the pandemic on small and large scale. The third section presents a state of the art on the role of artificial intelligence and contributes to the field by proposing a generic architecture for fighting virus aspects based on AI key concepts. Finally, the fourth section presents the feedback from countries that have declared victory against the virus and through a critical look compares these countries with others that have been less effective. The last section synthesizes all these points and opens up different perspectives for improvement.

2 Standards, Policies and Referential

Leveraging the worldwide expertise of numerous communities during Covid-19 has been achieved by proposing various dedicated standards, referential and road maps aiming at providing a high and broad-based description of the measures, barriers and best practices to be followed in order to address the current challenges that threaten several sectors and communities. These specifications included medical domains by certification organisms such as AFNOR [5], ASTM [6], IEC and ISO [7] and health organizations [8], industrial [9] and economic working groups [10], digital healthcare practitioner and digital solutions ecosystems and last but not least social science experts and research networks. Standard-setting builds international consensus and smart cooperation for enhanced response, it provides a well-developed auditing system for continuous monitoring of compliance with guidelines in the field of public health preparedness and emergency management [11].

Standardization efforts to date have addressed a series of challenges arising from the evolution of the pandemic and its short and long-term impacts. Through this part we will explore four essential challenges in the management of the Covid-19 pandemic which are, the management of the triple crisis sanitary, social and economic and the elaboration as well as the incorporation and respect of the prevention and response plans.

In response to the health crisis, standard-setting initiatives have focused on the use of a number of existing standards for the design, verification and validation of PPE, medical devices and mental health management systems for both patients and healthcare professionals, as well as for all stakeholders involved in managing the pandemic [12]. Other standards have focused on the development of the digital healthcare roadmap and the strengthening of existing standards in the field through the conclusions drawn

from the current health crisis [13]. A last category was interested in the development of a real time monitoring system of epidemiological indicators and the development of new indicators taking into account several features that combine the characteristics and clinical aspects of Covid-19 with its evolutionary social, economic and health conditions such as the open source system proposed by Oxford University [14].

Against the social crisis and the new constraints imposed by the pandemic on the territorial and global management of communities, the efforts made have focused on the establishment and implementation of a new global dynamic. This new dynamic has addressed a number of public services offered by the administrations and that could generate potential risks factors accelerating the spread of the pandemic, such as education and public transport services. Thus the new dynamic driven by digitalization has consisted in strengthening the implementation of standards for the use of digital tools in its fields through, for example, the proposal of guidelines for the integration of e-learning [15], the strengthening of the normative framework for digital public administration and cryptocurrency and the blockchain for the dematerialization of transactions and finance, which constitutes a major source of threat [16].

The third category of challenges that constitutes a turning point for the management of the pandemic in the post-lockdown period are the response and prevention plans. The generalization of prevention and response plans and their efficiency requires the establishment of a standard framework for compliance, implementation and audit of protection and prevention measures. Among the tools that have been used by a large community in the context of the current pandemic are tracing and tracking applications. These applications require a considerable level of confidentiality, interoperability and connectivity, and their deployment has required considerable efforts around the world, resulting in a number of communication protocols dedicated and specific to the current context, which have been proposed in the context of several projects in Japan [17], the USA and Germany. A number of countries within the framework of international cooperation against Covid-19 have also publicized their prevention and response plans which has resulted in a substantial international knowledge base [18].

Against the economic crisis, countries have tried to strengthen the resilience of their value chain by using existing standards or by trying to develop benchmarks that meet current constraints. The efforts made have particularly tried to address a twin crisis by proposing a new economic approach that integrates health constraints with respect to public healthcare of human resources that drive the economic wheel. Thus, some countries and normalisation organisms such as ISO or ILO have been working on the proposal of a new standard for the organization of working environments to ensure high productivity while providing a compliant OHS performance [19]. Other communities have focused on the definition of a structured framework for Tele-working. In some countries new laws have been put in place and new procedures have been introduced, revolutionizing particular areas, such as the example of Morocco with a new standardization of port procedures through its Port Net project [20].

By analysing the impact of its efforts on the evolution of the pandemic and the criticality of its impacts, we were able to deduce six relevant areas of development that could be integrated into the management of a risk of future pandemics, and thus put in place a roadmap and resilient health crisis management systems.

2.1 Preparedness and Quick Response

Standards, policies, accreditations and regulations allow innovation to benefit from all relevant expertise in numerous fields to accelerate the process of implementation and industrialization of technological solutions and medical equipment to counter Covid-19 impacts. This process can be enhanced by compare and comply solutions enabled by natural language processing technologies that takes as an input gathered expertise and gives as an output compliance results and shared with both innovators and institutions through cloud platforms.

2.2 Quality Assurance and Infrastructure

Standardization can assure high quality levels and compliance with well-developed technical requirements to help design sustainable and mature hospital infrastructures for quality diagnostics, proven testing processes, efficient metrology systems and medical devices for Public Health Emergency Preparedness system maturity enhancement.

2.3 Transparent Communication and Global Consensus

Acting as an interactive bridge of mutual exchange between different collaborators to build a trustful relationship between institutions in charge of crisis management and different social communities. Creation of collaborations and committees for pandemic management.

2.4 Experience Feedback and Knowledge Management

Capitalization on past experiences in pandemic management on smaller scales and lessons learned in the management of epidemics that the world experienced before such as H1N1, Ebola, MERS or SARS and that the world is currently experiencing throughout the world according to the countries that succeeded in their preparedness and response plans such as South Korea, Singapore and Taiwan.

2.5 Continuity and Resilience

Resilience is defined as the ability to recover from a crisis or unpredictable event that has occurred during a structure's normal activity and operation. Several standards for business continuity management [21], risk management [22], and emergency management emphasize this concept as a key to achieving dynamic proactivity for healthcare, economic, industrial and social systems. The situation currently will give birth to new standards for the new global pandemic and to prevent potential outbreaks in the future which can help the reinforcement of organizational systems resilience.

2.6 3R Resistance-Relaunch-Recovery Management

At present time of preparation for deconfinement according to the new requirements of community life encouraging the respect of the 3R's, the role of standards is essential to define the guidelines for each of these three dimensions according to the new constraints, risks and parameters of each region [23].

3 Territorial Intelligence

3.1 Pillars and Concepts

Researches carried out on territorial intelligence identified it according to two strands. The first strand focused on economic intelligence and thus defined it as a set of governance strategy aiming at the creation of a dynamic network between socio-economic and institutional agents in order to ensure business intelligence and favorable conditions for the development of economic competitiveness. The second strand defines it according to a cooperative approach whereby IT is a cooperation of different scientific, industrial, governmental and economic ecosystems for the creation of an efficient local capital towards a sustainable local development [24]. The latter concerns the development of an intelligent territorial information system. The current pandemic context has led several countries to rethink their industrial and territorial policies and to promote cooperative logistics promulgated by IT as drivers for the improvement of their ecosystems' response and preparedness to the short and long term impacts of the health crisis [25]. This cooperation can be apprehended according to three pillars Collective intelligence, economic intelligence, and geospatial intelligence and four levers of improvement Intelligent infrastructures, Blue economy and finally reinforcement of the digital transformation. Table 1 represents Territorial intelligence pillars and their potential against Covid-19.

3.2 Opportunities for Growth

Infrastructure Rehabilitation

Confronted with the health crisis, the reinforcement of health, transport and telecommunication infrastructures has become essential. To ensure that health measures are respected, particularly in rural areas, several conditions are required, including building ventilation, water availability, intelligent waste management and medical assistance availability. The development of renewable and especially photovoltaic technologies, geospatial intelligence, additive manufacturing and digital systems engineering for medical devices make it possible to achieve an intelligent and autonomous rural and urban health infrastructure. In Africa many areas due to the vulnerability of the infrastructure are isolated from the world during disasters. International associations such as the United Nations in collaboration with local institutions are continuously mobilizing to address this situation. Today, due to the Covid-19, the responsibility is exclusively passed on to local organizations [26]. This transition can be achieved efficiently with Territorial intelligence strategies that enable the establishment of advanced regionalization plans. The last point concerns further strengthening of telecommunications infrastructure. As a result of the pandemic, several activities such as education have been forced to go digital, which requires the establishment of an intelligent IT infrastructure that includes basically electrifying all of the areas, including rural areas, availability of connected objects mainly smart phones and computers, accessibility to the network and resilient, secure and mature information systems [27].

Blue Economy

Health crisis and preventive measures throughout the world have given rise to a double social and economic crisis due to the disruption of several value chains of the world's

Table 1. Territorial intelligence pillars geospatial, economic and collaborative intelligence

	Key features against Covid-19 challenges	Driven Technologies	Field of application under the auspices of Covid-19
Geospatial intelligence	Based on multidimensional analysis of imagery and collected geospatial information, it aims to accurately capture, visualize and portray reference physical assets and human activities on earth in the time of pandemic	<ul style="list-style-type: none"> • Interactive mapping and geo-statistics for collection, processing and dissemination of geographical data • Business information models BIM for cities 3D modeling • Machine learning exploitation through Geospatial intelligence for forecasting in order to support decision making 	<ul style="list-style-type: none"> • Local response matrix for the efficient management of commodities supply Through Geographic Information Systems • Social problems tracking and most vulnerable areas detection • Open geospatial data platforms for disaster response • Access to critical social and sanitary data and information's for multinational joint operations
Economic intelligence	Constitutes actions and plans governed by context analysis and smart cooperation between decision makers, technology watchers and project manager with the aim of ensuring economy competitiveness and resilience to context changes and uncertainties	<ul style="list-style-type: none"> • Business intelligence technologies and market provided software's • Knowledge management for internal resources exploitation and optimization • Unemployment forecasting and management of new jobs opportunities through territorial cooperation 	<ul style="list-style-type: none"> • Innovation and technological reinforcement through public and private investissements • Contextual Consumption survey and analysis • Policies preparing for the new normal and businesses recovery according to feedback capitalization and extended knowledge management • Establishment of economic and social monitoring committees at national level

(continued)

Table 1. (continued)

	Key features against Covid-19 challenges	Driven Technologies	Field of application under the auspices of Covid-19
Collaborative intelligence	Consists on creating territorial cooperation of stakeholder's clusters in order to develop shared and available expert systems for decision support and collaborative well being	<ul style="list-style-type: none"> • Forecasting methods based on artificial intelligence • Collaborative platforms for Risk assessment • Cloud services • Expert systems for decision making support • Multiagent systems for autonomous systems development 	<ul style="list-style-type: none"> • Large scale forecasting of key sanitary, social and economic indicators related to pandemic impacts • Smart supply Chain establishments based on General Collaborative Intelligence • Development of cities management systems resilience to encounter pandemic impacts • Establishment of collaborative platforms for crowdsourcing that gathers experts and local innovators

economic leaders, but above all of the emerging economies [28]. A response to this disruption by some countries has been achieved by local development of certain raw materials through innovation and reengineering, restructuring and accommodation of certain production chains and refocusing on local resources. These three aspects are typical principles of the blue economy. Blue economy consists of the creation of added value by relocating both economy and production through the exploitation of local resources and the mobilization of all local ecosystems and countries agents. As an enabler of territorial intelligence and a consolidator of circular economy, blue economy could be an efficient weapon against the current crisis especially for most affected fields such as tourism and commodities market.

Reinforcing Digitalization

Digitization solutions have been a driving force in the current pandemic, through their artificial intelligence [29], big data, and additive manufacturing pillars which contribute to improving the response of different systems, including healthcare, social and industrial systems. Territorial intelligence as we defined it in the first part is based on the establishment of intelligent territorial information systems. The latter which aims at the efficient communication of data concerning the territory and its components and their

association with the knowledge developed by the country's technological and strategic clusters for the proposal of strategic plans, policies and preventive measures and elements of response to the impacts of Covid-19.

4 Applications that Integrate AI to Fight Covid-19

AI can certainly be considered as a “powerful” tool that can help generate information to develop more accurate and effective strategies at all levels of the fight against the epidemic: detection of outbreaks, outbreak estimation, treatment research and medical diagnosis, prediction of future outbreak and management of the transition period and to allow a return to the rather normal situation.

Considering the importance of AI to fight against Covid-19, several authors have attacked this aspect by proposing several solutions. There are the main applications against Covid-19 using IA:

The authors of this work [30] propose a deconfinement strategy which is based on the following elements:

- A progressive and decentralized deconfinement by steps in localities according to the relative demographic contagion factor (RDCF).
- The algorithm makes it possible to have an epidemic monitoring cell.
- The strategy requires that the inter-city traffic is kept extremely limited and regulated.
- HPAHs and the elderly, as well as people at high risk, must be kept confined in reduced contact with the population.
- The wearing of masks must become mandatory.

“AlloCovids” [31] service is based on an artificial intelligence and designed by Inserm (the French National Institute for Health and Medical Research) to remotely diagnose possible Covid-19 infections, and if cases are found, they will be added to the database of infected people, while being directed to the most appropriate care service.

Foch Hospital [32] developed AI-based medical imaging software to detect lung damage caused by Covid-19. The tool, developed by the German company Siemens Healthineers, was successfully tested on 150 patients.

The AI aim also to develop a solution [33] that will be based on epidemiological modelling to propose an estimate of the number of medical staff who could become ill in the coming days.

Several actors have used AI algorithms, which have regularly proven their potential for drug discovery [34]. With two logics at work: observing existing molecules to determine their potential in the face of a new pathology (repositioning) and inventing new molecules from scratch (design).

This solution [35] is based on artificial intelligence (AI) to understand the evolution of the coronavirus and determine the actions to be taken to limit its impact.

More specifically, this solution will make it possible to identify the clinical severity of the cases contaminated by the pandemic, and will help doctors to determine which patients really need to be treated and which ones can be confined at home.

The authors proposed [36] a mobile application called BreakTheChain that integrates AI for virus tracking and prediction of its behavior. The BreakTheChain application can perform three main functions/

- Identify: all the essential data of the individual is identified and updated.
- Alert: once the patient is positive on the COVID-19 test, the application sends alert messages to the employer or institution. It also alerts neighboring hospitals
- Predictor: evaluate the database and identify the possible location where the virus may spread in the coming weeks.

AI is also used to detect abnormal respiratory patterns of people [37] (which is an essential indicator of infection) and this is done through Deep Learning (DL) (aiming to classify six significant respiratory patterns related to COVID-19).

There is also the COVIDX-Net solution [38] which is intended to help radiologists automatically diagnose COVID-19 in radiological images. This solution is based on deep learning.

The authors of this work [39] use the AI-based machine learning to predict any synthetic inhibitory antibodies to the Corona virus.

AI also includes the deep learning that will be used to detect whether a person is wearing a mask or not [40].

The use of AI and surveillance technologies to track the spread of coronavirus or to improve control and detection capabilities appears to be an effective response, but any excessive or unethical use can lead to serious violations of the right to privacy and non-discrimination.

5 Coronavirus Fighting Using AI – Architecture

The proposed architecture (See Fig. 1) consists of three main layers and two cross functions layers. The first three layers are data sources, AI applications and user domain layers. The two inter layers are security and network layers. The main purpose of this architecture is to ensure a distributed and intelligent management of the pandemic, by means of a distributed and intelligent structure based on artificial intelligence technologies and a meta-structure driven by secure and efficient networking and interoperability mechanisms.

The first layer is an acquisition layer designed to collect a large amount of data and information on the real environment as well as on the evolution of the pandemic and its social and economic impacts on the short and long term through a set of data collection and acquisition devices such as smart sensors, IoT objects and clinical databases conceived for the scientific and medical exploration of Covid-19 around the world. These data collected through the hardware and software components of this layer will undergo a first pre-processing aiming at ensuring their fast and secure transport, hence the usefulness of the integration in the architecture of the two crosscutting layers.

The second layer of the architecture consists of three modules. The first data management module collects the incoming data and information flows and ensures its processing over several stages, cleaning, merging, analysis, and processing. The resulting flow from

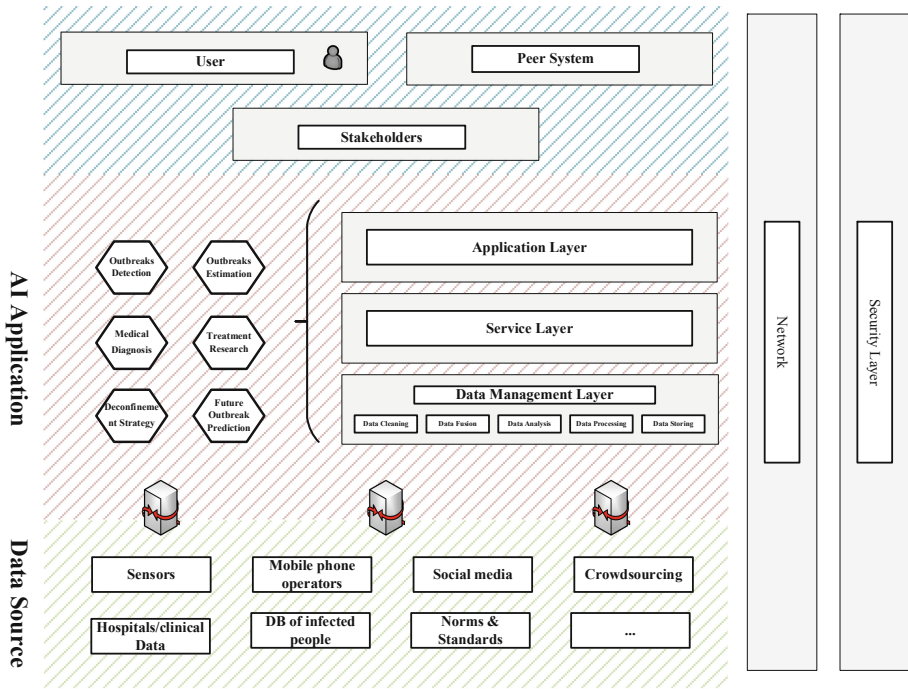


Fig. 1. Coronavirus fighting using AI – architecture.

this module is routed to an intermediate storage device that communicates it to the other two service and application modules. This layer provides a number of functions and is the basic rules engine for pandemic prediction, diagnosis and analysis applications. The security of the information and data flows between these modules and the connectivity between them is ensured by the cross-functional layers.

The last layer of the architecture is a front-end platform for interfacing with the various users of the architecture. Three categories of users constitute this layer: stakeholders who are involved in the management of the pandemic including government institutions, industrials or external parties and a larger scientific community that can exploit the feedback resulting from the different analyses output of the previous layers. The second category are the main users of the architecture including citizens, health care professionals, and patients suffering from Covid-19. The third category consists of peer systems that can communicate with the architecture to exploit the results obtained in specific applications. The communication with these users, the access management and the security of the transactions are ensured by security and network layers.

6 Countries' Experience with Covid-19

6.1 New Zealand

New Zealand appears to be a model for combating the spread of the Coronavirus, with a strategy of prudence and acting rapidly. Furthermore, New Zealand's objective was not to slow down the coronavirus epidemic, but simply to eliminate it.

Indeed, severe measures had been taken to restrict entry into the territory, even though the country had only 6 confirmed cases. Regarding the Covid-19 detection tests, they were carried out on a large scale (nearly 8,000 tests per day) in the population, compared to some European countries, which made it possible to detect the infected persons very quickly and to isolate them.

In addition, strict containment measures have been put in place, and on the whole, the population remains disciplined and confined.

An economic plan to reduce the future recession had been announced.

The results of the measures taken by the government (to date) are very encouraging, as the number of active cases in New Zealand is decreasing every day. But despite these results, deconfinement will be gradual in order to continue to search for the last cases.

6.2 South Korea

For South Korea, it adopted two concepts to win the battle against Covid-19, massive testing and tracing.

In addition, in South Korea, containment has not been applied. Masks are worn by everyone and temperature taking is widespread.

South Korea was able to draw logistical and economic lessons from the SARS in 2003 and the MERS in 2015, which enabled it to anticipate, in particular, the provision of equipment.

Indeed, the country was able to limit the spread of Covid-19 thanks to measures taken very early:

South Korea started producing the test kits a week before the first case appeared, in order to be as prepared as possible.

In addition, from the very beginning of the outbreak, South Korea took the initiative to quarantine returnees from abroad. This measure helped, in the first instance, to slow down the spread.

Secondly, the use of contact tracing applications was introduced, making it possible to trace the people who were in contact with the cases declared positive, in addition to the movements of the latter.

6.3 Morocco

Against Covid-19, the Moroccan government has had to face different challenges.

Indeed, in parallel with the challenge of the rapid spread of the COVID-19 infection, it has taken the responsibility of raising people's awareness of the critical situation while avoiding creating panic and convincing people of the idea of containment despite its economic consequences on families [41].

Among the instructions taken into account in this regard, limiting the circulation of people, social distancing, stopping almost all professional activities and requiring the population to use protective masks and gloves, closing borders, suspending travel to the cities most affected by the pandemic.

To succeed in all these instructions, Morocco is putting in place several actions [42]:

- A strong intervention: Elements of the security forces were quickly deployed in the cities to ensure compliance with the containment instructions.
- The Economic Supervisory Committee was created with the aim of identifying the measures necessary to maintain economic stability.
- Creation of the Special Fund for Coronavirus Pandemic Management. The purpose of the Fund is mainly to finance the hospital and medical equipment needed for people infected with the virus, as well as the deployment of financial measures for people in need.
- Involvement of the Central Bank to facilitate access to credit for both businesses and households.
- A measure for the benefit of employees who have lost their jobs. All employees who lost their jobs due to the crisis received a monthly allowance and a delay in the payment of their bank loans. This measure is supported by the Covid-19 Special Fund.
- Support for the informal sector as it was directly impacted, given the sudden cessation of its activities, which caused a disruption in the financial inputs of the families that depended on it.
- ...

Despite all the instructions and efforts, Morocco could not succeed in its fight against the Covid-19. This is due to the underestimation of the seriousness of the disease on the part of Moroccan citizens. On the other hand, the weak infrastructure of the health, education sector and even of the scientific research stage have participated in Morocco's failure against Covid-19.

6.4 United States

In contrast, we take the example of the United States to draw the lessons and what not to do.

The United States is being badly affected and has wasted precious time in managing the crisis.

84133 deaths have officially been recorded, for 1390746 infected people (statistics up to 14/05/2020). This is more than in China, where the epidemic had broken out.

Indeed, the United States did not take things seriously and American hospitals are very poorly prepared. Moreover, it took far too long to mobilize the federal government, businesses and to organize aid.

In conclusion, the lesson we can learn from the experience of the United States is that to win the battle against Covid-19, it is necessary to be quick and reactive (the United States waited three months and 3,800 deaths to recognize the seriousness of the Covid-19 epidemic).

6.5 Discussion

In view of the experiences of the different countries against Covid-19, there are several lessons to be drawn and adopted in the Moroccan context for the management of any pandemic:

- A rapid risk assessment, based on scientific criteria.
- Rapid and decisive government action.
- Raising awareness and engaging citizens without panicking them.
- Strengthening and reversing the health and scientific research sectors.
- Working on innovations and integration of the latest technologies and techniques (IoT, IA...).
- Implementing interventions at various levels.

7 Conclusion and Future Works

On the basis of the feed-back that we have presented throughout the paper with regard to four axes of the fight against Covid-19 that are artificial intelligence, standardization, territorial intelligence, and capitalization of countries response and preparedness plans to the pandemic, we have been able to draw several conclusions on the pandemic and its current situation. These conclusions were concretized within the paper by proposing a number of contributions to the different axes that are the proposal of a generic architecture for the fight against the pandemic based on AI and an action plan to reduce the risks of the outbreak and to improve the resilience of different health and socio-economic systems based on standardization and territorial intelligence. The aim of its proposals is to develop proactive, smart and resilient local and global response systems based on knowledge capitalization and advanced communication and information technologies, thus limiting the impact of the current crisis and the risks of future outbreaks. Our future work will focus on the concrete implementation of these.

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