

How to evaluate and select policies in the context of a population health index? A multi-methodology to assist policy-makers under uncertain conditions

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Abstract – Throughout the world, indexes have been developed to provide a systematized and aggregated way to observe specific phenomenon across different contexts, being the population health (PH) one of those. In fact, the EURO-HEALTHY project proposed itself to build a Population Health Index (PHI) that would describe the state of the PH across Europe. Although these indexes provide a good basis for evaluating and selecting policies with the highest potential to PH and reduce health inequalities, no literature has provided tools to evaluate policies while departing from a PHI.

Departing from the PHI developed in the EURO-HEALTHY project, this thesis develops a multi-methodology using the MACBETH approach, to evaluate and select policies with the highest potential to promote health and health equity, which follows a set of steps: a) structuring of the policy evaluation problem departing from a PHI; b) identification of the key policy goals and their operationalization; c) development of a participatory process using MACBETH and other concepts from Multi-Criteria Decision Analysis to evaluate policies on an overall benefit unit; d) analysis of policies' doability in light of the EURO-HEALTHY PH scenarios; e) use of concepts of multi-criteria portfolio decision analysis to assist the selection of policies that maximize the overall benefit while considering their doability, as well as conflict aspects captured by the number of countries benefiting from each policy.

Furthermore, this multi-methodology can be used in different index settings. The provided illustrative example shows the information basis, the questioning protocols and the results of applying such methodology.

Keywords – Population health; health policy; policy evaluation; policy selection; multi-methodology;

I. INTRODUCTION

In the current context of increasingly complex problems arose the need to develop a tool to aggregate information within a single unit, which led to the creation of index. In time, a wide range of fields started to use this tools in order to study specific phenomenon in a structured and aggregated manner allowing to the development of new insights. It was relatively recently that, within the health field, the use this tools started, in order to characterize the current state of health of a population.

Currently, it is widely accepted that there is a multiplicity of dimensions that impact the population health. Even though the definition of such dimensions is clear, there is a need, from decision makers and policy formulators, to assess the impact, on population health, of undertaking (or not at all) specific courses of action. For decision makers, it is of utmost importance to determine the portfolio of policies that have the potential to generate the best outcomes.

Following this need, we aim at the development of a novel multi-methodology to determine which policies have the highest potential to promote health and fight health inequalities in the context of a population health index which consists in making use of a common analytical tools to determine, at first, the impact of specific policies in the context of a population health index, followed by the use of multi-criteria decision analysis and resource allocation concepts to develop a tool to support decision making, regarding the selection of policies.

The fundamental importance of this methodology arises at a time where an increase in health expenditure requires, more than ever, the promotion of policies that accomplish the highest health gains along with the increase in health equity within each region and in Europe. The significance of this thesis is further augmented by the current stage of the European Project, where uncertainties regarding the future of the union are growing.

The main goal of this thesis is to develop a multi-methodology to assist decision-makers in the evaluation and selection of policies with the highest potential to promote health and to mitigate health inequalities in the context of a population health index. The development of this multi-methodology starts with a throughout research for literature regarding this topic. Later on, in order to test the multi-methodology, an illustrative application is performed using a set of sample policies and targets.

II. CONTEXT

A. Key Concepts of Health

In the beginning of the work, there was a need to clarify the terms ranging from “policy” to “public policy” and finally to “health policy” and which of the several definitions, in literature, would provide us the baseline for our work.

Firstly, according to the Oxford Dictionary, it has been found that policy is either a “contract of insurance” or “a course or principle of action adopted by an organization or individual” [1].

Secondly, it was verified that among different authors, several definitions might be encountered to public policy: Clarke E. Cochran et al stated that stated that “public policy always refers to the actions of government and the intentions that determine these actions”, furthermore they also say that “public policy is the outcome in the struggle in government over who gets what” [2]. Besides, Thomas Dye adopts a wider view for the public policy definition saying that it comprises all the actions that undertaken, or not at all, by the government [3]. Furthermore, Charles L. Cochran and Eloise F. Malone consider that it “consists of political decisions for implementing programs to archive societal goals” [4].

Health Policy constitutes a subsection of public policy. Given that the field that this work is focused is health, it was found to be relevant the characterization of this concept. It has been found that, according to the WHO – who build its own definition of it –, stated that “Health policy refers to the specific decisions, plans and actions that are undertaken to achieve specific healthcare goals within a society”, allowing to establish targets for medium to long term achievements [5]. Considering the key attributes of public policy identified, it is possible to state that the WHO organization’s definition is line with them, thus it will be the ground for this work.

B. Population Health

Population Health represents a crucial concept in the context of this work. Nonetheless, there is a wide range of definitions from multiple authors regarding this concept, thus not being possible to state a consensual one. Through time, different authors proposed definitions for the concept in stake [6].

In spite of creating an understanding about population health, there was a need to define the concepts of determinants of health and also health outcomes [7]. Such concepts serve as ground to the measurement of the overall population health. The first, determinants of health, is concerned is concerned with specific events, such as mortality and disease incidence [7].

The WHO, has defined determinants of health as: “the conditions in which people are born, grow, work, live and age, and the wider set of forces and systems shaping the conditions of daily life” [8]. In other words, such determinants include factors that might impact, in any way, i.e., directly or indirectly, the health status of a person and, therefore, leading to different health outcomes [8].

Furthermore, considering the general model proposed by Evans and Stoddart, it is possible to characterize the determinants of health into five different classes, such as: Social determinant; Physical environmental; Healthcare determinant; Genetic; Behavioral determinantst[9].

C. Population Health Indexes

1. GeoHealthS

The GeoHealthS (Geography of Health Status – An application of a Population Health Index in the last 20 years) project set its main goal the evaluation of health of the Portuguese population during the past 20 years [10]. In order to achieve what was proposed it has been undertaken the development of a Population Health Index – latter named as INES – at the municipality level [11].

In the hope that a consensual agreement on how the index would reflect the population health would be reached, a socio–technical process was selected [10]. Here, the social part of the process is not only concerned with actual evidence from research and literature, but also with the integration of the points of view of the stakeholders, making use of participatory methods (Delphi panels and Decision Conferences) [10]. Additionally, the technical side makes use of

computerized tools to develop a multi-criteria decision analysis model (MACBETH) [10].

As a result, from this work, the INES was created featuring 6 areas of concern, that correspond to the previously mentioned determinants of health – except for the genetic determinant that is not contemplated –, and the two most used dimensions of measurement of health outcomes, particularly the mortality and morbidity [11].

Furthermore, the 6 areas of concern jointly integrate 46 dimensions, where each one has, at least, one indicator assigned. This multiplicity aims at the characterization of all the 279 mentioned Portuguese municipalities in three moments across the last 26 years – in 1991, 2001 and 2011 – in each of the dimensions [10].

2. EURO-HEALTHY

EURO–HEALTHY (shaping EUROpean policies to promote HEALTH equity) is a Horizon2020 project that stands for the development of tools that assist in the understanding of which policies have the most potential in the pursue of health gains and equity, across Europe [12]. The development of such tool has its foundation in a Population Health Index (PHI) that encompasses the 27 EU countries alongside with the United Kingdom, 273 NUTS II regions, with a particular focus on 10 metropolitan areas [12].

As a result of such a wider index, it will comprehend various lower–level indicators [12]. In fact, at the level immediately below, two indexes are comprised [12]. Here, the first concerns with the health outcomes field and the other is concerned with the aggregation of the determinants [12]. Besides, indexes for each of the Public Health areas of concern, allowing assessing how policies might increase the overall performance.

Furthermore, in the EURO–HEALTHY program, given its nature that encompasses several countries within the EU, it was pursued a socio–technical approach that allowed to, on the one hand, use MCA in the technical side for building the model and on the other hand, stakeholders were asked to participate in the model’s construction, being this its social component [12].

D. Objectives

The main objective of this thesis I to develop a methodology to assess which policies have the most potential to maximize health and reduce health inequalities across Europe. Specifically, by departing from a systematized and aggregated representation of the population health throughout the different European regions, which allows to make comparisons among different policies. Besides, it also provide information regarding the extent of which different policies impact the different factors that contribute to the population health in an holistic and transparent way based on comprehensive methods.

III. LITERATURE REVIEW

The goal of this work is to develop a methodology to support the evaluation and selection of polices, particularly specific policies or portfolios that allow the increase in population health and promote health equity, while using a population health index.

Although there is a lack of studies related to this topic, and no studies regarding the evaluation of policies in the context of a PHI, this section will be focused on the review of concepts that can be useful in the development of the multi-methodology

A. Public Health Policy Evaluation

Policy evaluation tools are comprehensive and transparent tools that aim at the creation of knowledge to decision makers thus, allowing them throughout the decision making process by aggregating the information, hence reducing it, they have to be aware of in order to improve the efficiency and efficacy of the process.

1. The “Planning Programming Budgeting System” (PPBS)

The PPBS has been one of the earliest systematic policy formulation tools to be developed and implemented. Its implementation was attributed to the Systems Analysis Unit within the U.S. Defence Department in the mid 1960’s, with the main goal of attaining greater efficiency through the integration of budgeting with policy development [13].

Furthermore, as specified by DonVito, the main goal of the PPBS was to provide stakeholders with an improved analytical ground to improve program decision-making [13]. This managing function, consists on the definition of objectives, in a first moment, followed by the elicitation of courses of action that aim at the accomplishment of such objectives culminating in the selection and implementation of the chosen strategies [13].

2. Application of a multi-criteria decision analysis approach in Norway for clarifying the policy-makers preferences when evaluating public health policies.

Being one of the richest countries around the world and the second country with the highest health expenditure, following the USA, Norway owns of one of the highest levels concerning its population health [14]. Moreover, this country’s health system is defined as a “decentralized national health service with universal coverage of primary care under the responsibility of the municipalities and with specialized care under national governance” [15]. Also, the main focus of this system is to provide health care universally, according to each individual’s needs, aside of income, local or regional accountability [15].

Although this is true, the country has developed a broad system that allowed to reach a transparent solution to complex problems, through the use of scientific mechanisms [15]. Taking into account that Norway created, in 2001, the Patients’ Rights Act (PRA), it has been studied, through a multi-criteria decision analysis (MCDA) approach, if policy-makers’ real preferences are in line with the formal framework, elucidated in the PRA [15].

As a result of this process, a composite league table was created, whose utility lies in its ability to classify and rank interventions within a specific context [15]. This league table is an explanatory example of what is often perceived as the most important contribution of MCDA [15].

3. Using multi-criteria decision analysis in the development of a public health program in Ghana

Alongside with the health systems around the world, the Ministry of Health in Ghana acknowledges the need to address two broad objectives in this field: efficiency and equity [16]. In fact, these objectives are described in the second Five Year Programme Work (POW 2001–2006) where the vision, targets, priorities, strategies, resource envelope and resource allocation for this specific field are thoroughly described [16]. Furthermore, in order to assist in the enhancement of the third Five Year POW, Ghana’s Ministry of Health developed a program not only to identify, within society, groups that should be given priority, but also to aid in resource

allocation and to identify new evaluation dimensions that might impact in the selection of interventions [16] [17].

In order to respond to this question, multi-criteria decision analysis was performed to provide guidance in the priority setting of Ghana’s public sector [17]. Additionally, the selection of such tool was based on its ability to contribute to the transparency and accountability of the policy making process [17].

Through this project, it has been found that the Ghana’s policymakers are focusing their concerns towards vulnerable populations and the intervention’s cost-effectiveness, thus translating into a high concern amongst interventions in children health, reproductive health and communicable diseases. Diseases of the poor, at the other hand, were found that are not the preferred target for interventions, meaning that prioritization of such diseases is no longer increased, even though it is targeted to reduce inequalities among different socio-economical classes [16].

4. The MARCCO program – an example of the application of multi-criteria resource allocation in public health programs

The need for a transparent prioritization of interventions in the health sector, as stated before, is of utmost importance nowadays [18]. Within the Northern Lisbon group of health centers, it was created a community care division, whose goal was to deliver health services and education to all the population – having a greater focus on societal disadvantaged groups [18]. From within the mentioned need and the creation of this division, there was a need to develop a methodology to assist in the appraisal of the multiple projects that were to be selected [18].

This methodology was designed using multi-criteria decision analysis as the setting implementation and development and also making use of a socio-technical approach [18]. From this work, arose the Multi-Criteria model to Allocate human Resources in Community Care programs (MARCCO) [18].

Later on, after MARCCO’s model development, it was perceived as important to, not only apply it to the short-term evaluation but also in the long term, in order to provide a more accurate assessment of the policies to undertake [18]. Additionally, these two different time horizons, combined with different constraints allowed for the evaluation of programs within different scenarios [18]. Furthermore, this methodology permitted an efficiency analysis by comparing the overall benefit of the programs against their costs [18]. With the help of the PROBE software, this comparison was performed and recommendations, concerning the selection of the programs, were submitted to the stakeholders [18].

B. Analytical Models to Evaluate Policies

Within the succeeding section analytical models are to be presented, alongside their applications in the context of public health policy selection and evaluation.

1) Mathematical Programming Models

Mathematical programming models, in general, share a main goal of maximizing or minimizing a quantity, which is referred to as the objective function [19]. In this work’s context the objective function is comprised of several aggregated functions, i.e., an index, that, ultimately, aims at maximizing health gains and equity.

Furthermore, mathematical programming models involve a common structure that is composed of some components, some mentioned already [20]. These are: a) Objective functions – mathematical representation of the desired optimization value, either its maximization or minimization (e.g. profits or costs, respectively) [19]; b) Constrains – two types of constrains identified those that can

be violated at some cost, soft-constraints, and those that cannot, hard-constraints. They are used to limit the solutions [19]; *c*) Variables – variables that are being determined by the problem's solution. Typically, can't assume negative values [19]; *d*) Parameters – numerical values that describe the problem [19];

In short, these models, which are described by parameters, are used, as techniques to optimize the objective function, comprised of variables, by respecting the solution's constraints.

2) Multi-criteria decision analysis

Multi-criteria decision analysis (MCDA) is used in the public health policy context by measuring the value of different policies by aggregating the results from the single evaluations, each of which related to a specific criterion, in indicators whose aim is to describe the global performance.

Furthermore, it is relevant that this methodology can be computerized into a tool, its main goal is to assist in the decision making process by providing clear information to stakeholders concerning all the policy options, rather than substituting their role as final decision makers by a mathematical model [21], thus solely promoting "good decision making" [22].

Additionally, the methodology also enables the contemplation of many value systems in order to fully incorporate the individual stakeholders' preferences [21] and it should make itself as the favored methodology when there is the need for a consensual solution for a given problem.

Concerning the evaluation dimensions, they can be developed through different approaches. The top-down approach, that begins with the definition of the focus and, hierarchically, structures the tree of fundamental objectives or concerns [23]. On the contrary, the bottom-up approach, begins its construction with definition of the different policy's impact that will allow for the construction of a reliable set of evaluation dimensions [23]. Ultimately, it has been found that, in the "real world", the combination of both approaches might bring the best results [23].

3) Multi-criteria portfolio decision analysis

With the growing number and complexity of problems, mentioned in the previous section, it is clear that decision makers face, more than ever, the difficult task of accurately weight the costs and benefits [24]. It is possible to identify five causes to this struggle, i.e., properly determine which policies to pursue, and they are: *a*) Benefits usually illustrated by multiple objectives – frequently conflicting [24]; *b*) High number of possibilities decreases the possibility of an informed decision – impairing the ability to develop a deep knowledge of each policy [24]; *c*) The mutually optimal outcome, most of the times does not reflect the optimal outcomes of each separate unit [24]; *d*) High amount of people engaged in the process, thus leading to possible competition [25]; *e*) Lack of efficacy in implementation from actors that disagree on the allocation of resources. [24]

This lead to the development of a comprehensive method that arose from within the multi-criteria decision analysis methodology. The methodology allows to evaluate the impact of the different sources of uncertainty while addressing the problem at stake and properly prioritize the different portfolios under evaluation.

C. Public Health Policy Objectives

1) Equity

Equity is a wide-ranging concept that is addressed in multiple fields. Given the context of this work, the focus is the equity in

health concept. Furthermore, taking into account this multiplicity of fields that address this concept, contrarily to the previous section, there is a vast amount of literature concerning this topic.

To start, given the frequent misunderstanding of equity and equality concepts [26], it has been found of utmost importance to clarify both before advancing to a deeper characterization of equity. Equality is vital in the operationalization and measurement of equity [26]. Equity can be understood as: even though it might represent an inequality, it is perceived as just and fair [27].

Consequently, the definition of equity is presented. One of the most relevant definitions of equity in health is provided by the World Health Organization, stating that: "*Equity in Health: (i) the absence of systematic or potentially remediable differences in health status, access to healthcare and health-enhancing environments, and treatment in one or more dimensions of health across populations or population groups defined socially, economically, demographically or geographically within and across countries. (ii) a measure of the degree to which health policies are able to distribute well-being fairly*" [28].

Here, it is clear that the definition encompasses two different components that are perceived as very important to the context of this work. The first component is focused not only on the multiple dimensions of the population health, such as the state of health and access to health care, but also on the multiple locations and their differences in performance, which is the ground for the population health indexes' development [12].

2. Health Gains

Health gains can be described as the increases at the level of health indicators that, in turn, allow studying the evolution of the health context. Given the indicators' ability to express improvements in health results, those might be translated as gains in life years, reduction of the prevalence of diseases amongst others. Furthermore, there is a particularly relevance in studying the health gains that arose from the ability to intervene in avoidable cause through policies.

In the context of population health indexes, dimensions cover a wide range of subjects such as: air quality, access to quality health care, building environment, among others. In fact, these dimensions allow assessing the performance of a region in specific indicators. Besides, the impact of a policy can be determined by making computing the difference between the value after policy implementation and the initial value.

D. Motivation

Throughout the performed search of articles and studies for a methodology to evaluate and select policies using a PHI, we were not able to find any integral approach that allowed to tackle this issue. Accordingly, this reveals the need for a novel multi-methodology that combines multiple methods. Here lies the key motivation for this work, given the fact that there is a lack of literature methods that allow to, in a combined manner, to evaluate and select polices in the context of a PHI in order to allow the identification of the extent of which different policies impact specific factors that, consequently, improve the population health and reduce health inequalities. Hence, the main goal of this thesis is to fill this lack of methods in the evaluation of policies and allow an improvement in the process of evaluating and selecting policies that maximize population health and health equity.

IV. MULTI-METHODOLOGY

We used a normative approach to develop this thesis, which makes use of different methods, along the multiple stages of the work, in order to allow the evaluation policies and help select the ones that have the most potential to promote health and increase health equity in the context of a population health index. Furthermore, the used approach meets Minger’s definition of multi-methodology – the use of multiple methodologies within a single intervention and framework [29].

It is also relevant to explain that, the importance of using different methods within the different stages of this work lies on the fact that each of those stages presents challenges that need to be tackled. Consequently, each of those challenges needs distinctive methodologies for, successfully, overcoming them.

In order structure the multi-methodology, we departed from Belton’s model building framework [30]. It was clear since the beginning that the context of our problem was very different from the one we found in Belton’s, represented in Figure 1. The reason why we have decided to adapt this framework lied on the fact that we were working with multiple tools at the same time and thus creating a need for further steps and detail within the “Model Building” stage.

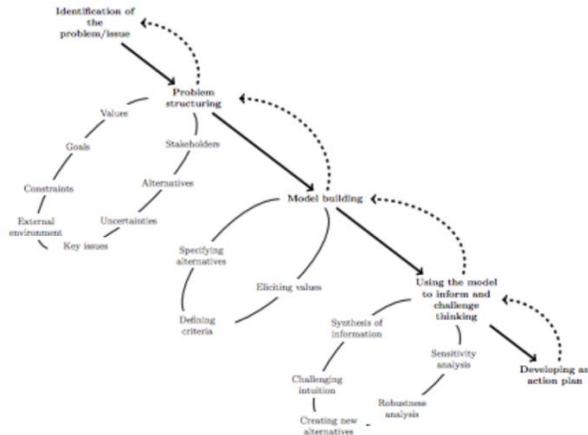


Figure 1 - Belton's framework for developing a multi-criteria analysis model [30]

Following that, we have arrived to the framework that was used. The summarized description of the work, illustrated in Figure 2, starts with the problem structuring, where stakeholders and their fundamental values are defined, core goals made explicit, the constraints and key issues are enumerated, uncertainties of this problem are made clear – also the influence relationships amongst them –, and, finally, some alternatives for the evaluation that allow to achieve the defined goals.

Secondly, we have designed the multi-methodology for policy evaluation and selection. This stage starts with the approach structuring, differentiating the multiple phases of the multi-methodology and the actions within. After, tool selection and design was performed to meet the actions’ needs for their successful completion. After the tools have been defined, evaluation dimensions were defined in order to allow for proper goal operationalization. Later, the adequate analysis space was defined, as well as the alternative interventions under analysis that were specified. Finally, weights were attributed to each of the evaluation dimensions and value models were built.

Lastly, the results communication was addressed. Here, sensitivity and robustness analysis of the model were performed and new alternatives explored. After that, visualization tools were selected and a tableau de board conceptualized for efficient information synthesis.

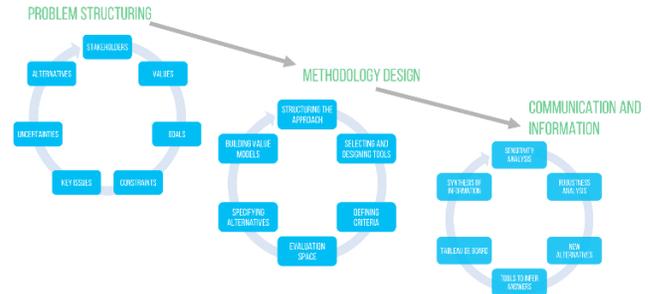


Figure 2 – Overview of the multi-methodology's framework

The main goal of this methodology is to assist decision makers, in the moments where they are faced with the problem of selecting, amongst multiple alternatives, the ones that will deliver the best results and attain specific objectives – in our context, improving population health and reducing health inequalities. In order to do so, we are going to make use of PHIs and ask for the decision makers’ contribution in making explicit decisions throughout the multiple phases of this work.

A. Problem Structuring

Here we will talk about the first stage of the multi-methodology, the problem structuring. This stage will allow to properly define the problem in different levels such as the identification of the stakeholders and their fundamental values, the main goals, the key issues and constraints, that are going to be encountered in the works’ development, uncertainties that need to be taken into account, and how do they influence each other, and also some alternatives in the development of this work.

Properly defining the stakeholders allows inferring their needs and preferences. We have identified the key stakeholders, in the context of public health policy, as European policy-makers, national policy-makers, regional policy-makers and also local policy-makers [31].

The fundamental values that guide the stakeholders’ vision provide also a baseline to identify their need and the main goals of the work. Values such as: universality, social justice, human dignity, solidarity, access to quality care and equity were found to be this baseline we were looking for [32].

Goal definition – and also operationalization – has a key role in the development of this work, across its different stages. There has been identified “Ends” and “Means” goals [22]. Being so, the “Ends” goals include the maximization of the population health and the maximization of the multiple equity measures across the regions under study – these goals have already been identified in the literature review in the chapter 3. Regarding the “Means” goals, these include the optimization of the policy design process and the optimization of the resource allocation. It is relevant to mention that, by meeting the “Means” goals, we are also getting closer to achieve “Ends” goals.

Furthermore, we also identified some key issues that are encountered in the context of evaluation and selection of policies., such as, which policies to evaluate, their classification in a relevant taxonomy, the bridging of policy results to indicators and indexes,

given the lack of data and finally, the cost analysis and implementation issues.

Besides, we have determined the uncertainties relevant to the problem in question. Also the identification of the relevant uncertainties, in the context of this work, it has been found important to divide these uncertainties, as seen in Figure 3, into two groups.

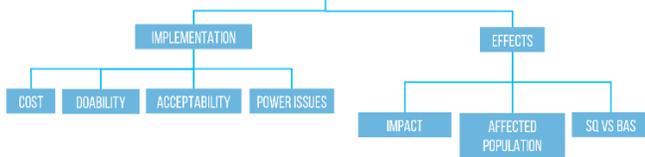


Figure 3 – Key uncertainties

B. Methodology Design

The first step of the “Methodology design” stage consists in the structuring of the approach. Here we have divided the multi-methodology in four phases that comprehend everything from data gathering up until the analysis. A brief description of the actions that are performed and used tools, under each of the phases is as follows. In phase 1, we are comparing population health indexes, in order to determine the approach used to characterize the population health, which was later used to perform the simulation of policies in the selected health index. In phase 2 we designed visualization tools in order to achieve an efficient communication of the Status Quo analysis. In phase 3 we used the Status Quo analysis of the previous phase and compare with the results of undertaking specific policies. This action enables us to assess the impact of a policy in the different regions and also areas of concern using different methods. Finally, in phase 4 we started to use MCDA that enables us to determine the benefit of the selected policies and their doability while taking into account the preferences of the different stakeholders.

The MACBETH® approach is among the many options within the multi-criteria decision analysis context. This approach allows the elicitation of weighting coefficients, through the interaction with the stakeholders where they provide qualitative judgments regarding the difference in attractiveness between options. An overview of the approach, and its multiple phases, is described in **Erro! A origem da referência não foi encontrada.**

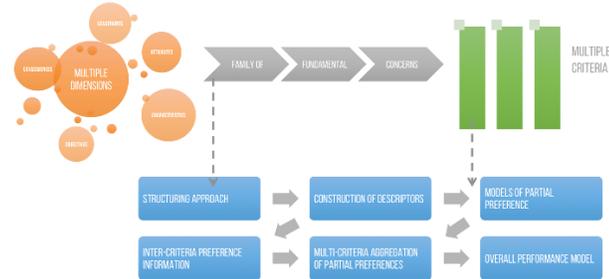


Figure 4 - Overview of the MACBETH® approach [33]

One of the main reasons to use this method lies on the fact that it has available a software with the approach implemented – the M-MACBETH® [34]. This software, not only allows a simpler implementation of the approach, but it also is able to identify judgments inconsistencies and propose alternatives for rectification. Moreover, the software translates the qualitative judgments in MACBETH scale – **Erro! A origem da referência não foi encontrada.** – to numerical scores and weights [24].

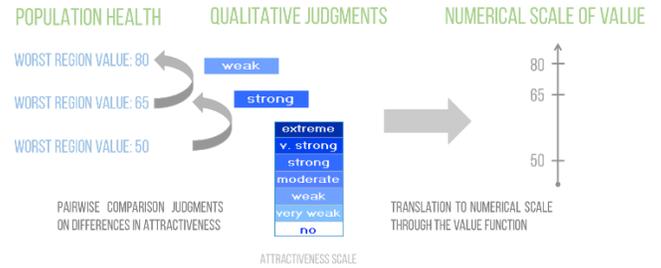


Figure 5 – Example of the application of MACBETH® in the conversion of qualitative judgments to a numerical scale (based on [18], [35], [36])

Depending on the preferences of the different policy makers, multiple models can be used in order to express those preferences, such as: Additive linear models, additive nonlinear models and non-additive nonlinear models.

At this point, we have specified two main concerns for the evaluation and selection of policies, i.e., the “evaluation goals” and the “implementation issues”, respectively. Within the evaluation goals we have the “maximize the population health” goal and the “increase equity” goal. Furthermore, inside the implementation issues goals we have the “minimize power issues” goal and “maximize acceptability” goal.

Finally, we are specifying potential evaluation dimensions for goal operationalization – illustrated in Figure 6. It is important to mention that these evaluation dimensions must be independent, exhaustive and non-redundant.

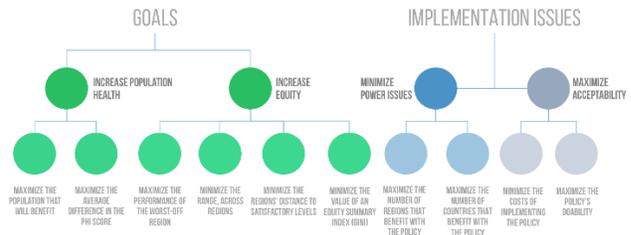


Figure 6 – Potential evaluation dimensions for the problem of evaluating policies in the context of a PHI

Bearing this in mind, we have selected, for the “improve population health” goal the following evaluation dimensions described in Figure 6.

C. Results Communication

In order to provide answers to policy-makers, regarding the evaluation and selection of public health policies, there is a need to choose tools that allow to accurately communicate the recommendations of the models. In order to do so, we need to define à priori what exactly do the policy-makers want to know, regarding public health policies.

Firstly, we have identified that one of the main concerns was to understand which policies, or policy packages, would bring the most overall benefit, accounting both for the promoting health and increasing health equity goals. This can be achieved by using performance bars where each of the policy packages’ benefit is represented.

Secondly, we recognized that, for the European policy-makers, power issues constituted one of the key aspects the needed to consider when implementing health policies, i.e., in order for the policies to be successfully approved and implemented by the European countries, it must target a broad number of countries and regions. In order to effectively display this information, we will

make use of maps where the countries and / or regions that will benefit with a given policy or policy package are highlighted

Besides that, there is a need to establish a European profile where it is possible to observe the current state of the population health and the impact of each policy on the SQ within each of the evaluation dimensions. This allows policy-makers to quickly understand how each policy or policy package is going to affect each of the evaluation dimensions side by-side, in an aggregated form, as illustrated in the Figure 7.

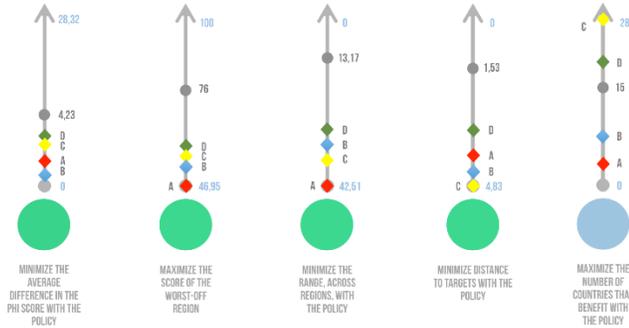


Figure 7- European profile, an example on how to visualize the impact of each policy on the different evaluation dimensions

At this point, and taking into account the policy-makers’ identified needs, there was a need to establish a central tool for communicating all of the information previously identified as central to selecting which policies to pursue. In order to do so, we decided that a graph that plotted the overall benefit in function of the doability of the different policies (or policy packages), in the two scenarios under study. Besides, this graph would also provide information regarding the number of countries that would benefit with each of the different options.

V. APPLICATION OF THE MULTI-METHODOLOGY

In this work, we selected the “Average PHI score”, the “Score of the worst-off region” and the “Range across regions” dimensions as the basis for the illustration that is being developed.

At this point we decided that the illustration of the application of the multi-methodology for policy evaluation, would make use of an additive linear model. The reasons we have selected this kind of model to the detriment of other type is associated with the fact that this model are [35]: a) Simple – the mathematical foundations of the model are easy to implement and to explain to the stakeholders; b) Widely known – allows for its use by many different stakeholders in multiple contexts; c) Allows the processing of a complex problem with evaluation dimensions of particular importance in a precise way; d) The fact that technical parameters enjoy an easy and clear interpretation – thus contributing for transparency; e) The ability to overcome constraints associated with the dependency relationships between two or more evaluation dimensions, through their aggregation in a higher-level criterion;

Furthermore, it is also important to mention that there is a concern, regarding the evaluation of policies, to use ratio scales. These scales have a common zero point and comprise numerical equalities, ranking order, equality in terms of intervals and ratios [37]. Therefore, these properties make them the right types of scales to use within this thesis context.

Given that this problem is framed within the context of the EURO-HEALTHY project, the starting point for the evaluation of policies is the PHI developed within this project that depicts the current state of population health across European regions. This is

what we refer to as the Status Quo (SQ) of population health in Europe. In line with the goals of improving population health and decreasing population health inequalities, we have considered, for this illustrative application of the multi-methodology, the following evaluation dimensions: The health of the European population, as captured by the average of the differences (between a model region and each of the regions) in the value of the PHI; Inequalities in population health across European regions, as captured by the population health score of the worst-off region and the range of population health between the best and the worst-off regions in Europe.

Accordingly, we can summarize the SQ health and the health equity profile in Europe as follows in Figure 8.



Figure 8 – SQ health and health equity profile in Europe

In order to apply the multi-methodology, there is a need to establish targets and to gather some samples of policies that are going to be under analysis.

Departing from the multidimensional SQ, described in the previous subsection, we can start to evaluate the impact of policies. Hypothetically, in each of these health and health equity dimensions it would be desirable to attain a situation in which all the regions have the highest possible population health levels (correspondent to the best levels of performance in each indicator of the PHI). That is, the best attainable situation would be for policies generating a PHI of 100 for all European regions.

Although, the best attainable level is ambitious and not realistic to be achieved until 2030. Accordingly, the Figure 9 visually portrays a target level. This target level represents a “model region” which was defined as the region that comprised the median value in each of the indicators, followed by the aggregation of these values into the EURO-HEALTHY’s PHI score.

Given that this case acts as a merely illustrative example, the targets were set for the “Average PHI score” the score of 4,23 was defined as it is the score of the “model region” and for the “Score of the worst-off region”, the score of 76. Besides, for the “Range across regions” the target was set as the difference between the “model region” and best region: 13,17.

Typically, this target levels is defined by the policy-makers, given their ability to establish what is within a reasonable level to achieve within the period to which the analysis refers to.

Accordingly, it is also the responsibility of the policy-makers to identify in which policies the analysis is performed. Given the illustrative nature of this application of the multi-methodology, we have selected three policy packages on which the analysis will be carried. These policy packages are:

Policy A: Policy package to support unemployment reduction, targeting regions with an unemployment rate above 20% and promoting a reduction in unemployment by 3 percentage points.

Policy B: Policy package to support the implementation of a pollution reduction program, targeting regions with PM2.5 pollution values above 20% and promoting its reduction by 1 percentage point.

Policy C: Policy package to fund a program for the reduction of tobacco users, targeting regions with a daily smokers rate above 20% and promoting its reduction by 1 percentage point.



Figure 9 - Targeted health and health equity levels to be pursued by policies vs. the SQ and the best attainable levels

In order to elicit weights and value functions, for the evaluation dimensions, we must take into consideration the approach that is being used to construct the model. In our case, we selected the MACBETH which requires attention to its unique questioning protocol in order for it to successfully translate the stakeholders' preferences. It makes use of two reference points for each of the evaluation dimensions, allowing for proper consideration between the swings before answering. In our context, the used reference points are the SQ (lower reference) and the target attainable level (higher reference).

An overview of the developed question protocol is as follows: Firstly, evaluators are asked to rank the evaluation dimensions in decreasing order of importance by answering questions such as: Consider that you are in the SQ in all of the evaluation dimensions, if you had to choose a policy package that would improve one, and only one, of the evaluation dimensions, from the SQ to the target level, which one would you choose? This question is then repeated, for the remaining evaluation aspects, until all have been classified. This step allows for the ordering of the evaluation dimensions, decreasingly in preference, on the MACBETH®'s weighting matrix.

Up next, evaluators are asked to classify, using MACBETH®'s semantic categories, in terms of attractiveness each of the evaluation dimensions, ranked previously, in the selected order. At this step, evaluators are asked questions like: How attractive would you consider, for de European Union, the improvement of the most important evaluation dimension, i.e. the one you selected first on the last step, from the SQ to the target level? Once again, this question is repeated for each of the remaining evaluation dimensions. The aim of these questions is to complete the last column of the MACBETH®'s weighting matrix.

After, it is asked to the evaluators to define the difference in attractiveness between achieving the target level in the most important dimension and in each of the other dimensions, using the seven semantic categories once again. This process is performed for every pair of evaluation dimensions in order to fully complete the MACBETH®'s weighting matrix.

Finally, in order to establish the value functions of the evaluation dimensions, it is asked to the evaluators to define the attractiveness of a swing from the SQ to the target level and a swing from the target to the best attainable level – illustrated in Figure 9. This process is performed sequentially for each dimension.

Furthermore, this questioning protocol has also been used to infer the policies' doability in two contrasting scenarios for the future of Europe. In this particular case, we firstly asked the evaluators to order the policies from the most to the less doable and to classify them in terms of doability, using the semantic categories from MACBETH. After, we asked them to judge the different in doability between all the possible pairs of policies (in our case, between Policy A and Policy B, Policy A and Policy C, Policy B and Policy C).

From this we were able to fill the judgements matrix in MACBETH and arrived to the results below, in Figure 10.

	[Worst]	[Range]	[PHI]	[all lower]	Current scale
[Worst]	no	moderate	moderate	extreme	4.3
[Range]		no	very weak	v. strong	3.1
[PHI]			no	v. strong	2.6
[all lower]				no	0

Consistent judgements

Figure 10- MACBETH's judgements matrix filled with the judgments gathered from the questioning protocol

Accordingly, we determined the overall benefit of each of the policies by filling the judgments matrix with the results from the questioning protocol.

Furthermore, we did the same for the policies' doability and arrived to the doability, for the different policies, which are described in Figure 11.

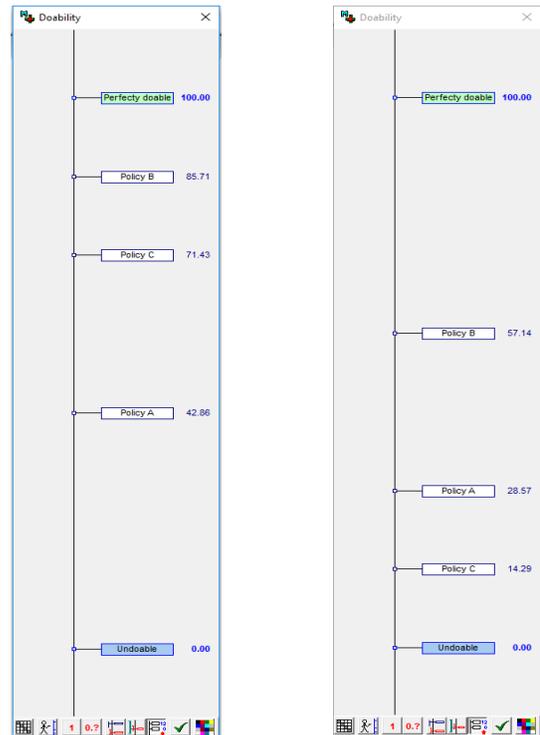


Figure 11 - Doability of the defined policy packages in the "Failing Europe" (left) and "Sustainable Prosperity" (right) scenarios.

Finally, from this results it has been possible to compile them into a graph that allows decision-makers to visualize the policies' benefit in function of their doability together with the number of countries that might benefit with each of those, as seen in Figure 12.

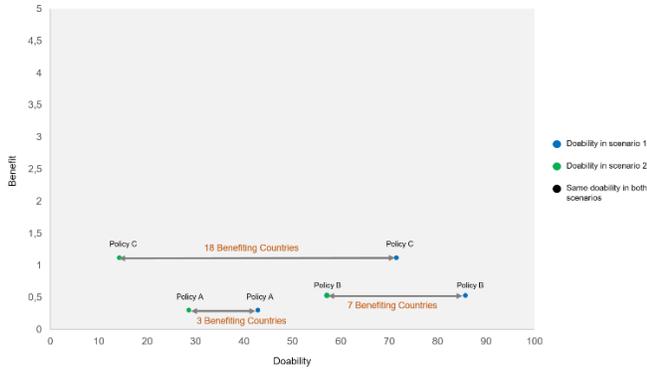


Figure 12 - Aggregated information regarding the overall benefit of policies, the policies' doability and the number of countries that benefit with the policies

VI. DISCUSSION

The main objective of this thesis was to develop a methodology that would allow to assess which policies have the most potential to promote population health and reduce health inequalities while making use of a population health index. In order to do so, a multi-methodology was presented, covering multiple aspects from the structuring of the problem to the identification and operationalization of the policy objectives, to the evaluation of policies with the MACBETH approach and the definition of some policies' doability with the help of scenarios. Furthermore, it provides tools to communicate the results of the evaluation, both specifically for each of the evaluation dimensions and aggregately, combining all the results in a single graph.

A. Main achievements of this work

The significance of this thesis arises from the lack of reliable quantitative methodologies to assist decision-makers in the process of evaluation and selection of policies promote health and health equity. It is important to bear in mind the fact that this work aims only to assist decision-makers. Furthermore, this thesis aimed at going further than the state-of-the-art, by providing a multi-methodology, which comprises different tools, to evaluate and select health policies while departing from a population health index, i.e., a novel multi-methodology that combines multiple tools, such as multi-criteria decision analysis, foresight and multi-criteria portfolio decision analysis.

The application of the multi-methodology used data and the PHI from the EURO-HEALTHY project along with the scenarios produced within the context of the same project. Even so, it is important to remember that the proposed multi-methodology is generic thus comprising the potential to be applied to different projects. Furthermore, the application of the multi-methodology comprised small sets of policies and evaluation dimensions, given its purpose of providing, with concrete examples, an illustration of the process of evaluating and selecting health policies, in the context of a population health index, and its potential as a decision support methodology to assist decision-makers.

B. Advantages and Disadvantages of the Multi-methodology

Given the high complexity of the field of population health and public health policies we have encountered the first key adversity that had to be overcome during the development and application of the multi-methodology. This adversity regarded the lack of a complete and holistic set of policies to be evaluated. This has been overcome with the creation of a few narrow and target oriented

policies we developed. Therefore, no comprehensive approach was developed to perform the selection from the supposedly initial set of policies.

Furthermore, the other key adversity we had to surpass was the fact that no policy-makers were participated in the process. This caused throwback in terms of the selection of the evaluation dimensions to use and in the definition of weights and value functions for those evaluation dimensions.

In fact, we believe that the results from the overall benefit unit constructed during the evaluation of the policies were greatly affected, at the one hand, by the lack of comprehensive and holistic policies or policy packages, at the second hand by the few evaluation dimensions used to assess the policies' benefit, on the third hand by the fact that the judgements that gave rise to the evaluation dimensions' weights and value functions were not provided by decision-makers but from a single evaluator from the EURO-HEALTHY project and finally, the fact that the ideal way to determine the status quo and the impact of policies was to make the calculations for all the indicators of the index and only after applying the index's aggregation, which has been found to be questionable given the kinds of indicators used. Accordingly, we performed the arithmetic average of the policies' impact from within the multiple averaging approaches that might be used. By performing a sensitivity analysis of the results from the MCDA model, the most appropriate technique to determine the policies' impact could have been found.

Additionally, we also believe that given the high number of indicators that the PHI comprises, this multi-methodology can produce better results in the evaluation and selection of strategies to improve population health and health equity instead of on the evaluation of field specific policies or policy packages.

Consequently, these resulted in skipping the application of the multi-criteria portfolio decision analysis, given the lack of available policies, thus not meeting the requisites to build multiple portfolios of policies to properly apply this approach. Besides, the last stage of the multi-methodology, hasn't been fully explored.

Also, there are some other models that might have been applied throughout the application of the methodology, such as: a) goal programming to determine the amount of resources to achieve a given target or to determine the extent of achievement of the target with the available resources [38].

Even with the presented weaknesses, this multi-methodology still has its advantages. For instance, it provides a transparent and holistic approach to the evaluation and selection of policies that promote public health and mitigate health inequalities. It also provides a clear and easy to interpret communication of the results by providing information regarding field specific information regarding the impact of the policies, it makes use of maps to efficiently demonstrate the regions and countries that benefit with each of the policies and finally it provides an aggregated way to see all the information relevant to selection of policies.

Besides, it had a practical application on the regions across Europe and it leveraged the results from the construction of scenarios to the future of Europe in the determination of the policies' doability, which produced very interesting results as a way to diminish the uncertainty, by providing two likely and contrasting scenarios regarding the future of Europe by the year of 2030.

VII. CONCLUSIONS

Throughout this thesis it has been identified the need to develop methods to assist in the evaluation and selection of policies that promote both an increase in population health and the reduction of

health inequalities. However, there is a lack of studies that address this need and none fully provides a holistic approach to the purpose in stake. Therefore, this thesis aims at going further and develop a multi-methodology that contributes to the reduction of the literature gap concerning the evaluation and selection of policies in the context of a PHI.

Furthermore, in order to achieve the goals we set for this work, we identified the multiple steps of the policy formulation cycle, the monitoring of the policies' impact and the aspects that determine the population health. Using different methods, we assessed the policies' impact on the current state of the population health – i.e. the Status Quo – followed by the construction of a questioning protocol that would allow to capture the decision-makers' judgments, regarding the attractiveness of the evaluation dimension, that would later be used in the construction of a multi-criteria decision analysis model that aggregated all the information into one overall benefit unit. Following that, two contrasting scenarios were used to establish the policies' doability in each of them in order to try to decrease the impact of uncertainty in the selection of policies. Finally, the number of countries that would benefit with each of the considered policies was determined and, lastly, the whole information was aggregated into one graph that effectively provided the results of the application of the multi-methodology.

Even though it has been found that the multi-methodology provided great insights regarding the policies' doability and successfully addressed the issue of eventual conflicts that would rise from the number of countries that benefit with each of the policies, the determination of the overall benefit of each of the policies was found to be small. On the one hand this could be explained by the fact that we were evaluation policies that targeted only one specific indicator which is not absolutely true, for instance, the implementation of a policy package that promoted the reduction of the unemployment rates will also have impact in the health habits, build environment amongst others. These side effects of a specific policy must be comprised within the policy impact assessment stage. On the other hand, we believe that the evaluation and selection of large and holistic strategies for the promotion of population health and health equity would comprise a higher degree in terms of the overall benefit of each of the strategies.

Finally, it is safe to state that this thesis accomplished the proposed objectives successfully, by providing a multi-methodology to evaluate and select policies in the context of a population health index that can be used in a wide range of realities.

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