POLITECNICO DI TORINO

Corso di laurea in Architettura per il Progetto Sostenibile

HUMANIZING EMERGENCY RESPONSE. ANALYSIS OF IMPLEMENTED COVID-19 HEALTHCARE FACILITIES

Candidate:
Chiara Ghislanzoni

Supervisor:
Professor Francesca De Filippi
Politecnico di Torino

Co-supervisor:
Postdoctoral Researcher Grazia Giulia Cocina
Politecnico di Torino

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Abstract

Backgrounds. The COVID-19 pandemic has put into trouble the global healthcare system. A sharp increase of infections and critically ill patients has tested the resilience of healthcare infrastructures, forcing them to quickly adapt in order to face this extremely dangerous emergency.
Healthcare facilities were soon called to properly respond to a sudden demand for emergency care and Intensive Care Units beds in an exceptionally short time and, as a result, that different emergency strategies were speedily implemented.
With the aim of overcoming the lack of spaces in existing facilities, three main strategies have been adopted. Following the example of Wuhan, China, where an emergency hospital was built in a couple of weeks, a part of the world took the challenge of building temporary facilities from scratch, while the other part relied on existing buildings. If the second strategy mainly focused on implementing existing hospitals working on partial expansions and resilience of the structures, a third one tried to repurpose non-sanitary building typologies, such as convention centres, schools and hotels, into healthcare ones.
For the purpose of guaranteeing a complete response to Covid-19 emergency, all implemented structures had to satisfy complex requirements in terms of epidemic management and infection containment, in terms of building and constructive characters and in terms of users' psycho-physical well-being. Thanks to innovative technologies and fast assembled building structures building requirements were satisfied, while, at the same time, strict procedures implementation and PPE utilization contributed to contain infection spread. What actually was neglected, being thought of secondary importance, was the psycho-emotional well-being issue. That was soon reflected on many collateral problems, which involved scarce and fragmented communication, healthcare workers' mental exhaustion and patients' uneasiness and loneliness.

Objective. After studying the peculiarities which characterize healthcare facilities implemented in response to Covid-19 emergency, the objective of this thesis was to elaborate a multi-criteria analysis able to underline strength and weaknesses of healthcare building implementations. Having detected a lack of attention towards the humanization issue in emergency conditions, the next point of the thesis was to highlight applicable humanizing strategies for their implementation in future cases of emergency.

Methodology. The research was carried out through an examination of literature which allowed me to identify key elements implemented in the elaboration of the methodological analysis.

Conclusion. My research and analysis aim at contributing to provide a deeper understanding of the key factors involved in the implementation of resilient healthcare facilities with particular concern about elements able to users' guarantee psycho-emotional well-being and humanized cares even in emergency condition.

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1. INTRODUCTION

Since the start of 2020 the whole world has been experiencing a rather exceptional event, so rare that it hadn't occurred for a century: the spread of a pandemic disease. In the first months of 2020, an increasing number of people in Hubei province, in the south of China, started to show some infectious pathologies of unknown aetiology. Day by day, the infection spread over other parts of China, then throughout Europe and finally dragged in the rest of the world. This epidemic put healthcare systems into trouble worldwide, and on 30th January the World Health Organization declared Covid-19 outbreak a Public Health Emergency of International Concern.

After having identified some common symptoms imputable to acute respiratory distress syndrome, an increasing numbers of people started to show extremely severe pathologies hardly curable with basic medical equipment.

In order to treat so great number of critical patients, who needed to be hospitalized, healthcare facilities reached unsustainable situations. In a very short time Intensive Care Units and hospital wards witnessed a steep surge of beds demand, not being able to properly respond. Once the international healthcare system demonstrated its unpreparedness to face this kind of emergency, international authorities, organizations, architects and designers started to implement various solutions to make up for healthcare facilities inadequacies. Such issues were approached in different ways: some architectural interventions led to the implementation of existing hospitals, others consisted in the conversion of non-healthcare facilities into healthcare ones, meanwhile small stand-alone units were deployed close to hospital sites.

Picture 1 and 2. Advertisements suggesting correct behaviour to limit infection spread.

1.1 SCOPE OF WORK

From the beginning of Covid-19 outbreak, the two most urgent issues were providing suitable PPE for people and medical staff and making up for the shortage of beds in overcrowded hospital structures.
As beds demand increased day by day, many architects and designers were called into action. Relying on their expertise in the creation of architectural solutions, devices and tools able to prevent and reduce spread of infection, all over the world architects started to design numerous healthcare facilities in addition to the existing ones. In accordance with distinct needs and resources availability, various kind of interventions were implemented. Some of them involved the conversion hospitals into dedicated Covid structures, while others mainly relied on non-healthcare buildings.
The construction of this kind of temporary building solutions gave me the opportunity to analyse how such medical structures performed during the emergency and made me understand which design elements had positive impacts on clinical operations and users' wellbeing and which ones produced opposite results.

My research aims to elaborate an analysis of the different healthcare facilities' typologies adopted all over the world to fight Covid-19. Moreover, this thesis does not want to be a mere review of what has been done, but, through a further evaluation of three main fields of survey, aims at focusing attention to some applicable interventions in the field of "humanization of healthcare facilities".
Although great efforts have been done during in the last few decades in this field, this worldwide healthcare emergency has put a strain on the role of a humanized environment and person-centred approach , revealing the lack of attention to this important issue which determines healthcare users' well-being. The ultimate aim of this paper is to call attention to some conceived or successfully realized interventions which can be applied in case of future emergencies similar to the ongoing one.

Picture 3. Case studies of realized building implementations to face worldwide COVID-19 emergency.

1.2 METHODOLOGY

The research study followed three different steps of a different nature: the first consisted in a literature analysis of the issue, the second involved an evaluation, while the third tried to propose some possible interventions.

- Literature analysis

Due to the novelty of Coronavirus-Sars-Cov2, a first documentation was necessary to understand its epidemic outbreak and its worldwide implications in the healthcare sector.

In parallel with the lack of hospital beds issue, it has been studied how, all over the world, healthcare systems responded to that problem. A primary identification of guidelines given by International Health Organizations, has given the opportunity to examine healthcare facilities in terms of infection containment. The practical recommendations of the guidelines have also provided me with instruments and methodological directions towards which orienting the overall research.

The core analysis has followed an organizational scheme based on the same criteria for each studied model. To understand the peculiarities each model, I analysed the main reasons leading to the adoption of specific building models, the users who they relate to, all means required for the realization and flows characterizing each building solution.

- Evaluation

The evaluation process has taken into account two methodological phases which included a survey and a summary that enabled me to make specific comparisons and considerations.

Relying on the literature analysis previously done, the first evaluating process has considered a series of criteria according to which each healthcare model has been assessed and awarded a colour corresponding to distinct satisfaction levels. Once assessed all the different areas of interest, that include all the criteria – among which there are flexibility of the spaces, capability of offering complete cares and sustainability of the adopted building solutions – each healthcare model has been evaluated on the basis of scarce/sufficient/optimum responses to specific needs.

Subsequently, a summary of all analysed categories, then, has allowed me to compare performances among different building implementations, understanding, at the same time, which field of intervention has been carefully developed and which not.
On the other hand, with the adoption of a bilateral reading of this last phase, it was possible to establish the performance of every single building model, while on the other hand it was possible to understand whether a more general users' comfort has been taken into consideration during the implementation of each building solution.

- Proposal

The following phase considered the humanization issue in detail. A literature research has led to a more focused understanding of issues and opportunities in such field of interest.
In a perspective of prolonged response to Covid-19 disease, the study has finally led to some considerations of what might be improved in the future, especially focusing on users' wellbeing.

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2. RECENT EPIDEMIC DISEASES

Since the overall study is conducted on medical facilities with the purpose of treating Covid-19, it can be useful to provide some information about the main characteristics of such disease.

2.1 CORONAVIRUSES AND COVID-19

Covid-19, the new virus which has spread since the start of 2020 belongs to the family of Coronaviruses. Coronaviruses are a large family of respiratory viruses that can cause mild to moderate illnesses, ranging from common colds to respiratory syndromes such as MERS (Middle East Respiratory Syndromes) and SARS (Severe Acute Respiratory Syndrome).

Coronaviruses are common in several animal species, but in some cases can evolve to infect and spread among people. Right now there are seven known types of human coronavirus; some of them were identified in the 1960s, while others were only detected in recent times, in the new millennium. The virus responsible for the current epidemic is a new strain of Coronavirus never identified in human before. Evidences currently available suggest that SARS-COV-2, also called Covid-19, has originated in animals[1].

Symptoms

The most common symptoms of coronavirus in humans include cough, fever and breathing difficulties. In more severe cases, the infection can cause pneumonia, acute respiratory distress syndrome, kidney failure and even death. More specifically, common human coronaviruses usually cause mild to moderate upper respiratory tract illnesses, like cold, which last for a short period, and additional symptoms that can include: headache, runny nose, cough, sore throat, fever and general feeling of being unwell.

In addiction to the symptoms the symptoms described above, human coronaviruses can sometimes cause lower respiratory tract illnesses, such as pneumonia and bronchitis. These outcomes are more common in people with pre-existing chronic cardiovascular or respiratory diseases, as well as individuals with weaker immune systems[2].

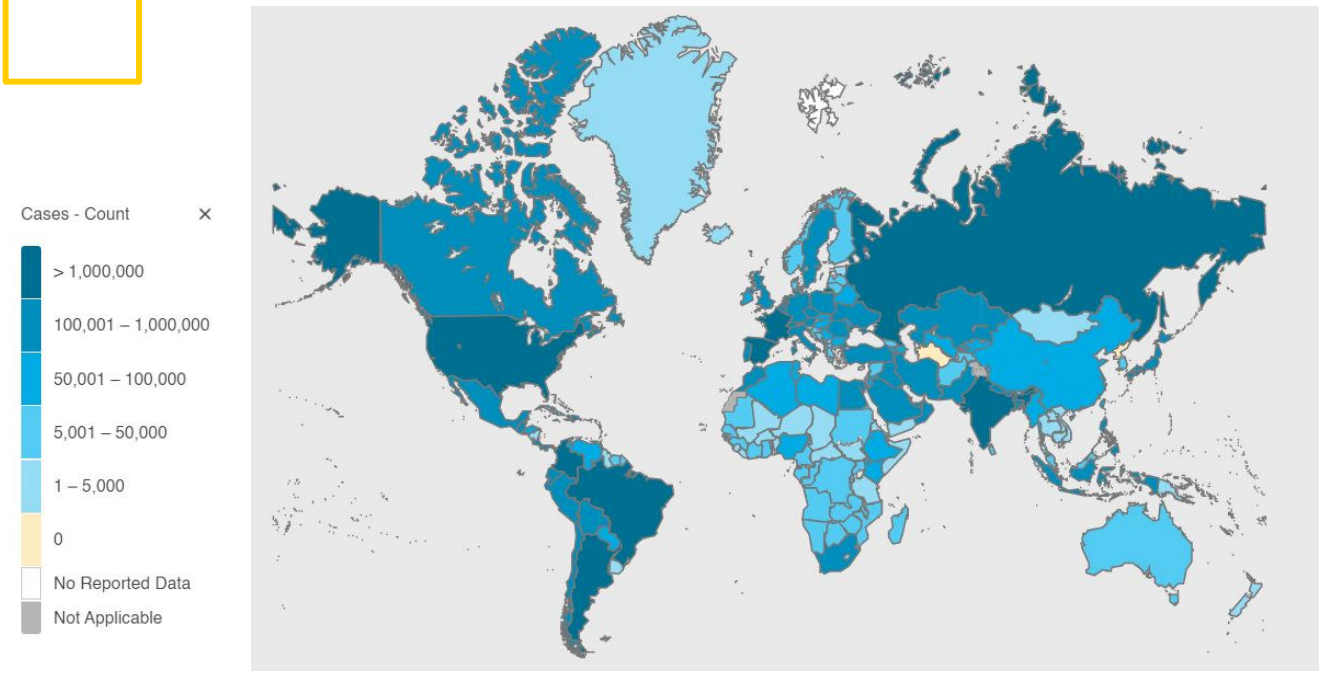
Contagiousness and lethality

Last evidences provided by the European Centre for Disease Prevention and Control confirm that the incubation period, which corresponds to the amount of time that passes between the infection and the development of the first symptoms, lasts around 12-14 days. But what strongly characterizes the new Coronavirus is rather minor lethality compared to the coronaviruses responsible of past epidemics of SARS and MERS; what differs is the contagiousness rate which results higher with respect to the ones observed in the other coronaviruses. For this reason, while the first two epidemics remained confined in specific regions of the world, this last one turned into a pandemic reaching almost every nation.

Diffusion

On 31 December 2019, Chinese health authorities reported a cluster of pneumonia cases of unknown aetiology in the city of Wuhan, China. Many of the initial cases reported a history of exposure to Wuhan's South China Seafood City market and a first potential transmission from live animals to humans was suspected. In the following weeks a new coronavirus was identified as the causative agent for these cases, and less than one month later, the World Health Organization officially named the novel disease Covid-19[3].

In March 2020, after assessing the levels of spread and severity of the SARS-CoV-2 infection, WHO declared that the Covid-19 outbreak record over the past months could be characterized as a pandemic which, however, could still be controlled [4]. Despite these first assessments the infection spread widened uncontrolled reaching over 100 million confirmed cases all over the world[5].



Picture 1. Map of Covid-19 diffusion updated at 29th of January 2021. Globally there have been 100.819.363 confirmed cases, including 2.176.159 deaths, reported to WHO.

2.2 HOW CORONAVIRUS DISEASE INFLUENCES PEOPLE HABITS AND CITIES

Health and diseases have always shaped our cities, strongly impacting them. But what will Covid-19 do?

Through history, disease outbreaks have forced innovations in urban design and people habits: when fighting against cholera in 1800s, for instance, new plumbing and sewer systems along with devising of new zoning laws to prevent overcrowding, became mandatory. When Olmsted, the father of landscape architecture, proposed his vision for Central Park, he described it as "the lung of the city", a place rooted in precaution rather than in pleasure. He believed that green open spaces would be curative for city dwellers beset by a dense tangle of buildings, streets and other people. And actually he was right, and in the last two centuries his thesis has had lots of scientific evidences.

From past epidemics to more recent ones, fear of illness and desire for health have played an important role in shaping our cities. Several epidemic diseases urged to invest in building modern sanitation systems. Health concerns led cities to clean up their streets and bring light and air into buildings designs[6].

Symbiotic relationship between cities architecture and epidemics has always been complicated. Diseases and their consequences have forced cities to transform and progress, especially where building density plays crucial roles in enabling diseases to spread. Under a similar light, with the new Coronavirus we are experiencing the same situation: the virus has entered urban spaces that still retain much of the infrastructures that previous epidemics spurred to creation.

The disease gripping present-day cities, therefore, is unlikely to result in sweeping and concrete infrastructure change. Rather, it will simply change the way we interact with the built environment prompting deep behavioural changes.

The current state of the world offers few hints to that purpose. A combination of authorities' statements and general anxiety has led a large number of public places not to be made use of. Those that are still thriving like parks, bike paths and streets now give Olmsted a prescient sight, in so far numerous cities all over the world are expanding bike lanes and pedestrian areas to reduce crowding on public transportation. Another part of the debate is linked to the impact of building density on public health; the issue continues to require architects and planners to design buildings and cities able to cater both for environment and public health. Along with these doubts there are also other questions about how technology should be integrated in designing and building cities in order to fight the spread of possible diseases.

One possible approach could be creating building that can easily and quickly switch to different use in case of emergency, while other possible solutions relying on technological instruments could reduce passenger congestion, waiting time and person-to-person contact.

Probably these issues will not have immediate answers, rather, it is more likely that situations linked to the pandemic should utterly change our habits and beliefs. Some people might decide to move toward less crowded areas, while others might change their own way of travelling and getting about[7].

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PICTURES

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3. CURRENT POLICIES ADOPTED IN HEALTHCARE SECTOR

Covid-19 crisis is more than a global health emergency, it is a systemic human development crisis strictly influenced by our interaction with the ecosystem we are part of, which, as a consequence, affects the global economic and social development in unprecedented way[1].

Cities and urban settlements are at risk of Covid-19. Many densely populated areas have experienced high contamination numbers and deaths, witnessing the capability of diffusion of the virus. Thus, preparedness in cities and other urban settlements, is critical for an effective local and national response to Covid-19. Policies to tackle the ongoing crisis, reducing vulnerabilities, in short and long terms, are crucial to enable every country to recover from this all-inclusive shock.

3.1 HEALTHCARE PREPAREDNESS IN THE EPIDEMIC MANAGEMENT

Every society, settlement, group and individual is vulnerable to adverse events and of course has different abilities to respond properly to crisis of different nature that could occur from time to time[2]. As recently witnessed with COVID-19, such an event could be a worldwide health emergency that puts under pressure the overall medical system. Unique dynamics within many settings, at local, regional or national level, affect their own preparedness, such as population density, administrative policies, wealth and availability of different resources.

- Context and urban settings

Different areas, even within the same country, may require different approaches to essential health services trying to maintain theme the same for all.

Cities are complex urban settlements, dependent on each other, on smaller neighbouring towns and on rural areas. They often work as national or international hubs, collecting large amounts of goods and people, reaching them through airports, seaports and ground crossings. Due to these huge flows, the risk of spreading an infectious disease such as COVID-19 is decidedly high and difficult to control especially in crowded places like supermarkets, overcrowded public transport systems[2] and mass gathering events.

People living or frequenting such crowded places come from extremely various backgrounds. As to public health emergencies some groups are more vulnerable and in case of spreading of infectious diseases, they are the first to get in trouble. Moreover, rural-to-city migrations in many regions of the world determine unplanned urbanization, which leads to set up of informal settlements. A substantial section of those living in such run down places are often unemployed or dependent on informal economies, finding extremely difficult to live in healthy and decorous condition[1].

Besides the considerable number of people living in countries affected by humanitarian crises, also urban poor and homeless people living in inadequate housing conditions or without any available accommodation are differently impacted by the COVID-19 outbreak. In these setting conditions, critical measures for COVID-19 prevention and control that have been a feature of the response in higher resource settings may be more difficult to implement and some of them could result potentially harmful to the survival of many community members. As a matter of fact, public health and social measures in these environments have to be balanced against other risks, such as lack of income, food insecurity and access to basic services.

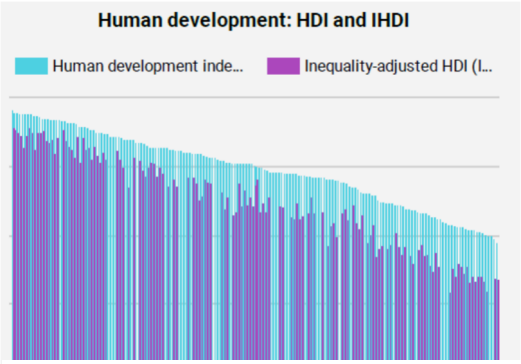
In addition to the problems previously illustrated, it has to be remembered that a large number of such settings have an extremely weak health system; the capacity of

testing, isolating and treating those developing infectious disease, as a consequence could result particularly feeble. It is therefore really important that authorities and policy-makers rely on people's involvement informing, containing the spread of the virus and preventing behaviours which could harm the population.

Collectively, these dynamics call for unique preparedness measures; pressing health vulnerability as well as social disparities thus require that authorities build resilience in an inclusive way, managing the whole emergency cycle – from preparedness and readiness to response, to eventual recovery form COVID-19. New governance arrangements must be rapidly established.

- Exploring preparedness and vulnerability in numbers

While every society is vulnerable to crises, their ability to respond differs significantly all over the world. The Development Programme of UN has analysed preparedness to Coronavirus of 189 countries taking into account several factors influenced; among other features, some of the most relevant were the level of development, inequalities, the healthcare system capacity and internet connectivity. They allowed States to assess how well a they could respond to multiple impact crisis like COVID-19.



Picture 2. Chart of Human development by UNDP

Analysing the overall situation, what is strikingly clear, are the huge disparities that exist between the most developed countries and the least developed ones – the former relying on an average of 55 hospital beds per 10.000 people, compared to 7 hospital beds for the latter. When we analyse the digital sector, the situation definitely worse: still 85.5 percent of the global population, mainly for economic reasons, can't count on a reliable broadband internet, which strongly limits the possibility of working and accessing life-long education.

Human Development

Human Development Groups	Human development index (HDI value) 2018	Inequality adjusted HDI (HDI value) 2018	Inequality in HDI (percent) 2018
Very high	0,892	0,796	10,8
High	0,75	0,615	17,9
Medium	0,634	0,507	20
Low	0,507	0,349	31,1

Picture 1. Table of human development by WHO

The HDI (Human Development Index) is a composite index measuring average achievements in three basics dimensions of human development – a long healthy life, skills and decent standard of living. As shown in the table, while the high human development countries reach a level of almost 0.9 out of 1, the low human development ones merely reach 0.5 in the overall scale. This means that while on average a person from a developed country lives in a fair situation condition determined by availability of certain benefits and opportunities, healthy life and skills, people in underdeveloped countries just have half of such benefits and opportunities.

Health system

Human Development Groups	Physicians (per 10.000 people) 2010-17	Nurses and midwifes (per 10.000 people) 2010-18	Hospital beds (per 10.000 people) 2010-18	Current health expenditure (% of GDP) 2016
Very high	30,4	81	55	12
High	16,5	30	32	5,7
Medium	7,3	17	9	3,9

Picture 3. Table of health system by UNDP

What mentioned above is mirrored in the sanitary sector: people living in low human development countries have 1/8 of the number of physicians, nurses and hospital beds available to the corresponding people living in the high human development ones.

Connectivity

Human Development Groups	Mobile phone subscription (per 100 people) 2017-18	Fixed broadband subscription (per 100 people), 2017-18
Very high	127,8	30,5
High	113,6	18,8
Medium	91,9	2,4
Low	67,5	0,4

Picture 4. Table of connectivity by UNDP

Another key factor influencing life, social interaction, work and education during these months of pandemic is connectivity. Despite the fact that also in least developed countries 68% of people have a mobile phone subscription, what divides the world is the access to a fixed broadband connection; in least developed countries just 0.5% of the population has this chance. It thus becomes impossible for people settled in isolated areas getting in touch, gathering useful information on the health situation and getting on their businesses.

Although everyone is potentially affected in one way or another by this pandemic, some individuals or groups are more vulnerable, suffering more harm and having to cover a longer road to recover from it. Among the causes that influence vulnerability there are different factors such as poverty, social protection, working planning and exposure to the immediate economic impact of travel bans[4].

Poverty adds also long lasting consequences; despite recent poverty reduction, still 40 percent of the global population live in multidimensional poverty without any social protection. With regard to this, globalization has brought new opportunities and efficiency gains, but, as witnessed with COVID-19, disruption of one point of the global chain has triggered serious local problems in many places. This has caused particularly strong consequences on countries and economies that mainly rely on tourism.

Population living below income poverty line

Human Development Groups	Population in multidimensional poverty (%), 2009-18	Population vulnerable to multidimensional poverty (%), 2009-18	PPP $ 1.90 a day (%), 2010-18	National poverty line (%), 2010-18	Working poor at PPP $3.20 a day (% of total employment), 2010-18	Social protection and labour programs (% of population without any), 2010-18
Very high	-	-	0,6	-	-	31,3
High	4,5	12,5	2,1	10,4	8,5	38,8
Medium	29,4	18,4	17,7	23	40	31,9
Low	62,3	16,2	45,1	44	68,4	86,1

Picture 5. Table of population poverty by UNDP

In accordance with what already expounded, the data analysed by the UNDP confirm a different kind of vulnerability of nations, in short and long terms. The immediate economic vulnerability mainly shows remittance and existing inflows and inbound tourism expenditure due to the crisis in term of GDP percentage. In addition to immediate dramatic feedback, there are conditions that keep worsening. As mentioned above, high and medium developed countries are quite able to face the emergency, while low human development already present a huge percentage of people living in multidimensional poverty.

- Considerations in planning urban preparedness for COVID-19

An adequate preparedness in cities and settlements is essential for an effective response on different levels, in case of emergency. For these reasons, strategic preparedness and response planning, in addition to other official documents, provide key considerations in the COVID-19 outbreak management. In order to be effective, any public measure must be implementable and designed in a way that promotes willingness to comply. To that purpose, in planning and managing the different stages of the emergency is essential to comply with the following guidelines:

- adopt a coordinated multi-sectoral approach[5]: In order to ensure effective implementation of measures to administrate local resources, it is essential to coordinate private and public sectors taking into account all the different sub-sectors (health, social services, transport, education, communication, security, commerce and economy and many others);
- promote coordination and coherence[6] in measures across different levels of governance, from national to local levels;
- identify existing vulnerabilities alongside the management of COVID-19[7]. This includes the use of local risk assessments, profiles and considerations that may emerge from health measures implementation;
- identify and equitably protect vulnerable subpopulation[8]. Consider the likely impact of the pandemic on physical and mental health introducing safeguard and providing essential social services;
- consider the diverse social and cultural interactions with health issue[9] and perceptions that may influence the effectiveness of public measures. It is thus important to provide clear public health messages that are transmitted by suitable means, able to reach different communities;
- consider the extent of reliance on the informal economy[10] as important source of livelihood for poorer people. Control how the disruption of the informal sector could compromise the access to essential services, leading to an increased level of crime and insecurity;
- guarantee continue provision of essential services[11], from the strictly medical ones to more general transport and energy supplies, housing, communication and others;
- ensure that existing health facilities are prepared for COVID-19[12] and mobilize additional resources, if needed, relying on local governments, community and organizations. This includes identifying human resources and services to supplement healthcare facilities in advance of a surge of patient demand;
- ensure adequate housing[13], try to ensure social protection and basic needs and reduce the risk of people becoming homeless;
- ensure that preparedness measures are rooted in a robust evidence-base[14]. This includes researching on how similar settings have managed the emergency of COVID-19, learning and adapting it from their experience and sharing results with one another. Starting from this, local authorities should take a further step and plan longer-term health threats.

- Key areas for an effective response to COVID-19

Taking into account what already expounded, it is consequently essential that national and local authorities focus their action on mainly four different key areas in order to prevent or respond to the spread of COVID-19.

The first area requires coordinated local plans for effective responses to health risks and impact. Cities are the first who implement the measures adopted by national governments[15]. They therefore need to coordinate with higher authorities in the country. Moreover, they have to make complementary efforts by addressing challenges on the ground and introducing measures for specific vulnerable groups. Each city and urban settlement has the duty to implement its own local plans, ensuring measures to contrast the spread of COVID-19 in accordance with local populations. The flexibility of plans is thus essential to rapidly react to changing epidemiological situations,

not forgetting the local capacity to respond to it.

The second area of intervention involves the communication risk and people's involvement that could encourage compliance with measures. Clear and direct messages on public health have to reach as wide an audience as possible, comprising all segments of society. This firstly means communicating local ordinances and regulatory measures, and secondly disseminating information to support preparedness and measures that could implement the local response. Communication should be developed with active involvement of local communities in order to create possible solutions. In this phase relying on volunteers, society organizations, civil protection and universities may lead to relevant innovations and new knowledge. This involvement can improve the chance of compliance especially among vulnerable people.

Cities and local authorities should also work with organized citizens groups to identify the vulnerability of a community or part of it, fight misinformation and ensure essential services to those who live in difficult situations (including those who may have a negative impact on their mental well-being[16]).

The third key area is that which implies appropriate approaches to public health measures and physical distancing to slow down the transmission of diseases such as COVID-19. Where physical distancing in domestic settings is not feasible, local authorities should identify public facilities where people can be quarantined or hosted guaranteeing secure housing which can enable physical distancing. Measures should be balanced maintaining provision of essential goods and services while enhancing physical distancing in public spaces, restricting access to a fixed quota of people and promoting active mobility. Cities and urban settlements therefore have to rule and organize services and facilities.

The fourth strategic area which every government and authority have to struggle for operating properly is the access to healthcare services for COVID-19 without stopping essential services from working. If on one hand urban settings should be able to manage a surge in medical centres demand, which includes having a plan for case management of COVID-19 in health facilities, on the other hand essential services should be kept functioning so as not to worsen and change patients' conditions into critical ones. As a consequence, urban settings should project the pandemic surge using modelling and healthcare data from areas that have already experienced the emergency, getting ready to a possible new emergency. Continuation of primary health care services and functions is equally important: essential services, such as vaccinations, must continue to prevent morbidity[17].
Medical functions are not the only services which have to be maintained, ensuring the continuity of other essential ones – such as social services, home care, public transport, waste disposal, food and energy supplies - also contributes to the prevention of COVID-19[18].

The last strategy to be implemented is preparation for future emergencies. In periods between epidemic peaks, urban settlements should enable a sustainable suppression of transmission whilst allowing resumption of parts of social and economic life, balancing economic benefits and epidemiological spread risk. This is the time when actions adopted to respond urgently to emergency have to be converted into longer–term measures, going on planning and health system that can respond to a further epidemic surge. It is imperative that cities document, learn and adapt during their COVID-19 experience, by means of proactive approaches. Finally the acquired knowledge needs to be reviewed and readapted for a future draft of preparedness and response planning.

3.2 PROTOCOLS AND STRATEGIES DEVELOPED BY INTERNATIONAL ORGANIZATIONS

Once that national and local authorities had experienced a surge in demand of healthcare facilities due to the spread of COVID-19, and after an early detection of the ongoing phenomenon, a series of operational considerations and management guidelines were given by the World Health Organization. In accordance with what studied by WHO, some smaller healthcare organizations started to work in the same direction, seeking to implement life-saving treatments without compromising public health objectives and health workers safety.

In particular, public health objectives at all steps of preparedness and response plan seek to:

- prevent outbreaks, slow and stop transmission;
- provide focused care for all patients, especially those seriously ill;
- minimize the epidemic impact on health system, social services and economy[19].

Since new infectious diseases usually start locally, it is essential to understand their dynamics in order to deny or reduce the opportunity to spread among people. Epidemic and pandemic diseases usually develop through the following phases: the first step is the introduction into a community, then outbreak with localized transmission follows, a subsequent amplification to a pandemic magnitude, ending with a phase of reduced transmission owed to an acquired population immunity or effective control of the disease. The dynamics described above must be taken into account to define the necessary response and interventions. It is crucial to manage the outbreak in different ways according to each specific phase as expounded below.

- Anticipation

In the first stage of response, introduction of the disease cannot be predicted but can be anticipated. An anticipation of risk enable a focus on the most likely threats. Preparedness plans based on past lessons learned from past experiences should contain a variety of scenarios and possible solutions to allow a reactive response.

- Early detection

Early detection allows the rapid implementation of containment measures reducing the risk of potential spread. Healthcare workers must be trained to recognize potential suspect cases; they are also asked to reduce community transmission risk by isolating severely ill people. Doing so, they must also know how to protect themselves and avoid outbreaks amplifying in healthcare facilities. For this purpose it is therefore essential to put in place centres for diagnosis and treatment.

- Containment

Like early detection, effective and rapid containment of infectious diseases is of vital importance. In order to carry it out, skilled professionals should implement the necessary countermeasures. Pre-training healthcare workers is consequential to guarantee efficient operations.

For the first phases – from early detection to localized transmission – some procedures are recommended. It is indeed essential to foresee a proper triage procedure at all levels of public health system to enable early detection of suspect cases. Designated health facilities should provide adequate cares, thanks to their provision of ICU and engineering measures. It is also necessary to define clear referral pathways for suspect or confirmed cases, as well as develop a control and mitigation plan.

- Transmission and strategic priorities scenarios

Countries and subnational areas have experienced different situations regarding COVID-19 outbreaks. In order to classify and properly respond to the emergency it is thus important to identify and rank cases according to their type and number. In the epidemiological scenarios of the past months we can detect four different circumstances:

- countries with no cases;
- countries with one or more cases locally acquired;
- countries experiencing case clusters limited in time, geographic locations or by common exposure;
- countries experiencing larger outbreaks of local transmission[21].

One or more of the above situations could be experienced in several areas; it is therefore crucial to develop and tailor focused approaches to different contexts. According to the severity of the infectious disease different resource requirements are needed, starting from some containment precautions ending with high-engineering equipment (from Oxygen therapy to mechanical ventilation systems).

- Key clinical and IPC* activities for different transmission scenarios

As mentioned above, each country might face one or more scenarios at different times. In order to adequately manage each situation, is relevant that authorities and health workers respond to the emergency according to specific priorities, typical of every scenario. Regardless of how severe each case may be, the first recommendation that has to be followed, is setting up screening and triage protocols at all point of access to the health system, including health centres, clinics and communities. For the following phases, instead, each scenario presents its own procedure protocol.

The "no cases" context includes setting up COVID-19 telephone hotline and referral system for clinical assessment or testing. It includes also setting up COVID-19 designated wards in health facilities and conducting an active contact tracing and monitoring of suspect cases.

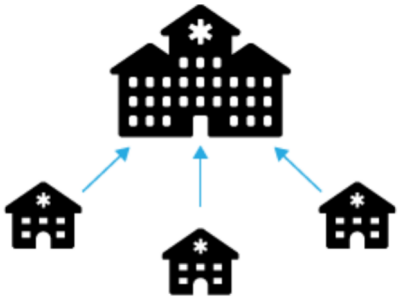
Instead the "sporadic cases" context includes the care of all positive patients in isolation according to disease severity, while continuing a rapid contact tracing.

The situation changes in the scenario of "clusters of cases". Here, due to an increased number of positive patients, the resources have to be managed in different ways. Care for all COVID-19 patients occurs in designated areas according to the severity of the disease. Because of the surge of hospital beds needed, wards and ICUs should be converted into COVID-19 ones. Where health facilities can no longer manage patients with mild-to-moderate disease, they can be transferred either to temporal community facilities (stadiums, gymnasiums, tents..)or sent home. A rapid referral to hospital is thus required, while a plan for new structures to increase health system capacity should be implemented.

The amount and the specificity of recommendations becomes stricter in case of "community transmission". While some confirmed or suspect COVID-19 patients are treated in hospitals, others should be treated in alternative healthcare structures. Since main healthcare facilities for the most part have to rely on extra structures both in the triage and screening phase and in the care delivery one, mild-to-moderate patients can be assigned to such structures or at home, once a rapid referral to hospital is guaranteed.

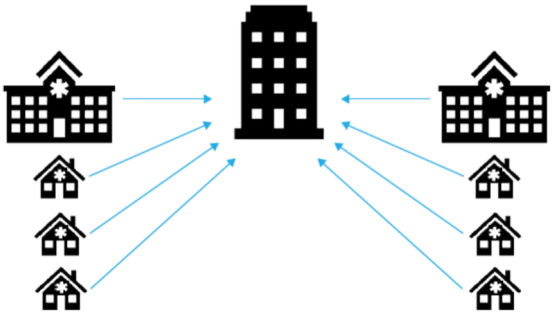
The four scenarios clearly show how an increasing number of healthcare dedicated spaces are needed according disease severity. In the first three cases the patient's journey could be represented as in the picture 6, where primary health centre

identifies potential infections, which only at a later time are referred to hospitals structures that manage the surge of beds and ICUs[22].



Picture 6. First phase of a patient's journey

Once the infectious disease reaches pandemic level and health system capacity becomes not spacious enough, additional structures have to be rapidly put up or reconverted. A new strategy is therefore implemented: in order to simplify patients pathways and reduce the risk of exposure, primary healthcare facilities and hospitals refer to SARI (Severe Acute Respiratory Infections treatment centre) only in critical situations[23].



Picture 7. Patient's journey during control and mitigation phase

* Infection Prevention and Control

- Operational consideration of management of COVID-19 patients and patients with non-infectious diseases.

Unfortunately, in the past months the most critical scenario was also the most frequent one in hospitals all over the world. Essential health-care services suffered because of the additional demands brought about by the urgency of managing COVID-19 cases. Lots of people suffering from non-infectious diseases were not treated or cured because of the pressing situation due to Coronavirus infection. Actually, primary care is a vital part of the healthcare system and has a role in minimising the burden of COVID-19 hospital facilities are presented with. At the same time, primary care needs to goes on with its usual activities. It is therefore essential that health staff work effectively to manage basic cares to prevent the healthcare system from being overloaded. To ensure continuous availability of services, the shown response mechanisms should be in place well before widespread community transmission is detected.

- In-action and after-action review

Once all the operative actions to control and manage COVID-19 outbreak have been established, it is also essential conducting an IAR and AAR[24]. After-Action Reviews are structured, qualitative reviews of the actions taken during the emergency response to identify the lessons learned and the best practice in case of a further emergency. They can focus on different details and elements.

Similar to AAR, In-Action Reviews seek to identify best practice and lessons learned, amidst the ongoing health emergency response. The purpose of an IAR should be to quickly identify readily-implementable actions to immediate improve the current response[25]. Ideally, an IAR may include not only a rapid review of what has already happened during the response, but also a look-ahead towards emerging issues that may require a shift or modification of the response strategy.

Both of them try essentially to contribute to the cycle of continuous quality improvement in emergency preparedness and response planning. To do so, they follow four key phases: design, preparation, implementation and dissemination. The design step includes defining the scope of the reviews methodology, developing a detailed agenda and defining the team. The preparation

phase instead includes information collection, interview and questionnaire elaboration and material collection. In the implementation phase, an AAR/IAR is conducted, debriefing all participants with preliminary findings and evaluating the review itself. In order to finalize the process, the dissemination phase is put in practice: final reports, results and conclusions should be collected and made broadly available. A relative action plan for implementing key recommendations should be developed[26].

- Basic requirements for Severe Acute Respiratory Infection Treatment Centre

First of all the indications given to prevent , control and respond to COVID-19 outbreaks could not possible be implemented without specific medical supplies. Equally important were healthcare-infrastructures which played a strategic role in managing the pandemic. As experienced all over the world, the aggressiveness which every country has been hit with, has led all the international and local authorities to take decisions focused on increasing the number of beds in healthcare facilities. Once the existing healthcare infrastructures were no longer able to face the surge of hospital beds needed, new solutions have been implemented.

Because of the contagious nature of COVID-19, several indications in terms of spaces, equipment and medical treatments should be followed in order to simplify the heavy task of the health workers involved and to limit, as much as possible, disease transmission.

To comply with all the recommendations, different national and international organizations, such as World Health Organization, European Centre for Disease Prevention and Control collaborated giving specific guidelines so as be able to find temporary solutions. As regards Severe Acute Respiratory Infections Treatment Centres and general hospitals, they highlighted the indications listed below.

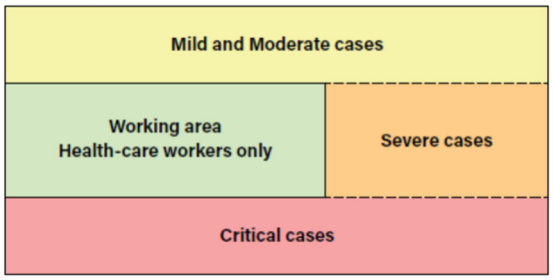
Ventilation. One of the key factors essential for Respiratory Infection Treatment centres is providing a correct ventilation, especially to more vulnerable patients.

Ventilation moves outdoor air into a building or a room, distributing it within the building. The overall purpose of ventilation in buildings is to provide healthy air for breathing by diluting the indoor pollutants deriving from the structure. In order to ventilate building there are three methods that could be equally employed to guarantee clean air to their users: natural, mechanical and hybrid ventilation. Usually, as long as the minimum ventilation rate is guaranteed the use of natural ventilation is encouraged. When this is unpracticable, it can be replaced by alternative solutions.

Natural ventilation drives outdoor air towards the building openings. Its use strongly depends on climate, building design and human behaviour. Instead the mechanical one drives air mechanically through fans installed in walls or windows. Finally, hybrid relies on natural driving forces to provide the desired flow, and use mechanical ventilation when the natural flow rate is too low.

Recommended characteristics for finishes and furniture. During the selection of material and furniture used in a SARI Treatment Centre, some characteristic have to be taken into account. First of all, it is necessary to select material that can withstand repeated cleaning. Secondly, it should be as durable as possible and easy to be repaired. The resistance to microbial growth is equally important; it is suggested to avoid any porous materials that hold moisture, such as wood and fabric.

Basic layout



Picture 8. Basic layout of severe acute respiratory infection treatment centre

The proposed layout is based on clinical definition of people with severe respiratory infection, and relative condition categories. This in particular, represents one of a number of possible solutions. Behind this pattern lie some key considerations which may led to different kind of organization. For this reason medical care should be provided as soon as possible[27]. People with different severity disease present different risks and, for this reason, they are kept in different sectors. Ensuring a clear demarcation or separation between patient and staff areas reduces the risk of nosocomial infection. The centre should be divided into two zones: one area for health-care workers and another for patients. The second one then has to be divided according to disease acuity of patients in mild, severe and critical zones[28].

Basic screening principles. For the anticipation, detection and response to the localized transmission phase, screening plays a critical role since it represents the first step of a series of procedures. What is strongly suggested is having specific protocols for patient screening, including designation of screening areas and patient traffic flows both inside and close to the hospital. Moreover, hospital should apply screening criteria in order to admit firstly critically ill patients and then treatable ones; without neglecting, of course, health services to non- epidemic patients.

Waiting room. The waiting room should be composed by individual booths open on both sides to ensure proper ventilation. All booths have to be clearly organized in a way that allows correct patients flow. Once used they have to be disinfected to avoid nosocomial infection. In case of unavailability of individual booths, a distance of 2 m between patients should be guaranteed.

Isolation room. The isolation room is a transitional area for people suspected of being positive to Coronavirus disease. These spaces have no specific features since they are temporary areas; in case of necessity they could also be used for sampling.

Minimum requirement for converting existing building into a SARI* Treatment Centre.

In absence of health-care facilities designated for COVID treatment it is necessary to make up for new structures. The minimum requirements that repurposed buildings (rather than new ones) have to meet are the following:

- "minimum ventilation rate of 60 litres per second per patient for mild and moderate wards" [29];
- "minimum ventilation rate of 160 litres per second per patient for severe wards and intensive care units" [30];
- airflow from clean to dirty zones;
- patient and staff flows can be clearly defined and distances respected;
- all finishes, furniture and patient care equipment can be effectively cleaned or disinfected[31].

* Severe Acute Respiratory Infection.

3.3 REFERENCES

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PICTURE

[P1;P2;P3;P4;P5]

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4. TREATING MODELS AND ADOPTED SPATIAL STRATEGIES

As the world cities, in the past months, experienced a steep influx of patients suspected to be infected by Covid-19, many hospitals were not able to face such a surge of beds. The world healthcare system crisis in fact demonstrated an insufficient preparedness to this novel infectious disease that required quick and effective responses.

To make up for the narrowing availability, temporary healthcare facilities have been erected in some unlikely places. These urgent works involved extraordinary efforts by national, international and intergovernmental organizations and healthcare providers. In a short amount of time in fact were adopted several strategies to face the emergency. Some of them have planned the whole construction of temporary healthcare facilities, while some others focused more their attention to the conversion of existing buildings. Where it was possible, the implementation was operated on hospital structures, where not, local authorities identified alternate care sites within non-medical buildings - such as football stadiums, hotels, conference centres - for such a purpose.

Along with this primary necessity, other needs arise time by time. Some of them were of healthcare nature as the necessity of more Intensive Care Units and the isolation wards for positive patients, while some others worked just as temporary shelters for nurses, doctors and homeless people.

4.1 ADAPTIVE REUSE OF EXISTING HOSPITALS

If in most instances the lack of hospital beds due to the spreading of Coronavirus was compensated relying on external structures already built while waiting for those under design and construction, in some cases, especially when the emergency started, hospitals were reorganized and implemented to face that predicament.

Without any doubt, hospital structures are one of the most suitable to properly face difficulties than other structures converted into healthcare facilities, although the vast number of patients needing treatment put in serious trouble the overall medical system, even hospitals.

As a matter of fact, the epidemic issue led to reorganize all the hospitals; in order to contain cross-infections, the hospitals faced some architectural changes among with new enclosures of spaces, the reorganization of new pathways and the deployment intermediate changing rooms for medical staff.

In other cases whole- dismissed or not - hospitals were converted in specialized ones to treat people positive to Covid-19.

In this chapter I will analyse both: on one hand the reorganization of ongoing hospitals and on the other the reconversion of dismissed ones (or part of them) into specialized structures.

4.1.1 READAPTED EXISTING HOSPITAL

- Reasons leading the adoption of this specific model

The first adopted solution to contrast the spread of Coronavirus in the past months, included the readaptation the existing hospital layout. Most of the healthcare facilities were reconfigured and several transition spaces were turned into treatment areas.

Although in the hospital sector were done big efforts to respond to the surge of hospital beds, readapting the existing hospitals' layout resulted insufficient; this was essentially due either to the lack of adaptable space within the hospital or to the shortage of safe building solutions, staff and specific resources.

Being the first implemented solution aimed to respond to Covid-19 outbreak, in most of

the cases all around the world this action was realised just to made a quick fix the ongoing emergency rather than being developed in a systematic manner. Although not everywhere, this subsequently brought to the implementation of alternative solutions to fight the healthcare crisis.

The decision of readapting the existing hospitals were mainly based on the features listed below:

- relying on existing building represents the fastest way to respond to the shortage of hospital's beds;
- hospital structure is already conceived and designed for responding to health needs;
- the hospital already disposes of adequate electrical, ventilation and plumbing systems;
- with just some limited spatial changes distinct needs can be solved;
- small amount of building resources are required;
- the building cost is quite low; especially if compared to other alternatives.
- the healthcare facility has the possibility of treating patients with distinct disease acuity;
- the hospital is equipped with secondary facilities (canteen, toilets, laboratories…);

- Users

Reconversion, readaptation and implementation of hospitals in the past months have increased the amount of people who can be cured. It is possible to group their users in four different categories with distinct needs. The first category includes those patients who tested positive to Coronavirus but showed mild symptoms; although they were contagious they did not require specific cares. The second category instead, includes patients tested positive to Covid-19 who were and had been seriously ill; along with their contagiousness, they also present critical respiratory symptoms and therefore need ed available Intensive Care Units.

There are other two more equally important categories: that made up of patients suffering from diseases not related to Coronavirus and, last but not least, healthcare workers.

Due to such a complex environment, the flow management within the building, as well as avoiding cross-infections between patients and medical staff, proved quite difficult. Seeking to solve this problem, several indoor partitions were deployed within hospitals to allow separate communication routes.

- Means and resources that the model requires

Hospitals with existing shell space that could be easily converted or which already had infrastructure in place were more readily available than using conference centres, hotels and sport centres that need significant conversion work to serve as temporary care sites. As a matter of fact, they were proved more cost effective and patient and care-giver centric than other healthcare models.

In regarding to new facility layouts and site configurations, Covid has driven organizations and professionals to reconsider all healthcare implementations in a perspective focused on infection control strategies.

Technology. Along with additional signage that facilities have been adding to communicate safety reminders or direct patients and families across their buildings, also touchless technology controls in acute care environments can reduce the number of shared surfaces that people touch[1]. Another key role of technology within healthcare facilities can be performed by widespread adoption of cameras and monitors, which can address the problem of isolation that many have faced, and can also allow to "visit" family members in a remote way.

Technical staff. Differently from other chosen solutions, reconverting existing hospitals

involved an extra effort in the management of both patients suffering from Covid-19 and the other ones. As experienced in the first virulent wave of Coronavirus, part of surgical staff must inevitably face relocation. The surgical team must be divided into two sub-teams: a dedicated Covid one working in the Covid units and a surgical "clean" team dedicated to other procedures not involving Coronavirus[2].

Corridors. The spread of a pandemic of infectious character has revealed how hospital transition spaces are really fundamental. When well designed, corridors and pathways can meet a number of needs in case of emergencies. In fact, if large enough, they can be used both for accommodating additional beds properly organized and working as transition spaces dividing clean and dirty areas.

For instance, during the Covid outbreak some hospitals decided to close corridors to keep transition pathways within contaminated or clean ward, while other facilities turned their pathways into triage rooms, laboratories and sub-intensive care wards.

Wards. Along with a constant training of surgical nurses able to properly respond to the health condition of every patient, what became crucial was providing beds for all the patients who required them. A massive internal reorganization took place; as elective operations were cancelled, the increased need for ICUs beds led to the conversion of operating rooms and recovery areas into critical care units. Existing private patient rooms were converted into semiprivate ones; each room could accommodate two infected patients with adequate distance between beds. That was possible using alternative patient care areas and moving a few closed inpatient units online[3].

After a first "random" intervention, Covid dedicated ward clusters have been gradually activated by progressive reconversion of complete medical, outpatient and rehabilitation wards reorganized in other places.

- Existing flows and connections

The pathways of several hospitals are usually attended by large number of people providing services, waiting for some cures or walking from one place to another. They therefore assume great importance in the determination of the internal flows of stuff, staff and patients. As Covid reached healthcare structures, being extremely contagious by nature, new spaces were set up in order to separate people and wastes transition. To comply with the healthcare protocols given by the World Health Organization, according to which clean, semi-clean and contaminated spaces, several hospitals were driven to close some wards. In some cases, when their width allowed it, corridors were physically separated into dirty and clean zones. Otherwise, entire corridors were closed with fire doors and partitions in order to contain Coronavirus spread.

- International examples

San Matteo Hospital – Italy

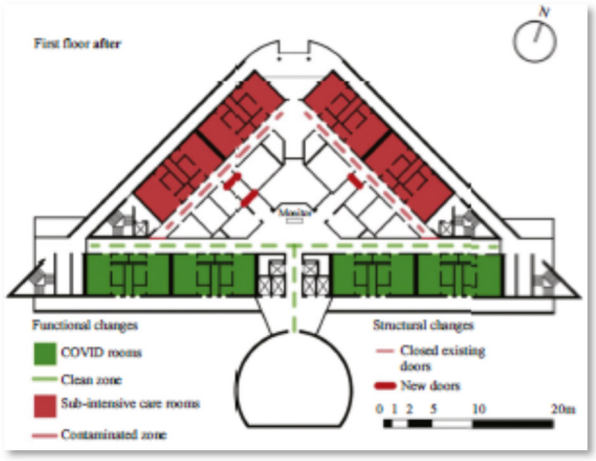
Italy's Covid-19 disease outbreak originated from Codogno, a small town not far from Pavia, home of one of the largest teaching hospital being involved in the management of the outbreak since its inception.

Before the Coronavirus outbreak the Division of Infectious Diseases (ID) was arranged in two floors located in a stand-alone four-storey building[4]. The ground-floor hosted the ID outpatient clinic, a day-hospital and ultrasound services, while the first and second floors were for inpatients. A further third floor, identical to the other two, hosted the Division of Clinical Oncology.

Since the first case of Covid-19, the hospital, day by day, was internally reconfigured in order to free up space for new incoming patients. As news about the novel Coronavirus reached the hospital, the outpatient clinic closed as a precaution to

avoid any risk. In the following days the regular patients were transferred to other wards while the ground floor was set up to let suspect case access the building avoiding cross-contamination with others patients. As the numbers of critical patients increased in such a rapid time, a section of the first floor was transformed into a sub-intensive care ward. To do so, four corridors were closed with fire doors, two of which were installed overnight. This subdivision allowed to allot some space to the ID wards and the rest to Covid care, enabling free circulation of physicians and nurses in a contaminated zone.

In a very short time the number of patients waiting for the result of the nasal swab grew so rapidly that became impossible to cope with them; therefore a further area needed to be allocated to Covid positive patients. To get a further circumscribed area as contaminated zone, the hallways connected to the central hall were rapidly closed. The smaller outpatient offices were separated in single waiting rooms for Covid positive patients, while the larger ultrasound office and the day-hospital were transformed into a triage area. The conversion of the ground floor into an emergency area was accomplished in just 24 hours, while additional beds were found thanks to the relocation of the oncology ward[5].



Picture 1. Plan of the first floor of San Matteo hospital after functional changes.

Thanks to the joined efforts of specialists, residents, nurses, administrative and support staff, the quick changes to the structure were accomplished with great foresight capacity, able to cope with the emergency.

Although the described reconversion represents a successful example to cope with the emergency, some needs of patients not affected by Coronavirus were overshadowed. Of course, in a perspective of ordinary response to Covid-19 it is thus important balance the needs of both categories of patients, separating the spaces without penalizing either of them.

Hospital del Mar - Spain

The Barcelona Teaching Hospital is part of a medical cluster in which investigation, learning and health assistance melt together. It has been involved in the Covid treatment since the beginning of the pandemic outbreak. As in the middle of April the contagious curve reached its top level, a new cross- strategy was implemented to accommodate more Covid-19 patients. The hospital transformation was possible taking into account different scenarios to be equally developed; in the first scenario that were hospital belonging to the cluster was transformed and enlarged to host more patients; the second scheme involved its ground floor occupation and reconversion, while the third one required the implementation of some facilities into the nearby sport centre.

Transformation works included a first intervention in the day-hospital building, followed by its expansion at the ground level, completed by a third one in the adjacent building.

The day-hospital was converted into intensive care units, through the substitution of seats with more beds and the implementation of oxygen equipment; in the meantime the ground floor, (which was supposed to be under renovation) was organized in two units. Distinct pathways were clearly defined in

order to distinguish dirty zones from semi-dirty and clean ones. The transformation work took just six day with two additional days for the installation and deployment of equipment, furniture and, where needed, signs.

Picture 2. Hospital del Mar before and after the reconversion of the ground floor.

The third intervention was the transformation of the sport centre into sub-intensive infectious wards. The construction works lasted the same amount of time needed for the reconversion of the hospital building, despite of the different building procedures realised. In this case, the conversion works were treated an ephemeral architectural performance, with just the deployment and installation of rent building material and equipment. Indeed, this building choice was taken in order to avoid waste and spare money once the emergency ended[6].

Picture 3. Spatial reconfiguration of the sport centre close to Hospital del Mar.

In accordance with the elaborated work behind these structural changes, the architects involved in the transformation process understood all the shortcomings and potentialities a hospital has. For this reason, once the work had been completed, they suggested some eligible improvements for the future post-pandemic hospital. The given advice consists of designing flexible hospital that include large spaces with variable use, dedicated circulation for patients and hosts and rely on linear and repetitive distribution of spaces[7].

4.1.2 HOSPITAL CONVERTED INTO SPECIALISED COVID HOSPITAL

- Reasons leading the adoption of this specific model

The massive stress for the worldwide healthcare system due to Coronavirus outbreak forced health authorities to take urgent measures to limit disease spread and potentiate the territorial emergency system to intercept and contain new cases. Public hospitals were immediately subjected to overflow of Covid infected patients saturating their capacity, so that some of them were totally converted into specialized Covid centres. This represented the best cost effective solution, which balanced health management benefits and quantity of human and material resources needed. In addition to these considerations, the listed features convinced public authorities to implement hospital reconversion:

- available existing buildings can be made ready to host lots of Covid patients in a comparative short time;
- hospital structures are already conceived and designed to respond to health needs;
- hospital already have at their disposal adequate electrical, ventilation and plumbing systems;
- focused spatial changes can solve needs;
- the building cost is contained; especially if compared to other alternatives.

- healthcare facilities are equipped to treat patients with any grade of disease acuity;
- hospitals are equipped with secondary facilities (canteen, toilets, laboratories…);
- specializing a whole building to a specific disease allows patients to be treated properly, also when complications arise;
- nosocomial cross-infections rate among patients is reduced (even if this does not usually occur with healthcare workers).

- Users

The reconversion of hospitals into dedicated Covid ones enabled the streamlining of the treatment of different pathologies. As a result, critical patients received faster cares with respect to common hospital procedures. In particular, the pre-triage system allowed patients showing fever or moderate respiratory symptoms to be separated from those who had more critical ones since their very first approach to the hospital.

As well as the patients who were selected in order to be hosted in the above specialty structures, also the medical staff underwent the same procedure. As a matter of fact Covid hospitals were managed only by healthcare workers properly trained to deal with such an infectious disease. Some part of the staff teams were allotted to the "clean" zones of the hospitals while some others to the "dirty" ones[8].

- Means and resources that the model requires

Converting a large specialized hospital into one dedicated to Covid patients involved meeting several procedures and standards both in the work flow and in the training system of medical and supporting staff. In converted structures the work process included the division of existing wards into observation and isolation ones, installation of locks, weekly plans for supplying PPE, designation of new entrances to hospital and communication routes and medical staff.

Triage. Triage procedures could be very complicated if there is just one available entrance to the hospital. To solve this problem, in order to avoid possible contacts between positive and negative subjects, some areas to perform pre-triage were identified. Patients with fever and respiratory symptoms were directed to respiratory triage routes for a rapid screening, while patients with moderate-critical alterations were directed to Covid-19 screening laboratories.

Observation wards. In the first coronavirus pandemic phase the test results exceeded 24 hours. Some suspect cases waiting for result showed too severe conditions for keeping them just in home quarantine. For this purpose observation units were created within hospital wards. As the origin of the respiratory symptoms noticed in patients in observation wards was unknown, every patient had to be separated from the others in order to avoid cross-infections. They were therefore confined in "red" single rooms connected by semi-dirty corridors as in several cases was impossible to airlock the entrances of every room[9].

Isolation wards. As soon as test results confirmed positivity to Covid-19, patients were moved to the isolation wards in order to manage both complications of the disease and concomitant ones. Here patients' rooms, procedures rooms and corridors are considered "dirty" zones where medical staff can stay for a maximum of 4 hours in accordance with the predictable calculation of PPE usage.

Access and communication routes. Concurrently with preparation of internal instructions, training staff and installation of locks, it was decided to limit the entrances to the hospital, reserving some entrances for Covid patients. According to the structure of the building, availability of internal communication, unusual localization, some entrances were closed. Subdivision of clean

and dirty zones followed, as well as the creation of distinct pathways able to reduce contamination risks.

Training of medical staff. In order to guarantee that all healthcare workers complied with each and every safety recommendations was essential devising a plan for the central training system aimed at presenting proper employment of PPE. To do that, each group of trainees was highly diversified in term of either position held or type of ward. Taking into consideration these distinctions, details and procedures were adapted to the profile of each group[10] .

- Existing flows and connections

Once dirty and clean zones had been determined, routes through which infected patients would be moved were separated in order to reduce the risk of infection among staff and to guarantee a continuous supply of materials, food and medicaments, also facilitating the transport of tests to laboratories.

In order to limit the amount of time a person took to go through a lock , it was decided to organize separate transportation for the laboratories, warehouses, pharmacy and waste. Some parts of the building were therefore kept just as communication routes for the staff, while others just for patients and "dirty" materials. Additionally, specific lifts were dedicated to Covid while other "clean" lifts were reserved for staff and materials[11] .

- International examples

MSWiA Hospital – Poland

The several weeks pandemic of the Covid-19 disease forced the healthcare system of numerous countries to adjust and reshape their healthcare resources, turning entire hospitals into specialized Covid ones; the MSWiA of Warsaw, Poland, was one of those. In order to convert a multi-specialized hospital into a dedicated Covid one, the staff was prepared to new working conditions. To do so , a team was formed with the task of developing special rules to be followed in wards, planning "red" and "green" areas and transportation routes, drawing up procedures for PPE usage and conveying the resulting protocols to the whole staff.

The WSWiA Hospital is situated on a 16 hectare lot consisting of 31 buildings of different sizes which had been built between 1950 and 2012. The huge complexity of the hospital represented an enormous organizational and logistical challenge for the staff responsible for its transformation into a dedicated Covid centre[12].

According to the first WHO indications and available protocols, the transformation phase followed the following steps:

- the first intervention was the closure of some entrances to the building; in order to keep the Covid spread situation under control, specific routes were created towards the entrances and the triage system[13];

- the triage system was then divided into two pre-triage sub-systems: one for severe respiratory symptoms and another for moderate respiratory symptoms;

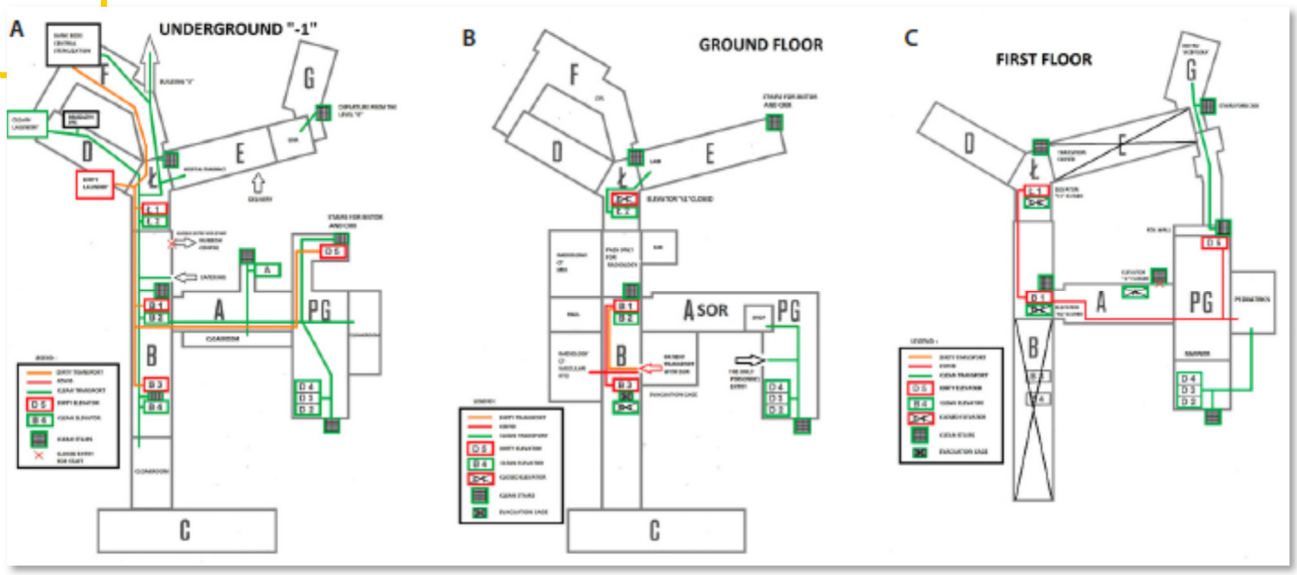
- the first macro-intervention within the hospital consisted in the overall division between clean and dirty spaces;

- once all the internal services and spaces had been divided into red and green according to their level of contamination, different communication pathways were separately organised for patients, medical staff, food and waste;

- the first specifically focused intervention was the reorganization of the ground floor with isolation wards and observation wards[14];

- finally, the last intervention was the implementation of the available Intensive Care Units.

The successful outcome achieved by this kind of intervention, was mainly due to the correct management of the several flows within the



Picture 4. MWSiA hospital plan and communication routes

building along with a careful use of PPE and a uninterrupted medical staff training.

Maria Pia Hospital – Italy

Along with the Maria Pia Hospital in the city of Turin (Piedmont), other four similar healthcare facilities belonging to the same health group were converted to treat patients positive to Coronavirus with dedicated staff properly trained.

In order to convert into such kind of facilities, intervention followed certain specific rules that enabled a better response to the infectious disease. Firstly, occurred an individuation of available hospitals suitable to be repurposed into Covid Hospitals; along with the possibility of moving away the patients not affected by Covid-19, they had to own spatial and systems requirements able to define dedicated zones and pathways where patients might be properly cured while were guaranteed safety conditions for both the staff and patients[15]. The second step consisted of guaranteeing a perfect isolation of wards. This further implied the disposal of new filter zones for the medical staff access and for the donning and doffing procedures.

As third, an efficient and effective point-of-care workflow has minimized unnecessary patient and staff movement. In support of that, room layout exam table placement and consultation room have been essential considerations in the building transformation project.

For safety reasons due to the contagious origin of Covid disease and due to the limited amount of PPE, the access to those hospitals was just allowed for specifically trained medical staff and for positive patients[16].

4.2 OPERATIONS ON NEW BUILDINGS

The response of worldwide governments to the scarcity of beds and Intensive Care Units in hospitals due to the novel Coronavirus was extremely differentiated depending on the preparedness of each individual State, its wealth and the availability of different kinds of resources.

This is shown by the most advanced States, among which there are China and the United States where various solutions geared to the diverse needs were implemented.

One possible solution was building totally new infrastructure and temporary hospitals from scratch; where this solution was not implementable, the healthcare system relied on more compact temporary structures.

4.2.1 CONSTRUCTION OF WHOLE HOSPITALS FROM SCRATCH

- Reasons leading the adoption of this specific model

Since the lack of beds in the past months in hospitals was increasing on a daily base, some worldwide governments took the decision of building new medical facilities. Instead of reconverting existing buildings or adding some temporary "small" structure, they preferred to create new medical clusters of larger dimensions.

The adoption of this solution was essentially due to the following reasons:

- the availability of big fields relatively close to the major cities that could host the healthcare facility;
- the existence of infrastructures that allow hospital connection with the city;
- the possibility of having in short time big amount of workers and medical staff;
- availability of big amount of money to be invested on the hospital construction;
- availability of building material in a short amount of time;
- according with the availability of medical resources, the decision to keep all the patients - from the mild acuity disease ones to the severe acuity ones - in the same structure.

- Users

The construction of new hospital from scratch designated to make up for the lack of beds in the healthcare sector, enables the designers to elaborate focused layouts depending on the needs that specific building aims to satisfy. To do so, making a quick analysis of the needs of future users as well as the environment in which the hospital will be built, could bring to the implementation of primary services over others. For instance, in the case of Coronavirus pandemic, the layout of new hospitals might accommodate large numbers of patients with different disease's severity. In addition to that, it, other essential facilities can be represented by inspection quarantine units, treatment wards, co-working areas, general wards and rest areas for medical staff[17].

Disposing of large building plot moreover allow to organize the designed hospital into different zones according with the specificity they own. For instance, splitting the area into sub-areas enable to host people with different needs in smaller "communities"; some of those areas could be mainly restricted to patients while others can be dedicated to rest of medical staff. In this way cross-contamination rate can decrease.

Differently from other healthcare structures adopted for COVID-19 treatment, the solution of building entire hospitals from scratch enable the health system not to

differentiate incoming positive patients according to their screening result. In other words, if other healthcare systems select and host only those patients with mild-to-moderate disease, the hospital cluster is designed in way that welcome a more various public. On one hand so, the healthcare facility needs more medical resources and ICU, but on the other one, the availability of more medical equipment, enables to treat patients which health conditions could worsen, in the same place. Hence, a further referral system is not required.

- Means and resources that the model requires

Building an hospital from scratch appears an extremely challenging operation, since involves big availability of manpower, materials, empty space and a huge kind of resources in a short timeframe. Having a look at the international panorama, only few countries have the possibility to respond to such healthcare emergencies, building completely new infrastructures in a such short timeframe. China is one of those ones, since it is able to balance rapid bureaucracy with collaboration of contractors and immediate availability of several resources[18].

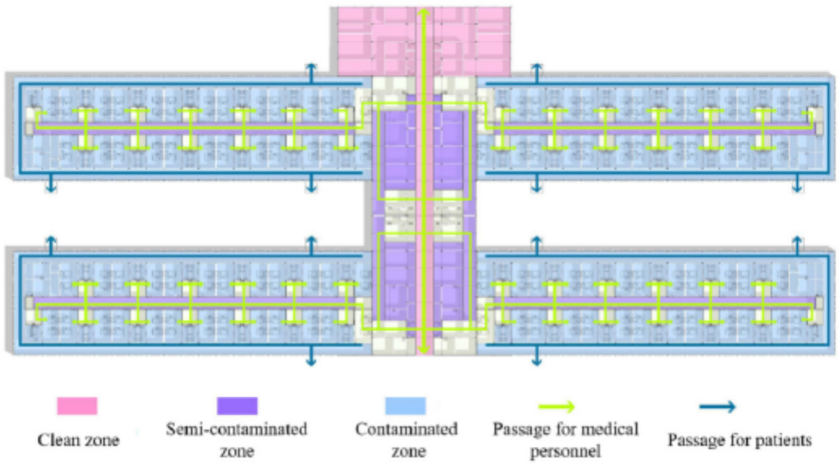
Manpower. As witnessed with the construction of some hospitals during the first wave of Covid-19 pandemic on February 2020, huge numbers of construction workers were hired simultaneously in order to deliver the hospital project as soon as possible. Main contractors in fact had to coordinate different sub-contractors in order to conduct different disciplines, maximize the productivity and maintain progress in accordance with the schedule. Therefore, communicating information among project stakeholders could be challenging due to the large number of those involved in the process and due to organizational fragmentation. The difficulty can be even higher due to the intersection of more cross-disciplinary processes that have to be conducted in parallel. As well as the building phase, also the working phase counted lots of medical workers being involved in the process. during the critical period over thousand medical staff was simultaneously employed. A remarkable example, in this sense, is represented by Leishenshan Hospital construction, in the busiest construction day, were counted fifteen thousand workers working at the construction site, while more than thousand physicians and nurses were simultaneously employed in the critical phase[19] .

Additional works. In addition to simpler actions that also other models involved - such as assembling the interior finishing - the construction of a new healthcare facility involves procedures of site levelling, foundation engineering, pipeline embedding, arranging anti-seepage membrane and assembling prefabricated components.

Logistic area. The healthcare site as mentioned before, along with the mere medical treatment area, needs additional essential facilities that aim to guarantee complete and adequate disease detection and treatment. Close to the entrance in fact the logistic area can welcome incoming patients, screen and lead them towards distinct places depending on their swab result.

Medical area and isolation ward. As the patient gets its medical result is then led to the corresponding isolation ward of the medical area. The isolation wards are distinguished according with the patients' disease severity. Keeping separate treatment places, focused care protocols can be carried out providing better cares' efficiency and decreasing worker-to-patient ratio. Within every isolation ward the spaces is further divided in order to contain cross-infections. Spaces strictly reserved to positive patients are divided from "clean areas" by intermediate spaces of medical staff transition and don/doff.

The medical treatment area moreover requires complex building service systems that incorporate subsystems including heating, ventilation and air conditioning system, a water supply drainage system, a lighting system and other electrical system that are implemented in the building phase in order to be fully operational once the building is tested[20].



Picture 6. Layout and flows of Leishenshan hospital

- Existing flows and connections

A strict separation of pathways for patient and medical staff is an essential requirement to comply with during the building project. To satisfy this requirement, the flows for both personnel and patients have to be visualised and changed making them as efficient as possible. Being the primary element of design of the hospital, pathways layout can thus influence the shape of the overall building structure as long as, the key rules to avoid nosocomial cross-infection are guaranteed. Clean, semi-dirty and dirty zones have to be separated.

Since many realized hospitals have taken the Beijing hospital built for the SARS outbreak of 2003 as model, lots of them have adopted the same functional layout of fish-bone shaped structure. With this particular conformation patients can enter directly to the isolation wards through the branches and access to bathrooms through the patients pathway. A long corridor located in the middle is dedicated to the medical staff; this allows to enter in the isolation wards through a buffer zone. Thanks to a route simulation is then possible to establish waste flows and disposal, and clean supplies within the treatment area. The chance of cross-infection is therefore minimized[21] .

- International examples

Leishenshan hospital - China

The outbreak of COVID-19 poses a threat to the public health system firstly in China and then in other countries throughout the world. As the epicentre in the region of Wuhan started to confirm huge number or positive cases to the novel Coronavirus, the government made the decision to build two specialty field healthcare facilities: Huoshenshan and Leishenshan Hospitals. These two field hospitals were modelled on the base of Beijing's hospital, which treated severe acute respiratory syndrome in 2003. During their service period, they admitted respectively 3059 and 2011patients[22] . Put in place to treat people with novel Coronavirus, this temporary hospital broke all records. Although China is used to get projects done in a fast way, with this medical facility it surpassed all previous expectations[23]. The rapid and successful development of those hospitals should be praised from both managerial and technological methods. Key stakeholders, designers, main contractor and governmental departments, in fact strictly collaborated with each other, allocating sufficient resources in a short timeframe; over ten thousand construction workers worked in shifts to accelerate the construction process.

In less than 10 days, they were able to create 1.000 beds. Built from scratch, the project delivery was facilitated by the use of some

technologies. Firstly, the prefabrication modular construction method has avoided time-consuming construction work in situ, secondly, the building information modelling (BIM), turned out extremely useful in the implementation of the product and management of construction processes[24]. As projects of hospital generally have complex design requirements that are influenced by many uncertainties, praises to the BIM technology important implementations were introduced during the design and building phase, allowing to reduce construction timeframe to just ten days.

The huge area where was built the Leishenshan hospital measures approximately 220.000 m^2 and consists in three main zones, including a logistic one, the medical staff living area and the medical treatment area. The medical staff living area was adapted from the canteen of the Athletes' Village, while ten new buildings were newly built to satisfy the other spatial needs. Container prefabricated units were assembled on site providing the overall structure of 400 rooms and over 2300 beds for medical staff.

The medical treatment area instead adopted a fishbone layout, complying with the "three zones and two passages" principle and the national design code for infectious disease hospitals. The zones include clean, semi-dirty and dirty areas, while the corridors are subdivided in passages for patients and passages for medical staff. Similar to other infectious disease hospitals, the Leishenshan hospital owns isolation wards, consultation rooms, intensive care station , liquid oxygen stations and further facilities to protect all the community.

Nur-Sultan's hospital – Kazakhstan

Although Kazazhstan was not among the heavily affected countries, it has taken the pandemic seriously. On the study of previous examples adopted in China, also Kazakhstan decided to respond to the shortage of hospital beds' with the construction of a new hospital[25] .

Although the size is not comparable with a realized Chinese hospital, featuring one third of it, the total area of the site measures 7.000 m^2, costing to the State €11.7 million. According to the achievements had in the previous building sites, also the hospital located in Nur-Sultan surpassed the expectations in term of timeframe: in only 13 days the hospital has been built offering 200 more beds to the health system of the country[26] .

In order to comply with this short amount of time, the hospital was assembled out of modular blocks using technologies for constructing prefabricated buildings.

The layout of the building follow exactly the model took into consideration. As Leishenshan hospital and the other Chinese hospital built before it, the healthcare facility has a fishbone structure, in which six parallel branches of the building are connected through a transversal corridor. This particular configuration enable the separation of the three zones as previously indicated.

Picture 7. Top view of Nur-Sultan's hospital

4.2.2 ADDITION OF MEDICAL EMERGENCY UNIT CLOSE TO THE HOSPITAL

- Reasons leading the adoption of this specific model

During the pandemic outbreak, architects recognised the need to create temporary

facilities that can be quickly developed and deployed in response to several needs. Focusing on their know-how to find fast and efficient design solutions that can be implemented anywhere, designers proposed flexible, fast assembled, mobile and simple structures[27] .

With a very tight timetable, only a limited number of projects were implemented while others remained just on a conceptual level, being deferred to a later time.

According to the requirements and needs that they tried to satisfy, the mobile units were implemented in many ways. Some of them were designed and built for healthcare workers to rest, while some others for patients recovery and screening procedures.

Such flexibility was just one of the characteristics that led worldwide architects to implement this model of healthcare facility. Equally important were the features listed below:

- the modularity of these structures allows more units to be assembled in larger "clusters";
- the building cost is lower than the corresponding facility within a hospital;
- the fast assembling phase can be guaranteed using prefabricated structures;
- opportunity of building medical units both on-site and off-site;
- reduced dimensions which enable infection's spread prevention;
- the movable structure, once fallen in disuse, can be moved away or dismantled;
- the spatial layout of each single unit is designed to host different activities;
- the adoption of this solution satisfies specific needs;
- its reduced dimensions allow the unit to be deployed in sites with different characteristics and conformations.

- Users

When COVID-19 pandemic hit many countries all over the world, it exposed local societies to diverse vulnerabilities. Some concerned housing, while others were more specifically related to healthcare. Once architects were called into actions to find some possible solutions, they tried to solve such critical issues. For the reasons previously explained, most of them resolved to develop the model of small movable building units.

Their specific configuration allowed to provide for various needs. The first one was the shortage of hospital beds for patients positive to the new Coronavirus; the second was the lack of intensive care units followed by the necessity to isolate medical staff from their families. A further important need consisted in finding proper places to complete screening procedures.

According to the urgency of every kind of request, firstly the intensive care pods were developed, then the isolation units and finally the shelter ones. Most of those movable units in actual fact, were conceived for treating patients with mild-to-moderate disease, some were designed for being transformed into Intensive Care Units for patients presenting critical health conditions, while just few solutions took into consideration the provision of shelter for homeless people.

- Means and resources that the model requires

Pathways: as the simple makeshift facilities usually are characterized by an easy deployment, they can generally be installed anywhere. Some of them are allocated close the hospitals in small numbers, while others, due to their ease of application to scale up structures, can be deployed in larger healthcare facilities. The availability of large empty areas within the cities are therefore essential to host such facilities in critical times. Disposing of such large places further enables the creation of outdoor pathways conceived for medical staff transition and don/doff. This solution, developed in outdoor areas, allows structures to have

reduced indoor spaces of service, limiting possible cross infection among patients and medical staff, the absence of a common roof may represent a drawback.

Screening/pre-function: The screening facility has the important role of picking out people affected by Coronavirus from those not infected; it must, therefore, be positioned close to the entries of any healthcare building. According to the flexibility of the single unit solution, setting up a screening area within a tent, rather than a pod, results quite easy. Except for the outer shell, just some basic equipment are required in order to create a triage space. Movable partitions can be deployed to guarantee the required distances among people suspected of being positive to Covid-19, without the need of further barriers.

Restroom: given the necessity for medical staff to rest between their work shifts without posing possible infections risk to their families, several architects have worked on providing them with shelters. Each unit can come with a bed alongside a toilet, a sink and a shower. Some units also have separate chambers for medical professionals to don and doff protective equipment[28] .

Isolation ward: the isolation ward is conceived as a deployable wellness unit for isolating non-critical patients. It can host a connected don/doff chamber, depending on the connecting pathways to which it is linked[29] .

Intensive Care Unit: making up the shortage of hospital intensive care space, various developed projects focused on ICUs. Differently from other kinds of shelters, intensive care ones needs additional equipment and infrastructures systems to which it is possible to connect. The primary necessity that the units aim to satisfy is contrasting the spread of the virus; for this purpose lots of the designed models have recurred to bio-containment creating negative pressure through extractors inside each pod. Critical care equipment also includes ventilators and monitors as well as intravenous fluid stands, syringe drivers and other technology to support containment and disease treatment.

Secondary services: alongside primary needs consisting of providing shelter and care for those hit by Covid-19, other core necessities had to be taken into account in coping with the crisis. One of them, for instance, was providing food for all those hosted in makeshift units. Acting in an emergency, due to shortage of available time, elaborating kitchen units at the same design level of other functions is virtually impossible. For this reason when the single unit solution is favoured, authorities and managers have to alternatively provide those services in a different manner.

- Existing flows and connections

This particular building solution presents different opportunities of connection both among the multiplicity of units and between the units and the main hospital they refer to.

Differently from other building models, the single unit presents more than one possible way of connection to the other healthcare facilities. As a matter of fact, considering its reduced dimensions useful to respond to flexibility, mobility and easy construction requirements, internal pathways were not considered during the design process of the very unit. They were rather conceived as separate and additional infrastructures.

In accordance with the study which has been carried out on this kind of building model, connecting pathways were designed in very different manners. Some of them were just open empty spaces kept free for healthcare staff circulation, while others were conceived as closely integrated parts of an overall building[30].

Picture 8. Comparison of outdoor and indoor pathways of designed models.

Since the first solution is implemented in the open air, there is no need of transitional spaces between clean and dirty areas. On the contrary, the second solution involves the design of intermediate spaces for medical staff don/doff.

Climate is another factor to take into account dealing with this kind of connection pathways. Disposing several units in outdoor spaces is encouraged in countries with warm and dry climate, while it can results quite difficult in colder and wetter countries where there is the necessity of close and protected spaces. For these reasons, solutions with close connecting pathways or deploying containers units into covered spaces were the most frequently adopted.

- International examples

As mentioned above, the design of field emergency facilities in form of containers, tents, pods, etc. was the most developed solution during the first wave of Covid-19 spread.

In this chapter I will present and analyse some of them which proved to be very effective thanks to their characteristics.

CURA (Connected Units for Respiratory Ailment) – Italy

As COVID-19 pandemic spread internationally, the first prototype of an open-source project to create plug-in ICU from shipping container was built and installed at a hospital in Italy[31]. Produced in four weeks as a result of a joined effort of an international partnership, the project was sustained by public and private sectors among which several universities, firms and other partners.

Picture 9. CURA pod in OGR, Turin (Italy)

The first CURA pod was installed in the framework of a temporary hospital set up in the OGR industrial complex of Turin. The CURA task was providing ICUs for the hospital which had about 90 beds for patients affected by Coronavirus.

Each CURA unit is hosted in a 20- foot intermodal container, repurposed with bio-containment equipment able to create indoor negative pressure. In addition to an extractor for negative pressure, the pod contains all the medical equipment needed for intensive care patients including monitors, ventilators, intravenous fluid stands and syringe drivers[32].

On the opposite sides of the containers two glass windows allow doctors to have a continuous sense of the patients' status both inside and outside the pods. This is also

potentially useful for getting external visitors closer to their relatives in a safer way.

Thanks to the international collaboration, the CURA came out as a responsive and agile unit, able to adapt to any place[33]. Each pod, as a matter of fact, works autonomously and can be shipped to any location around the world, adapting to the needs of diverse healthcare infrastructures. In addition to its rapid deployment, CURA is configured to be easily enlarged: the unit could be connected to the rest of the hospital by an inflatable structure that serves as a storage and changing room. Potentially, the inflatable unit can be used to connect more than one pod creating multiple modular configuration[34] .

Picture 10. Conceptual view of CURA deployment

JUPE – Texas (USA)

Flat-pack startup JUPE realised one of the world's first stand-alone intensive care unit along with other care facilities to help hospitals under pressure for Coronavirus. The team formed by rocket-engineers, car-designers, architects, humanitarians medical doctors, tried to develop a new makeshift facility called Jupe Health. The Jupe shelters came in three distinct versions, including a rest unit equipped with beds for providing a place to rest and sleep for medical professionals; a care version for isolation of patients who don't require critical care, and further "Plus" option that is essentially a self-contained ICU for critical patients.

Considering the low cost of each single unit – between $14.000 and $ 78.000, which corresponds to 1/30 of the cost of a standard hospital room – Jupe pods were quickly acquired from Texas government and from other States to fight Coronavirus.

Its success was due to the peculiarity of being foldable and dismountable. Designed for easy mobility for the most vulnerable areas, Jupe Health can deploy up to 24 units with a single 40' flatbed and heavy-duty pickup truck[35]. According to the startup team, the design structure, made with a common base and readily available materials, can be mounted by one single person in just "minutes". With hospitals pushed to their limits,, Jupe units provide, because of their easy deployment, a long-term solution to ease and maintain surge capacity.

Picture 11. Axonometric view of indoor furniture layout of Jupe Health.

Jupe Health is characterized by great adaptability both of the interior and exterior configurations. As a matter of fact, the same shell can host all three distinct functions of restroom, isolation and intensive care, with a few minor alterations and implementation of ventilation and electrical systems. Instead, as to the external cover instead, the flat-packed units are enclosed by a faceted exterior that can come in either a soft or hard shell, in accordance with external temperature and climate. Then, units can be completed with either solar or battery-power and fitted with water- disposal.

4.3 RECONVERSION OF EXISTING BUILDINGS

After considering every possible alternative to make up for the shortage of hospital beds, one of the most reliable solutions was focusing on the building architectural heritage available in each town of every nation. As a matter of fact, having a look at the variety of constructed buildings each city has, allows us to understand the resources which States can rely on.

In particular there are some kinds of buildings with various functions that, thanks to their own characteristics, in case of emergency can be quickly reconverted and repurposed with alternative intended uses. They are characterized by distributive freedom and big dimensions so as to cater for diverse and complementary functions.

This category could embrace all those space classified as "non-places" by the anthropologist Marc Augé. In other contexts and times such spaces could be criticized due to their absence of identity which they cannot convey to their visitors, but actually, in the current situation, the commercial centres and related facilities, stadiums, conference centres, car parks, hotels and large infrastructures could result extremely useful.

4.3.1 RECONVERSION OF CONFERENCE CENTRES INTO HOSPITALS

- Reasons leading the adoption of this specific model

The key point of acting in an emergency is having a restricted amount of time that generally leads to taking some tactical decisions. For this reason, as COVID-19 spread throughout the world, one of the most adopted solution for treating this disease has been the reconversion of conference centres and pavilions.

Thanks to its characteristics, the pavilion structure is well-suited to be converted into temporal healthcare facilities or control centres. The same is true for conference centres which, by their very nature, are flexible, convertible spaces, and their architectural and infrastructural system are typically conceived to provide adaptability to the future needs of undefined clients. These reasons, with the characteristics listed below, make the reconversion of these structures, the most used healthcare model for the emergency due to Covid-19:

- the existing structure is not currently in use, or hosts just temporary events;
- it is a flexible space suitable to be converted into something else;
- it has an existing skeleton that can be filled in several ways;
- due to existing infrastructure, it requires low investment costs;
- a short amount of time is needed to build partitions or overall structure;
- partitions materials or blocks can be rented saving waste at the end of the emergency;
- prefabricated panels can save construction time, enabling a quick assembling phase;
- the plumbing, electrical and diffused ventilation system are suitable for large energy power loads;
- opportunity to host large numbers of people with limited amount of staff;
- a limited number of skilled workers is needed, not just in the construction phase;
- since they are usually recently renovated building, they are generally well performing

- Users

The flexibility of conference centres is crucial also to the kind of users it could host. As a matter of fact, if on one side the lack of beds in hospitals led the decision to convert conference spaces in additional healthcare facilities, on the other hand further necessities

came out in the emergency, such as providing temporary housing for doctors and nurses who moved from their homes, finding a place for patients' quarantine or hosting other needy people like homeless.

In most cases, however, conference centres have been transformed into healthcare facilities. As first experienced in China, and then in the rest of the world, isolating and treating only mild-to-moderate cases of COVID-19 in these structures allowed to free up the scarce medical facilities of high-level hospitals, such as the inpatient units providing respiratory support and intensive care for patients with severe/critical Covid-19. Such kind of facilities made it possible the growth of beds vacancy from 4% to 16% in just 15 days [36].

- Means and resources that the model requires

In terms of human workforce the solution of repurposing conference centres into healthcare facilities allows to have low worker-to-patient ratio for two reasons: first, all the hospital patients share the same primary admission diagnosis, reducing the complexity of care, secondly, all of them have only a mild to moderate disease. According to this primary selection, shelter management results more efficient and easier than in a non-structured hospital.
The other key factor in the decision of adopting one is the capacity to respond to determined additional specific additional needs that are not just mere medical cares. For this purpose specific conformation of the space and the availability of power systems, determine all the possible additional extra activities that a medical facility involves, such as screening functions, eating or socializing.
Here follows an analysis of the peculiarities of conference centres and the spaces they are made of that could be converted for emergency.

Entry/lobby/pre-function: an urban community focused on conference centre is often provided with multiple entry points at different spots of the same block. Entries may be close to bus drop offs sites or to public transport stations, allowing for convenient ambulatory access[37]. As a matter of fact, if repurposed to a temporary healthcare facility, the entries could be zoned or focused on specific patients' needs, relying on signage outside the building to direct other users to alternative entries. Separate entries should be allocated to family access/registration, staff/private access and to what could be more medically focused and be configured.

These spaces are typically opened and connected to the rest of the building in a way that easily organize "traffic" pattern from the point of entry to the next destination of any person.

Restroom: Conference centres are usually designed at nominally 1 square meter per person so the accompanying facilities must be able to allow for that density. Large banks of public restrooms are normally accessible from both the public side and the event side of the facility. While these restrooms aren't personal or isolated, they do offer needed capacity if isolation is not required.

Halls: the centrepiece of most conference centres exhibit halls which can be expansible open areas with soaring ceiling, flat floors and a flexibility that is not available in other commercial/public spaces. Usually the large size of these spaces, even if differently articulated, allows to partition them in small units with movable walls; this could be particularly convenient in a healthcare facility whenever different treatments or severity levels of disease need specific spaces allotted.

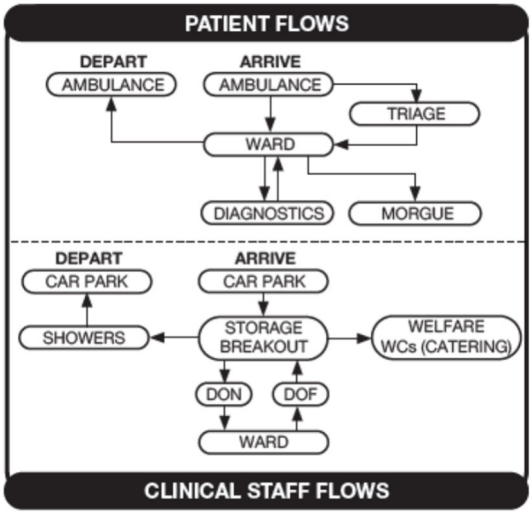
Meeting rooms: the desired flow of conference centres typically pushes/pulls event attendees from the exhibit to smaller breakout sessions in blocks of meeting rooms or multi-purpose spaces. Though their dimensions of that are not comparable those of the halls, the meeting rooms still have the flexibility and sub-divisibility in mind[37]. Power is generously provided so that they can

support a multitude of functions in a temporary conversion. Meeting rooms could be dedicated to high or low acuity patients, used as command control or respite zone for emergency staff.

Kitchens: given the frequency of banquet events in conference centres, these are usually provided with full cooking kitchens. The advantage is that they are well-suited for providing patient nutrition and meals to families, staff and caregivers as needed. They are further connected to ballrooms and exhibit halls allowing for efficient and isolated delivery lanes to all parts[37].

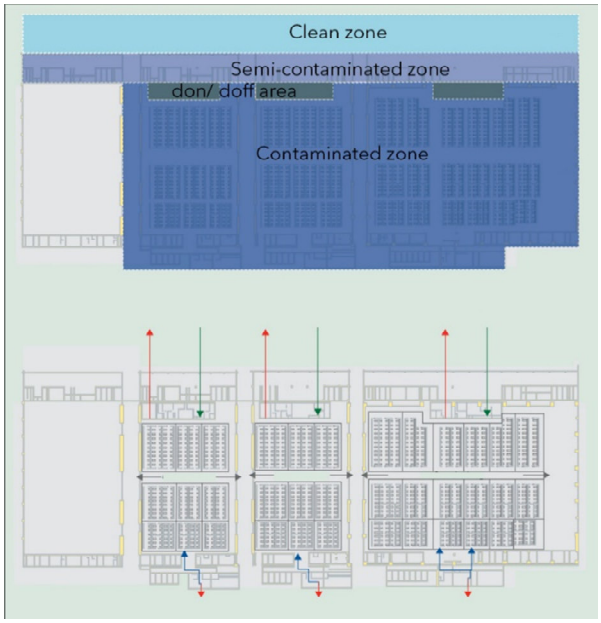
- Existing flows and connections

The primary consideration that must be made in order to organize internal flows and spaces' connection, in show to deal with infection control, separating clean and dirty areas. As well as people attending those places, also materials, food, medicines and whatever enters in those healthcare facilities, have to be clean and disinfected in order to avoid further spreading of the any infection.



Picture 12. Scheme of flows conceived for ExCel centre

Consequently is thus important keeping different accesses, corridors and intermediate areas. As shown in different case studies previously analysed, in fact, the large spaces of conference centres, being extremely flexible, allow to well separate dirty, semi-dirty and clean zones, as well as creating suitable sub-divisible corridors[38]. Usually the dirty part is left to patients' life, the semi-clean zones is where health workers put on and take off their protective suits, and finally the clean zone is where supplies are received. Also transition spaces are divided: one for patients and another for health workers.



Picture 13. Spatial distribution of ExCel centre, London

- International examples

Fangcang shelter hospitals - China

These kinds of shelter hospitals have been the first developed to make up for the scarcity of hospitals beds designated for treating the virus. As the outbreak in Wuhan reached its most severe point, with thousands of new infections per day, the city opened three Fangcang shelter hospitals by converting exhibition centres and stadiums. As the epidemic in Wuhan subsided and bed

occupancy moved to zero, Fangcang shelters were successively suspended.

Chinese officials and experts developed Fangcang shelter hospitals providing them of isolation, triage, medical care, monitoring and referral, shelter and social engagement[39]. The existing public venues were rapidly implemented with beds, sheltered space and the three zones and two passages of hospital isolation wards.

Although Fangcang shelter hospitals have some historic precedents, such as makeshift hospitals, emergency fields hospitals, emergency shelters, they can rely on three different characteristics and five different functions that set them apart from facilities previously used.

The three key characteristics that make them particularly well suited for health emergencies are firstly, the rapid construction, as they are based inside existing buildings, completed in just 29 hours[40]. Secondly, their massive scale. Fangcang shelter hospitals leverage large-scale public venues, increasing health-care capacity. In just over a period of three weeks 13.000 hospital beds were provided in China, supporting Chinese COVID-19 policy of leaving no patient untreated. The third characteristic is the low cost of Fangcang shelter hospitals. Keeping investment costs low was attainable avoiding unnecessary building construction costs by reconverting existing buildings instead of setting up new physical infrastructures. Another key factor that enabled low running costs was the Fancang space organization that allowed low worker-to-patient ratio.

Picture 14. Bird-eye-view of a Fangcang shelter

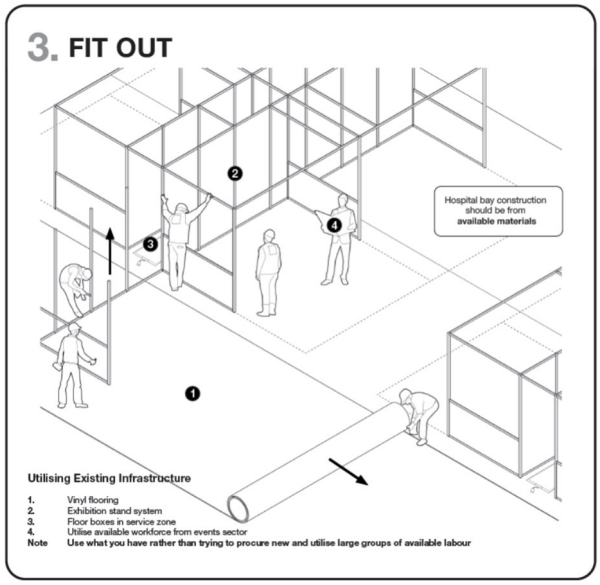


Figura 5. Portion of the poster explaining the reconversion of ExCel centre

The five essential functions[36] that made Fangcang shelter hospitals particularly well suited to respond to the emergency have been already mentioned. Firstly, isolation prevents patients with mild to moderate entity disease coming into contact with others and, as a result, increasing the possibility of transmission. Secondly, Fangcang hospitals have a strategic triage function: they meet additional admission criteria for patients. In this way they immediately recognize disease acuity and lead patients to the right healthcare facility, either Fancang hospitals or more specialised traditional hospitals.

A third function Fangcang shelter hospitals provide basic medical care, including antiviral and antibiotic medication, oxygen and mental health counselling. The fourth function is the frequent monitoring and rapid referral. These facilities were integrated into the overall health system so that frequent monitoring allowed to be taken under control on daily basis.

The fifth essential function of Fangcang shelter hospitals is providing essential living and social engagement. As a matter of fact the structures were conceived as patients'

communities in which people resulted positive to COVID-19, even if separated from the COVID-19 negative population, support each other and engage in social activities. Health workers provided emotional support. Community activities included eating together, watching television, dancing, reading and celebrating birthdays [41].

NHS Nightingale Hospital – London, U.K.

"The less that has to be built or procured, the quicker things can happen" [42]. "Solutions have to be simple, repeatable and modular" said J. Hepburn, the principal of BDP building engineering service, the firm who was entrusted the hospital construction[43]. In this way he described their methodological approach in the development of NHS Nightingale Hospital.

Working with numerous clinicians, consultants, contractors, the ExCel management team and British Army, BDP created 500-bed hospital expandable to 4.000 beds in around 2 weeks.

With a surface of 1-million square feet, the conference centre in the docklands of East London represents the largest critical care unit, not just in England but in the whole world.

As for the conversion of ExCel London into the world's largest care facility, BDP is eager to share its adaptive design approach hoping it might be used as a blueprint suitable to be replicated elsewhere in case of need.

Following the conversion of the building into the NHS Nightingale Hospital, BDP prepared an IKEA-esque poster that explains how to create an hospital within a conference centre[44].

In realizing the health facility they focused on some essential features of primary necessity which had to be taken into consideration.

What became crucial in organizing the layout of all the spaces was to know in detail all the required resources and characteristics of the site. As a matter of fact was particularly important to know the proximity to appropriate staff accommodation, air ambulance access, availability of space for medical gases and ambulance parking, space for staff changing and showers and fire strategy considerations. Consequently the awareness of these data brought to the creation of a possible layout of different spaces, involving triage, wards, pharmacy, don/doff areas, diagnostic place and staff canteen[45].

It was really essential to reuse prefabricated elements usually adopted for stands as far as possible.

For this reason the bed heads and service corridors were constructed from a component system that is usually used in exhibition stands with some additional reinforcement to allow systems to be fitted to the walls. Adding minimal building interventions allowed freedom in building set-ups.

Moreover, clinical flows determined the circulation strategy within the building: wards are linked with a temporary tunnel through the central boulevard to the diagnostic area and staff move from the boulevard to and from the ICU wards through the don/doff rooms, allowing PPE to be put on or taken off, which is the key to infection control.

4.3.2 RECONVERSION OF HOTEL

- Reasons leading the adoption of this specific model

Hotels and motels and other accommodation facilities are perhaps the most versatile and, due in part to low occupancy rates brought on by the Covid-19 outbreak, the most readily available spaces to repurpose during a pandemic.

Providing privacy, some comfort and isolation, they can be used to treat non-critical

patients recovering from Covid-19 related illnesses, quarantine patients suspected to be infected, high-risk healthcare workers front-line, and provide a temporary shelter to homeless people. Authorities of many cities have leased hundreds of hotel rooms to respond to beds demand. In the light of a primary detection of suitable hotels, many of them were converted into fully functional temporary healthcare facilities[46].

Along with what already mentioned, such conversion into healthcare facilities was brought about also thanks to some further characteristics hotels are equipped with:

- individual rooms with private restroom which can help to prevent cross-contamination;
- low occupancy due to crisis of tourism: lots of accommodation facilities were temporary unused;
- layout easily convertible into isolation wards or whatever was needed;
- limited construction interventions, mainly related to electrical and ventilation infrastructures implementation;
- comparatively low cost of implementation;
- complementary facilities such as kitchens, laundries etc.;
- as soon as bed demand decreases hotels can return to their original function.

- Users

According to a study conducted by the team entrusted with the Javits Centre expansion in New York, the solution of reconverting existing hotels into healthcare facilities can be implementable only when they have the specific requirements listed in the paragraph above. The same study has also analysed three scenarios based on patients' needs and how they can be matched with available hotels. The first scenario involved non-Covid-positive patients recovering from illnesses who do not require life-support equipment and who, consequently, can be relocated to suitable facilities in order to free hospital beds. The second scenario involved non-Covid-19 positive patients that require specialised and powered equipment, while the third one involved Covid-19 positive patients in treatment. This analysis demonstrates how some hotels can better adjust in supporting each specific scenario. Cleanable surfaces, nurse-call devices, mechanical and electrical systems are all factors that might be needed to add to any hotel conversion.

In accordance with each designated scenario hotel room types that can support patients have been identified: a standard King Suite room could represent the best solution for scenario 1; a larger King Suite can support the second scenario, while a large (600 sf) King Suite can work for scenario 3[47].

- Means and resources that the model requires

The conversion of hotels into medical facilities, although not expensive, needs some specific requirements. Their satisfaction thus determines whether a hotel can host one, two or all three previously illustrated scenarios.

Hard flooring. Before checking any requirement a hotel room needs to meet, hard flooring is what it cannot do without. Surfaces made up of LVT, tiles and wood are easy-to-clean and perfect for quick turn-around preparation for new patients.

Connecting doors. When the rooms are provided with doors that separate suites from parlour and living room, it is possible to convert the latter into ante rooms for nurses to don/doff whenever they have to. If no intermediate doors are provided, this setup can work as patient room only if is provided negative pressure in the room is supplied.

Heating Ventilation Air Conditioning system. Usually these facilities do not have exhaust air capability at the level required for infectious disease rooms and typically utilize recirculating room units with minimal

outdoor air. The exhaust systems likely need to be upgraded to provide airflow and maintain negative pressure in the space. If such changes are not possible, host rooms can just be used for scenarios 1 and 2[48].

Connecting room. A connecting room can be used as an ante-room to maintain necessary pressure levels in the isolation rooms and act as nurses station. Before any conversion HVAC systems need checking.

Accessible pathways. The hotel layout must be organised in such a way that allows both patients transfer and medical support.

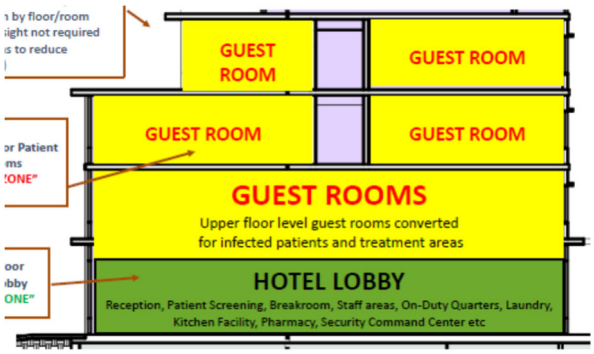
Kitchens, canteen. In most cases accommodation facilities contain a kitchen that can provide meals for patients, staff and occasional visitors as well as providing some alternative services, laundry included. This, in case of health emergency, can result extremely useful all essential services patients need can be provided.

In addition to the architectural interventions that a hotel reconversion requires, there are also other minor variations involving furniture changes, some soft goods, alongside PPE provision and operational changes.

- Existing flows and connections

A number of studies have demonstrated how hotels can be turned into basic healthcare facilities without substantial architectural changes. One of the most effective allocation of spaces includes a subdivision that goes vertically from the most clean to the dirtiest zone. The Hotel lobby, in fact, can be used as "clean zone" all complementary services, including canteen, kitchen, breakroom and laundry, can be found. Within such large spaces it is thus possible to add further medical facilities like pharmacy, screening zones and security command centre. Moving to the upper levels guest rooms, corridors and staff rooms can be converted into single isolation rooms, storages or healthcare offices for patients care[49].

If the accommodation structure has more than one stairway system, it is possible to operate a further subdivision of spaces within the same level. Separating a whole floor allows a better organization of spaces in clean and dirty zones.



Picture 16. Building section of a possible hotels reconversion.

- International examples

Baltimore Alternate Care Site model - Maryland, USA

Pandemic responses vary widely across the States, driven by the need of large-scale isolation facilities and rapid expansion of healthcare spaces. Concern for inadequate hospital capacity, combined with a need for isolation spaces, led the local authorities to open an Alternate care site in a 400-bed Baltimore hotel. As in other cities, given the concerns of owners regarding financial guarantees, potential damages and restoration requirements, the process of locating a suitable and available hotel was not an easy one.

The plan elaborated for this hotel was conceived to accommodate individuals who did not require in-patients care but were in an unstable living situation.

The hotel infrastructure proved to be well suited to provide safe and comfortable spaces, , safes to store personal medication, food services, security, conference centre and spaces converted in command centres. Availability of Wi-Fi as well as the ability to maintain hot and cold zones and indoor climate control, along with other precautions, made the overall management easier.

Stations for donning and doffing were built into each occupied floor with limited architectural modifications.

To better organize the provision of any kind of care, this model recurred to the use of telehealth technologies that allowed chronic care management, behavioural counselling, pharmacotherapy and consultation. The adoption of this organizational method brought to an implementation of off-site medical staff, preventing cross-infections along with a small increment of on-site staff[50].

Picture 17. Baltimore hotel conversion for COVID-19 treatment

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5. EVALUATION PROCESS

5.1 ANALYSIS

The evaluation process took into account three different macro areas of interest which allowed a more complete study of each building typology to be carried out. The first macro area is represented by the "response to epidemic disease" and it includes all the technical measures that enable the spread of infection to be contained within the medical structure. "Building characters" was the second macro area of interest analysed. This encompasses every criteria directly related to the construction of any healthcare building. Finally, the last area of study concerns users' "psycho-physical well-being" which involves many indicators regarding patients' comfort during hospitalization experience.

- Response to epidemic diseases

This macro area of interest is mainly concerned with building operations and adopted solutions which can guarantee proper response to infection containment. This task is referred to any kind of architectural interventions able to minimize infection risks, guarantee proper cares to non-Covid patients and give quick and effective responses to the healthcare emergencies. The flexibility of structure, the dimension and the configuration of isolation wards are just a few instances of possible implementation that can be realized to preserve patients' well-being.

Minimazing infection risk > Presence of separated pathways > Isolation ward dimension > Treatment area layout	**Guaranteeing cares to non-Covid patients** > Presence of separated spaces dedicated to non-Covid patients
Guaranteeing completeness of response > Satisfaction of needs relative to different disease severity > Thoroughness of healthcare system response > Additional facilities and services	**Guaranteeing fast response** > Construction time frame > Modularity > Building technology/ system characterized by fast assembly

Table 1. Areas of interest belonging to 'Response to epidemic disease' macro-area

- Building characters

By building characters we mean every possible aspect concerning building construction. As a matter of fact, since this large indicator takes into consideration sub-criteria of very different natures, it can be split into sub-groups dealing with a number of aspects, ranging from the economic to the environmental concerns, as well as building layouts.

Although they are not specifically oriented towards the healthcare sector, such criteria lay at the basis of any building design process. For these reasons they usually are the first parameters taken into account for any kind of building operation, both in construction from scratch, in refurbishment or conversion of existing buildings.

Making solutions economically sustainable	**Minimizing environmental impact**	**Guaranteeing flexibility**
> Cost of building construction and maintenance	> Disassembling structure	> Presence of infrastructures which can be adapted in case of need
> Context within which the structure is located	> Recyclability of building materials	> Spatial layout
> Renting building materials	> Proximity of building materials to building site	> Use of easily adaptable building technology / construction system
	> Supply of renewable energy	

Table 2. Areas of interest belonging to 'Building characters' macro-area

- Psycho-physical well-being

The third macro-area of interest, according to which each model of developed healthcare facility has been evaluated, is psycho-physical well-being. It deals with how the medical environment influences users' experience and how tools improving medical staff's work can generate better working and living conditions. As highlighted by many other studies in this specific sector, users' psychophysical well-being can be realized through a careful design of programs, physical environment and tools able to guarantee a better experience in healthcare buildings. A good design of the building envelope, for instance, could guarantee thermal, acoustic and visual comfort, while the presence of recreational spaces dedicated both to patients and healthcare workers might relieve stress and pain due to the critical situation they have to face. Along with what already described, it is also essential to provide patients with the opportunity to get in touch with their relatives; for this purpose dedicated safe spaces and technological equipment should be implemented in every healthcare structure.

Enhancing psycho-emotional well-being	Guaranteeing environmental well-being
> Privacy > Caregivers support > Mental disengagement > Continuity with domestic environment	> Thermo-hygrometric comfort > Visual comfort
Guaranteeing safety and usability	**Guaranteeing working well-being**
> Orientation > Flows optimization > Spatial distribution	> Arrangement of tools

Table 3. Areas of interest belonging to 'Psycho-physical well-being' macro-area

5.1.1 RESPONSE TO EPIDEMIC DISEASE

Area of interest	**Minimizing infection risk**		
Indicator	Presence of separated pathways		
Requirements to which the indicator responds	Separating the routes of users with different needs attending the building		
Indicator description	It refers to the presence of physically separated corridors or spaces that enable users with different needs to communicate.		
	Scarce	Sufficient	Optimum
Satisfaction levels	Absence of: > partitions between "dirty" and "clean" spaces	Presence of: > airlocks between "clean" and "dirty" areas	Presence of: > airlocks between "clean" and "dirty" areas > differentiation of corridors designated for different purposes > don and doff areas properly enclosed
Means through which requirements are satisfied	> Stickers fixed to the floor to allow to keep safety distancing	> Fire doors, plasterboard partitions, plexiglass partition	> Fire doors, plasterboard partitions, plexiglass partition, inflatable structures
Healthcare models	> Temporary unit	> Reconverted Conference Centre	> Hospital conversion > Dedicated hospital > New hospital > Reconverted hotel

Area of interest	Minimizing infection risk		
Indicator	Isolation ward dimension		
Requirements to which the indicator responds	Keeping the minimum safety distancing among patients		
Indicator description	It refers to the size of each place within the medical facility in which the patient is treated, tested or hosted.		
Satisfaction levels	Scarce Absence of: > partitions between infected patients' beds > minimum safety distances between patients' beds	Sufficient Presence of: > partitions that enclose patients during treatment, test or stay in the health facility	Optimum Presence of: > large distances among patients' beds > partitions that enclose patients during treatment, test or stay in the health facility > eligibility for hosting patients with different disease severity
Means through which requirements are satisfied		> Curtains, movable partitions	> Fire doors, plasterboard partitions, plexiglass partition
Healthcare models		> Reconverted Conference Centre > Temporary unit	> Hospital conversion > Dedicated hospital > New hospital > Reconverted hotel

Area of interest	Minimizing infection risks		
Indicator	Treatment area layout		
Requirements to which the indicator responds	Organizing spaces in an efficient way in order to minimize unnecessary risks and extra don/doff operations		
Indicator description	It refers to the layout of the indoor spaces designated for patients' care and stay.		
	Scarce	Sufficient	Optimum
Satisfaction levels	Absence of: > Efficient organization of spaces	Presence of: > efficient layout of areas to distinguish spaces with different needs > shared spaces used at different times	Presence of: > efficient layout of areas to distinguish spaces with different needs > connecting pathways and spaces dedicated to distinct needs > organization of internal routes such as to minimize PPE waste
Means through which requirements are satisfied		> Fire doors, plasterboard partitions, plexiglass partition	> Fire doors, plasterboard partitions, plexiglass partition, inflatable structures
Healthcare models		> Reconverted Conference Centre > Hospital conversion > Temporary unit > Reconverted hotel	> Dedicated hospital > New hospital

Area of interest	Guaranteeing cares for non-COVID patients		
Indicator	Presence of separated spaces dedicated to non-Covid patients		
Requirements to which the indicator responds	Keeping separate facilities for patients with different diseases		
Indicator description	It refers to the presence of wards, laboratories and facilities that don't require infection containment equipment		
Satisfaction levels	Scarce Absence of: > Spaces dedicated to treat negative to Covid patients	Sufficient Presence of: > Some additional bed to make up for the scarcity within hospital structures > Pathways separated from"dirty" spaces	Optimum Presence of: > Spaces, laboratories and wards dedicated to patients not suffering from Covid > Pathways separated from"dirty" spaces
Means through which requirements are satisfied		> Fire doors, plasterboard partitions, plexiglass partition, beds	> Fire doors, plasterboard partitions, plexiglass partition, inflatable structures, beds
Healthcare models	> Reconverted Conference Centre > Reconverted hotel > Dedicated hospital	> Temporary unit	> Hospital conversion > New hospital

Area of interest	**Presence of solutions which can guarantee response's completeness**		
Indicator	Satisfaction of needs relative to different disease severity		
Requirements to which the indicator responds	Responding to distinct healthcare needs		
Indicator description	It refers to the availability of spaces, means and human resources able to treating patients with different needs		
	Scarce	Sufficient	Optimum
Satisfaction levels	Characterized by: > Focused response, specialized on Covid-19 patients with mild-to-moderate symptoms	Characterized by: > Focused response, specialized on Covid-19 patients showing different disease acuity	Characterized by: > Being able to take care of both Covid-19 patients and other patients showing different symptoms
Means through which requirements are satisfied	> Presence of screening areas and isolation wards	> Presence of screening areas, isolation wards, laboratories and ICUs	> Presence of screening areas, isolation wards, laboratories and ICUs along with separated "clean" spaces for patients not infected by Coronavirus
Healthcare models	> Dedicated hospital > Reconverted hotel > Reconverted Conference Centre	> Hospital conversion	> Temporary unit > New hospital

Area of interest	**Presence of solutions which can guarantee response's completeness**		
Indicator	Thoroughness of healthcare system response		
Requirements to which the indicator responds	Responding to healthcare needs		
Indicator description	It refers to healthcare facilities spreading on the territory, enabling fast screening and cares.		
	Scarce	Sufficient	Optimum
Satisfaction levels	Characterized by: > Few healthcare facilities with larger dimension able to respond to distinct severity diseases	Characterized by: > Coexistence of some healthcare facilities with larger dimension able to respond to distinct severity diseases balanced with smaller ones	Characterized by: > Thorough territorial distribution of smaller healthcare facilities
Means through which requirements are satisfied	> Large hospital, multi specialised hospitals	> Not strictly medical structure realised by conversion of non-medical spaces	> Tents, singles units, small healthcare structures
Healthcare models	> Dedicated hospital > Reconverted hotel > New hospital > Hospital conversion	> Reconverted Conference Centre	> Temporary unit

Area of interest	**Presence of solutions which can guarantee response's completeness**		
Indicator	Additional facilities and services		
Requirements to which the indicator responds	Providing response to additional needs not related to patient's health		
Indicator description	It refers to the availability of additional core services such as kitchen, canteen, laundry…		
	Scarce	Sufficient	Optimum
Satisfaction levels	Availability of: > Additional services even if not located within the healthcare structure	Availability of: > Additional services partly located internally, relying on conversion of healthcare spaces and partly supplied by external providers	Presence of: > Additional services and facilities within the healthcare structure
Means through which requirements are satisfied	> Take away solutions	> Take away solutions and spaces repurposing	> Presence of kitchen, canteen, laundry, meeting room
Healthcare models	> Temporary unit	> Reconverted Conference Centre	> Dedicated hospital > Reconverted hotel > New hospital > Hospital conversion

Area of interest	**Presence of solutions which can guarantee fast responses to the emergency**		
Indicator	Construction time frame		
Requirements to which the indicator responds	Guaranteeing quick response to need of hospital beds		
Indicator description	It refers to the speed at which the building solutions can be built or implemented		
	Scarce	Sufficient	Optimum
Satisfaction levels	Building time frame	Building time frame	Building time frame
Means through which requirements are satisfied	> Slow: the overall construction takes more than 1 month > Large building intervention	> Medium: the overall construction takes around 15/20 days > The solution requires limited building interventions	>Fast: the overall construction takes around 1 week >The solution mainly relies on ready made products or materials > Large use of manpower
Healthcare models		> Reconverted Conference Centre > Reconverted hotel > New hospital	> Hospital conversion > Dedicated hospital > Temporary unit

Area of interest	**Presence of solutions which can guarantee fast responses to the emergency**		
Indicator	Modularity		
Requirements to which the indicator responds	Guaranteeing flexibility of spaces		
Indicator description	It refers to the use of modular construction method able to be scaled up in a fast way		
Satisfaction levels	Scarce Absence of: > space reconverted into health facility as it is	Sufficient Presence of: > Modular spatial organization	Optimum Presence of: > Easily implementable modular structures > Use of ready-made units suitable to respond to some health necessities in a fast way. > Opportunity of implementation by means of repetitive deployment of modular elements.
Means through which requirements are satisfied	> Fixed organization of spaces.	>Prefebricated panels and mobile partitions.	> Containers, tents, pods. > Prefabricated deployable unit.
Healthcare models	> Reconverted hotel	> Hospital conversion > Dedicated hospital	> Temporary unit > Reconverted Conference Centre > New hospital

Area of interest	**Presence of solutions which can guarantee fast responses to the emergency**		
Indicator	Adoption of building technology / construction system characterized by fast assembly		
Requirements to which the indicator responds	Guaranteeing reduced construction timeframe		
Indicator description	It refers to the use of construction technologies which can be quickly implemented		
	Scarce	Sufficient	Optimum
Satisfaction levels	Characterized by: > Small building changes not of prefabricated nature	Presence of: > Adoption of mobile ready-made partitions	Presence of: > Massive use of prefabrication system > Dry construction method;
Means through which requirements are satisfied	> Massive construction system	>Prefabricated panels and mobile partitions	> Containers, tents, pods > Prefabricated deployable unit
Healthcare models	> Reconverted hotel	> Hospital conversion > Dedicated hospital	> Temporary unit > Reconverted Conference Centre > New hospital

5.1.2 BUILDING CHARACTERS

Area of interest	**Presence of economically sustainable solutions**		
Indicator	Cost of building construction and maintenance		
Requirements to which the indicator responds	Sustainable cost of the building		
Indicator description	It refers to the investment cost of the building realization		
	Scarce	Sufficient	Optimum
Satisfaction levels	Charaterized by: > High cost of construction and maintenance: some millions of €	Charaterized by: > Medium cost of construction and maintenance: around 250.000 €	Charaterized by: > Low cost of construction and maintenance: less than 100.000 €
Means by which requirements are satisfied	> Construction of whole buildings or large building interventions	> Construction of medium-size buildings or consistent building interventions	> Reduced building interventions > Small dimension of the building solution
Healthcare models	> New hospital	> Reconverted Conference Centre	> Temporary unit > Dedicated hospital > Reconverted hotel > Hospital conversion

Area of interest	Presence of economically sustainable solutions		
Indicator	Context within which the structure is located		
Requirements to which the indicator responds	Sustainability and possibility of building		
Indicator description	It refers to the context within which the facility is located. It takes into account mainly the economic aspect		
	Scarce	Sufficient	Optimum
Satisfaction levels	Characterized by: > Economic disparities and low economic development	Characterized by: > Medium-high economic development, without the resources for capability of making immediate and considerable investments	Characterized by: > High economic development of the country, with opoortunity of immediate large investments
Means through which requirements are satisfied	> Low economic availability	> Medium economica availability	> High economic availability
Healthcare models	> Temporary unit	> Reconverted hotel > Reconverted Conference Centre > Dedicated hospital > Hospital conversion	> New hospital

Area of interest	Presence of economically sustainable solutions		
Indicator	Renting building materials		
Requirements to which the indicator responds	Investing smaller amount of money just for limited time		
Indicator description	It refers to the opportunity of renting building materiasl in order to save construction money temporary employed		
	Scarce	Sufficient	Optimum
Satisfaction levels	Absence of: > Availability of rentable building material > Governance and/or building project not developed in this sustainable way	Presence of: > Partial availability of rentable building material > Governance and/or building project partially developed in this sustainable way	Presence of: > Partial availability of rentable building material > Governance and/or building project partially developed in this sustainable way
Means through which requirements are satisfied		> Building partitions, wood/metal structures	> Readymade units, tents, pods > Building partitions, wood/metal structures
Healthcare models	> Dedicated hospital	> Reconverted hotel > Hospital conversion > New hospital	> Temporary unit > Reconverted Conference Centre

Area of interest	**Presence of solutions which can minimize environmental impact**		
Indicator	Disassembling structures		
Requirements to which the indicator responds	Producing less C&D waste promoting reuse of building materials		
Indicator description	It refers to the possibility of easily dismantling the structure producing low C&D waste while enabling reuse of materials		
Satisfaction levels	Scarce Characterized by: > Use of fresh connecting materials such as mortar, plaster	Sufficient Presence of: > Limited use of prefabricated material partly joined with fresh mortar and plaster and partly assembled through dry construction method	Optimum Presence of: > Large use of prefabricated materials assembled through dry assembling method
Means through which requirements are satisfied	> Mortar, plaster	> Building partitions, wood/metal structures	> Building partitions, wood/metal structures, tissue, inflatable material
Healthcare models	> Dedicated hospital	> Reconverted hotel > Hospital conversion	> Temporary unit > Reconverted Conference Centre > New hospital

Area of interest	**Presence of solutions which can minimize environmental impact**		
Indicator	Recyclability of building materials		
Requirements to which the indicator responds	Reducing C&D waste, enhancing the transformation of building materials into second raw material		
Indicator description	It refers to the possibility of recycling building material in the building end-of-life phase.		
	Scarce	Sufficient	Optimum
Satisfaction levels	Absence of: > Reciclable building material	Presence of: > Limited amount of recyclable building material used in the healthcare facility's construction	Presence of: > Large amount of recyclable building material used in the healthcare facility's construction
Means through which requirements are satisfied	> Traditional building method (masonry structure)	> Wood, plasterboard partitions, wooden/metal structures	> Ready-made units, tents, pods > Wood, plasterboard partitions, wood/metal structures
Healthcare models	> Dedicated hospital > Reconverted hotel	> Hospital conversion > Reconverted Conference Centre	> Temporary unit > New hospital

Area of interest	**Presence of solutions which can minimize environmental impact**		
Indicator	Proximity of building materials to the building site		
Requirements to which the indicator responds	Reducing air pollution in transporting materials		
Indicator description	It refers to the opportunity of reducing CO_2 emission in transporting materials toward the building site		
	Scarce	Sufficient	Optimum
Satisfaction levels	Characterized by: > Difficulty to find specific building material	Characterized by: > Medium availability of specific building material	Characterized by: > Large diffusion of building material
Means through which requirements are satisfied	> Ready-made standalone units, prefabricated partitions	> Prefabricated building element	> Bricks, fire doors, concrete, prefabricated concrete elements
Healthcare models	> Temporary unit > New hospital	> Reconverted hotel > Reconverted Conference Centre	> Dedicated hospital > Hospital conversion

Area of interest	**Presence of solutions which can minimize environmental impact**		
Indicator	Supply of renewable energy		
Requirements to which the indicator responds	Reducing CO_2 emission		
Indicator description	It refers to the adoption of instrastructure systems which use renewable energy		
Satisfaction levels	Scarce Characterized by: > Consumption of fossil energy sources	Sufficient Characterized by: > Consumption of both renewable and not renewable resources for building infrastructures	Optimum Characterized by: > Consumption of totally renewable resources for building infrastructures
Means through which requirements are satisfied		> Building partitions, wood/metal structures	> Readymade units, tents, pods > Building partitions, wooden/metal structures
Healthcare models	> Dedicated hospital > Reconverted hotel > Hospital conversion	> Reconverted Conference Centre	> Temporary unit > New hospital

Area of interest	**Presence of solutions which can guarantee flexibility of spaces**		
Indicator	Presence of infrastructures which can be adapted in case of new needs.		
Requirements to which the indicator responds	Availability of essential services in every area of the medical facility		
Indicator description	It refers to the presence of infrastructures systems that could be implemented or used in accordance with different users' needs.		
Satisfaction levels	Scarce Absence of: > Infrastructures (ventilation, electrical and plumbing system) that could satisfy users' specific needs.	Sufficient Presence of: > Infrastructures that could be implemented in order to satisfy users' specific needs.	Optimum Presence of: > Infrastructures (ventilation, electrical and plumbing system) that could satisfy users' specific needs. > Infrastructures that could be used in addition to others.
Means through which requirements are satisfied		> Implementable ventilation system, plumbing system, electrical system	> Implementable ventilation system, plumbing system, electrical system > Additional and performing infrastructures
Healthcare models		> Reconverted Conference Centre > Reconverted hotel > Temporary unit	> Hospital conversion > Dedicated hospital > New hospital

Area of interest	Presence of solutions which can guarantee spaces flexibility		
Indicator	Spatial layout		
Requirements to which the indicator responds	Adaptability of spaces		
Indicator description	It refers to the possibility of easily readapting the spaces according to new needs		
	Scarce	Sufficient	Optimum
Satisfaction levels	Absence of: > Spatial freedom, due to fix organization of spaces	Presence of: > Spatial freedom due to re-adaptable organitazion of spaces	Presence of: > Spatial freedom due to re-adaptable organitazion of spaces > Structural freedom > don and doff areas properly enclosed
Means by which requirements are satisfied	> Multi-purpose re-adaptable spaces	> Large re-adaptable spaces > Frame structure	> Large re-adaptable spaces > Frame structure > Mobile partitions > Material surfaces suitable for several uses
Healthcare models	> Hospital conversion > Reconverted hotel	> Temporary unit	> Reconverted Conference Centre > New hospital > Dedicated hospital

Area of interest	**Presence of solutions which can guarantee flexibility of spaces**		
Indicator	Use of easily adaptable building technology / construction system		
Requirements to which the indicator responds	Guaranteeing freedom and flexibility of spaces		
Indicator description	It refers to the use of construction technologies and systems that enable flexibility and adaptability of spaces		
Satisfaction levels	Scarce Absence of: > Flexibility due to construction system	Sufficient Presence of: > Freedom of spaces given by the type of structural system	Optimum Presence of: > Freedom of spaces given by the type of structural system > Convertible spaces through quick and efficient demolitions or disassembling > Use of prefabricated structural elements easily assemblable
Means by which requirements are satisfied	> Massive construction system	> Frame structural system	> Frame structural system > Prefabricated unit > Prefabricated partitions
Healthcare models	> Reconverted hotel	> Reconverted Conference Centre > Hospital conversion	> Dedicated hospital > New hospital > Temporary unit

5.1.3 PSYCHOPHYSICAL WELL-BEING

Area of interest	**Presence of solutions which can guarantee psycho-emotional well-being**		
Indicator	Privacy		
Requirements to which the indicator responds	Guaranteeing different levels of privacy to hospitalized people		
Indicator description	It refers to the presence of fixed or movable partitions which can guarantee privacy to patients during their permanence into the hospital		
	Scarce	Sufficient	Optimum
Satisfaction levels	Absence of: > Partitions dividing rooms with multiple beds and clinic spaces.	Presence of: > Movable partitions dividing rooms with multiple beds and clinic spaces.	Presence of: > Movable or fixed partitions dividing rooms with multiple beds and clinic spaces.
Means through which requirements are satisfied		> Presence of tents or movable screening partitions	> Presence of tents or movable screening partitions > Fixed partitions such as walls, glasses, doors.
Healthcare models	> Reconverted Conference Centre	> Dedicated hospital > Hospital conversion > Temporary unit	> New hospital > Reconverted hotel

Area of interest	**Presence of solutions which can guarantee psycho-emotional well-being**		
Indicator	Caregivers support		
Requirements to which the indicator responds	Opportunity for care givers to support patients		
Indicator description	It refers to the presence of means and/or spaces dedicated to care givers in order to support patients during their hospitalization		
	Scarce	Sufficient	Optimum
Satisfaction levels	Absence of: > Technological means or dedicated spaces enabling patients to be visited by their relatives	Presence of: > Technological means or dedicated spaces enabling patients to be visited by their relatives	Presence of: > Technological equipment, furniture or dedicated spaces enabling patients to be visited by their relatives
Means through which requirements are satisfied	> Cameras enabling remote visits	> Cameras enabling remote visits > Presence of temporary space / solution allowing patients to be visited	> Dedicated spaces appropriately separated enabling visits > Presence of cameras enabling indirect visits > Presence of furniture allowing care givers' stay
Healthcare models	> Reconverted hotel > Reconverted Conference Centre > Temporary unit	> Hospital conversion > Dedicated hospital > New hospital	

Area of interest	**Presence of solutions which can guarantee psycho-emotional well-being**		
Indicator	Mental disengagement		
Requirements to which the indicator responds	Availability of spaces and tools which can ease hospitalization period		
Indicator description	It refers to the presence of means and/or spaces allowing the patients to take their mind off their pain, alleviating suffering during their stay into the healthcare facility.		
	Scarce	Sufficient	Optimum
Satisfaction levels	Absence of: > Facilities for leisure activities	Presence of: > Facilities for leisure activities	Presence of: > Facilities for leisure activities > Equipment allowing leisure activities
Means through which requirements are satisfied		> Dedicated spaces like living rooms, garden, reading room, pool	> Dedicated spaces like living rooms, garden, reading room, pool > TV sets, radio, computer > Programs of social engagement > Sofa, armchairs, vending machines
Healthcare models	> Reconverted hotel > Reconverted Conference Centre > Temporary unit	> Hospital conversion > New hospital	> Dedicated hospital

Area of interest	**Presence of solutions which can guarantee psycho-emotional well-being**		
Indicator	Presence of furniture/ equipment providing continuity with domestic environment		
Requirements to which the indicator responds	Availabilty of spaces and furniture creating warm and cosy environment		
Indicator description	It refers to the presence of furniture and finishing which can put at ease patients staying the healthcare facility		
	Scarce	Sufficient	Optimum
Satisfaction levels	Absence of: > Cosy finishing	Presence of: > Cosy finishing	Presence of: > Cosy finishing > Furniture not specific of medical facilities
Means through which requirements are satisfied		> Use of colours, natural and artificial light, warm finishing such as wood	> Use of colours, natural and artificial light, warm finishing such as wood > Chairs, armchairs, sofa, closet, plants
Healthcare models	> Reconverted hotel > Reconverted Conference Centre > Temporary unit	> Hospital conversion > Dedicated hospital	> New hospital

Area of interest	**Presence of solutions which can guarantee users' comfort**		
Indicator	Thermo-hygrometric comfort		
Requirements to which the indicator responds	Providing correct temperature related to patients needs		
Indicator description	It refers to the provision of proper temperature within the building		
	Scarce	Sufficient	Optimum
Satisfaction levels	Absence of: > Correct thermal insulation of the building envelope > Solar control of openings and transparent components	Presence of: > Thermal insulation of the building envelop	Presence of: > Correct thermal insulation of the building envelope > Solar control of openings and transparent components > Thermal inertia
Means through which requirements are satisfied		> Insulating material within the building envelope	> Presence of insulating material in the building envelope, shading system, glass with solar control
Healthcare models	> Temporary unit	> Reconverted Conference Centre > New hospital	> Dedicated hospital > Reconverted hotel > Hospital conversion

Area of interest	**Presence of solutions which can guarantee users' comfort**		
Indicator	Visual comfort		
Requirements to which the indicator responds	Relieving patient hospitalization by means of the quality of the spaces of the healthcare facility		
Indicator description	It refers to the availability of natural light in patients' rooms, and to the agreeable design of the spaces		
Satisfaction levels	Scarce Absence of: > View on outfdoor spaces > Homogeneous distribution of light > Design of spaces aesthetically enjoyable	Sufficient Presence of: > Partial view on outdoor spaces and direct light > Dishomogeneous distribution of light	Optimum Presence of: > Incoming direct light and view on outdoor spaces > Possible interaction with outdoor spaces > Homogeneous distribution of light > Design of spaces aesthetically enjoyable
Means through which requirements are satisfied		> Presence of windows in isolation rooms	> Presence of windows in isolation rooms > Presence of terraces or garden with the hospital structure
Healthcare models	> Reconverted Conference Centre > Hospital conversion > Temporary unit	> Reconverted hotel	> Dedicated hospital > New hospital

Area of interest	Presence of solutions which can guarantee safety and usability		
Indicator	Orientation		
Requirements to which the indicator responds	Enhancing ease of movements and finding one's bearing within the healthcare facility.		
Indicator description	It refers to the presence of recognisable elements enabling patients to find their bearing orientation and to the availability of clear layout of spaces		
Satisfaction levels	Scarce Characterized by: > No clear direction signs, conveying an impression of a badly planned building	Sufficient Characterized by: > Presence of orientating elements, direction signs on the walls and on the floors which convey a feeling of confidence in the building accessibility	Optimum Characterized by: > Presence of orientating elements, direction signs on the walls and on the floors which convey a feeling of confidence in the building accessibility > Clear distribution of spaces and paths within the hospital
Means through which requirements are satisfied	> Sporadic signs	> Signs on walls/floors,	> Spaces layout, paint, signs on wall/floor, labels,
Healthcare models	> Temporary unit > Reconverted Conference Centre > Reconverted hotel	> Hospital conversion > Dedicated hospital	> New hospital

Area of interest	**Presence of solutions which can guarantee safety and usability**		
Indicator	Flows optimization		
Requirements to which the indicator responds	Enhancing ease of movements and guaranteeing separate and safe paths for staff, stuff and patients		
Indicator description	It refers to the presence of distinct paths for medical staff, garbage management, patients and medical equipment enabling safer flows		
	Scarce	Sufficient	Optimum
Satisfaction levels	Characterized by: > Multipurposed paths; intersection of flows	Characterized by: > Presence of some specific path combined with multipurpose paths	Characterized by: > Presence of distinct paths within the hospital separating flows in safety conditions > Clear distribution of spaces and paths within the hospital
Means through which requirements are satisfied		> Dedicated lifts, movable or fixed partitions, door lock	> Separated corridors, dedicated lifts, partitions
Healthcare models	> Temporary unit > Reconverted Conference Centre > Reconverted hotel	> Hospital conversion	> Dedicated hospital > New hospital

Area of interest	**Presence of solutions which can guarantee safety and usability**		
Indicator	Spatial distribution		
Requirements to which the indicator responds	Providing essential services to each ward, with a coherent optimized organization of spaces		
Indicator description	It refers to the presence of services organized in clusters around core spaces for each ward.		
	Scarce	Sufficient	Optimum
Satisfaction levels	Characterized by: > Absence of some essential services in some sectors of the healthcare building	Characterized by: > Presence of some essential services in specific sectors of the healthcare building	Characterized by: > Optimized spatial layout with services located close to core spaces > Organization of spaces according to their specificity
Means through which requirements are satisfied	> Lack of some services within every ward	> Facilities evenly dislocated in all the sectors of the hospital building	> Clusters of dedicated facilities, dedicated lifts, partitions
Healthcare models	> Temporary unit > Reconverted Conference Centre > Reconverted hotel > Hospital conversion	> Dedicated hospital	> New hospital

Area of interest	**Presence of solutions which can guarantee 'well-being' working conditions**		
Indicator	Arrangement of tools		
Requirements to which the indicator responds	Make essential medical tools available for healthcare activities, easing medical staff's work		
Indicator description	It refers to the proximity and the accessibility to essential medical tools required for common medical activities		
	Scarce	Sufficient	Optimum
Satisfaction levels	Characterized by: > Scarcity of technological and medical equipment which can guarantee medical staff's proper work	Presence of: > Technological and medical equipment which can guarantee medical staff's proper work	Presence of: > Technological and medical equipment enabling common medical treatment > Technological tools enabling diagnostic work, and clinic information management
Means through which requirements are satisfied	> Essential tools for visiting patients within doctor's office	> Medical tools for visiting patients, informatic tools, monitors, alarms	> Medical tools for visiting patients, IT tools, monitors, cameras, alarms
Healthcare models	> Temporary unit > Reconverted Conference Centre > Reconverted hotel	> Hospital conversion	> Dedicated hospital > New hospital

5.1.4 EVIDENCES

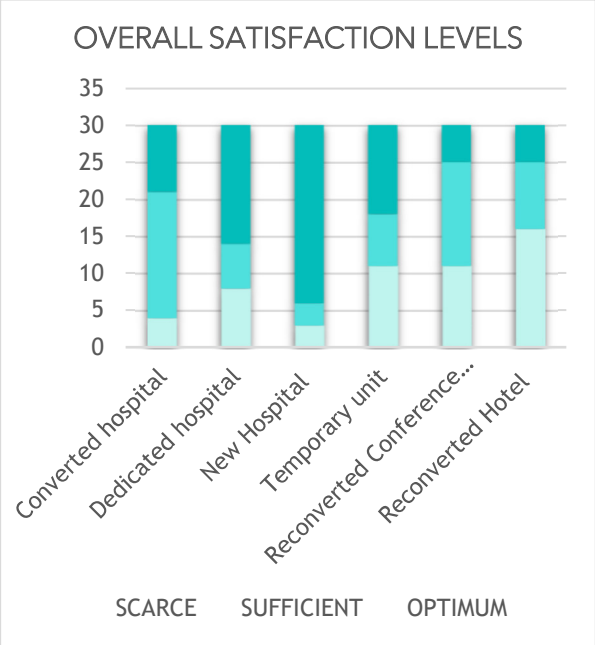
- Appendix n. 1

The table shown above which summarizes previous tables, awards to each criterion a colour gradient that ranges from 'scarce' (light light blue), passing through 'sufficient' (medium light blue), to 'optimum' (dark light blue), according with how much every healthcare facility satisfies each specific requirement. Proceeding from top to bottom, analysing vertically the table, it is possible to understand how many requirements each healthcare model satisfies in a scarce, sufficient or optimum way. A horizontal reading of the table, instead, let us understand whether each examined area of interest has been properly fulfilled. In this way, it is possible to get some evidence of the performance of each specific building solution and, at the same time, understand which requirements were effectively satisfied during the healthcare emergency.

Vertical reading

According to the vertical reading and summarized by the graph 1, it is possible to rank from the best performing facility to the worst performing one in the following order: new hospital, dedicated hospital, reconverted hospital, deployment of temporary unit, , reconverted conference centre, and, finally, reconverted hotel. Although the first solution represented by the 'new hospital' built from scratch, at present, results unfeasible due to the large amount of economic and physical resources it requires, it represents the best way to respond to healthcare emergencies such as Covid-19. This building model in fact, being built with a high contribution of prefabricated elements, may be developed in a way that can fulfil several needs, from the mere medical ones to those involving performing building features and users' psychological well-being.

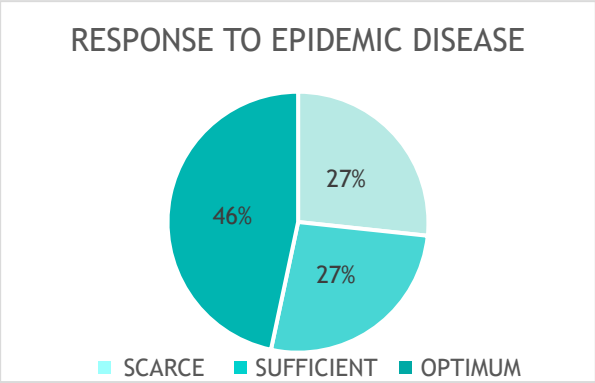
On the contrary, the worst solution devised during the first wave of Covid-19 emergency consisted in the reconversion of existing hotels. This predictable result is mainly due to the general layout of the buildings being less flexible and hardly convertible into well performing specialised medical facilities. Generally inappropriate infrastructure systems along with fixed distribution of the spaces make the hotel conversion quite "expensive" and inefficient.



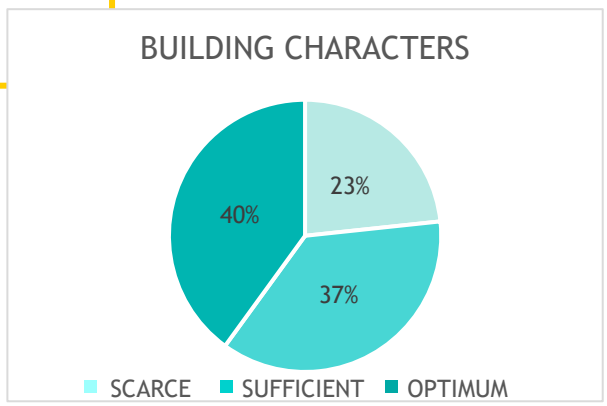
Graph 1: Comparison among building interventions performances

Horizontal reading

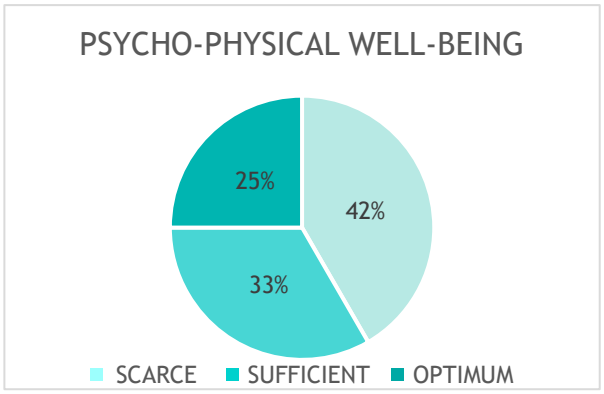
Carrying out a horizontal reading of the table, instead, it is possible to get some evidence regarding the three main examined areas.
Summing up performances belonging to the three satisfaction levels is then possible to establish a comparison among satisfied requirement levels, as shown in graphs 2,3,4.



Graph 2: Satisfaction to 'response to epidemic disease' area



Graph 3: Satisfaction to 'building characters' area



Graph 4: Satisfaction to 'psycho-physical well-being' area

Through a compared analysis of these three graphs it is possible to assess the criticality with which the 'psychological-well-being' issue has been tackled.

If the first two indicators involving 'building characters' and 'response to the epidemic disease' satisfy in an 'optimum' way 40-46 % of the requirements, it is not possible to assess them comparing the criteria regarding the psychophysical wellbeing of the users which shows worse performances: just 25 % of requirements respond to a 'optimum' level. To a certain extent, this scarcity might have been anticipated since all the solutions were carried out in extreme emergency conditions, constrained by the need of providing quick solutions. Acting in such a context, all efforts were focused on pressing needs not being able to take into account people's routine care. Taken this into consideration it is possible to explain why criteria dealing with users' psychophysical well-being result so scarce.

Overall Evidences

Regarding with the response to epidemic disease, all the implemented structures focused on strategies reducing, as far as possible, all cross infection transmission while trying to lighten burden into hospitals. Complying with these requests, often the designed solutions relies on prefabricated elements and modular building systems so as to guarantee more flexible distribution of spaces and provide a quicker and efficient answer.
As well as epidemic management, building solutions result well performing in relation with their general characters. As a matter of fact, their realization has been as cost effective as possible while trying to guarantee adaptability and reuse of materials.

Despite during the last years complex and advanced studies on the humanization of the healthcare spaces have been developed, what has actually been done for the emergency facilities to face Covid-19, comes out quite deficient.
This lack of attention to such an important issue is partly due to the fact that all the designed solutions have been implemented during an extremely critical phase of the epidemic and therefore tried to primarily solve mere medical issues. Secondly, a lack of long-term vision has led to consider this crisis just a transitory event. This has led to sacrifice some elements of comfort that actually are essential for patients hospitalized for long times.

Daily news about the ongoing healthcare crisis witnessed all those secondary problems that medical staff, patients and care givers face up because of scarce attention to all design elements providing users' psycho-physical well-being. Although focused care in the provision of facilities, tools or design spaces could appear irrelevant from some perspective, actually the environment in which every day those people are dipped strongly influences their experience. For instance, disposing of suitable equipment and tools allow medical staff to work in a

better way and, at the same time, reduces the sense of anxiety in patients. Moreover, taking advantage of presence of living rooms, courtyard, and comfortable spaces the patient can live a better hospitalization period feeling less pressure and stress.

Since the aim of my research is understanding whether the analysed structures could provide proper responses in a prolonged situation of Covid-19 treatment, and, since the "psychophysical well-being" factor resulted extremely underdeveloped, in the next steps of the study I will analyse in detail this specific issue. This should help me to comprehend which architectural solutions have been neglected in this specific sector and could therefore be implemented in the future.

6. THE ROLE OF HUMANIZATION IN HEALTHCARE FACILITIES DURING COVID-19 EMERGENCY

6.1 HUMANIZATION IN HEALTHCARE FACILITIES

- Humanization in the last decades

In the last decades hospital design literature has paid increasing attention to the need of "humanizing" hospital environments. Concern about designed healthcare environments aiming at proper responses to psycho-emotional needs, in addition to those of functional nature, has acquired more and more relevance especially in architectural products dedicated to care and assistance. In accordance with this human-centric perspective, design approach to healthcare environment mustn't be conceived depending on diseases cure, rather as the rallying of all the knowledge acquired from multidisciplinary studies together with the aim of improving patients' experiences and staff's conditions through building design.

With particular regard to socio-sanitary environments, has been proved that psycho-social features of spaces can have effects on patients – in terms of clinic improvements and safety conditions - as well as on medical staff – in terms of performance improvement, enhancing quality of cares. As a consequence reducing stress situations and conditions through environmental improvements becomes an unmissable requirement which cannot be neglected anymore by public client and designers.

- Humanization in emergency situation

The influence of spatial aspects on patients' well-being has been described as crucial for more humanizing care[1]. And so it is.
This particular attention on designing more comfortable places and enhancing better experiences to hospitalized patients through proper technological devices and humanizing cares usually takes moderate amount of previous workload and a particular sensitivity toward the issue. In a normal situation such measures can be implemented during first design process while emergency conditions require a completely dissimilar undertaking.

As experienced by Covid-19 spread, acting in emergency conditions, completely overturns necessities, transforming priorities into ancillary needs. New functional requirements add to the existing ones, making impossible to do activities, attend specific spaces and use devices usually available in other situations. Unfortunately these rising restrictions limit the adoption of most of the humanizing solutions which can be adopted in normal times, being their positive effect considered not immediately perceptible and, therefore, of secondary importance.

Despite a first effort in guaranteeing basic cares to patients affected by Covid-19, a sense of loneliness, stress and being 'burnout' came out among hospital users. This was in part due to the critical and unexpected healthcare situation and in part to the lack of attention on psycho-emotional wellbeing of patients, care-givers and medical staff involved in the process.

- Similarities and differences

As introduced above, designing and implementing humanizing spaces, devices and solutions completely differs in normal and emergency situations despite some key elements remaining unchanged.

From a first analysis, attention to the humanization issue results scarce and often insufficient due to a change of priorities. As a matter of fact, if in normal conditions the main priority within a hospital is balancing physical and psycho-emotional users' well-being, in an emergency the focus of all the staff essentially turns to mere medical aspects. For instance, with regard to Covid-19, the upcoming needs were mainly related to containment of the infectious disease. This led to the adoption of restrictive measures on

movements, on PPE usage and on contact with other people.

In such a condition, for safety and capacity reasons, a selection of **users** attending the building can be done. Although several healthcare buildings are multi-specialized facilities capable of hosting patients with illnesses of diverse nature, critical situations might force to close some wards or displace them. Hence hospitals that usually welcome large number of patients are transformed into specialized structures totally different from usual context, limiting their services to specific users with determined needs.

As a consequence of changes in priorities, needs and users, a turnover in the attended **spaces** of the healthcare facility is also needed.
Usually hospitals or medical structures own a variety of space dedicated to different activities characterized by specific design, furniture and devices for users' experience. For instance, triage room will have different characteristics from the waiting room, from the doctor's office, from the living room and so on. Each of them should be conceived to specifically respond to patients', caregivers' and medical staff's needs, while pathways and corridors are conceived as multi-functional public spaces.
In contrast to what just described, critical situations like the Covid-19 one, have forced a limited access to most of the mentioned spaces, especially those open to the public, to be put in place. Moreover, in addition to these restrictions, movements of people and stuff are limited so as to contain possible nosocomial cross-infections. Consequently all common pathways need to be split in order to create distinct dirty and clean routes.

6.2 ROLE OF HUMANIZATION IN ORDINARY CONDITIONS

- Priorities

The concept of humanization in the healthcare sector has undergone changes in the way of conceiving "health" and the respective means able to guarantee it. From a mainly bio-medical approach, according to which taking care meant treating diseased organs, in the last decades, attention was moved to a bio-psycho-social approach, more focused on the individual as a whole[2].
In this new cultural context, patients are not just intended as pathologies carriers but as persons with physical, functional, psycho-emotional and social needs.
Several studies have demonstrated that the way patients and caregivers live and feel their experience of the disease is influenced both by clinical factors and by elements of a different nature. Scientific evidences demonstrate that psycho-physical relief does not rely just on scientific and professional cares, but on other factors such as interpersonal interactions, access to information and the environmental quality in which patients are treated, which remarkably influence clinical results.

"Humanization" conceived as interpretation of users' psycho-sensory needs, firstly refers to interdisciplinary approaches involving medical sciences, communication between patient and medical staff, workers' education and issues dealing with spatial design of spaces dedicated to care. This "patient-centred care"[3] perspective is therefore characterized by respect of patient values, information, communication, physical comfort and family involvement. These values can be grouped in two distinct directions of strategies: the communicative one and the spatial one.

Communication

The "Communication in Medicine and Healthcare sector" theme cover different fields, from the primary one based on communication between medical staff and patients, to those involving the community of medical workers, the public and care givers. As a matter of fact, it has been proved, in various circumstances, that a suitable communication between doctors and patients, patients and care givers and among the medical community may raise the level of satisfaction of medical performances.

Doctor-patient. In order to enhance the so called "therapeutic alliance"[4] between medical community and patients, the former must have the capacity of listening and dipping into the narrative fabric of the patient, without just considering evidences. On the contrary, keeping the patient involved in the medical dynamics and developments increases the level of satisfaction and compliance. Thus, it results especially important including psycho-social support, able to make patients conscious of their diseases, treatments and hospital procedures.

Patient-care giver. Involving family, relatives and people somehow close to patients in patient's experience assure psycho-emotional support which can turn into a more positive convalescence. As a matter of fact sharing information, fears and feelings with care givers is in fact essential to alleviate the status of stress and impotence the patient feels.

Medical staff community. The current complexity of health assistance requires particular attention towards relation dynamics which occur within medical staff communities. In the hospital context this kind of attention has to be taken into account since there are two communicative knotty problems particularly hard to manage; one is horizontal communication and the other is the asymmetric relationship[5]. The first occurs among interlocutors belonging to the same communicative level, for instance between two doctors of the same ward doing the same job. Instead, complementary relationship occur between individuals belonging to different communicative levels, like the relation between doctor and nurses. Keeping correct management of communication avoids disclaimers dynamics, conflict and weird reactions also toward relatives asking for information.

Comfort

In addition to the essential role of communication, scientific evidences have underlined the necessity of a holistic approach to medical cares which takes also into consideration all the physical elements influencing patients' daily life within healthcare facilities. Design of spatial-functional characteristics of the medical environment, sure enough influences users' well-being conditions and enhances better clinical outcomes. The physical environment influences:

- Patient safety, especially referred to nosocomial infection and medical mistakes;
- Pain, sleep, depression and hospitalization period, privacy, communication and social support;
- Working conditions, stress, work efficiency and level of satisfaction.

- Users and relative necessities

Once taken into account the profile of users attending healthcare facility, it becomes necessary considering all the aspects which connote them as "persons". Some are of an individual nature (age, character, physical features, ...), others are of cultural nature (habits, spoken language, way of use of spaces, …) those of social and spiritual nature (social class, level of education, religion…), as well as those connected to the users' condition within the healthcare building.
In accordance with this last field of interest, establishing patients' profiles results especially useful since the types of pathology patients suffer from, is strictly related to their experience of hospitalization and to their

capability of using of socio-sanitary services. As to that, physical conditions like mobility, response to medicines, pain and vulnerability to possible nosocomial infection and the psycho-emotional factors induced by the pathology become decisive. Additional features influencing hospitalization experience can also be:

- level of consciousness;
- need of socio-emotional support;
- necessity of meeting family and care givers;
- need of continuous medical assistance;
- communication between medical staff and family;
- length of hospitalization period;

The family member / care giver is the person who takes care of the patient out of necessity, and closeness. Among the relatives visiting patient, we should also take into consideration the young, that cannot be considered caregivers but might have positive psychological effects on patients hospitalized for a long and hard period. For what concerns relatives and care givers, except in particular cases, they generally do not accompany patients but during their visits, they may need upgraded information about patients. It is therefore essential that staff keeps a continuative and efficient communication among their community and with care givers.

Medical community is a heterogeneous group of workers including different professional levels of the hierarchy and having distinct tasks.
Healthcare staff belongs to an occupational category particularly exposed to phenomena of job related stress. This pronounced exposure is due to both physical and psychosocial conditions, as well as the consciousness of the strain of their job. In addition to mental, psychic and physical workload, also a environmental/spatial conditions can influence the overall workload; as a matter of fact, unfavourable conditions due to dysfunctions or anomalies can increase stress level in the personnel who consequently are more likely to make mistakes. The need of working well-being, thus, refers to the necessity of allowing medical staff to be free of working in conditions which do not compromise workflow.

- Attended spaces and pathways

In accordance with the variety of users previously introduced and their necessities, analysing the spaces they attend within a healthcare facility becomes essential.

Info point/ reception. It is the place through which people approach healthcare facilities. In reception spaces are carried out main front-office activities and public relations of administrative character. The open to the public part is mainly dedicated to users needing assistance, while the private part, through which patient are lead to different wards, is usually located in an area closed to the public.

Waiting area. This is the place where patients wait for their turn to be visited. Traditional waiting rooms are usually characterized by sitting areas and, maybe, desks. According to the duration of users' stay additional furniture and more comfortable seats and designed spaces can be provided.

Hospital room. It represents the place in which most of medical activities not requiring patient's movement, take place. This is also the environment within which patients conduct their private life, have their meals, rest, leisure and personal meetings. All the activities done in this space vary depending on mobility conditions and disease acuity which characterize intensiveness of cares.

Staff working station. It represents the place where main clinical and administrative activities take place. Working station configuration strongly influences work organization, workload and staff movement. As a matter of fact, having a more or less centralized character, can guarantee different

kinds of support and determine specificity and distribution of competences.

Doctor's office. The conducted activities within this space are essentially of temporary nature, not involving long hospitalization. Here medical activities involve patient anamnesis, along with medical visits and documents consultation.

Meeting room. It is a place in continuous evolution, transforming in relation to changing practices and healthcare structures. Meeting rooms thus becomes the place where traditional meetings take place along with compared diagnosis by distinct disciplines and students'/professionals' education. Its comfort is essentially due to its flexibility and to the capability of enhancing social interaction.

Living room. This is the place where patients can better interact with relatives, care givers or other patients. It is more than just a space, it is the place in which, more than other spaces, the patients experience a domestic environment, thanks to availability of armchairs, sofa, domestic furniture and tools provide mental dis-engagement, relax and psychological support.

Corridor – connecting area. The primary function of connecting spaces often overlaps with the ones of breaking, waiting, service or supporting that might have more or less defined boundaries. Performing directional functions, the connecting area must be characterized by ease of orientation, proximity to the main services and accessibility for all kind of disability users may have. Factors that mainly influence connecting space dimensions are the "traffic" which characterize this space and the typology of users attending it.

Outdoor garden/court. The availability of outdoor spaces can offer occasions of meeting, social interaction and mental dis-engagement both for patients and medical staff. Natural environments and elements produce positive effects on psycho-emotional well-being, both during users' active and passive activities [5].

- Intervention of humanization

As to the definition of the main categories of users, activities and attended spaces/pathways previously described, it is therefore possible to assess the whole requirement framework relative to humanization issue. It mainly refers to the categories of requirements listed below:

- Psycho-emotional well-being;
- Environmental well-being;
- Usability and accessibility;
- Safety;
- Working well-being.

In order to better describe each category content it is essential to fully investigate sub-criteria that guarantee macro-criteria compliance.

For instance, the psycho-emotional well-being is determined by respect of privacy, family cares, opportunity for patients of benefiting from mental dis-engagement along with attending healthcare spaces characterized by continuity with the domestic environment.

Environmental well-being is determined by provision of visual, acoustic and thermo-hygrometric comfort, while safety and usability of spaces are mainly related to orientation issues, spatial distribution and overall accessibility.

The last category not to be neglected is represented by the working well-being of medical staff, who need a correct predisposition of equipment and space where performing in good mental and physical conditions.

- Appendix n. 2

6.3 ROLE OF HUMANIZATION DURING COVID-19 EPIDEMIC

As expounded above, assessing "users profiles" results essential medical staff first approach patients, since such profiles allow specific patients' necessities to be understood. Above all, establishing the type of pathology and its correspondent acuity enables healthcare communities to manage facilities organization, especially in critical situations such as Covid-19 emergency. Given that all kinds of users have their own necessities, actually patients with moderate disease acuity are the ones showing the most compelling ones due to their intermediate conditions which let them aware of their conditions without being completely autonomous and needing some kind of assistance. In fact, "moderately ill Covid patients" present some peculiar characteristics: their clinical conditions usually are not as serious as to require particular respiratory devices, but at the same time, requires clinical support. This clinic situation determines a number of needs which critical patients don't have, such as requiring direct or indirect relationship with relatives and medical staff, ways of mentally restore, psycho-social support and disposing of equipment to live hospitalization in safety conditions. All these necessities require clear management of the whole healthcare system.

- COVID pathways and attended spaces

Despite the large number of needs that "moderately ill Covid patients" may have, during Covid-19 healthcare emergency hospitals and healthcare facilities, having to manage infective patients while guaranteeing cares for patients suffering from other diseases, have markedly modified them. This situation has determined access interdiction to some spaces along with the elaboration of new pathways to separate "dirty" and "clean" flows. At the same time, rigorous procedures conceived to limit cross-contaminations have defined new sequences of actions carried out in dedicated spaces, so as to limit users mobility to just essential movements. The latter are essentially attributable to the following steps: pre-triage, triage, waiting, clinic control and potential hospitalization.

In accordance with each stepped needs, users are hold in distinct places responding to diverse necessities, as expounded below.

1st STEP

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PRE-TRIAGE

1 Description

Located before triage at ED, pre-triage is done by nurses who measure body temperature, identify likely Covid patients and lead them to triage or alternative facilities. Nursing staff also inform relatives / caregivers of waiting procedures and communication means. Before the entrance everyone is provided with PPE (surgical mask, gown, hands hygiene).[6]

Dedicated space: specific unit, waiting room

1 Spatial requirements:

- Flexibility of space and furniture
- Opportunity to keep safety distancing among people

1 Satisfied necessities:

- Orientation toward next steps
- Environmental comfort
- Safety: infection containment

2 Description

Triage procedures allow nurses to acquire data provided by patients at pre-triage and conducts evaluations in order to assess access priority and allocation for patients to be visited[7].

Dedicated space: emergency department, reception

2 nd STEP

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TRIAGE

2 Spatial requirements:

- Opportunity to keep safety distancing among people
- Continuity with domestic environment
- Arrangement of private and public areas
- Proximity to connective spaces

2 Satisfied necessities:

- Privacy
- Mental dis-engagement
- Restorative potential
- Environmental comfort
- Orientation

3 Description

Waiting patients have to be located in large rooms which enable social distancing and can guarantee subdivision of spaces in accordance with low, medium and high Covid infection risk[8].

Dedicated space: waiting room

3rd STEP

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WAITING

3 Spatial requirements:

- Opportunity to keep safety distancing among people
- Continuity with domestic environment
- Multi-functionality and spatial flexibility
- Ergonomic seats

3 Satisfied necessities:

- Environmental comfort
- Mental dis-engagement
- Cross-infection prevention
- Care
- Restorative potential

4 Description

In accordance with the necessity of treating patients whose Covid risk has still to be assessed, emergency rooms have to be treated as potentially "dirty" areas. In these zones it is necessary to provide areas where care patients with moderate illnesses are cared for, while guaranteeing other spaces for patients not suspected of been infected by Covid-19[9].

Dedicated space: clinic, doctor's office

4 th STEP

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CLINIC

4 Spatial requirements:

- Opportunity to keep safety distancing among people
- Presence of core facilities (changing rooms, toilets)
- Multi-functionality and spatial flexibility
- Visual and acoustic privacy

4 Satisfied necessities:

- Environmental comfort
- Mental dis-engagement
- Space configuration for psychological support and communication
- Digitalization of patient clinic data
- Accessibility in safe conditions
- Flexibility

5 Description

Once Covid patients' severity is assessed, they are sent to the corresponding space which can be either a specific ward within the same building or another hospitalizing structure.
This represents the place where patient stay till their healing or improvement of clinic conditions.[10]
Dedicated space: specific ward, hospitalization room

5 th STEP

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HOSPITALIZATION

5 Spatial requirements:

- Opportunity to keep safety distancing among patients' beds
- Some level of visual/ acoustic privacy
- Presence of "staff zone" for clinic data management
- Continuity with domestic environment

5 Satisfied necessities:

- Environmental comfort
- Mental dis-engagement, restorative potential
- Cross-infection prevention
- Communication with outdoor

Additional 'cross-issues' strategies to be taken into account.

In addition to the described spaces and processes, a resilient healthcare facility must be able to be transformed in case of hyper flow of patients. Hence a functional program is fundamental in complex healthcare facilities which are facing an emergency. In particular, a healthcare building design conceived to respond to Covid related necessities should consider some 'cross-issues' strategies such as:

- keep separate access for staff, as well as for visitors who are not directed to emergency departments;
- a strong relation between the emergency department and infectious wards requires [11] a fast connection for the movement of patients and healthcare workers, therefore boosting short and horizontal connection is essential;
- the presence of storage areas is also required, which in case of infective emergency such as Covid-19 can host the huge amount of PPE, sanitary materials and contaminated waste;

In case of fast diffusion of an infectious agent, all ordinary wards, along with the implementation of additional filter areas, have to transform ordinary rooms maximizing the number of single rooms in the event of hyper flow of patients. [12]

- Users and relative necessities

The 2019 coronavirus disease created unprecedented stress on the healthcare facilities in such a way to overturn usual priorities of bio-psycho-social nature into bio-medical ones, temporary neglecting the psycho-emotional component. For each individual involved in the emergency - from patients to family members and healthcare workers - over the time, it became harder and harder living with all the restrictive conditions influencing daily life in healthcare facilities.

Forced by the emergency of the whole healthcare system, main priorities in healthcare structures became 1) limiting and controlling infection spread, 2) Providing an efficient organization of structures and available resources.

Employing comprehensive and realistic planning process. Realizing planning process at different levels became essential in order to organize healthcare spaces, workforce and To allocate limited healthcare resources in a rational, ethical and efficient way. In order to do so, the main actions the healthcare sector could implement were:

- participating in a local healthcare coalition which included public and private agencies to integrate system-wide planning with local planning;
- organize resources in terms of available spaces, workers, PPE and medical resources;
- using telephone and internet-based advice lines to reduce unnecessary visits to hospital emergency departments.

Limiting and controlling infection spread. Along with the necessity of providing many hospital beds as possible, one of the two main issues consisted in limiting nosocomial cross-infections. In order to do so, the accidental contamination of the healthcare environment was limited by implementing respiratory etiquette, preventing staff from getting infected with the use of personal protective equipment and providing specific don/doff procedures while limiting the number of staff who are exposed to Covid-19 patients.

While the first pandemic wave was mainly characterized by the novelty of an unknown virus to be jointly fought by all medical communities who were undividedly focused on discharging essential needs previously illustrated, the following months, due to a prolonged persistence of the virus and decreasing energies to fight it, all the individuals involved in that difficult situation started to show some additional needs of psycho-emotional nature, due to mental fatigue. As a matter of fact, despite individuals involved differed for role, task, period spent within healthcare facilities, they all started to show needs shared by patients, caregivers and medical staff.

Relation. Despite during the last decades family-centred cares acquired key roles in the arrangement of ICU cares[13], however, restricted visiting policies associated with Covid-19 inhibited the opportunity to provide family-centred cares yielding just complex and fragmented communications. Hence, new implementation strategies for delivering family-centred care and providing clinical information during times of restricted visiting were urgently needed[14].

Picture 1. Patients visit during Covid-19 emergency

Psychologic support – staff and patients.

Long work shifts, rather than hard conditions in which medical staff worked and keep working during this emergency, has put to the challenge both their working performances and psycho-emotional stability.

Lessons from Covid-19 first wave and other epidemics demonstrate that rates of stress, burnout and post-traumatic stress among healthcare workers significantly increase both during these episodes and almost certainly for some years after[15]. Similarly, rates of productivity decrease and work performances worsen, showing lack of psycho-emotional and occupational well-being. Rather than re-establishing the old health system that led to a 'burnout epidemic', it is necessary to engage all team members in rebuilding higher-functioning systems that further workforce well-being[16].

Picture 2. Medical staff needing psychological support during Covid-19 emergency

Environmental comfort

Along with relational and psychological support, all healthcare facilities users need to attend a safe and welcoming space. As a matter of fact, evidence from different studies demonstrates that crowded healthcare facilities reconverted for the emergency, in many cases resulted inappropriate in terms of safety and liveability, not conveying to patients sufficient levels of privacy and autonomy. As a matter of fact what patients need is experiencing a situation in which the very real risk of infection transmission together with patients' psychosocial experience are simultaneously addressed in a welcoming and collaborative environment which contributes to healing and well-being[17].

HEALTHCARE FACILITY USERS

PATIENTS

FEATURES:
- reduced mobility;
- rifferent level of consciousness;
- potentially harmful to other people due to their infectivity.

NEEDS:
Relational needs
- getting in touch with relatives remotely;
- meeting relatives in presence;
- receiving clinical information;
- establishing relationship with medical staff;

Psychological needs
- need of acceptable levels of privacy;
- opportunity to experience recreational scenarios;
-psycho-social support
- provision of recreational devices/spaces/equipment;

Health needs
- differentiation of routes for patients /medicine/ meals / waste;
- efficient organization of don/doff procedures;

Spatial needs
- efficient space distribution enhancing orientation;
- recognisability of "dirty" and "clean" spaces/routes;
-clear directions ruling users movement within the buildings.

CAREGIVERS

FEATURES:
- caregivers provide psychological support to patients;
- they sporadically attend healthcare facility to visit patients;
- moderately exposed to possible infection within healthcare builidings.

NECESSITIES:
Relational needs
- getting in touch with patients remotely;
- meeting patients in presence;
- establishing relationship with medical staff;

Psychological needs
- opportunity to experience recreational scenarios;
-psycho-social support;

Health needs
- efficient organization of don/doff procedures;
- control of possible cross-infection;

Spatial needs
- efficient space distribution enhancing orientation;
- recognisability of "dirty" and "clean" spaces/routes;
-clear directions ruling users movement within the buildings.

MEDICAL STAFF

FEATURES:
- medical staff provide psychological/ medical support to patient;
- highly exposed to possible infection;
- visit patients daily.

NEEDS:
Relational needs
- getting in touch with patients to communicate clinical information;
- establishing relationship with patients;

Psychological needs
- opportunity to experience recreational scenarios;
- psychological support;
-provision of recreational devices/spaces/equipment;

Health needs
- differentiation of routes for patients / medicines /meals /waste
- efficient organization of don/doff procedures
- control of possible cross-infection.

Spatial needs
- efficient space distribution enhancing orientation;
- recognisability of "dirty" and "clean" spaces/routes;
-clear directions ruling users movement within buildings.

- Humanizing interventions

As understood, the complicate situation of managing a widespread infection risk determines a series of action, procedures and restriction limiting a complete humanized hospitalization experience. However disposing of good level of preparedness allows healthcare structures to manage interventions which can guarantee person-centred approach, improving disease experience for all the individuals involved in the hospitalization process.

Disposing of updated preparedness plan, along with healthcare structure resiliency in fact represents a key element in order to not succumb in other possible emergency situations. In order to comply with this necessity, it is essential having a look forward, planning and designing future healthcare facilities' needs. Elaborating an "after-review" of the Covid-19 emergency in fact may result useful when rethinking the hospital of the future, since numbers of improving building elements should be designed in advance.

To guarantee a safer and more humanized healthcare environment even in emergency situations, it is therefore necessary to rely on building resiliency and to implement those spatial solutions enhancing users' environmental comfort.

Although planning in advance remains a key point for a better hospital living, further humanizing intervention can be implemented work in progress, for a limited span of time or for being potentially kept permanently in the future. Along with large structural changes, other smaller actions, requiring smaller amount of resources, can be easily applied in a way to improve psycho-socio-emotional well-being of patients, related caregivers and healthcare workers.

Thinking about users' well-being, the main three aspects on which designers, administrators, and the whole healthcare community can work are essentially related to physical space improvement, relational issue humanization and 'soft' minor actions improving patients well-being.

In the light of the current emergency, intervening on built environment can enhance better users' experience in terms of keeping safety behaviours, orienting towards specialized wards and alleviating mental burden typical of hospitalized patients and medical staff operating continuously under pressure.

The second field of intervention should regard a fundamental issue: relationships. Providing dedicated places where vulnerable people can meet relatives and doctors in safety conditions actually could help to provide psycho-emotional support, alleviating sense of abandon and loneliness. In relational field, the medical community becomes essential because of its central role. It has to transform itself into promotor of any kind of communication. For this purpose in fact, is essential disposing of specific program of social engagement which can guarantee efficient contacts among patients, doctors and caregivers.

The last field of intervention includes those kind of attentions, easily implementable, which can supply alternative ways of humanizing the hospitalization experience. In this sense activities of social engagement reveal of essential help since they allows users' to feel themselves part of a community, overcoming problems related to their suffered disease or distress.

In the following pages I will show some successful humanizing interventions which have been considered successful from different studies and which could be implementable now as well as in case of future infective emergencies.

- Appendix n. 3

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7. CONCLUSION

Healthcare sector crisis caused by COVID-19 outbreak can be reconducted to some critical factors:

- lack and inadequate preparedness plans to face infective emergencies;
- scarce resilience of existing hospital structures;
- lack of specialized manpower able to manage such a critical situation.

The three types of implemented strategies put into practice to respond to hospital beds' scarcity got alternate results due to their own characteristics. From a constructive point of view, both implementations of existing buildings and construction of new ones positively responded to ease of building, fast assembling, adaptability and environmental sustainability. As well as they got good compliance levels of building characters, they also positively respond to infection containment; as a matter of fact organization of separated pathways, isolation wards and don/ doff spaces contributed to certain levels of safety.

The users' 'psycho-physical wellbeing' field, instead, resulted being the one which has recorded scarcest compliance level. As a matter of fact, emergency solutions conceived for containing infection in healthcare facilities actually limited movements within buildings, forced use of PPE hindering communication or drastically reduced arrangement of psychological support provided by caregivers.

For the purpose of solving such problems it is essential taking into account both long terms interventions and short terms ones. The first ones involve mainly design aspects of the physical environment; working on the creation of resilient spaces which can respond to several needs, in fact, it is possible to reduce infection risk and improve thermo-hygrometric conditions.

On the other hand, it is essential to implement other temporary interventions which can be easily and quickly applicable. Such kind of solutions usually do not require long time of planning and implementations, therefore they can be applied during the emergency. These possible actions includes the implementation of dedicate spaces and programs of social engagement which can allow to establish better relationships among the individuals involved. Alternative psychological therapies and other kind of minor attentions, then, could contribute in the humanization process.

The elaborated preliminary analysis has been essential to comprehend strengths and weaknesses of the realized healthcare facility models. Its focus on humanizing aspects has further contributed to highlight how the humanization issue within healthcare facilities is a unavoidable element to take into account in the process of healthcare facilities' implementation in ordinary and, especially, in emergency conditions.

To further implement the topic of this thesis could result interesting applying more specific research on realized case studies, in a way to assess and possibly indicate specific practical solutions that in this thesis are just suggested.