Building Population Health Scenarios: A new methodology for informing health policy

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Abstract — The health context is rapidly changing. As individuals are living increasingly longer, they are prone to develop health problems and live with long-term illnesses. New technologies emerge and health systems are facing sustainability problems. Adequate policy-making, within and outside the health sector, needs to reflect on possible population health scenarios when analysing which policies should be prioritized and adopted. There has been little research on using population health scenarios in general, and specifically for Portugal.

This study proposes a new methodology for building population health scenarios, being applied to Portugal. The proposed methodology is qualitative, based on experts’ views, and makes use of an adapted morphological analysis. In a first stage, for a wide range of population health dimensions/indicators, experts were asked to explicit their world views on which is the likely evolution of those indicators and on which factors will influence that evolution. Then causal maps were used to model the deep causes that may influence an indicator or a set of indicators. An adapted morphological analysis were used to obtain different combinations of plausible evolutions of the population health key variables identified from the experts’ answers. Finally, based on that information, qualitative scenarios were built.

The proposed methodology was applied to produce four population health scenarios for Portugal – “Sea Change for Health”, “Better Primary Care, Old Problems”, “Hospital Reform” and “Health If You Can Get It” –, identifying causes for distinct evolution patterns on population health, and enabling health policy-makers to act on factors that promote population health.

Keywords — Foresight; scenario methods; population health; health policy; uncertainty modelling; Portugal.

I. INTRODUCTION

How will population health look like in Portugal in the year 2025? This is a complex question, particularly given the health context in which we are involved. On the one hand, individuals are living increasingly longer, due to faster diagnostics of health risks and to better medical treatments, equipment and medicines. On the other hand, they are prone to develop health problems and live with long-term illnesses (Hoeymans, Loon et al. 2014). At the same time, new technologies are emerging and health systems are facing sustainability problems (World Economic Forum 2013).

An adequate policy-making, within and outside the health sector, needs to reflect on possible population health scenarios when analysing which policies should be prioritized and adopted. These different scenarios for population health are the recognition that the future is uncertain, but can be defined using the information and knowledge we have today (Institute for Alternative Futures 2014), and making use of concepts such as foresight and scenario planning. Further, a correct evaluation of the health policy strategies requires also the recognition of structural uncertainties, and in what way these uncertainties may impact in the multiple objectives of such strategies. There has been little research on how to identify and model those uncertainties and on using population health scenarios in general, specifically for Portugal.

This study aims developing methods to build population health scenarios that are relevant for analysing the evolution of population health indices. Particularly, a new methodology for building alternative population health scenarios will be designed so as to identify causes for distinct evolution patterns on population health, and to enable health policy-makers to act on factors that promote population health. The methodology will be applied to build population health scenarios (health care provision component) for Portugal.

II. CONTEXT

A. Defining Population Health

Population health is a relatively new broad concept, with no consensus in literature on what this term refers to. Sometimes there is also a discussion about whether the terms population health and public health are similar or different. The Public Health Agency of Canada (2012) started to define population health as “an approach to health that aims to improve the health of the entire population and to reduce health inequities among population groups. In order to reach these objectives, it looks at and acts upon the broad range of factors and conditions that have a strong influence on our health”. Young (1998) defines it as “a conceptual framework for thinking about why some populations are healthier than others, as well as the policy development, research agenda, and resource allocation that flow from it”. Kindig and Stoddart (2003) stated that population health refers to “the health outcomes of a group of individuals, including the distribution of such outcomes within the group”. More recently, Cohen, Huynh et al. (2014) detailed that the “core elements of the population health approach included..."
focusing on health and wellness rather than illness, taking a population rather than individual orientation, understanding needs and solutions through community outreach, addressing health disparities/health in vulnerable groups, addressing the social determinants of health and intersectoral action and partnerships⁶.

For this work, a consistent and accepted definition of this term is described by Kindig (2007), who defines population health as a broader concept which includes health determinants, health outcomes and health policies and which aims to understand the relation between these three components.

B. Population Health Indexes

Nowadays, the current measurement of population health is captured by a multidimensional population health index. The project of America’s Health Rankings (University of Wisconsin 2014) and the GeoHealthS project (Santana, Freitas et al. 2015), are two main examples of population health indexes, illustrated in figures 1 and 2.

Both indexes start from policies and programs implemented at a local level that can affect population health in a variety of ways and may target two main components: health outcomes and health determinants.

The scope of these indexes was to characterize and monitor population health, globally and in different areas of concern and thus provide a decision-making support tool at the local level, particularly in defining priority areas for the improvement of population health. This way, it is relevant for health policies to analyse what determines the evolution of these indexes in the future, considering the inherent uncertainty that characterizes the evolution of each health determinant and outcome.

The new methodology approach proposed will use the GeoHealthS project as starting point having current information on its index, and aim to build scenarios that can influence the evolution of population health as captured by the index. The methodology to be developed in this thesis will be potentially applied to the EURO-HEALTHY project, to model future scenarios of population health for the European context.

C. EURO-HEALTHY Project

This thesis is part of an European investigation project, called EURO-HEALTHY, whose purpose is to advance knowledge on which policies have the highest potential to enhance population health and health equity across 28 European countries, 273 regions and within metropolitan areas, which represents about 500 million inhabitants, having at the core the development of a multidimensional health index to measure the population health (EUROHEALTHY Consortium 2015).

Within the EURO-HEALTHY project it is important to consider that a health index is built to characterize today’s health. The scenario methodology proposed in this thesis aim to inform the construction of scenarios within the EURO-HEALTHY project.

Our scenario study proposes a new methodology for building alternative population health scenarios, to identify causes for distinct evolution patterns on population health, and to enable health policy-makers to act on factors that promote population health. Therefore, the health determinants of the index and its past evolution should be considered in our scenario study when consulting experts to obtain qualitative and quantitative information on what will influence the evolution of those population health determinants.

III. LITERATURE REVIEW/STATE OF THE ART

This chapter introduces key concepts in foresight and scenario planning and clarifies what are the typical scenario approaches in a field that literature reveals a considerable and sometimes discordant number of different definitions, methodologies and principles (Bradfield, Wright et al. 2005). It then reviews previous studies that have built scenarios in the health context.

A. Foresight and scenario planning

The term “Foresight” or “Prospective” is understood in the philosophical sense put forward by Godet (1997) as “une attitude d’esprit (l’imagination et l’anticipation) et un comportement (l’espoir et la volonté) mobilisés pour assurer la qualité et la maîtrise de l’existence présente et future” (Godet 2007). In a more practical way, the Institute for Prospective
Technological Studies defines foresight as a “systematic, participatory, future-intelligence-gathering and medium-to-long-term vision-building process aimed at enabling present-day decisions and mobilizing joint actions” (Institute for Prospective Technological Studies 2006). Therefore, foresight is identified with future studies and particularly associated with scenario building (Rialland and Wold 2009).

Herman Kahn, one of the founders of future studies and scenario planning, defines the concept of scenario as “a set of hypothetical events set in the future constructed to clarify a possible chain of casual events as well as their decision points” (Amer, Daim et al. 2013). A scenario is therefore a description of a future situation and the sequence of events which enable one to move forward from the actual to the future situation (Amer, Daim et al. 2013).

Pierre Wack, in one of his articles about the use of scenarios at Shell (Wack 1985) suggests that the best way to think about the future is not look for better forecasts by improving the techniques but to accept the uncertainty of the future, try to understand it, and make it part of our reasoning. This uncertainty may arise from multiple sources, such as the structure and complexity of a system, incomplete information, simplifications, preferences and decisions, (Morgan, Henrion et al. 2006) and is addressed by scenario planning.

In fact, scenario planning helps decision-makers to identify, understand and explore the main drivers (or drivers of change) of the context in which they have to act, i.e., any factors or forces that can potentially influence a given strategic focus, and the driving forces, i.e., the forces of change outside the organization that will shape future dynamics in predictable and unpredictable ways (Scearce and Fulton 2004).

B. Scenario approaches

There are three main schools or major approaches referred in the scenario planning literature for the development of scenarios. Two out of these three principal approaches for scenario development were initiated in the United States of America, and one emerged in France. These approaches are: Intuitive Logics, Probabilistic Modified Trends and the French approach of La Prospective (Amer, Daim et al. 2013) (Bradfield, Wright et al. 2005).

1) Intuitive Logics

Intuitive Logics approach has taken most of the attention in the literature and was firstly presented by Herman Kahn at the Rand Corporation in the 1960s (Amer, Daim et al. 2013).

According to Scearce and Fulton (2004), Goodwin and Wright (2009), Burt, Wright et al. (2006) and Institute for Prospective Technological Studies (2006), the basic process of scenario building using the Intuitive Logics approach should include the following steps: identify the focal issue/issue of concern and the time horizon which will be captured in the scenarios; identification and analysis of the drivers; brainstorming for determine key uncertainties; selecting and prioritizing uncertainties according to impact and predictability; and finally, developing scenarios and its implications.

2) Probabilistic Modified Trends

Alongside with the previous approach, another school of scenario techniques using the probabilistic modification of extrapolated trends emerged also at the Rand Corporation in the USA and has evolved mainly through the work of Olaf Helmer and Ted Gordon (Amer, Daim et al. 2013) (Bradfield, Wright et al. 2005). This scenario planning approach includes two different matrix based methodologies: Trend Impact Analysis (TIA) and Cross Impact Analysis (CIA).

Although Trend Impact Analysis and Cross Impact Analysis are associated with probabilistic forecasting tools, these methodologies develop a range of alternative futures instead of a simple extrapolation of historical data, and when connected with expert judgements and narratives about these futures, they generate scenarios (Bradfield, Wright et al. 2005) (Amer, Daim et al. 2013).

3) The French approach of La Prospective

The French approach of La Prospective aims to develop normative scenarios for the future and to articulate idealtic future images so that scenarios can be used as a guiding vision to decision makers, policy makers and thus provide a basis for future action (Amer, Daim et al. 2013) (Bradfield, Wright et al. 2005). The work of Berger, De Jouvenel and Durand, the French pioneers in scenario planning since the 1970s, has been continued and expanded by Michel Godet, who has worked in the tools of La Prospective (Bradfield, Wright et al. 2005) (Godet 2000). Godet has developed scenarios for several French national institutions and created his own mathematical and computer based probabilistic approach for building scenarios.

La Prospective seems to be a combination of the Intuitive Logics and Probabilistic Modified Trends methodologies.

C. Review of Scenario Studies in Health

Preparing for the future is a necessity for every health policy-maker. The application of foresight methods such as scenario planning to the health field has shown strong value and is referred by literature as a better way to “improve health systems and interventions, and prepare for future public health incidents” (Masum, Ranck et al. 2010).

This review is the result of the analysis of a set of 14 scenario studies obtained through literature search.

From this review it was possible to conclude that there has been little research on using population health scenarios in general, and specifically for Portugal. It appears that all the reviewed scenario works (14 studies) are based upon the same scenario planning approach – Intuitive Logics, with different adaptations. This fact leads us to conclude that, despite being commonly applied in many contexts, the other two major approaches are still not widely used to develop scenarios particularly for health context. Studies are also very context dependent and goal dependent. Moreover, no scenario study methodology can be entirely transposed to this thesis in particular and neither to the EURO-HEALTHY project.

Therefore, there is space in literature for developing a different and innovative scenario building approach for population health, with the scope of developing and testing new techniques.
IV. BUILDING POPULATION HEALTH SCENARIOS: A NEW METHODOLOGY APPROACH

Taking this into account, the starting point was to develop a new methodological approach for building Population Health scenarios: having current information on a population health index, and aiming to build scenarios that can influence the evolution of population health as captured by the index; making use of views of experts with multiple perspectives relevant for population health; need to collect qualitative and quantitative information for building scenarios; and need to consult experts that do not require many face to face contacts for cost reasons and to capture the diversity of perspectives without group bias.

This methodological proposal aims to articulate the Intuitive Logics approach and the French approach of La Prospective, making use, in such way, of some of its tools such as causal maps and morphological analysis.

The proposed process enables users to identify and analyse the problem asking the right questions to experts through a web-platform, identify problem variables, reduce them to key variables and build scenarios and its narratives through the information gathered from experts. The figure 3, illustrates the methodology framework for building exploratory scenarios and it is adapted to the specificity of the Population health context.

Figure 3 – The proposed methodology framework for building exploratory scenarios for Population health.

The proposed methodology framework, figure 3, for building exploratory scenarios for Population health can be overviewed and synthesized in the figure 4, where the steps of social and technical work are identified.

Figure 4 – Overview of the methodology for building exploratory scenarios for Population health. Green represents the social steps and Blue are the technical steps.

According to figure 4, the social and technical steps of the new methodology for building Population health scenarios includes: the development of a web-platform to inquire experts through a defined questioning protocol to obtain experts’ forecasts and its “deep causes” for each indicator; the aggregation of that information in causal maps; selecting key variables from the experts’ answers, developing possible evolutions (hypotheses) for each key variable and using morphological analysis to obtain plausible configurations of those evolutions; adjust and validate with experts the results of morphological analysis; using information previously generated (forecasts, causal maps and morphological analysis) to develop scenario narratives; and finally, perform a workshop to final validate these scenario narratives.

According to Michel Godet, a scenario is not a future reality, but rather a way of foreseeing the future. Moreover, to be effective, scenarios must engage four conditions: plausibility, consistency, relevancy, importance and transparency (Godet 2006).

V. APPLICATION OF THE METHODOLOGY TO BUILD POPULATION HEALTH SCENARIOS FOR MAINLAND PORTUGAL

In this chapter, we provide a preliminary application of the proposed methodology to build population health scenarios. The assumptions, outputs and results of each phase are described, as well as the final scenario narratives. The purpose of this application is to test the new approach and to get some insights on what are its current limitations and how to improve it in the future.
A. Phase 1 – Identify the key issue and goals

This phase aims to identify the key issue, decision or question of the problem. This way, this study wants to give answer to the question: “How will population health look like in Portugal in the year 2025?” since it wants to build scenarios of population health for Portugal and with a scenario time frame of ten years.

The starting point of the methodology was to clearly define what population health is and how it is actually measured. As we had seen before, Population health is a broader concept which includes health determinants, health outcomes and health policies, and it aims to understand the relation between these three components (Kindig 2007).

The current measurement of population health is captured by a multidimensional population health such as the already published County Health Ranking (University of Wisconsin 2014) and GeoHealthS (Santana, Freitas et al. 2015) indexes previously described in the section III.A.

The population health index specifically used in this application was the one of the GeoHealthS project, as illustrated in the figure 2. To this study, it is important to mention that we do not used the entire dimensions of the index, but only the nine indicators related to healthcare dimension, since we just want to test if this methodology works.

The healthcare determinants of GeoHealthS index used are:

- Nurses in Primary Care – Measured by the number of nurses in Primary Care (official clinics and extensions) per 1000 inhabitant, in mainland Portugal. This determinant is a measure for Primary Care responsiveness.
- Hospital proximity – Measured by the average time, in minutes, an inhabitant takes to get the nearest hospital of National Health Service, in mainland Portugal.
- Hospital doctors – Measured by the number of doctors in hospitals of National Health Service, per 1000 inhabitants, in mainland Portugal. This determinant is a measure for Hospital responsiveness.
- Hospital beds – Measured by the number of beds in hospitals of National Health Service, per 100 000 inhabitants, in mainland Portugal. This determinant is a measure for Hospital responsiveness.
- Access to pharmaceutical care – Measured by the number of pharmacies and mobile medicine depots per 1000 inhabitants, in mainland Portugal.
- Primary Care consultation – Measured by the number of medical appointments of family and general medicine in official clinics per inhabitant, in mainland Portugal.
- Pregnancy consultation – Measured by the number of medical appoints of maternal health in official clinics per live birth, in mainland Portugal.

These determinants are the basis for the questioning protocol to experts.

B. Phase 2 – Analysis of the problem

This phase aims to analyse the problem through the identification of the experts’ view on what will influence the determinants of population health. Therefore, a set of Portuguese experts with multiples backgrounds, perspectives and experiences should be involved.

Having defined the nine healthcare determinants, the next step was to develop the questioning protocol for each determinant (or indicator), according what information is desirable to obtain from experts. This protocol integrated two questions and it takes a maximum of 15 minutes to answer:

- **First question** – “What is the most expected value to the indicator, in mainland Portugal, to be observed in 2025?”;
- **Second question** – “Explain a set of at least three causes (changes and/or continuities), policies or others that will have to occur for your forecast of the first question happen”.

The next step was to implement a web-platform to collaborate with experts and collect quantitative and qualitative information for building scenarios. This web-platform was available at http://wehealthcarescenarios.weebly.com/. Since the experts are Portuguese, the platform was also developed in the same language to avoid misunderstandings.

After the experts’ registration, the questionnaire is started and displays one page at a time for each health indicator, which includes the definition of that indicator, the historical data of the indicator between 2000 and 2012 or 2013 (excluding two indicators – Primary Care proximity and Hospital proximity –, for which only the year of 2011 is available) and the two questions mentioned above. The historical data of each indicator was obtained through a variety of sources such as the GeoHealthS project itself, INE, DGS and PORDATA.

To participate in this questionnaire, 44 experts from multiples backgrounds, perspectives and experiences in population health were invited via email, but only 10 experts effectively completed the full protocol.

These experts were mainly professors, researchers and Health managers encompassing a range of different backgrounds, including Sociology, Public Health, Medicine, Geography, Health Administration and Health Management. Regarding experts’ gender, 7 were male and 3 were female, most of them aged more than 50 and living in “Lisboa e Vale do Tejo” region, with only two living in Central region of Portugal.

C. Phase 3 – Identification of problem and key variables

This phase aims to analyse and aggregate the information (forecasts for each indicator and, particularly, the causes of each forecast) gathered from all the experts in the web-platform. This phase included the following working steps:

1. **Identification of drivers**, which was performed through an extensive scanning of the gathered information, in particular the causes given to each forecast of each indicator. We began to identify a total of 68 drivers that will influence the future of population health;
2. **Selection of the problem variables**, which was performed through an empirical analysis of the identified drivers, we group them into 35 problem variables;
3. **Identification of 7 key variables**, which are sub-groups of problem drivers;
4. **Identification of 3 dimensions** for key variables;
5. **Development of an adapted influence matrix**, where it is possible to observe which problem variables influence which indicators (and if that influence is positive or negative), how many indicators are influenced by each problem variable, how many problem variables influence each indicator, and how many experts mentioned each problem variable;
6. **Building causal maps** to represent the experts’ beliefs about causal relationships between indicators and between indicators and drivers (problem variables).

Figure 6 describes the 3 dimensions identified to classify the 7 key variables.

![Figure 6 - Causal map extracted from the global causal showing experts’ beliefs about causal relationships between healthcare indicators.](image)

<table>
<thead>
<tr>
<th>3 Dimensions</th>
<th>7 Key variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contextual environment</td>
<td>• Social &amp; Demographic</td>
</tr>
<tr>
<td>Working environment</td>
<td>• Economic</td>
</tr>
<tr>
<td>Policies in Healthcare</td>
<td>• Technological</td>
</tr>
<tr>
<td>• Health professionals (Doctors &amp; Nurses)</td>
<td>• Primary Care</td>
</tr>
<tr>
<td>• Primary Care</td>
<td>• Hospitals</td>
</tr>
<tr>
<td>• Hospitals</td>
<td>• Pharmacies</td>
</tr>
</tbody>
</table>

**Figure 5** – 3 dimensions (policies in healthcare, working environment and contextual environment) identified to classify the 7 key variables selected (Primary Care, Hospitals, Pharmacies, Health professionals, Social & Demographic, Economic and Technological).

The final step of this phase, as we had seen, was the development of causal maps for each healthcare indicator, manually built in the decision explorer software®, according to the information obtained in the influence matrix. A global causal map was decomposed in its smaller causal maps to illustrate the causal relationships between indicators, figure 7, and to analyse the problem variables affecting each indicator, as exemplified in figure 8 for the indicator of “Hospital proximity”.

To understand the logic behind the causal maps it is important to note that in each map: the green box illustrates the dimension of healthcare determinants and the green lines define connotative relationships, that is, the indicators related to healthcare dimension. The red boxes are the healthcare determinants (or indicators) and the yellow boxes are the problem variables. The black arrows define the causal relationships between elements.

![Figure 7 - Causal map extracted from the global causal map selecting the indicator of “Primary Care proximity”](image)

Having identified the key variables of the problem, the phase 4 will describe the scenarios construction developed with a morphological analysis tool.

**D. Phase 4 – Scenarios construction**

This phase aims to develop and obtain relevant, coherent and plausible configurations of key variables possibilities, using the morphological analysis, which is, essentially, a method for identifying and investigating the total set of possible relationships or contained in a given problem complex (Ritchey 1998b).

To perform a morphological analysis it is necessary to firstly select the components/key variables of the problem (already identified in phase 3) and its hypotheses of future evolution. In this specific application, we defined two hypothesis for each key variable, as illustrated in table 2.

**Table 1 – Table of hypotheses.**

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Key variables</th>
<th>Description</th>
<th>Hypothesis 1</th>
<th>Hypothesis 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policies in Healthcare</td>
<td>Primary Care</td>
<td>How will the policies in the health sector for Primary Care?</td>
<td>Primary Care Reform</td>
<td>Maintenance of the current Primary Care service and policies</td>
</tr>
<tr>
<td>Hospitals</td>
<td>Primary Care</td>
<td>How will the policies in the health sector for Primary Care?</td>
<td>Hospital Reform: Increase in ambulatory care and day hospitals</td>
<td>Maintenance of the current hospital policies</td>
</tr>
<tr>
<td>Pharmacies</td>
<td>Primary Care</td>
<td>How will the policies in the health sector for Pharmacies?</td>
<td>Increase in the number of health professionals (doctors &amp; nurses)</td>
<td>Maintenance/Decrease in the number of health professionals (doctors &amp; nurses)</td>
</tr>
<tr>
<td>Working environment</td>
<td>Professionals</td>
<td>How will evolve social and demographic factors?</td>
<td>Increase in the number of health professionals (doctors &amp; nurses)</td>
<td>Increase in the number of health professionals (doctors &amp; nurses)</td>
</tr>
<tr>
<td>Social &amp; Demographic</td>
<td>Economic</td>
<td>How will evolve economic factors?</td>
<td>Increase in the NHS budget and economic recovery</td>
<td>Increased restrictions in the NHS budget</td>
</tr>
<tr>
<td>Economic</td>
<td>Technological</td>
<td>How will be the adoption of new technologies in health?</td>
<td>Fast introduction of new technologies in health: telemedicine, self-diagnosis, less invasive techniques</td>
<td>Less and progressive introduction of new technologies</td>
</tr>
</tbody>
</table>

This way, having two hypotheses for each of the 7 key variables, we will obtain 2⁷ = 128 possible combinations of configurations, which is our number of solutions in the initial space or morphological field.

The next is to define a set of exclusion constraints between hypotheses to reduce the morphological field and consequently to reduce the total set of possible configurations in the problem space to a smaller set of internally consistent configurations representing a solution space (Ritchey 1998b).

The next step in morphological analysis is to implement table 2 in Morphol software and define a set of exclusion constraints
between hypotheses to reduce the morphological field and consequently to reduce the total set of possible configurations in the problem space to a smaller set of internally consistent configurations representing a solution space (Ritchey 1998b).

The exclusion constraints were identified through a pairwise comparison of the hypotheses, excluding all incompatible pairs. Additionally, a group of 3 hypotheses was also excluded because of its incompatibility. These 8 exclusion constraints are then directly inserted in Morphol and detailed in table 3:

**Table 2 – Exclusion constraints.**

<table>
<thead>
<tr>
<th>“Primary Care Reform”</th>
<th>“Maintenance/Decrease in the number of health professionals (doctors and nurses)”</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Primary Care Reform”</td>
<td>“Increased restrictions in NHB”</td>
</tr>
<tr>
<td>“Hospital Reform: Increase in ambulatory care and day hospitals”</td>
<td>“Increased restrictions in NHB”</td>
</tr>
<tr>
<td>“Hospital Reform: Increase in ambulatory care and day hospitals”</td>
<td>“Less and progressive introduction of new technologies”</td>
</tr>
<tr>
<td>“Aging and decrease of the Portuguese population”</td>
<td>“Maintenance/Decrease in the number of health professionals (doctors and nurses)”</td>
</tr>
<tr>
<td>“Increase in the number of health professionals (doctors and nurses)”</td>
<td>“Increased restriction in NHB budget”</td>
</tr>
<tr>
<td>“Increase in NHB budget and economic recovery”</td>
<td>“Maintenance/Decrease in the number of health professionals (doctors and nurses)”</td>
</tr>
<tr>
<td>“Fast introduction of new technologies in health: telemedicine, self-diagnosis, less/massive techniques”</td>
<td>“Maintenance of the current Primary Care network and policies”</td>
</tr>
</tbody>
</table>

An exclusion constraint means that all possible configurations that include that pair (or triplet) of hypothesis will be excluded. Therefore, after executing the exclusion constraints, the initial space of 128 possible configurations is reduced to a morphological field of 22 configurations.

The Morphol calculations enables us to determine the number of common hypotheses between every scenarios and it enables the calculation of “Proximities indicators”, shown in the Indicator matrix of figure 9.

According to the advantages and disadvantages of each one, “Proximities map” and “Indicator matrix” are the key tools to select the correct scenario configurations to develop narratives in the next phase. Therefore, the chosen scenarios identified in figures 10, were:

- **Scenario 3: 1 1 2 1 1 1** – this scenario has a CT value of 86 common hypotheses with the rest of scenario group and a CM value of 4 closest scenarios (1, 4, 9 and 15), which should not be chosen. Its CX value means this scenario is completely different from scenario 19 once one is in the left limit of the proximities map and the other is in the right limit.

- **Scenario 10: 1 2 2 1 1 2** – this scenario has a CT value of 90 common hypotheses with the rest of scenario group and a CM value of 4 closest scenarios (5, 9, 12, and 20), which should not be chosen. This scenario was also chosen for being in the top limit of the proximities map.

- **Scenario 14: 2 1 1 1 2 1** – this scenario has a CT value of 86 common hypotheses with the rest of scenario group and a CM value of 3 closest scenarios (2, 13, 16), which should not be chosen. This scenario was chosen for being in the bottom limit of the proximities, which means it is almost completely different from scenario 10.

- **Scenario 19: 2 2 1 2 2 2** – this scenario has the lowest CT value (54 common hypotheses with the rest of scenario group), which means it is a scenario with minimum compatibility. It has only one closest scenario (22) that
The Primary Care and Hospital reforms will only be possible with the economic recovery and an increase in the NHS budget. Supporting these reforms, there will be a fast introduction of new technologies in health including new less invasive surgical techniques and an increase in telemedicine, self-diagnosis, monitoring and self-administration.

2) Scenario Two – “Better Primary Care, Old Problems”
Scenario two corresponds to scenario 10 of table 4. The “Better Primary Care, Old Problem” scenario represents a change in Primary Care, given the ageing population. The provision of Primary Health Care will, once more, face an organizational transforming reform with the objective of giving access to all citizens to high-quality and community-based health care, which includes all the changes already mentioned in scenario One. However, Hospital Care will maintain its current healthcare policies and the hospitals network will remain unchanged. Regarding Pharmacies, once again, there will be more responsibilities to pharmacies in pharmaceutical care. This way, the number of doctors and nurses will increase but only in Primary Care. The Primary Care reform will be driven by the economic recovery and by an increase in NHS budget but will be followed by a less and progressive introduction on new technologies in health.

3) Scenario Three – “Hospital Reform”
Scenario three corresponds to scenario 14 of table 4. The “Hospital Reform” scenario represents a change in Hospital Care driven by a fast introduction of new technologies in Health, including less invasive techniques which enable an increase in ambulatory care and day hospitals. However, there will be a maintenance not only of the current Primary Care network and policies but also in the pharmacies legislation. The number of health professionals (doctors and nurses) will increase but only in Hospitals.

The economic recovery and, once more, the increase in NHS budget will enable this Hospital Reform and support a slight increase in natality and the maintenance of the Portuguese population.

4) Scenario Four – “Health If You Can Get It”
Scenario four corresponds to scenario 19 from table 4. The “Health If You Can Get It” scenario represents a general maintenance of the main policies in HealthCare, including Primary Care, Hospitals and Pharmacies.

The National Health System will continue to experience severe budget restrictions, including an increase in user charges and a decrease in healthcare exemptions. The shortage of doctors and nurses in Primary Care hurts community health centres, which struggle to treat many new patients who otherwise prefer the more expensive private health services.

Regarding health professionals, there will be a
maintenance or perhaps a decrease in the number of doctors in hospitals and health centres, due to an increase of retirements and emigration of professionals. The public health sector becomes less attractive to Health Professionals who also have preference for the private health sector. At the same time, it is expected an increase in hiring foreign doctors.

There will be a migratory pattern of population from rural areas into urban areas, once there are also a high concentration of specialist doctors in these areas comparing to rural areas. There may be a slight increase in natality but with an increase of high-risk pregnancies due to unhealthy lifestyles and pregnancies at a later age. This way, the introduction of new technologies will be slow and progressive.

Table 5 presents forecasts for healthcare determinants that resulted from the subjective experts' opinions. They are merely indicative of the possible and plausible quantitative evolution of the healthcare indicators for each scenario, compared to the historic value of the last year available.

First of all, the selection of a correct set of experts, with multiple background, perspectives and experiences, is of great importance to obtain the desirable results. In this case, we invited a list of 44 remarkable experts but only 10 experts effectively completed the questioning protocol and this fact may have had impact in the final results because we could not get a representative sample of answers. However, the 10 experts were enough to enables us to test the methodology.

The web-platform was an interesting way to collaborate with the experts, not only because it is a less costly and time consuming participatory method, but also because allows us to capture the diversity of perspectives and answers without group bias due to face to face contacts.

The questioning protocol was carefully developed to fulfil the purpose of obtain quantitative and qualitative elements regarding the future evolution of the healthcare determinants. However, the option for providing information from the past each indicator may have led to a risk of thinking that the future would simply follow the trends of the past and thus to more conservative answers.

The obtained experts’ answers were, in some cases, very long which was helpful in the phase 3 of the problem and key variables identification and causal maps development. This phase requires a strong content analysis of the experts’ information and is very dependent on who performs it. It is also important to note that throughout this process there is always loss of information.

The morphological analysis is unfortunately an unknown or forgotten method despite its simplicity and virtues. The Morphol method for the construction of scenarios is made-up of numerous stages in defining variables, hypotheses and then obtaining possible configurations. Regarding the results of morphological analysis, we may comment this tool as being very useful to reduce the space of possible solutions (in this case, 128 combinations) to a manageable number of possible and internally consistent configurations, once it is necessary to identify what are the incompatible hypotheses.

As illustrated in figure 4, between the phase four and five, it is desirable to perform a workshop with the experts group to adjust and validate the results of the morphological analysis. Moreover, another workshop should be executed after phase five in order to validate the final scenario narratives. However these workshops were not performed due to logistic questions and also because they were not the priority to the objectives of this thesis.

The four developed scenario narratives can help Health policy and decision-makers identifying causes for the distinct evolution patterns on population health and enabling them to act on factors that promote population health.

### VII. Final Remarks

In this thesis, we have reviewed the main concepts of foresight and scenario planning, as well as the relevant scenario studies in health. This literature review, made clear that there is no standardized methodology for building scenarios. Moreover, there has been little research on using population health scenarios in general, and specifically for Portugal.

In chapter IV, we proposed a new methodology to build scenarios for population health, being applied to mainland Portugal. The starting point was to develop a new approach
having current information on a population health index and aiming to build scenarios that can influence the evolution of population health as captured by the index. Making use of views of experts with multiple and relevant perspectives for population health, we collected qualitative and quantitative information for building scenarios.

The influence and dependence between variables is of great importance to understand the problem. This way, the development of the causal maps proved to be a stepping stone when producing future scenarios, since it helped us to structure the experts’ beliefs about causal relationships between indicators and problem variables and then to obtain the key variables.

The use of morphological analysis proved to be a key method for our methodology and it can be trusted as a useful, non-quantified method for investigating problem complexes (Ritchey 1998b). It may help us to discover new relationships or configurations which may not be so evident, or which we might have overlooked by other less structured methods (Ritchey 1998a). Properly applied, morphological analysis offers an excellent balance between freedom and necessary constraints (Ritchey 1998a).

Therefore, we developed a different and innovative approach to scenario building, since its various techniques and tools have never been used in the same approach. The results from the analysis of experts’ answers together with the Morphol outputs are the basis for the development of scenario narratives. It is also as a process-oriented methodology whose insights and learning arising from the process are more important that the final scenario narratives. Scenarios are not forecasts or preferences, but plausible stories about the future. They depict relevant and divergent possibilities providing a rich context for improving decision-making in the present (World Economic Forum 2013). This way, the four developed scenarios can help leaders in health and healthcare to apply a future perspective to their own work, considering the inherent uncertainty that characterizes the evolution of population health determinants and outcomes.

As future work, the proposed methodology will be potentially applied to the EURO-HEALTHY project, to model future scenarios of population health for the European context. Throughout this methodology there are some phases which may be improved and future research should:

- Apply the methodology to the entire population health index of the EURO-HEALTHY project;
- Improve the implementation of the Web-Platform to obtain a better collaboration with experts;
- Improve the questioning protocol to obtain more accurate quantitative and qualitative answers;
- Define a more demanding set of criteria to select the experts group;
- Improve the development of more “visual-friendly” causal maps;
- Discuss methods for the analysis of experts’ answers;
- Develop a more complete platform for morphological analysis;
- Perform the two workshop phases to adjust and validate with the experts the results of the morphological analysis and to final validate the scenario narratives;
- From scenarios, discuss opportunities and strategic options for the future of health and healthcare.

In the beginning of this thesis, we put the question “How will population health look like in Portugal in the year 2025?” and, at the end, we think this new methodology for building population health scenarios was successful in exploring different ways of giving answers to this question.

VIII. REFERENCES