EVALUATING HEALTHCARE ORGANIZATIONS WITH A NETWORK MODEL WHICH INTEGRATES ANP WITH A REVISED-BSC

Gabriella Marcarelli
University of Sannio
Benevento, Italy
gabriella.marcarelli@gmail.com

ABSTRACT

The evaluation of healthcare organizations is complex due to the trade-offs between all healthcare features, benefits and costs to consider and the great number of stakeholders involved. Each healthcare policy is multidimensional and its criteria are both objective and subjective in nature, so multicriteria methods are appropriate decision-making tools for a general manager in the evaluation process. This paper proposes to evaluate the strategic policies of an Italian Healthcare Organization by means of the Analytic Network Process (ANP) integrated with a revised Balanced Scorecard (r-BSC) approach. This integrated network model allows one to take into account the micro-macro organizational setting opportunities and some normative constraints and incentives, typical of the Italian health context. So, it may be useful not only to rank strategic policies and derive priorities for perspectives, objectives and metrics involved in a strategic map, but also to assign a performance index to each element of the network model. *https://doi.org/10.13033/ijahp.v9i1.443*

Keywords: Healthcare organization; strategic management; Analytic Network Process; Balanced Scorecard; organizational decision making

1. Introduction

In recent years, in the health sector in Italy, as in other economically developed countries, deep changes have occurred as a result of the gradual aging of the population, the consequent growth of health care spending, the continuous progress of scientific and technological knowledge, increasing competition, the emergence of a greater awareness and attention for the quality of health care by users, and the chronic scarcity of available resources.

Since the nineties, Italian laws have intended to promote a more efficient and effective public health service management through decentralization and the introduction of a managerial vision. New organizational, managerial and accounting methods, typical of a company, have been introduced in Healthcare Organizations (HcOs) for translating strategies into operational terms. Healthcare organizations have paid attention to the

Balanced Scorecard (BSC), which allows them to define and enforce business strategies through an integrated and balanced system of qualitative and quantitative metrics: economic and financial metrics for measuring efficiency and quality and performance metrics for evaluating effectiveness and social sustainability. The BSC has the great advantage of aligning the strategy to operational management by bridging the gap between formulation and implementation of the strategy (Riccaboni, Busco, Bacci & Del Medico, 2008). HcOs need to adopt some tools and criteria to enable them to act effectively and efficiently and, therefore, to evaluate the overall results, in terms of consistency between resources employed and the results achieved in terms of protection of health.

The BSC has been applied as a tool for linking healthcare organization's long-term objectives and local operations and enhancing strategic linkage between central and local units. In Ramanathan and Ramanathan (2011) the BSC integrated with DEA (Data Envelopment Analysis) was applied to balanced performance evaluation of health authorities in the UK. In a comprehensive review, Zelman et al (2003) show that the BSC has been introduced across all areas related to healthcare. Some limitations and implications linked to the use of the BSC approach in the healthcare system have been explored by Chang (2007) and Bentes, Carneiro, Ferreira da Silva & Kimura (2012). First of all, the four dimensions of the BSC do not take into account the interests of some stakeholders (competitors, suppliers, community and regulators). The BSC was designed for profit-motivated organizations with the aim of maximizing the profit for the shareholder's of an organization. However, an organization operating in the public sector such as a healthcare facility, which has multiple objectives to deliver, may have difficulty incorporating a complex organizational and political context, institutional pressures and all causal relationships and conflicts within a simplified BSC framework (Chang 2007). Moreover, no standard mathematical method supports the BSC; thus, perspectives, objectives and metrics seldom have equal importance and, finally, relations among objectives and metrics are unidirectional (Bentes et al. 2012). In the healthcare context, the number of perspectives may be greater than four, so the number of performance objectives and metrics could be high and the evaluation could be more complex to deal with. Multicriteria methods are appropriate for facing these limits. HcOs and their policies are multidimensional and criteria involved are both objective and subjective in nature, so multicriteria methods would appear to be useful tools to handle the General Manager (GM). In particular, the Analytic Hierarchy Process (AHP) and the Analytic Network Process (ANP) analyze complex problems by combining both qualitative and quantitative aspects in a single framework (Saaty & Vargas 1982; Vargas 1990). Several applications of the AHP in the healthcare context exist (Forman & Gass, 2001; Liberatore & Nydick, 2008; Marcarelli, 2016; Sloane et al., 2003). It has been applied for defining the medical priorities of a community in order to determine hospital requirements, supporting the hospitals purchasing negotiation and evaluating organizational performance within the BSC approach (Saaty & Vargas 1982; Sloane et al., 2003; Bentes et al., 2012).

The ANP, used for coping with dependence and feedback, has been applied for modeling supply chains or evaluating different alternatives for end-of-life computers (Agarwal, Shankar, & Tiwari, 2006; Pramod & Banwet, 2010; Ravi et al., 2005). In the literature, some approaches that integrate the ANP with the BSC have been proposed for measuring management performance, evaluating the performance of a University in Taiwan,

defining an IT outsourcing strategy, and determining the weights for BSC perspectives (Chen, Huang & Cheng, 2009; Tzeng, 2010; Tjader, May, Shang, Vargas & Gao 2014; Tjader, Shang & Vargas, 2009; Thakkar, Deshmukh, Gupta & Shankar, 2007). However, in regards to a healthcare system, only a modified BSC has been applied for highlighting the necessity to consider more than 4 perspectives or a multicriteria method (such as AHP and ANP) has been suggested for deriving the weights to assign to perspectives or objectives/metrics.

This paper provides the GM of a HcO (local units or hospitals) with a strategic tool to analyze and select healthcare policies and strategies by integrating, within a single framework, a revised-Balanced Scorecard (r-BSC) with ANP. This model allows one to consider clinical and social implications, micro and macro organizational setting opportunities, and some normative constraints and incentives typical of the Italian health context (Ovretveit 1998; Cinelli, 2015; Hu, Wen, & Yan, 2015; Verzola et al., 2009).
The main contribution of this paper lies in the development of a comprehensive model (which incorporates ANP - rBSC) for analyzing a healthcare context (in particular, Italian healthcare organizations) characterized by a complex decision making process with many specificities. This model provides the analytical tool for ranking healthcare policies and measuring relative and global weight of each network element considered in the analysis (perspectives, objectives and metrics) by taking into accout the relationships among all the elements.

2. The Italian healthcare system

2.1 An overview of the INHS

The institution of the Italian National Health Service (INHS), founded in 1978, realizes the constitutional principle of health protection as a fundamental right of the individual and collective interest. The INHS differs from two health systems adopted in previous decades, that is, voluntary insurance and social security (of illness). The previous insurance system was suitable for achieving disease protection, thereby insuring at the moment when the disease had occurred, but could not be used to prevent. While in previous models, insurers simply pay back health costs incurred by clients, in the INHS the coverage provides uniform healthcare access to citizens by means of taxation, following a model similar to the Beveridge model developed by the British NHS (Nuti & Seghieri, 2013). The INHS is organized into three levels: national - the central government, regional and local - health authorities, and hospitals (Cinelli, 2015; Balduzzi & Carpani, 2013).

In the nineties, some legislative reforms of the INHS (see Legislative Decrees 502/1992 and 517/1993) transferred administrative and organizational responsibilities from the central government to the Regions, and transformed local health units and hospitals into public companies giving them broad management autonomy. The local health authorities have a purchasing function and the hospital units have a function of providing specialized health services. The central government is in charge of the general functions of planning, coordinating and control and the determination of Essential Assistance Levels (EAL), that is, benefits and services that the INHS has to provide to all citizens, free of charge or for a fee (ticket). Regions are responsible for institutional structure, organizational model of service delivery and funding criteria. Local health authorities, directed by public managers appointed by the Regions, manage services in the territory of competence and

are organized into Districts to supply health services of primary assistance and first aid. Health federalism focuses on the passage from a financing policy based on historic spending to one based on standard costs and requirements for each Region. Transfers to the Regions occur according to standard costs, that is, per capita spending supported by the most efficient Regions (benchmark) in supplying the EAL. Regions provide for the financing of local healthcare companies and hospital units according to different criteria. The former are financed according to the number of citizens residing in the territory of competence (by taking into account epidemiological and demographic factors), the latter are financed under the services actually provided (diagnosis related groups - DRG) and also receive a lump sum funding for highly specialized services.

2.2 The role of the General Manager

The management of health services is well-structured with regards to its functions (strategic and professional trend and management), the complexity of the organizational structures, and the different professional roles (medical, health, technical, administrative). At the top there is management including the GM, selected by the Region, and the chief administrative and medical officers, selected by the GM; at a lower level there is the operational management that is divided into the roles of medical, health and technical-administrative personnel (Fragale, 2013; Balduzzi & Carpani, 2013). The GM plays a key role because he or she attempts to find an internal balance between the need to ensure effective performance to users (quality of care and wellbeing) and the need to optimize the operational results, by taking as reference the centrality of the patient (Marcarelli, 2016). He is responsible for the results achieved by the company. By comparing the points of view of the main actors of the health system, the top manager, on the one hand, and the medical officer, on the other hand, it has been shown that common purposes and objectives do not always exist. Is it better to pay attention to health by improving the quality of care or to DRG? The GM should ensure that the mix of services and procedures provided is that which will give the greatest benefit for the population served at lowest risk and cost: rationalization of input and efficiency of output and outcome (Table 1). The future sustainability of the INHS is influenced by the increasing demand for health services by the population and the reduction of resources involved in financing the National Health Service (Toth, 2014). Financial measures undertaken in recent years by the Italian government have caused a curtailment of the national health fund. The spending review has imposed a reduction of the number of hospital beds by regions. Therefore, on the one hand, there are additional costs due to the aging population and the increase in chronic diseases, and, on the other hand, the new frontiers of medical science and the complexity of health services are constantly growing. Central and local government should consider these constraints and the need to cut both the expenditure and taxes for the low economic growth. The costs of health systems are determined by the offerings, such as new therapies and technologies, and the growing expectations of the population in terms of protection against risks to health and access to high quality healthcare.

Indeed, the aim of the last reforms of the INHS was to control expenditures and promote quality, efficiency and citizen satisfaction. Health conditions and longevity are influenced by many factors and conditions including hereditary characteristics (genetic heritage), social and physical environment, socio-economic status, and lifestyle (Marmot & Wilkinson, 2006; Gay et al., 2011; Figueras & Mckee, 2012). In 2012, the member states of the European Region of the World Health Organization agreed with a new common

model of politics which includes improving the health and wellbeing of populations, reducing inequalities in health, strengthening public health, and ensuring that health systems focus on the person, are universal, equitable, sustainable, high quality. This requires a new approach to healthcare systems in order to give priority to the prevention of disease, promote continuous improvement in the quality and supply of integrated services, ensure continuity of care, encourage autonomy in the care by patients and aim to provide support as close as possible to the patients home to protect the safety and cost-effectiveness (World Health Organization, 2013). Since the financing depends on the quality of services provided by the local health authority and its ability to attract users living outside the regional territory, in order to obtain greater financing, the GM of a local health organization could select policies that increase the quality of services and contain costs by also taking into account the healthcare offerings and demand in the regional and local territories by cooperating with other health organizations present locally (Clerico, 2015).

Table 1
Input, output and outcome

Input	Output	Outcome
Patients Technologies Material assets and services Employees Available spaces	Hospitalizations/drugs Outpatient services Laboratory tests	Patient safety Life quality/wellbeing

2.3 Macro and micro organizational setting: territorial integration and lean organization through information and communication technologies

Changes that occurred in the INHS in the 1990s involved HcOs getting a shift from bureaucratic-functional forms of organization (with an internal subdivision based on technical and operational homogeneity) to forms more oriented to resource management and results (divisional or matrix models). Traditional bureaucratic-functional models made horizontal integration hard to realize. A lean approach emerges in service organizations, as HcOs: it is characterized by flexibility, monitoring of inefficiencies and waste, customer value, and provision for the patient's centrality and the involvement of each operator in the improvement of performance (Costa et al., 2014). In regards to the organizational structure, at the local level, the keystone is represented by the local health structures with their Districts and Departments, focused on the results. Local health facilities are organized into departments. The Department is a sub-structure of the HcO and represents a managerial tool to coordinate clinical and organizational aspects of health services.

Attention to territorial assistance has modified services geography. The legislative decree No. 229, 1999, has extended the functions of Districts. They organize primary assistance, day surgery and home help. In coordination with hospital assistance, the Districts are responsible for managing social and healthcare activities delegated by municipalities and for supporting families and people in difficulty. They represent a place of social and health integration at the institutional, managerial and professional level. In order to

supply territorial health services, the Districts use several structures such as clinic, laboratory, hospice, and private hospital (rehab centre, nursing home). The concept of integration includes both the involvement of people in the health system and cooperation between different services with the aim of achieving common objectives. Inner integration is functional to outer cooperation. Several dimensions of integration exist: institutional, organizational, managerial, operational, and professional (Gosetti & La Rosa, 2006).

The integration may follow two directions: vertical, concerning different levels of government and responsibility within a given organization, and horizontal, concerning the relations among subjects (as professionals), organizational units or organizations, at the same level. In a context in which regionalization has resulted in widely differing situations, a particular role is played by information and its management in HcOs. Relations between data, information and knowledge have given rise to studies on health knowledge management. Technology, knowledge and human capital play an important role in organizations that take care of citizen health. The GM of a HcO plays a complex role because he has to balance managerial and organizational logistics with those connected to investments, such as technological ones. Socio-demographic changes and the need to balance available resources (economic, professional and organizational) and quality of healthcare assistance give rise to new modes of health services delivery that enable one to clearly trace a patient's path from the first moment they interact with the assistance network (Reina, 2012). The HTA is a strategic tool to meet the needs and expectations of citizens. Technologies entail an improvement in the level of satisfaction and the relationship with the patients, and facilitate communication and access to information and health resources. Furthermore, together with economic, professional and organizational resources, they improve the performance of a healthcare system. E-Health may involve several benefits:

- access to information about the patient's life history through the patient summary;
- improvement of service to citizens and support medical decisions;
- innovation in primary care through electronic health records, digitalization and electronic transmission of prescriptions and medical certificates;
- public identification by sharing useful information for health planning;
- improvement in access to health services by allowing citizens to reserve health services on the entire national territory.

Digital innovation of healthcare processes is a critical step to improve the cost-quality ratio of health services, limiting waste and inefficiencies, and reducing the differences between regions. Information and Communication Technologies (ICT) are crucial to managing the interdependencies and coordination requirements.

3. Evaluating strategies and policies of Healthcare Organizations

3.1 The Balanced Scorecard in health context: limits and opportunities

The Balanced Scorecard is a useful strategic measurement system, introduced by Norton and Kaplan (1992, 1996). It allows one to evaluate organizational performance from four perspectives (Financial, Customer, Internal Business Processes and Innovation Learning),

providing a balance between short-term and long-term objectives, financial and non-financial measures, lagging and leading indicators and internal and external perspectives. The BSC translates an organization strategy into four perspectives providing feedback around both internal business processes and external outcomes in order to continuously improve strategic performance and results. For each perspective a number of performance measures are considered. The BSC enables the manager to link the financial budget of a company with its strategic objectives and communicate strategic priorities of the GM to all levels of the hierarchy. Two main approaches to BSC may be used: one emphasizing a balance between perspectives, leading to focus on stakeholder satisfaction, and the other considering a hierarchy of perspectives, via strategy maps, in which some perspectives may be functional to the other. In regards to the latter, there is no single map, but the map depends on the organization features (Bisbe & Barrubés, 2012). In the hierarchy of perspectives there are cause-effect relationships between objectives which are simple and unidirectional, non-cyclical and do not involve conflict and compromises (no perspective or stakeholder has priority over the other).

The health system presents a dichotomy between the financial vision of the management and the clinical vision of healthcare professionals, so the BSC represents a good measurement system to integrate the two visions and control health costs, providing greater managerial flexibility. However, the use of BSC in healthcare exhibits some limits (Ramanathan & Ramanathan, 2011; Chang, 2007; Bentes et al. 2012):

- no standard mathematical method supports the BSC;
- perspectives and metrics seldom have equal importance;
- more than four perspectives are usually considered but, with increasing the number of perspectives, the number of performance measures increases and the evaluation may be more complex to deal with.

3.2 Outline of steps of the ANP

The ANP is a multicriteria method developed by Saaty for coping with problems that present dependence and feedback. The first step of the ANP is the decomposition of the problem into a set of decision elements (objectives, criteria, subcriteria and alternatives) which form a network of clusters and interactions between and within these clusters. In the simplest case there exists a single network, where all clusters can influence or can be influenced by the other clusters and their elements can influence or be influenced by some other elements within the cluster (inner dependence) or belonging to some other clusters (outer dependence). Relative weights reflect the relative importance of the elements belonging to each cluster with respect to the elements within the cluster or belonging to another cluster (Saaty, 2005). To each pair of elements (x_i, x_j) of a cluster, a positive number (a_{ij}) is assigned expressing how much (x_i) is preferred to (x_j) with regards to a given criterion. Saaty has proposed a nine point scale for comparing two elements: 1 implies indifference (equal impact) while 9 implies stronger impact (preference, or influence) of a row element than a column element; the reciprocal number from 1 to 9 expresses the inverse preference.

In a more complex case, multiple networks with Benefits, Opportunities, Costs and Risks (BOCR) exist. Control criteria for BOCR merits are determined and their priorities are then derived by pairwise comparisons using a supermatrix approach. For each control criterion a subnet of clusters is determined and the pairwise comparisons of the elements

within the clusters and among the clusters are performed according to outer and inner dependence. Judgments are expressed for answering two types of questions: 1) What element is preferred to another with respect to a given criterion? and 2) Given two elements, who influences a 3-th element with respect to a given criterion? The weights of the clusters are derived by pairwise comparisons of them with respect to the control criterion and these weights are then used to weight the elements of the supermatrix and obtain the weighted column stochastic supermatrix. Final priorities of stochastic supermatrix are calculated and syntesized by weighting each limit vector by the weight of its control criterion. The final ranking of the alternatives is given by a vector the components of which are obtained by the ratio BO/CR.

ANP may help managers understand the effect of their decisions and prioritize the areas requiring improvement. It is user friendly thanks to the SuperDecisions software, that allows for defining influence and feedback relationships between the elements of the map and performing a sensitivity analysis to verify whether results are reasonably stable: that is, there is preservation of the ranking among the alternatives when some other alternatives or criteria are added.

4. The ANP integrated with the r-BSC

After discussing the limits of the BSC (Section 3.1), the opportunities offered by the ANP (Section 3.2), and the characteristics of the INHS (Section 2), this paper proposes a network model which integrates the ANP with a revised-BSC for analyzing HcO performance and deriving priorities for interdependent (strategic or operational) objectives. Instead of a traditional BSC approach, the revised-BSC is characterized by the analysis of six interdependent perspectives which allows for the incorporation of the specificities of the healthcare context; moreover, it makes it possible to define every type of relationship (among perspectives, objectives and metrics) that may be analyzed by the ANP. Thus, the Analytical Network Process provides a proven way of eliciting and quantifying the relationships necessary to implement the BSC.

In the r-BSC model proposed in this paper, the following perspectives have been considered: Financial, Customer, Internal Business Processes, Innovation and Learning, Socio-Environmental and Clinical. The socio-environmental perspective is particularly important in healthcare because it contextualizes the organization within the territory of competence and pays specific attention to the institutional system, identifying constraints and opportunities. This dimension includes the characteristics of the population (incidence of chronic diseases), territory of competence (population incidence by age and lifestyle, i.e. obesity rate) and institutional context (regional funding availability). HcOs have to operate as a team to enhance synergies and ensure access and equity to all citizens of the Region by enforcing regional strategic plans. Interdependent relationships between relative objectives have been analyzed including: lack of skills that may affect some processes, low performance that may affect the quality perceived by customers, and decreasing customer satisfaction that may lead to inadeguate financial results.

Once the HcO mission is fixed, the GM defines strategic areas (macro-objectives) by which the mission may be achieved. Figure 1 shows the steps of the integrated model.

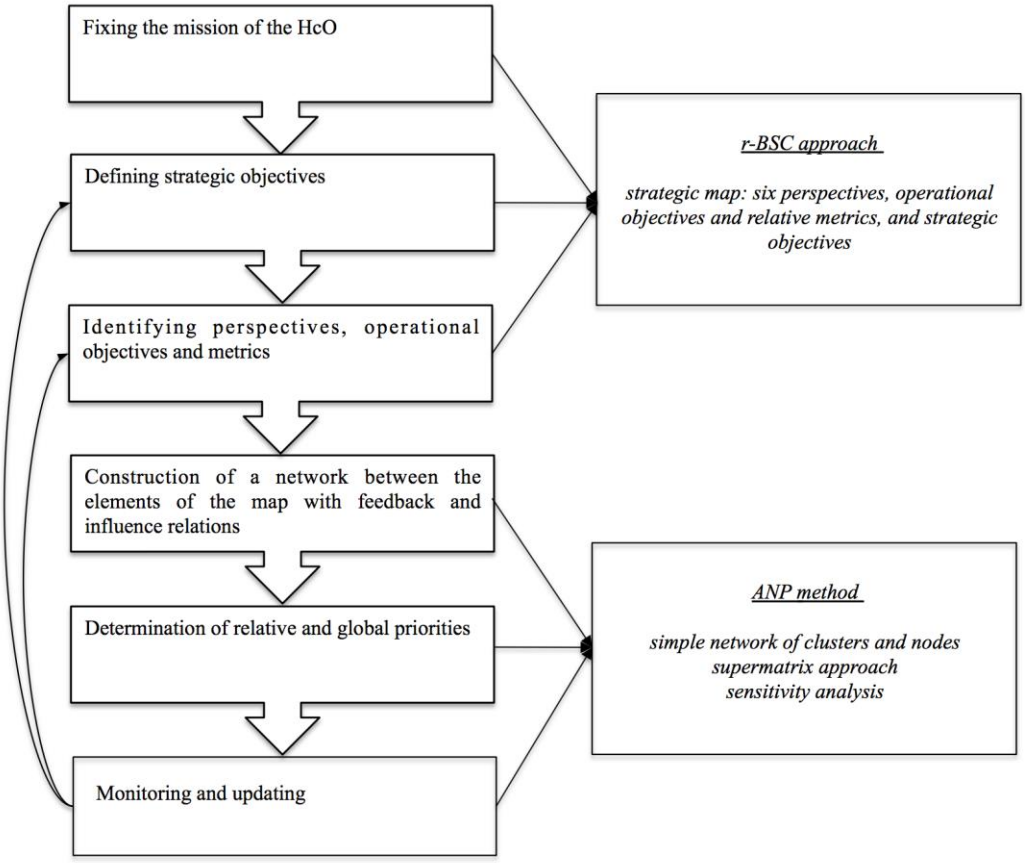

Figure 1. Steps of integrated model

Let us consider three strategic objectives (macro-objectives):

- improving the quality of healthcare services for citizens (e.g. reducing wait times for outpatient- performance as determined by the regional plan);
- rationalization of use of resources (reorganize the health-care system in the interior of the hospital and arrange staff relating to health professions based on regional indications; stabilize the temporary staff; improve the training of health personnel and create a dedicated database);
- strengthening of territorial healthcare (e.i. increase the seats of extensive rehabilitation beds in relation to the quota allocated by the region; increase the number of cases of home care).

Within the six perspectives of the r-BSC, the GM defines operational objectives and their metrics that allow them to realize their strategic objectives. Tables 2-3 itemize the elements of the r-BSC that represent the first three steps of the integrated model in Figure 1: Goal (mission), Strategic objectives, Perspectives, operational objectives and metrics.

Table 2
Clinical, Socio-territorial and Customer perspectives and relative operational objectives and metrics

Mission	**Strategic objectives**	**Perspectives**	**Operational objectives**	**Metrics**
To ensure **quality of care and wellbeing by optimizing the operational results** (appropriateness, efficiency and effectiveness)	Improve the quality of healthcare citizen	Clinical (ClinP)	Improve clinical appropriateness (O_1 ClinP)	Number of cesears Operating rate Rate of attendance at screening Percentage variation of compensation requests Hospitalization rate Appropriateness of admissions to first aid
			Improve ex-post effectiveness (O_2 ClinP)	Voluntary dimissions Transfers to other healthcare facilities Return to operating room Repeated hospitalizations Mortality rate Hospital infections Average weight of DRG
	Rationalize the use of resources	Socio-Territorial (STP)	Promote territorial integration (O_1 STP)	Number of agreements with private organizations Number of agreements with public organizations Number of protected dimissions and home cares
			Promote vertical and horizontal integration (O_2 STP)	Number of integrated managerial units Percentage of sharing or outsourcing technologies Percentage of sharing or outsourcing human resources
			Regulatory constraints and incentives (O_3 STP)	Constraints on employees turn over Percentage variation of regional limits Percentage variation for purchasing assets and services
			Improving lifestyle (O_4 STP)	Obesity rate Aging population
	Strengthen territorial healthcare	Customer (CP)	Improve customer satisfaction (O_1 CP)	Supply accessibility Supply availability Access to information Mean accesses to web site
			Improve accessibility (O_2 CP)	Diagnosis-to-treatment interval Mean time in days on waiting list for surgery Mean time to first consultation Time to appointment for complementary tests

Table 3
Financial, Internal Process and Innovation and Learning perspectives and relative operational objectives and metrics

Mission	Strategic objectives	Perspectives	Operational objectives	Metrics
To ensure **quality of care and wellbeing by optimizing the operational results** (appropriateness, efficiency and effectiveness)	Improve the quality of healthcare citizen	Financial (FP)	Increase redditivity (O_1 FP)	Earnings before interest and taxes Index of financial liquidity Time to cash in
			Increase productivity (O_2 FP)	Operating income Profit margin Economic value added
			Improve competiveness (O_3 FP)	Brand image Attraction rate Retention rate Incidence of passive mobility
			Reduce costs (O_4 FP)	Structural intervention Costs of production Supply costs Mean time for suppliers payment Incidence of costs for drugs consumption Incidence of costs for diagnostic materials
			Increase research funding (O_5 FP)	Course of fund raising
	Rationalize the use of resources	Internal process (IPP)	Promote use & security of ICT (reduce the dematerialization rate) (O_1 IPP)	Software Infrastructures and equipments Hardware
			Increase time efficiency (organizational appropriateness) (O_2 IPP)	Hospitalizations with medical drg Quick ordinary hospitalizations Hospitalizations for diagnostic tests Delivery time for medical reports Occupation rate of operating rooms Mean time for hospitalization
	Strengthen territorial healthcare	Innovation and Learning (ILP)	Enhance technological innovation (O_1 ILP)	Incidence of high technologies for medical equipments Technologies obsolescence rate
			Improve updating and continued training (O_2 ILP)	Specialized training Scientific production Cooperation with universities and main hospitals present locally Research financing
			Promote lean organization (O_3 ILP)	Intra and interdepartmental cooperation Organizational weelbeing Employee satisfaction (turn over rate, mobility rate, absenteeism rate)

The integrated model proposed in this paper is a network consisting of clusters and interactions between and within these clusters. There are some nodes representing decision criteria (perspectives, objectives and metrics) and alternatives, and some arcs depicting relationships among the clusters and their components. An arc connects pairs of nodes when there is significant interaction (with a two way arrow) or impact from one to the other (with a one way arrow). One-way arrows can also represent subordinate relationship between nodes. After all the required connections are made, the criteria are pairwise-compared, both within and between clusters.

The proposed model may be applied for deriving the weights to assign to strategic objectives in order to realize the mission, or for obtaining the ranking among alternative actions (different policies) once a strategic objective has been fixed. The alternatives are pairwise compared with respect to all metrics; each metric has a weight depending on the operational objectives to which it is connected. For the sake of simplicty, Figure 2 shows the clusters of perspectives, operational objectives and some clusters of metrics (in particular, all the metrics related to the objectives within the Socio-Territorial perspective and some metrics related to an objective of the Innovation and Learning perspective). It highlights some interdependencies among the clusters and/or the nodes. When comparing the elements within the cluster of "Internal Process objectives" with respect to the objective "Enhance technological innovation" in the Innovation and Learning

perspective, we capture the relative importance of internal process objectives when "Enhance technological innovation" is concerned.

In Figure 2, an arc connects the technologies obsolescence rate to the time efficiency objective (within the "Internal Process perspective"). This means that there is a dependence relationship among these two elements. There is also a dependence relationship among the number of agreements with public and private organizations and time efficiency. This implies that, if the technologies obsolescence rate is high then it would be useful to increase both the number of agreements with public or private organizations and the percentage of sharing or outsourcing technologies (improving horizontal, vertical and territorial integration) in order to preserve the time efficiency; furthermore, if the percentage of sharing or outsourcing technologies increases then the time efficiency and the clinical appropriateness may be enhanced.

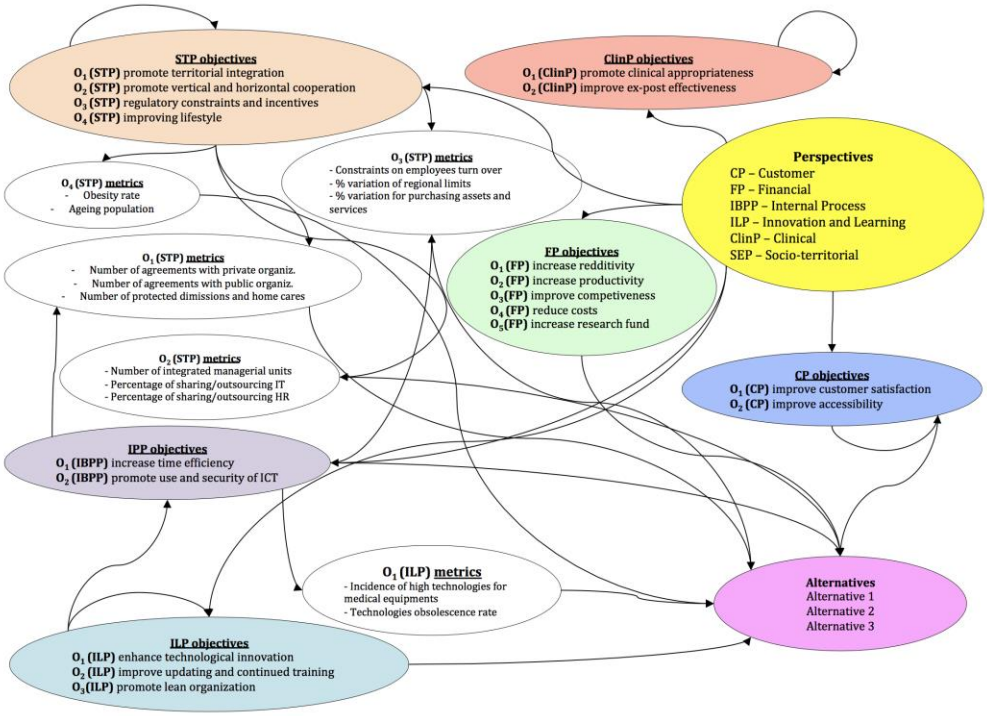

Figure 2. A network model.

The integrated model may be useful for deriving performance indices in order to evaluate the performance of each element of the model both with respect to operational objectives and different analysis perspectives. By assuming that a strategic objective has been fixed, in the case of a single network (with one control criterion and 6 perspectives), the performance index of the i-th alternative may be determined as follows:

$$Perf(i) = \sum_{s=1}^{6} P_s(i) V_s$$

where

$$P_s(i) = \sum_{k=1}^{m_l} \sum_{j=1}^{n_k} O_k^s M_j^{(s,k)} W_j^{(s,k)}(i)$$

indicates the performance of the i-th alternative with respect to the s-th perspective and V_s represents the weight of the perspective s. $W_j^{(s,k)}$ *(i)*, $M_j^{(s,k)}$ and O_k^s represent, respectively, the weight of the i^{th} alternative with respect to the j^{th} metric within the objective k of the perspective s; the weight of the j^{th} metric within the k^{th} objective of perspective s; the weight of the k^{th} objective of the perspective s. Finally, m_l and n_k indicate the number of objectives within a given perspective and the number of metrics of the k^{th} objective.
Some opportunities and advantages provided by the proposed integrated model are shown in Figure 4.

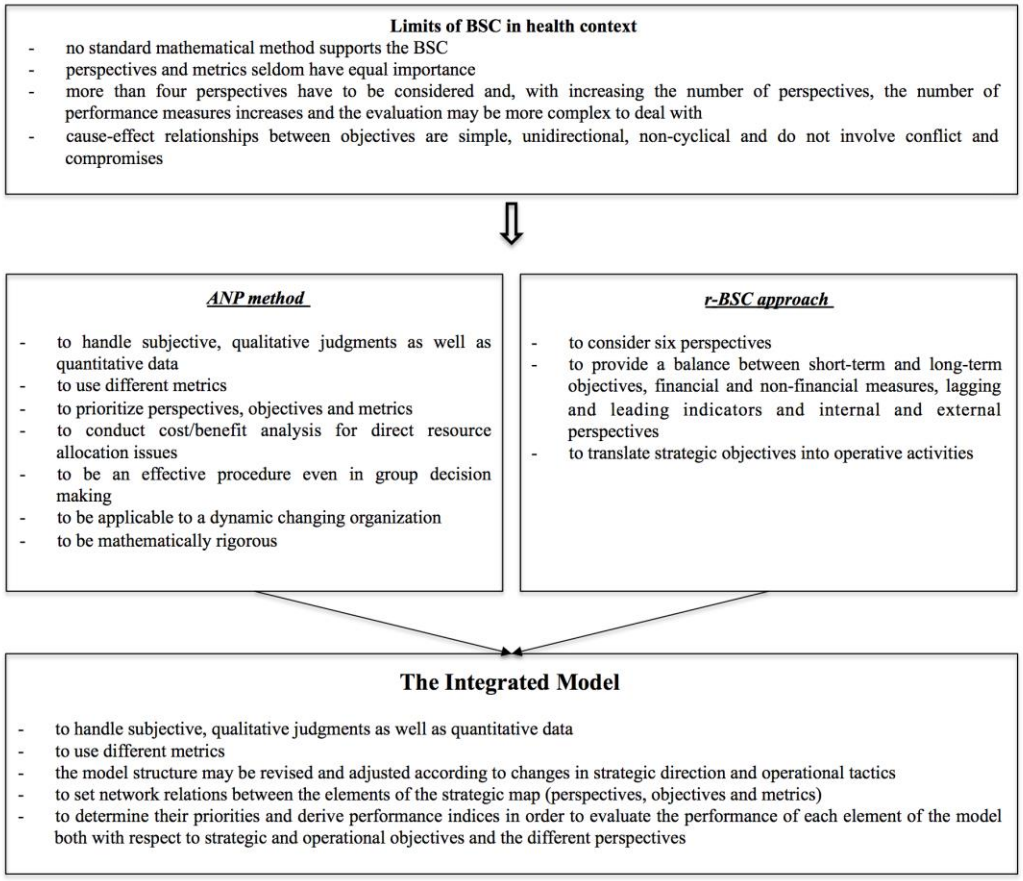

Figure 4. Advantages and opportunities of proposed Network Model

5. An example of decision problem

Let us consider a simple decision problem (Figure 3). Once the GM of a local HcO has fixed a strategic objective, i.e. "rationalize the use of resources", he has to select the best policy to realize that objective. The overall goal of the model is to derive a numerical score for each alternative.

He has to choose between two alternative policies:

- Closing some Departments or reducing their functions and, simultaneously, enhancing territorial cooperation (equipment sharing);
- Outsourcing IT and human resources in order to offer the same services and, simultaneously, enhancing excellent Departments.

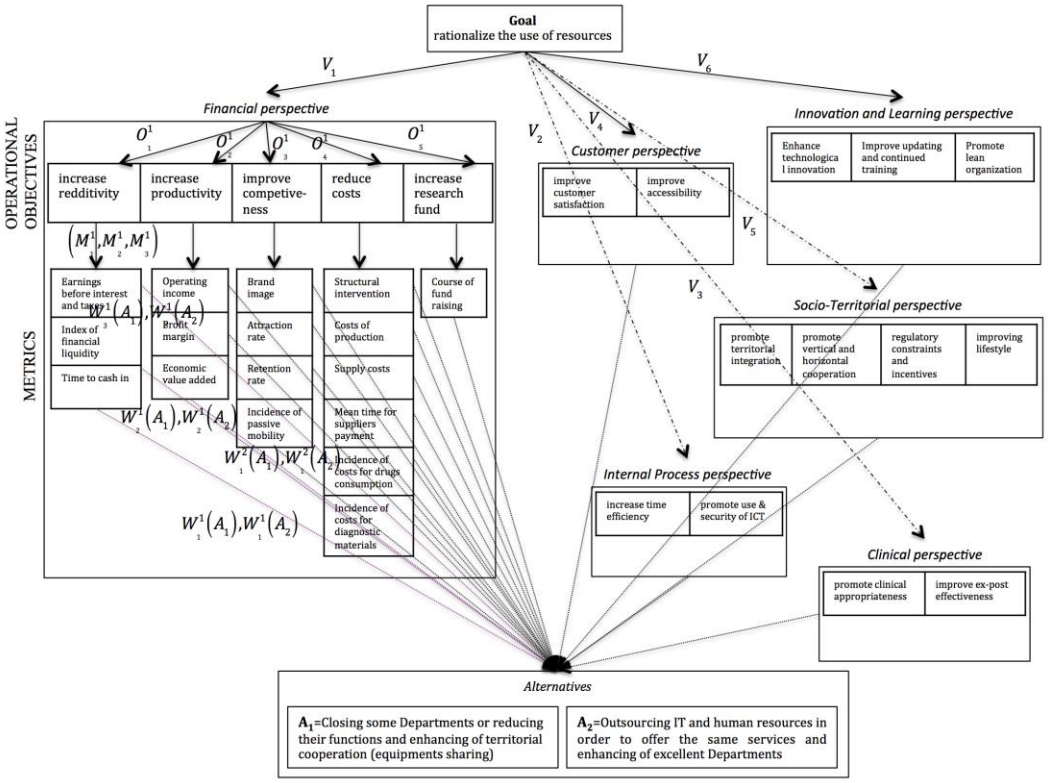

Figure 3. An example of decision problem

Under the assumption that there are no interdependent relationships between and within the clusters, the score (performance) of alternative A_1 with respect to the "Financial" perspective is given by:

$$Perf_{FP}\left(A_1\right)=\sum_{k=1}^{5}\sum_{j=1}^{n_5} O_k M_j^k W_j^k\left(A_1\right)$$

where $W_j\ (A_1)$ represents the weight of the alternative A_1 with respect to the j^{th} metric (within the objective k of the financial perspective), M^k_j is the weight of the j^{th} metric within the k^{th} objective and O_k represents the weight of the k^{th} objective. Tables 4-6 show some pairwise comparison matrices.

Table 4
Pairwise comparisons between operational objectives with respect to the "financial perspective"

Financial perspective

	Increase redditivity	Increase productivity	Improve competiveness	Reduce costs	Increase research funding
Increase redditivity	1	½	1/3	¼	½
Increase productivity	2	1	½	1/3	2
Improve competiveness	3	2	1	½	3
Reduce costs	4	3	2	1	4
Increase research funding	2	½	1/3	¼	1

The eigenvector of the above matrix provides the relative weights of the operational objectives: (0.077, 0.152, 0.256, 0.412, 0.102).

Table 5
Pairwise comparisons between metrics with respect to the objective "increase redditivity"

Increase redditivity

	Earnings before interest and taxes	Index of financial liquidity	Time to cash in
Earnings before interest and taxes	1	1/3	1/5
Index of financial liquidity	3	1	½
Time to cash in	5	2	1

Table 6
Pairwise comparisons between metrics with respect to the objective "improve competiveness"

Improve competiveness

	Brand image	Attraction rate	Retention rate	Incidence of passive mobility
Brand image	1	½	1/3	2
Attraction rate	2	1	½	3
Retention rate	3	2	1	4
Incidence of passive mobility	½	1/3	¼	1

ISSN 1936-6744
https://doi.org/10.13033/ijahp.v9i1.443

The pairwise comparison matrices of metrics related to "reduce costs" and "increase productivity" have not been reported. Table 7 shows the relative weights of metrics with regard to their related operational objective.

Table 7
The relative weights of metrics with respect to the related objective

Increase redditivity

	Relative weights
Earnings before interest and taxes	0.109
Index of financial liquidity	0.309
Time to cash in	0.582

Increase productivity

	Relative weights
Operating income	0.109
Profit margin	0.309
Economic value added	0.582

Improve competiveness

	Relative weights
Brand image	0.160
Attraction rate	0.277
Retention rate	0.467
Incidence of passive mobility	0.096

Reduce costs

	Relative weights
Structural intervention	0.1666
Costs of production	0.1666
Supply costs	0.1666
Mean time for suppliers payment	0.1666
Incidence of costs for drugs consumption	0.1666
Incidence of costs for diagnostic materials	0.1666

Increase research fund

	Relative weight
Course of fund raising	1

Table 8 shows the relative weights of the alternatives A_1 and A_2 with respect to the metrics considered in the Financial perspective.

Table 8
The relative weights of the alternatives with respect to the metrics

Metrics

	A_1	A_2
Earnings before interest and taxes	0.5	0.5
Index of financial liquidity	0.5	0.5
Time to cash in	0.5	0.5
Operating income	0.4	0.6
Profit margin	0.45	0.55
Economic value added	0.5	0.5
Brand image	0.4	0.6
Attraction rate	0.45	0.55
Retention rate	0.5	0.5
Incidence of passive mobility	0.5	0.5
Structural intervention	0.5	0.5
Costs of production	0.55	0.45
Supply costs	0.4	0.6
Mean time for suppliers payment	0.5	0.5
Incidence of costs for drugs consumption	0.7	0.3
Incidence of costs for diagnostic materials	0.6	0.4
Course of fund raising	0.5	0.5

Thus, the performance of the alternative A_1 with respect to the Financial perspective may be obtained as follows:

$$Perf_{FP}\left(A_1\right) = 0.5*0.109*0.077 + 0.5*0.309*0.077 + 0.5*0.582*0.077 +$$
$$+0.4*0.109*0.152 + \ldots + 0.5*1*0.102 = 0.6717$$
$$Perf_{FP}\left(A_2\right) = 0.6606$$

This means that, if only the Financial perspective is considered, then policy A_1 is preferred to A_2. Of course, the global evaluation of the alternatives will result from a weighted linear combination depending on the weights assigned to objectives and perspectives. The performance of each metric may be derived too.

6. Conclusion

The proposed model which integrates the ANP with the r-BSC approach has several advantages. First of all, this model is mathematically rigorous because of the ANP framework; then, it allows for handling subjective, qualitative judgments as well as quantitative data and using different metrics (financial and non financial). Moreover, it allows one to prioritize perspectives, objectives and metrics and to conduct the benefit/cost analysis, e.g. for direct resource allocation issues. It is an effective procedure even in group decision making, and is applicable to a dynamic changing organization.

The proposed integrated model may allow the general manager:

- to set network relations between the elements of the strategic map (perspectives, objectives and metrics);
- to determine their priorities and derive performance indices in order to evaluate the performance of each element of the model both with respect to strategic and operational objectives and the different analysis perspectives;
- to modify the model structure according to changes in strategic direction and operational tactics;
- to assess the robustness of the final solution through ANP sensitivity analysis;
- to compare the performance of different healthcare organizations.

By taking into account the importance of each element for achieving the mission (by means of some strategic objectives), the integrated network model allows the GM to individuate the more appropriate element for improving the performance of HcO, realizing the maximum benefit with the minimum effort in terms of resources employed. Of course, the decision-making power of the GM is not absolute, but moves within the limits established at the national and regional level by strategic planning. The need to contain costs has led HcOs to adopt practices usually used by private companies such as outsourcing and public-private cooperation. Integration and cooperation are strategic elements on which the HcO should rely. Cooperation would entail a decrease in costs and and an increase in benefits and make it possible to follow the whole process of taking charge of the patient.

The integrated model may be useful for many decision making problems; for example, the problem of selecting the best strategic policy in order to modify the business plan of a health facility according to the regional guidelines, or evaluating whether it is better to close or reduce some departments, or their functions, and enhance their excellence or open new departments. Obviously, this choice presupposes preliminary analysis of the demographic and epidemiological context of the territory of competence and is closely related to the offering of health facilities in the local and regional territory.

REFERENCES

Agarwal, A., Shankar, R., & Tiwari M.K. (2006). Modeling the metrics of lean, agile and leagile supply chain: An ANP-based approach. *European Journal of Operational Research, 173,* 211-225. Doi: http://doi.org/10.1016/j.ejor.2004.12.005.

Balduzzi, R. & Carpani, G. (2013). *Manuale di diritto sanitario.* il Mulino, Bologna.

Bentes, A.V., Carneiro, J., Ferreira da Silva, J., Kimura H. (2012). Multidimensional assessment of organizational performance: Integrating BSC and AHP, *Journal of Business Research, 65,* 1790-1799. Doi: http://doi.org/10.1016/j.jbusres.2011.10.039.

Bisbe, J. & Barrubés, J. (2012). The Balanced Scorecard as a management tool for assessing and monitoring strategy implementation in health care organizations. *Rev. Esp. Cardiol*. *65(10),* 919-927. Doi: http://doi.org/10.1016/j.rec.2012.05.011.

Chang, L. (2007). The NHS performance assessment framework as a balanced scorecard approach. Limitations and implications. *International Journal of Public Sector Management, 20(2),* 101-117. Doi: http://dx.doi.org/10.1108/09513550710731472.

Chen M.Y., Huang M.J. & Cheng Y.C. (2009). Measuring knowledge management performance using a competitive perspective: an empirical study. *Expert Systems with Applications, 36(4),* 8449-8459. Doi: http://doi.org/10.1016/j.eswa.2008.10.067.

Cinelli, M. (2015). *Diritto della previdenza sociale*. Giappichelli, Torino.

Clerico, G. (2015). *La governance della sanita pubblica. La coesistenza fra efficienza e qualità*. Giuffré.

Costa, G., Gubitta, P. & Pittino, D. (2014). *Organizzazione aziendale*. Italy: McGraw hill Education.

Figueras, J. & Mckee, M. (2012). *Health systems, health, wealth and societal well-being, assessing the case for investing in health systems*. McGraw Hill, Open University Press.

Forman, E.H. & Gass, S.I. 2001. The Analytic Hierarchy Process-An exposition, *Operations Research, 49(4),* 469-486. Doi: http://dx.doi.org/10.1287/opre.49.4.469.11231.

Fragale, E.N. (2013). La dirigenza delle aziende sanitarie dopo la c.d. riforma Balduzzi. *Istituzioni del Federalismo, 2(2013),* Note e commenti.

Gay, J.G., Paris, V., Devaux, M. & de Looper, M. (2011). Mortality amenable to health care in 31 Oecd countries, Paris, *Oecd Health Working Papers*, n.55. Doi: 10.1787/5kgj35f9f8s2-en.

Gosetti, G. & La Rosa, M. (2006). *Sociologia dei servizi. Elementi di organizzazione e programmazione.* Milano, Italy: Franco Angeli.

Hu, Y., Wen, J. & Yan, Y. (2015). Measuring the performance of knowledge resources using a value perspective: integrating BSC an ANP. *Journal of Knowledge Management, 19(6),*1250-1272. Doi: http://dx.doi.org/10.1108/JKM-10-2014-0431.

Kaplan, R.S. & Norton, D.P. (1996). Using the Balanced Scorecard as a strategic management system. *Harvard Business Review, 74(1),* 75–85.

Kaplan, R.S. & Norton, D.P. (1992). The balanced scorecard-Measures that drive performance. *Harvard Business Review*, *70(1),* 71-79.

Liberatore, M.J. & Nydick, R.L. (2008). The analytic hierarchy process in medical and health care decision making: A literature review. *European Journal of Operational Research, 189*, 194-207. Doi: http://doi.org/10.1016/j.ejor.2007.05.001.

Marcarelli, G. (2016). Multi-criteria decision making for evaluating healthcare policies: the benefit/cost analysis by the analytic hierarchy process. *International Journal of Medical Engineering and Informatics, 8(2),* 163-181. Doi: http://dx.doi.org/10.1504/IJMEI.2016.075754.

Marmot, M. & Wilkinson, R.G. (2006). *Using the Balanced Scorecard as a strategic management system, social determinants of health*. Oxford: Oxford University Press.

Ovretveit, J. (1998). *Evaluating health interventations*. Maintenhead: Open University Press.

Nuti, S. & Seghieri, C. (2013). Is the variation management included in regional healthcare governance systems? Some proposals from Italy. *Health policy, 114*, 71-78. Doi: http://dx.doi.org/10.1016/j.healthpol.2013.08.003.

Pramod, V.R. & Banwet, D.K. (2010). Analytic Network Process analysis of an Indian telecommunication service supply chain: A case study. *Service Science, 2(4),* 281-293. Doi: http://dx.doi.org/10.1287/serv.2.4.281.

Ramanathan, R. & Ramanathan, U. (2011). A performance measurement framework combining DEA and balanced scorecard for the UK health sector. *International Journal of Operational Research, 12(3),* 257-278. Doi: http://dx.doi.org/10.1504/IJOR.2011.042916.

Ravi, V., Shankar, R. & Tiwari, M.K. (2005). Analyzing alternatives in reverse logistics for end-of-life computer: ANP and balances scorecard approach. *Computers Industrial Engineering, 48*, 327-356. Doi: http://doi.org/10.1016/j.cie.2005.01.017.

Reina, R. (2012). *Organizzare i sistemi informativi per la sanita.* Analisi e esperienze Giuffre ed.

Riccaboni, A., Busco, C., Bacci, A. & Del Medico, G. (eds) (2008). *La Balanced Scorecard per l'attuazione della strategia nelle Pubbliche Amministrazioni*. Teoria, Casi ed esperienze. Knowita.

Saaty, T.L. (2005). *Theory and applications of the Analytic Network Process: decision making with benefits, opportunities, costs and risks*. Pittsburgh: RWS Publications.

Saaty, T.L. & Vargas, L.G. (1982). *The logic of priorities: Applications in business, energy, health, and transportation*. Boston: Kluwer-Nijhoff. Reprinted in Paperback (1991), Pittsburgh: RWS Publications.

Sloane, E.B., Liberatore, M.J., Nydick, R.L., Luo, W. & Chung, Q.B. (2003). Using the Analytic Hierarchy Process as a clinical engineering tool to facilitate an iterative, multidisciplinary, microeconomic health technology assessment. *Computers and Operations Research, 30,* 1447-1465. Doi: http://doi.org/10.1016/S0305-0548(02)00187-9.

Toth, F. (2014). *La sanità in Italia*. Il Mulino.

Thakkar J., Deshmukh S. G., Gupta A. D. & Shankar R. (2007). Development of a Balanced Scorecard an integrated approach of Interpretive Structural Modeling (ISM) and Analytic Network Process (ANP). *International Journal of Productivity and Performance Management*, *56(1),* 22-59. Doi: http://dx.doi.org/10.1108/17410400710717073.

Tjader Y., May J.H., Shang, J., Vargas L.G. &Gao N. (2014). Firm-level outsourcing decision making: a Balanced Scorecard-based Analytic Network Process model. *International Journal of Production Economics, 147,* 614-623. Doi: http://doi.org/10.1016/j.ijpe.2013.04.017.

Tjader Y., Shang, J. & Vargas L. (2009). Offshore outsourcing decision making: A policy-maker's perspective. *Working paper,* University of Pittsburgh. Doi: http://doi.org/10.1016/j.ejor.2010.03.042.

Tzeng M.L. (2010). Implementation and performance evaluation using the fuzzy network balanced scorecard. *Computers & Education, 55,* 188-201. Doi: http://doi.org/10.1016/j.compedu.2010.01.004.

Vargas, L.G. (1990). An overview of the Analytic Hierarchy Process and its applications, *European Journal of Operational Research, 48(1),* 2-8. Doi: https://doi.org/10.1016/0377-2217(90)90056-H.

Verzola, A., Bentivegna, R., Carandina, G., Trevisani, L., Gregorio, P. & Mandini, A. (2009). Multidimensional evaluation of performance: experimental application of the balanced scorecard in Ferrara university hospital. *Cost Effectiveness and Resourse Allocation, 7(15),* 1-8. Doi: 10.1186/1478-7547-7-15.

Zelman, W., Pink, G., Matthias, C. (2003). Use of the Balanced Scorecard in health care. *Journal of Health Care Finance, 29(4),* 1-16.

World Health Organization (Regional Office for Europe) (2013). *Health 2020: a European policy framework supporting action across government and society for health and well-being*.