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D.R.on.E

Decision support system to Respond to ongoing Epidemics

EXECUTIVE SUMMARY

COVID-19 pandemic has highlighted the need for fast and efficient reorganization of hospital structures. A wide literature of official guidelines has been developed about this topic and different strategies have been adopted. Nevertheless, if the aim of the guidelines is to be efficient and responsive especially in case of emergencies, already existing ones seem to lack in these aspects, due to the impossibility to achieve direct answers to some fundamental questions. They tend to overfill the user with a lot of information organized in such a way that does not allow easy links among them, rather than rearrange the knowledge according to specific issues that the reader may raise.

The “Decision support system for Responding to the ongoing Epidemic” (D.R.on.E) is a tool that can be used to help the users in the decision-making processes by gathering a lot of information coming from the literature and linking them with evidence based data. In fact, D.R.on.E, allowing both a top-down consultation and a bottom-up browsing, supports a faster experience: thanks to an hyperlink system, guidelines are complemented by further resources and automatic tools that support customization of the solutions based on the specific case parameters. Furthermore, D.R.on.E includes a pandemic prediction model built on local official data about COVID-19 diffusion, able to estimate the number of hospitalized patients at a certain time. This system helps the user to adopt the most appropriate strategy in order to fill the gap of beds that may be required in the facility in the near future.

The D.R.on.E decision making tool is an all-in-one resource worldwide accessible, which offers all the pieces needed to make the fastest, most efficient and straightforward decisions. This platform would not completely substitute traditional guidelines, but it may support them to be more user-friendly and less time consuming.

In conclusion, the proposed communicative model and the methodology developed to create the D.R.on.E tool for the COVID-19 pandemics, are contributions that may have important impacts on the communicative strategies adopted by the World Health Organization. It would help guidelines step forward by keeping in mind that they are a useful means only when they adapt to the user's need and resources availability and not vicesa.

KEY WORDS

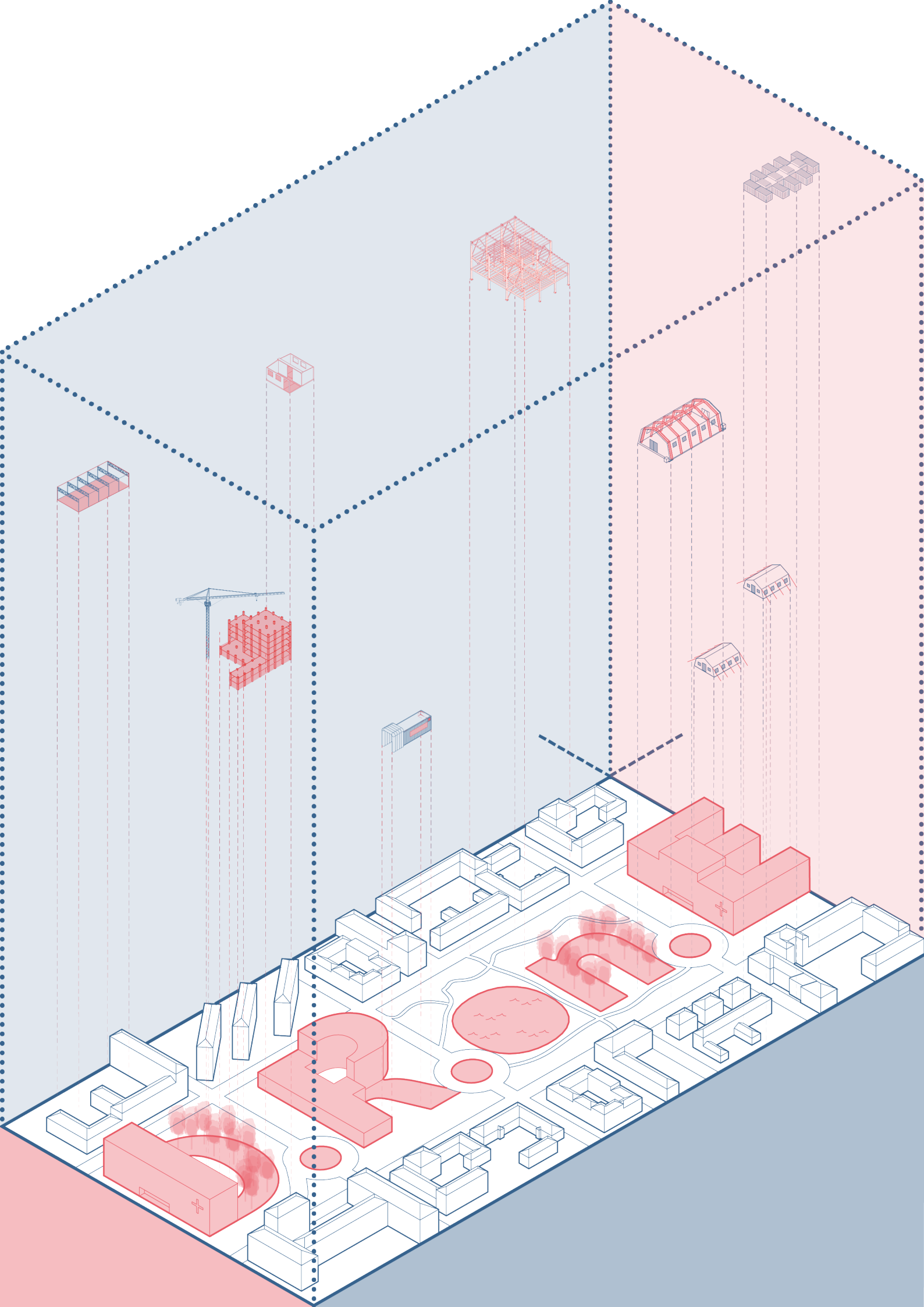
Pandemic emergency

Hospital repurposing strategies

Decision support system

Guidelines' reorganization

Resilience



**Project description
written by the Principal
Academic Tutor**

The current pandemic has pushed beyond the limits the existing health facilities and the operating procedures developed by local institutions. A rapid and well-organized response strategy is a key factor for future epidemics.

D.R.on.E aims to investigate innovative decision tools and support methods to assist operational experts and decision makers in responding to the current COVID-19 pandemic in a disruptive, timesaving, and locally appropriate way.

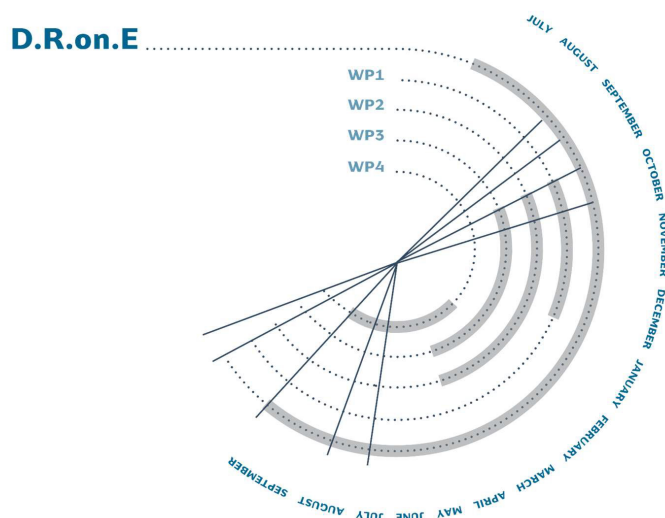
D.R.on.E will investigate how traditionally designed healthcare facilities stood the test of pandemic containment by integrating multi-scale dynamical models of disease transmission into parametric data-driven design tools, and will experiment with new aggregative formulas, understanding what topic has to be study in deep and implemented to support COVID-19 emergency management or future similar pandemic conditions.

A highly multidisciplinary set of skills is needed to build a multi-criterial decision support system to assess existing infrastructure, evaluate retrofiting options, reorganize information provided from the guidelines, and select appropriate materials.

**Team description
by skill**

The D.R.on.E team is rich in multidisciplinary and multicultural contributions. It is made up of 8 students from Italy, Mexico, China and Pakistan and attending 7 different courses of study relating to the fields of computer science, data science, architecture, civil and mechanical engineering.

The team was divided into 3 subgroups, called **Work Packages (WP)**, set up in order to maintain the multidisciplinary character and to clarify the tasks to be carried out in relation to the progress of the project. In this way it was possible to exploit many of the skills of the subjects involved in the project, which proved to be fundamental for its realization: the team had or acquired knowledge on how to create a website, on data management and on their organization for the realization of a pandemic predictive model (**WP 1**), on the scientific literature relating to hospital reorganization in the event of a pandemic emergency, on the 2D and 3D software for the creation of the graphic interface of the site and the exemplary drawings (**WP 2**), on the information relating to the materials and technologies to be used in the event of spatial reorganization, on the best ventilation modalities of the internal hospitals and on the optimization of the choices from the point of view of the cost-benefit ratio (**WP 3**). The whole group (**WP 4**) then joined forces to create the D.R.on.E system, holding together the complexities that emerged in each subgroup.



In addition, the team had the opportunity to actively collaborate with a representative of the Techné section of the **World Health Organization**, who made available her experience in the field of hospital reorganization to support the team during all phases of the project, from identifying the main problem to be solved, to reviewing the solutions developed by the team.

Goal

The **main goal** of D.R.on.E is to **provide a universal, easy to understand, and rearrangeable solution so that hospitals of any region, economic situation and size can quickly respond to epidemics of different severity.**

A universal solution is needed because the development of the epidemic situation, the budget, and the responsibilities are different for hospitals in any part of the world. Therefore, a tool that can be adapted, arranged and combined according to the actual situation must be provided.

The objective of D.R.on.E is to **gather the main existing guidelines and organize the needed information in an easily understandable way.** The result should be a user-friendly framework which takes and systematically guides the user through all the key elements that must be considered when working on a hospital adaptation project also helping the user in performing quantitative estimations of the needed interventions.

D.R.on.E aims to facilitate and accelerate the whole decision making process by helping the user to have their needs and data properly prioritized.

Understanding the problem

The unprecedented overload of the health system highlighted the need of undertaking rehabilitation, expansion or reconstruction processes to adapt the healthcare facilities to new needs. **A key element of success in such a context is to provide a timely and targeted response.** For this reason WHO Téchne, during the first months of pandemic, established a remote technical support helpdesk in order to provide customized solutions to applicants.

The COVID-19 pandemic stressed healthcare systems worldwide showing that a decision support system, intended as a compendium of planned solutions for spatial and technological reorganization of the hospitals, would have been a benefit.

During this epidemic crisis numerous projectual and development guidelines have been created by different institutions and agents to help architects and planners to carry out autonomous hospital adaptation projects in case of sanitary emergencies. Nevertheless, each of these guidelines may treat different aspects, or use different approaches that are not linked to one another. Additionally, most of these guidelines are ideally intended to be interpreted by design professionals while working along with healthcare figures. But in real life, during a sanitary emergency, this dynamic of work may be not possible because of lack of time and/or human resources, which leaves hospital managers to deal alone with confusing projects and disarticulated work processes.

This is linked to the peculiar limits of the guidelines that are currently provided to decision makers to make them able to do autonomous and correct changes to the facilities they manage: **reading and analyzing literature to design a project is a fairly time-consuming process, inappropriate for a dangerous situation like pandemics; furthermore analyzing and categorizing such a large body of material, as well as determining how to provide helpful categorization, is a difficult task.**

Exploring the opportunities

The team began approaching the topic through a careful examination of the currently existing guidelines about pandemic prediction models and hospital reorganization. Therefore, the **first idea** has been the **creation of a comprehensive guideline** to gather all the information together, mainly focusing on the communication to the user. In fact, during its research the team spotted that guidelines present a list of useful information but often organized in a sectorial way such that finding answers may be complex.

Another concept that emerged was **the creation of a collection of case studies** to explore interesting spatial and technical solutions that had been used in some hospitals. Although this appeared to be a valid method to easily show users how to solve their problem, the team valued it as too specific and not capable of being adopted by facilities belonging to different scenarios.

Looking for an alternative solution, the team began to **organize the information collected during the research into a matrix.** The goal was to create a tool fillable with some specific information relating to the peculiar users' hospital organization and capable of providing a score based on the compliance of the facility with the reference guidelines. Both the team and the stakeholders found

this aspect of a direct interaction with the users very interesting, therefore the concept changed again, **resuming the first idea** about collecting and reorganizing the information contained in the guidelines. In fact, among the various ideas explored, **this was still the most generic and potentially the most useful for users**, even if not very adaptable to specific needs. **The possibility of a direct interaction, however, opened up new horizons.**

In general, after examining different concepts and possibilities, the team identified the scope of communication as a fundamental part of the hospital reorganization process that can still be implemented to achieve better efficiency.

By focusing efforts on this aspect, the project developed by the team, can impact on a large number of healthcare facilities. In this way it would be possible to meet the requirements expressed by the main stakeholder of the project, World Health Organization - Techné, which needs greater autonomy of hospital during pandemic events, in order to focus on direct intervention only in critical cases.

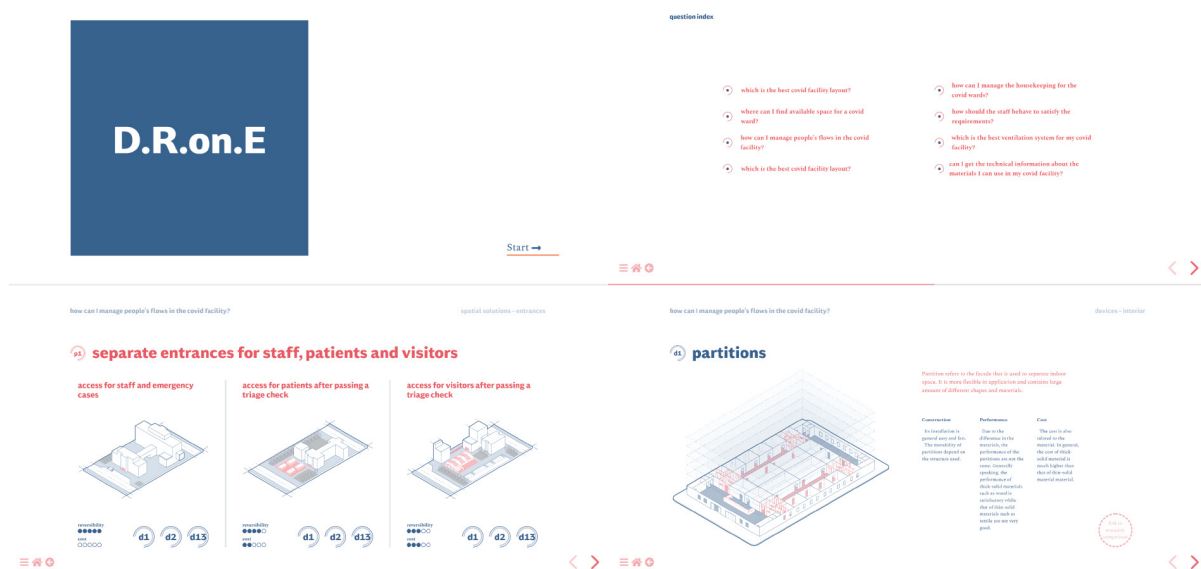
The D.R.on.E team aimed at a solution capable of coping with the development of the epidemic situation being aware that the budget and responsibilities are different for hospitals anywhere in the world. Therefore, it has been developed a tool that could be adapted, organized and combined according to the real situations. For this reason D.R.on.E can be defined a universal tool: not because it responds in the same way in every context, but because it can be adopted as a tool in different contexts as it contains solutions suitable for different budgets and needs.

Using analogies, our system should bring to the stakeholders the flexible, clear communication of a PowerPoint/Keynote presentation, with the possibility of reaching a guideline-like detail level, while integrating active widgets able to perform computations in place.

To achieve this, the **D.R.on.E team created a web-based decision support tool**, presenting an intuitive interface **to browse possible ideas and devices needed for the reorganization of hospitals** to face pandemic situations. **It collects and reorganizes guidelines information, allowing the user to obtain more appropriate answers to his issues by including customizable predictive tools.**

The developed tool allows both **horizontal and vertical navigability of the information contained. These latter** come from the guidelines but they **have been reorganized depending on problems to be solved and no more by sectors.** This allows a more intuitive and effective consultation. Furthermore, the choice of an **online platform allows the integration of the product with a series of tools** that request information from the user regarding the conditions of his hospital. **Moreover this choice allows, in the future, to have the possibility of update the guidelines contained in the system or to readjust it to cope with different pandemic situations.**

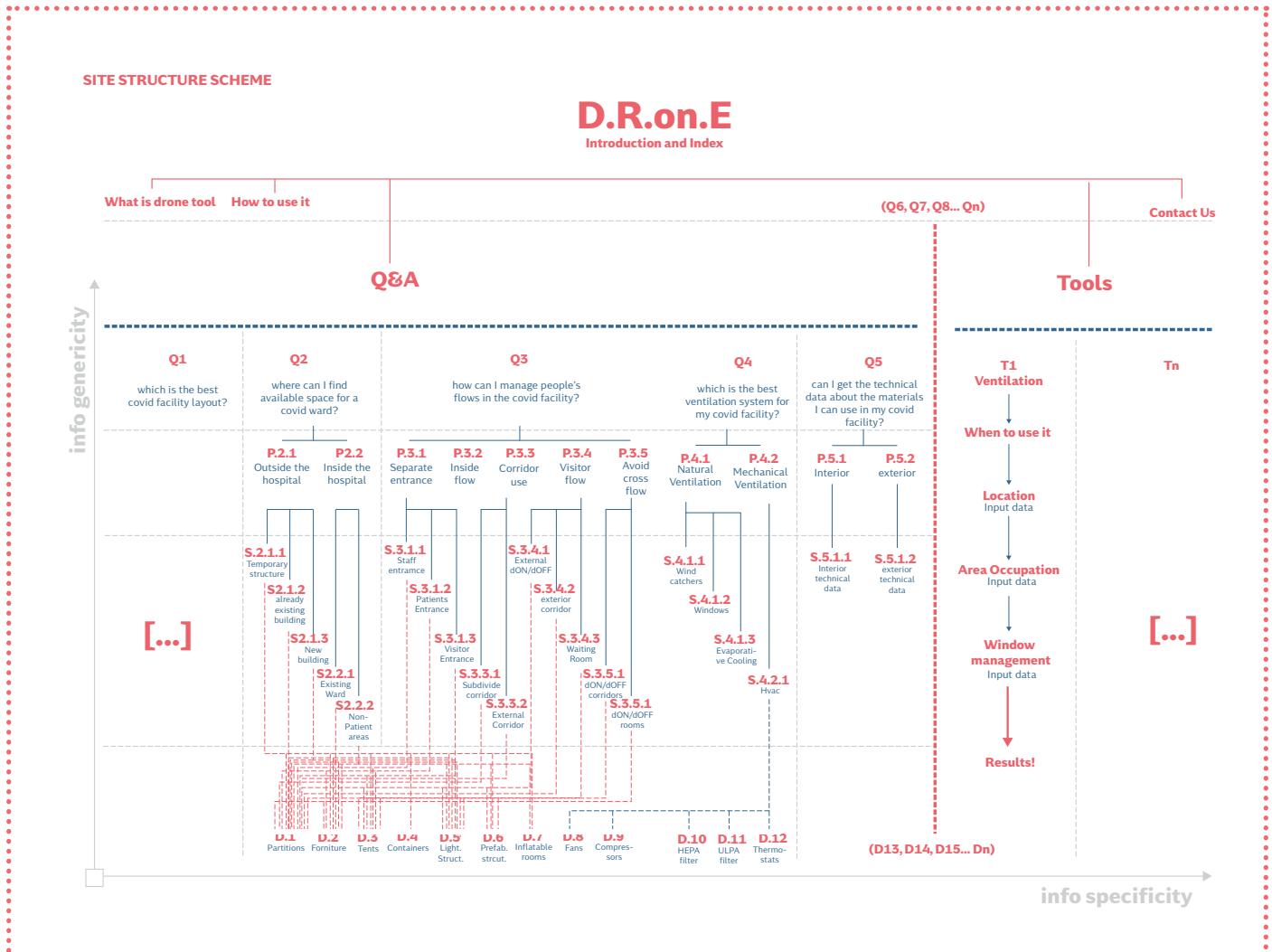
Generating a solution



The intention of **the tool** is to **use a universal language to be understood by different types of users**. For this reason **the D.R.on.E team aimed at creating a clear yet articulated structure**.

It is organized as a **hierarchical structure based on a series of fundamental questions** that the user poses during an hospital reorganization process.

From each question a series of **projectual ideas** branch out, opening to the exploration of some **solutions**. The latter use **devices** to which cost and reversibility characteristics are associated that make the user understand how much a certain solution can be suitable for his specific case.



The **main target of the browsing experience is to allow both a top-down consultation** of the complete set of solutions available **and a bottom-up navigation** to pair each user to the most relevant solutions for their boundary conditions.

The designed interface is an integration of a presentation-like navigation with a web-based hyper-link browsing. The user navigates through a deck of slides, each developing a specific concept, and each reachable from different points of the document. In this context, **a good design of the content is required to correctly distribute the atomic pieces of information to be communicated**

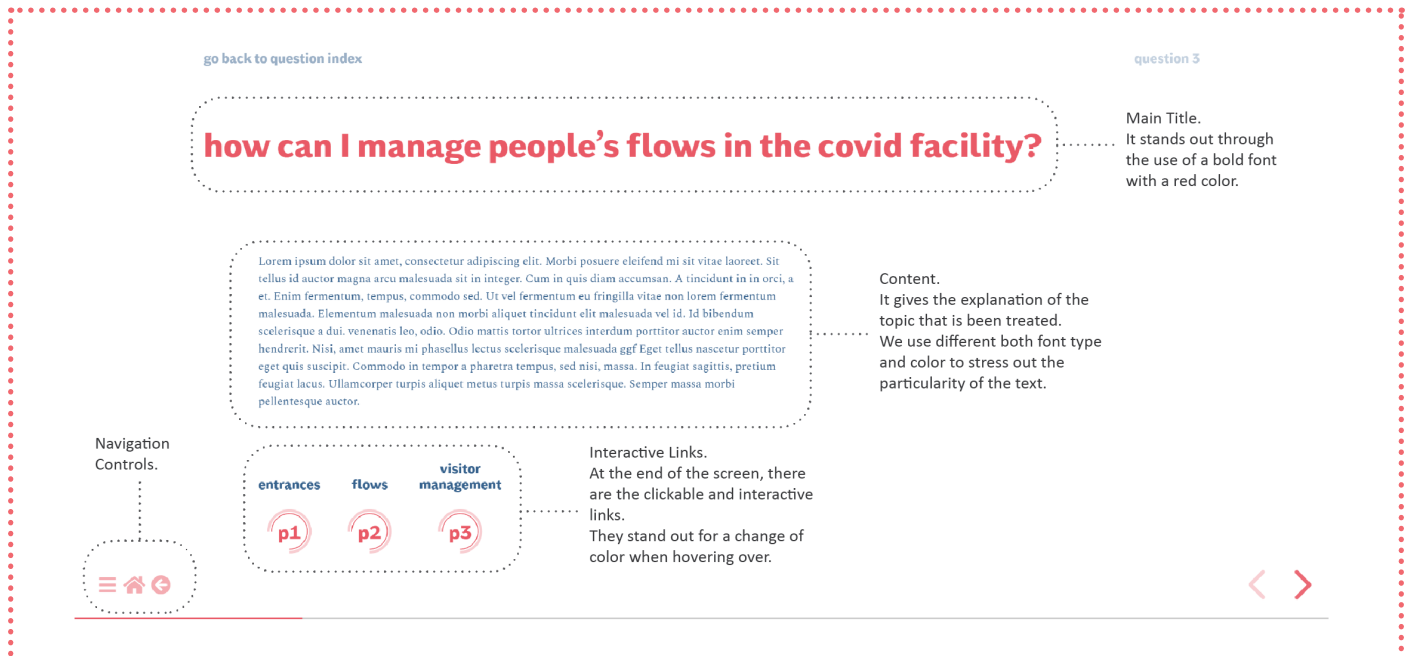
Once inside the D.R.on.E tool, the user finds a small tutorial on how to interpret the content and then an index with a series of questions, each of these questions refers to a specific topic.

The user finds **at the top of the screen the title which introduces the topic**. Then, **under the title there is the main content in textual and graphical way**. And last but not least, there are the **elements with which the user can interact and take them to further a subject**. In this way **it is guaranteed that the user will not miss any relevant information or get lost in the website**.

The typical structure of a question is a first screen which explains why that subject matters when transforming a hospital and then presents what are called **"projectual ideas"**.

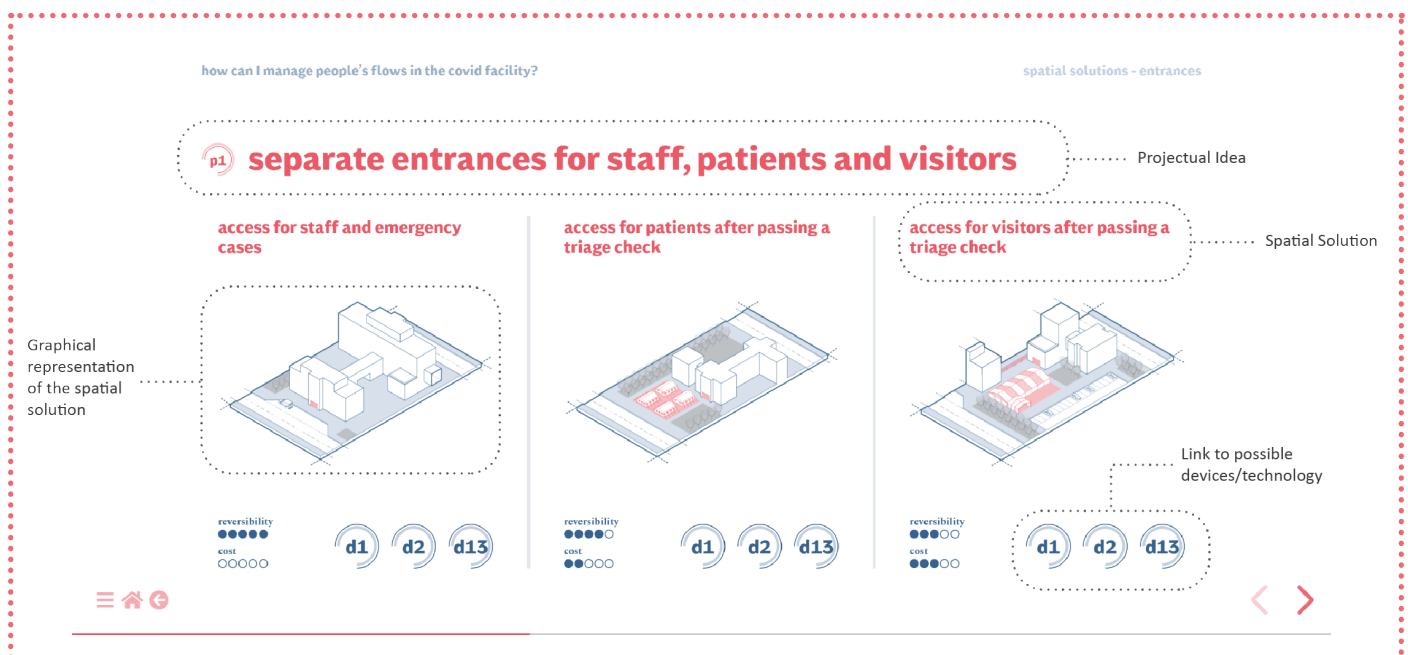
These projectual ideas are **general strategies that can be used to approach the issue of the question**.

After selecting one of the possible projectual ideas, **the user will find** what are called “**spatial solutions**”, which give the user **all the possible ways the projectual idea can be applied**. Each of these “spatial solutions” are addressed with an axonometric drawing and are provided with **interactive elements** which are called “**devices**”. These are the **technologies and systems that can be used when applying a “spatial solution”**. In the “devices” section, the user gets the main description and generalities of that specific technology. **From this part the user can choose to either go back to the questions or to access a database with other technical information about the devices** like levels of mobility, difficulty of construction, structure, costs, etc.



The choice to articulate the system around a series of fundamental questions is aimed at responding to the different and more dispersive management of information used in traditional guidelines. In the latter the themes are fragmented and it is rare that all the information the user needs is collected in the same place. **By making the questions explicit**, however, **it is already possible to give a purpose to the design solutions that are being explored**. The use of **hyperlinks** means that there is only one page on a particular device, but it allows access to that page to be retrieved from a very large number of other slides.

In this way, **the user is left with the possibility of a traditional horizontal exploration of information or a more dynamic vertical search through the connections between the different levels of the system**.



Furthermore, the **D.R.on.E system makes it possible to combine the search for solutions for the spatial reorganization of hospitals with tools** for the personalization of this research: through a **pan-demic prediction model**, that requires local data about covid diffusion, it allows to estimate the number of additional beds needed at a certain time, allowing to reorganize the facility before reaching an emergency condition; and across a **natural ventilation tool** integrated into the website, the system is also able to provide answers regarding the methods of **managing natural ventilation in relation to the specific data of the place**: coordinates, area and occupation of the room, number and size of windows. The latter tool is particularly significant for contexts with less financial resources where the use of mechanical ventilation is often too expensive to be effectively used and maintained.

1

location

2

**area and
occupation**

3

**windows
management**

Where am i located? ?



Which is the orientation angle of the external window? ?



How much is the floor area of the room? ?

area of room

Which is the room occupancy? ?

n° of people

Which type of room? ?

☒ Healthcare setting
COVID-19, where AGP are performed

☐ Healthcare setting
COVID-19, where AGP are NOT performed

☐ Residential setting
COVID-19 home care and self-quarantine at home

☐ Non-residential setting

How much opening surface oriented towards the exterior? ?

external opening surface

How much opening surface oriented towards the interior? ?

internal opening surface

Do the external openings have mosquito nets? ?

☐

Compute!

The fulcrum and the innovative aspect of the D.R.on.E project lie in this free possibility of exploring the contents and in the integration between general instruction retrieved from guidelines and specific information directly related to specific contexts. In this way the user interacts with an interface designed not only to provide him with the information he needs in the most immediate way, but also to allow him to visit alternative solutions or other types of devices in such a way to fully open up customization of the solutions proposed.

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