POLITECNICO DI MILANO

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PROPOSAL OF A METRICS FOR HEALTHCARE SUSTAINABILITY

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Dedica

Questa Tesi è dedicata ai
miei nonni, Enrico e Piero,
che mi trasmisero la passione per
la Meccanica e per l'Industria

"*C'è vero progresso solo quando*
i vantaggi di una nuova tecnologia
diventano per tutti."

Henry Ford (1863-1947), industriale americano

"*Siamo su un treno che va a trecento chilometri all'ora,*
non sappiamo dove ci sta portando e, soprattutto,
ci siamo accorti che non c'è il macchinista."

Carlo Rubbia (1934), scienziato italiano

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Carnate, 30 Giugno 2011

Abstract - Italian

Il concetto di sostenibilità riveste, ormai da diversi anni, grande importanza nella ricerca di modelli di sviluppo e di valutazione industriali. Nell'ambito della ricerca di metriche di valutazione ci è sembrato importante rivolgere l'attenzione ad un settore che del tutto industriale non è, il settore sanitario.

Tale ambito non è, ad oggi, ampiamente ed esaurientemente analizzato in riferimento alla sua sostenibilità, poiché, a primo effetto, non sembra avere un grande impatto sulle risorse del pianeta rispetto all'immenso settore industriale. Tuttavia, anche se con portata limitata, il settore sanitario contribuisce a tale impatto per mezzo di problematiche di smaltimento rifiuti, gestione delle risorse, attenzione al benessere e considerazione di dettagli che possono influire sulla psicologia e lo stress del paziente.

Si propone in questa tesi un modello di valutazione della sostenibilità delle strutture sanitarie quali ospedali o cliniche. Per favorire la completezza di tale analisi il modello di valutazione delle strutture sanitarie proposto in questa tesi è stato scorporato in undici differenti moduli: Paziente, Economato, Farmacia, Centrale di Sterilizzazione con Gestione strumentario chirurgico e Blocco operatorio, Servizio Pasti, Lavanderia, Rifiuti, Logistica, Edificio, Energia, Office.

Il modello di valutazione ha lo scopo di valutare la rispondenza a criteri di sostenibilità dei singoli moduli. Ognuno di questi è stato analizzato nelle sue principali caratteristiche e problematiche e successivamente confrontato con lo stato dell'arte in ambito industriale e sanitario. Cercando di andare oltre le normative già in vigore e le leggi già presenti si è cercato di valutare quanto la struttura sanitaria sia in grado di affrontare in profondità le tematiche di sostenibilità nella gestione di ogni modulo.

Il modello di valutazione è stato applicato in un moderno ospedale della Brianza. Tale test è stato utile per individuare punti di forza e debolezza del modello. Quali punti di debolezza si sono evidenziati la necessità di individuare delle opportune figure di riferimento per sottoporre l'intervista e la difficile applicabilità di alcuni indicatori. Punti di forza emersi riguardano il carattere globale e completo del modello e la capacità di fornire feedback specifici per ogni area. Si denota tuttavia la necessità di istituire un commitment che si prenda l'incarico di rendere efficace il modello. La continuità di analisi delle problematiche di sostenibilità ci permette di fornire una forte prospettiva futura al modello che può essere completato con altri moduli, i quali possono anche appartenere ad un ramo medico invece che ingegneristico. Inoltre si prospetta l'ampliamento e l'approfondimento delle sezioni oltre che il possibile monitoring continuo degli indicatori.

Abstract - English

The sustainability issue is since many years very important for the research of industrial evaluation and development models. In the field of evaluation metrics investigation we considered important to focus our attention towards a sector which has not a specific industrial concern. The healthcare sector.

The sustainability of this field does not present a complete and full background of scientific literature or general knowledge, because, at first sight, it doesn't seem to have a great impact on the planet resources if compared with the industrial sector. However, even if limited with his business, the healthcare sector contributes to the environmental impact with matters like the waste management, resources management, wellbeing and consideration of details that can influence the psychology and the stress of the patients.

In this work we propose a sustainability evaluation model of the healthcare facilities. In order to favour the completeness of the analysis the model is subdivided in eleven different modules: Patient-related aspects, Materials management, Hospital Pharmacy, Central Sterile Supply Department (CSSD) with Surgical instrument management and Surgical block, Food service, Laundry management, Logistic processes, Building-related aspects, Energy-related aspects, Office processes.

The evaluation model has the purpose to assess the coherence of the single modules with sustainability criteria. Each one of these modules was analyzed in his main features and issues and consequently compared with the state of the art in industrial and healthcare sector. Trying to go beyond laws and normative already consolidated we tried to evaluate if the healthcare facility is able to face sustainability issues in the management of each module and how deeply.

The evaluation model was then applied to a hospital in Brianza. This test was useful to identify weak points and strength points of the model. As weak points we identified the exigency to find the right persons available for the interview and the inapplicability of some indicators. Strength points emerged are the feature of a global and exhaustive model and the ability to provide specific feedback for every area. We noticed the need to establish a commitment taking the pledge of performing an efficient evaluation. A continuous improvement of the sustainability analysis foresees the possibility to complete the model with other modules, even with a medical view of the analysis. Furthermore the modules can be enlarged with other indicators and the analysis can be conducted as a continuous monitoring of the indicators.

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CHAPTER 1 - Introduction

In the last years the awareness of a too heavy exploitation of our planet's resources has begun to be widely diffused. Since many years we are hearing from the media about a constantly increasing overexploitation of the natural environment, the vegetal and the animal resources. For example, expressions such as deforestation, desertification, oil and ozone depletion, extinction of species, soil erosion and greenhouse gas increase are often heard. The following are examples of our indisputable misuse of our planet's resources:

- At the beginning of the 70's, 99% of the Amazon Forest was still intact. In the mid-1980's, 13.7% of the forest was completely compromised; in the following two decades, more than 55 million of hectares of forest were destroyed, the equivalent of the surface of France [helterskelter.altervista.org].
- 20% of world's mangrove forests have disappeared from 1980 [wikipedia.it].
- The release in the atmosphere of carbon dioxide, methane and CFC (chlorofluorocarbons), and the deforestation have increased the global temperature of $0.74 \pm 0.18°C$ in the only 20th century [wikipedia.en].

As shown above, today, as a global society, we are acting in an undoubtedly unsustainable way. Sustainability means meeting the needs of the present without compromising the ability of future generations to meet their own needs [Kreisberg].

Environmentally unsustainable behaviours generate results which are easy to recognize, but there are two other important aspects of sustainability, the social and the economic aspect. In fact, human activities are always contextualized not only in an environmental, but contemporaneously in a social and in an economic system.

The first one refers to the health and safety of people in a social system, the second to a long lasting wellbeing of an economic system. For example, a company which decides to improve its overall sustainability has to adopt virtuous behaviours to improve its respect for the environment, to promote the health and safety of its employees and to apply business strategies to guarantee an income able to last over time, for its survival on the market or its growth.

Sustainability has become for many companies a strategic variable, because it permits to differentiate the company from the competitors, and it contributes with the other company variables to the company's value creation. The present major worry is about an excessive consumption of our planet's resources, which could lead to their premature exhaustion and to a brusque stop of human activities, not only the productive ones. Sustainability, in particular in its environmental meaning, is a hardly incentivised theme in today's economy: for example, we can think about the term Corporate Social Responsibility (CSR), which proves that factors of ethical nature are nowadays integrated into the company's strategic vision.

1.1 What is sustainability

The need to conciliate economic growth and a fair distribution of the resources in a new development model started from the 70ies, after having realized that the classic concept of human development, based on the only economic and technological growth, would have caused a collapse of the natural systems in the near future. The economic growth only is not sufficient, a real development must be able to improve the quality of life over a long time.

"Sustainable development is a development which satisfies the present needs, whitout compromising the possibility for future generations to satisfy their own ones". This is the first definition of sustainable development, dated back to 1987 with the release of the Brundtland Report by the World Commission on Environment and Development (WCED). This name was given by the coordinator Gro Harlem Brundtland, who was the president of WCED that year, and who commissioned the report [wikipedia.en].

In its wider meaning, the concept of sustainability implies the ability of a development process to sustain the reproduction of the world's capital over time: this capital is economic, human/social and natural [sogesid.it]. The concept that must be taken into account is world's capital, but with a new role.

In fact, the conventional economic concepts referred to the following three principal production factors: earth, work, capital. With the word "capital" every physical and financial asset was meant, that could make possible the production of other assets and could be able to generate an income. Raw materials, land and work were excluded. These factors were not considered as "capital", even though they were essential to its production. The concepts illustrated above represented the economic thought which characterized the Industrial Revolution, and changed heavily in the last two centuries.

Human capital means everything that can be influenced by individuals:

- social capital, built by all members of a society;
- natural capital, represented by the natural environment and the natural resources;
- monetary capital or income, generated by an economic system.

Only considering always this definition of capital, it is possible to speak about sustainability of systems.

Sustainability is a word we often hear about, with a wide theory but only insufficient applications. Many companies adhesions to sustainable behaviours were often purely formal, in particular when a marked interdisciplinarity and a high scientific knowledge were required. Often companies promote "green" products, but considering the complete productive chain it is possible that maybe these products generate damages to the environment or to some communities.

The Green Marketing problem has to be analyzed carefully, because some companies promote "green" products with an eccessive easiness. Really sustainable organizations try not only to satisfy the normative prescriptions, but also use green marketing as a proactive instrument, to acquire competitive advantages through the reaching of environmental eccellence [Giacomazzi, 2002].

The big evident problems are those related to the environment, because it is the theme that easily involves the individuals who live in the First World, where economic and social sustainability are already high.

It is very important to consider the existence of all the three following elements of sustainability:

- social
- economic
- environmental

Analyzing Figure 2.1, it is possible to notice that the real sustainability can be reached only through the union of the three dimensions. The correlations between 2 sustainability elements of 3 generate different situations, which can be defined as shown in Figure 1.1.

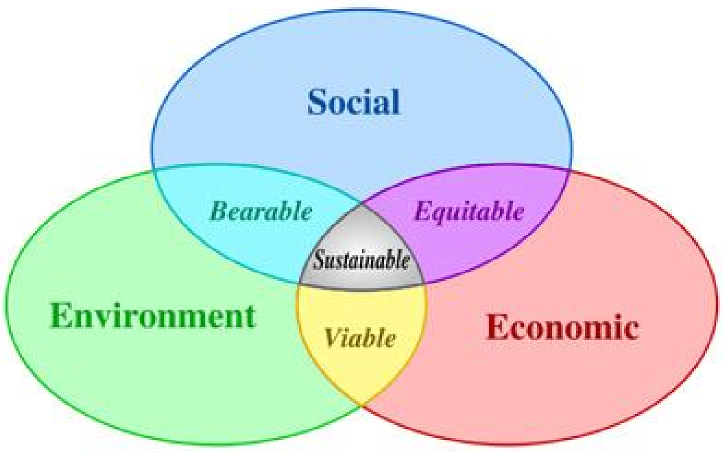

Figure 1.1 Interconnections between the three dimensions of sustainability [meridameridian.com]

The paragraphs of this chapter will analyze singularly every dimension of sustainability, trying to describe its present state, the positions assumed by companies and governments and to define the basic principles to face them.

1.2 Social sustainability

Social sustainability is the capacity to guarantee conditions of human wellbeing in terms of safety and health; it refers also to the ability of the people to recognize a common project and to act together to achieve the project goals, supported by the collaboration of various institutional levels. The achievement of the environmental and economic sustainability must proceed together with social sustainability, and one of these elements can't be pursued ignoring the others: the concept of social sustainability is not independent, and therefore it doesn't make sense to define its boundaries. The social sustainability includes elements such as equity, empowerment, accessibility, participation, cultural identity and institutional stability [sogesid.it].

Organizations' attention to social themes began in the 19th century, through the institution of the first syndicates and the reduction of the number of working hours in factories; those introductions considered only the working conditions for the employees in the plants, but the last years the focus moved from the workers of a company to all those who are taking interest in the company, the "stakeholders": employees, clients, suppliers, institutions, local communities.

In this way, the responsibility of a company doesn't fall only on its own employees, but on the entire net of actors who relate with the company: the company is not an independent reality anymore, but represents only a cell of a bigger living organism.

1.2.1 Safety

Every organization must provide to all its employees every available tool to optimize their safety level through technical, organizational and procedural prevention and protection measures: these must be adopted by the employer, his collaborators and his employees.

In Italy, starting from the post-war period, work accidents progressively decreased, because safety norms were gradually applied, that merged into the "Testo Unico sulla Sicurezza sul Lavoro", approved with the D. Lgs. n. 81 of the same year.

That decree foresees, for every organization, the compilation of a risk evaluation document containing:

- a risk evaluation report: all safety risks during the working activity are indicated, and classified according to different factors: working environment, equipment, organizational aspects;
- a list of the prevention and protection measures actuated to avoid the individuated risks;
- a list of the individual protection devices worn by the workers, for example safety shoes, helmets, gloves and covers;
- a program of the opportune measures to guarantee a long lasting improvement of the safety levels: maintenance, suitability checks, information.

INAIL, the "Istituto Nazionale per l'Assicurazione contro gli Infortuni sul Lavoro", is the Italian institution that provides information, assistency and consulency to sustain the full actuation of those norms regarding safety and health in working environments: safety at work is a dimension which is intrinsically related to the knowledge of the risk factors, and prevention is the most effective policy to be followed.

The fundamental commitment of the institution is promoting and motivating the culture of prevention at work in an incisive way. The drivers are both the integral protection of the workers and a containment of the social costs deriving from potential accidents [inail.it].

1.2.2 Health

Health, defined by the Constitution of the World Health Organization in 1948 as a "state of complete physical, psychical and social wellbeing, and not the simple absence of a disease" [wikipedia.en], is a fundamental right for every person.

This definition with an utopistic character refers to a state of complete satisfaction and happiness, and has to be intended as a reference point where to orient people's efforts; it is the result of social, economic, environmental and genetic drivers.

Organizations are able to influence these elements, acting on different levers such as:

- Remuneration: acts directly on the economic wellbeing of the individuals and has to be aligned to their expectations. Companies can reward the merit of an employee through pay rises and benefits, which improve his membership perception to the organization and therefore his productivity
- Motivation through work reorganization: practices such as job rotation, job enrichment and job enlargement increase motivation and attention at work
- Respect for minorities: an organization which manages recruitments attaching a great importance to women and ethnic minorities, will be considered by its employees as a fair organization

An equipe of doctors of the Università Cattolica del Sacro Cuore presented in December 2009 the results of a study which was conducted on 60000 workers in the last ten years: a fair and healthy working place reduces the risk of heart attack and cardiovascular diseases, ulcer and colitis. Moreover the work-related stress, accused by about 40 million workers in Europe, lowers the immunitary defences and consequently workers' productivity: the Agency for Safety and Work Health estimated that the annual costs for the collectivity, due to the lost working days because of various diseases, are about 20 billion Euros [medicinaintegrale.blogspot.com].
For this reason, every work environment should be made as liveable as possible: some simple expedients are often enough, such as the presence of an area for the refreshment of employees, or the presence of plants.

1.2.3 Development of reference standards

In the last years, social sustainability has become always more important: this is demonstrated through the birth of numerous reference standards and frameworks at an international level, which try to explicitate the elements that have to be evaluated to guarantee the respect of people's rights in an organization.

1.2.3.1 Global Reporting Initiative (GRI)

The Global Reporting Initiative, that was developed by a network of organizations from different countries, produced in 1997 a framework for the evaluation of sustainability policies and their comparison between different companies, with particular attention to social problems. The G3, third version of the framework, is applicable to all enterprises for a punctual evaluation and for the benchmarking between enterprises of the same sector, and takes into consideration different categories of social performance indicators [globalreporting.org].

1.2.3.2 AccountAbility 1000

AccountAbility 1000 is a standard that was developed in 1999 by ISEA (Institute of Social and Ethical Accountability), an international organization with a headquarter in the United Kingdoms, finalized to incentivize an ethical behaviour in every profit and non-profit organization.
This standard is based on the realization of a dynamic structure, for the continuous improvement of the quality of the social and ethical accounting, auditing and reporting processes: it is not a certifiable standard, because parameters that have to be respected are not defined, but it provides the guidelines that have to be followed to guarantee the stakeholders the accounting, auditing and social reporting quality [accountability.org].

1.2.3.3 Social Balance

Between the instruments of social responsibility, the Social Balance represents the result of a long activity, and in 2007 it was defined by the Italian Ministry of the Interior as follows: "The social balance is the result of a process with which the administration explains the choices, activities, results and human resource use in a certain period, to allow the citizens and different interlocutors to know and formulate an own judgement about how the administration interprets and realizes its institutional mission" [wikipedia.en].

Organizations can use the Social Balance to communicate periodically and in a voluntary way the results of their activity, not considering the only financial and accounting aspects; the document originates from the consciousness that all stakeholders have a recognized right or interest to know what effects the decisions of the organization produce towards them.

1.3 Economic sustainability

Economic sustainability can be defined as the ability of a financial system to generate a lasting growth of the economic indicators, to generate an income and work for the sustenance of populations. In a territorial system, economic sustainability means the ability to produce and maintain the maximal added value on that territory, by combining effectively resources to emphasize the specificity of products and territorial services [sogesid.it]. Through these definitions, the connection between the three elements of sustainability appears evident: it is not possible to speak about one single aspect, ignoring the implications of the other two. The social and environmental aspects of sustainability set limits to the economic sustainability, because economic sustainability can exist only if the other two elements are coherently developed.

Attention to the society and the environment is fundamental to avoid creating future imbalances. Today's wrong choices generate future costs, that are always heavier and less hidden. The clearest example is the pollution we have inherited after years of uncontrolled economic expansion. Another example is what is happening in China, where the unregulated attention to the only economic growth is generating a heavy disequilibrium to the entire planet, because the social and environmental capitals aren't taken into account properly. These wrong choices generate heavy costs to resolve environmental damages or social difficulties, which have to be tamponed with government's interventions, using a high amount of economic resources. For this reason, social and economic costs have to be internalized through new evaluation politics and techniques that are typically part of the economic sustainability.

It appears fundamental that the three dimensions of sustainability are interrelated through a multiplicity of connections, and therefore they can't be considered as independent elements, but must be analyzed under a systemic vision, because they contribute to the reaching of a common goal. If a company's planning choices are considering only one or two of these dimensions, a sustainable development can't exist.

Considering the previous facts, the concept of sustainability can be represented through three concentric circles, underlining that an economic system can exist only in a society, and that both systems exist only in an environment.

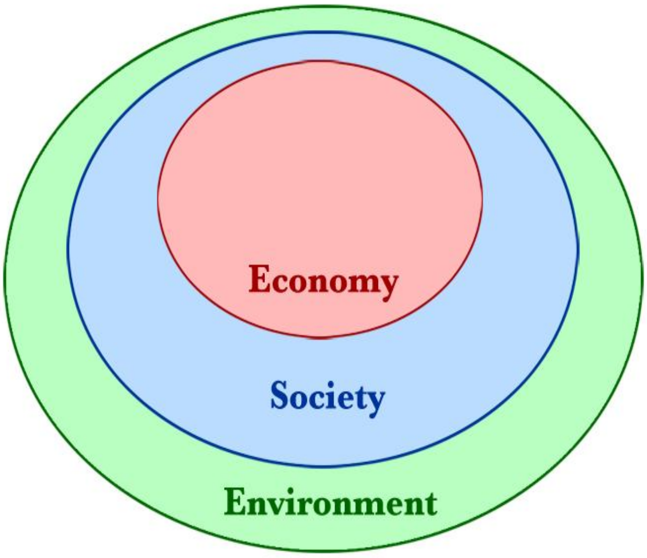

Figure 1.2 The concentric-circle model [wikipedia.en]

One of the most important problems, that can be generated by a too superficial analysis of the concentric-circle model, is the assumption that the fundamental nucleus of sustainability is economy. This aspect is only an important part of a big future-oriented concept, and it can't be taken into account singularly as the only driver to address the choices for a sustainable future.

At an international level, economic sustainability is measured considering some easily available indicators, which can give a picture of the level of sustainability that has been reached by the single countries:

- GDP (Gross Domestic Product): it's a measure of the income produced by a country, easy to compare with previous years' data. It permits to delineate the evolution of the income of a national economic system over the years, and begin doing observations about the economic sustainability of the system

- Consumption expense quote: it's used to take the economic wellbeing of an economic system under control, not only in quantitative, but also in qualitative terms. If expectations for the future in an economic system are optimistic, this indicator tends to increase, in the opposite case it decreases
- Research & Development expense quote: it has the same function and the same behaviour as the consumption indicator, furthermore it underlines how much an economic system is future projected in quantitative terms

These three measurements are often reported at a per capita level, to generate more truthful data and underline the not only economic administration of the single countries [Mittelsteadt, 2001].
These 3 indicators are often referred to a single company, and can therefore be useful to have a first measure of its sustainability. Under a single company's point of view, economic sustainability must evaluate every single project or internal initiative, to understand if the choices which were taken can increase the company profitability and its value over the years. Often, during these evaluations, we have to take into account some implicit advantages that are hardly expressible in monetary terms. As a matter of fact, the consideration of the only economic convenience of an intervention takes part in the field of the evaluations of different investment alternatives, and this is the main subject of business economics.
During the last years, many efforts were made in the field of sustainability development: in particular, institutions tried to encourage green politics, offering to companies a high level of support, economic as well. Another factor to consider is the continuous improvement of technologies, which often increases radically the efficiency of systems, producing high monetary savings.

1.4 Environmental Sustainability

Environmental sustainability can be defined as the ability to preserve the following three functions of the environment over time: resources supplier, waste absorber and direct source of utility. In a territorial system, environmental sustainability means the ability to emphasize the environment as a "distinctive element" of the territory, guaranteeing at the same time the protection and the regeneration of the natural resources [sogesid.it].
Also in this case, it is not possible to consider the environmental sustainability whitout taking into account the social and economic dimensions of sustainability. As written before, any choice taken into an economic system, as the one we live in, can't be detached from the monetary dimension.

Often, interventions to improve the environmental sustainability consume economic resources, sometimes they improve a company's financial structure.
The social dimension is indirectly connected to environmental sustainability, at least it appears to be: if all companies wouldn't consider the health of the environment in a certain territory, after a few years harmful natural conditions could develop, like polluted ground water, eccessive atmospheric pollution or more simply a reduction of green areas; the social sustainability would be worsened.
Another problem which is related to environmental sustainability is the ability to measure the performances of a system. In fact, it is very difficult to quantify punctually, and with an adequate schedule, the environmental effects of a determined activity. In the last years, the increasing importance of this theme has lead to the birth of different institutes, associations and companies that work exclusively on this theme. Environmental certifications are becoming always more important worldwide; specific procedures exist now for every sector of economy, and specific treatments about the measurement of environmental performances.
For these reasons, environmental sustainability is often used as a driver for the change, as a fluidizing element between the classic economic concept and the ideal of sustainable development. In the last years, meetings of national vertices in international conventions have increased, with the goal of establishing some guidelines for the environmental protection. The most important document in the history is the Kyoto Protocol, which was developed at a world's level for the care and protection of the environment.
A very important climate summit took place in 2009 in Copenhagen, to establish new objectives about the emissions cut within 2020. This conference had historical dimensions: fifteen thousand participants where there, representing 192 countries, some of the most influential personalities of the actual politic world and the representatives of the most important associations for the environmental protection, like the Danish prime minister Lars Loekke Rasmussen, the English Premier Gordon Brown, the Indian Environment Minister, Jairam Ramesh, the number one in ONU about climate, Yvo De Boer, the leader of the Global Climate Initiative of the international WWF Kim Carstensen, the director of Greenpeace International Kumi Naidoo [erantis.com].

1.4.1 The Kyoto Protocol

It is an international agreement, subscribed by 37 industrialized countries from the European Community, to reduce the greenhouse gases. We remember that the USA did not adhere to this protocol, even though USA were responsible of 36,2 % of the world's total amount of emissions.

The goal is reducing the greenhouse gases of a rate of 5%, compared to the levels measured in 1990, in the quinquennial 2008-2012. The Protocol recognizes that the industrialized countries have the main responsibility of the present levels of greenhouse gases, because of 150 years of uncontrolled industrial activity. Therefore, the highest limitations are assigned to these countries; in the contrary, lower limitations are assigned to development countries, to avoid compromising their economic growth [unfccc.int].

Below, we describe briefly the working principles of the Protocol. Every country that ratifies it, obtains a certain number of emittible carbon dioxide quotes, expressed in tons. The Protocol doesn't obligate the countries to emit maximally the allowed quantity: it foresees some market mechanisms, with which a country can obtain additional quotes. These mechanisms are three:

- Emission trading (or carbon market): Protocol's article 17 foresees that countries with unused quotes can sell these to countries with a higher emitting level as the assigned one.
- Clean development mechanism: Protocol's article 12 establishes that if an operator of an industrialized country implements a project of emissions reduction in a developing country, he can earn for his country some emission credit certificates (every certificate is equivalent to one ton of CO2), which can be sold. This article is used to incentivize interventions in the developing countries, where the available technologies are lesser.
- Joint implementation: Protocol's article 6 establishes a mechanism that is similar to the precedent, but that tries to encourage the collaboration between two industrialized countries in the development of new emission reducing technologies [unfccc.int].

1.4.2 Environmental situation in Italy

In Italy, the environmental situation is particularly delicate, because of the physical conformation and the climatic characteristics that involve the country. The task of the government, companies and individuals is more complex than in other countries, which are more homogeneous from a climatic and physical point of view. For example, our country is one of the richest in biodiversity, with half of the vegetable species and a third of the animal ones in Europe.

Moreover, it presents many areas which are subjected to risks of natural origin: when phenomena of endogenous origin (volcanic and tectonic activity) and of exogenous origin (relief's erosion and sedimentation of the depressed areas) interferes with antropic activities. Italy is, in Europe, one of the countries which is most subject to seismic phenomena [apat.gov].

The latitudinal extension creates a consistent climatic variation between the north and the south of the country. Therefore, Italy is more vulnerable to climatic changes related impacts than other European countries. From this point of view, it is meaningful to compare data about the temperature rise: at a global level, the rise of the overall average temperature (earth - ocean system) in 2006 was 0,76 °C compared to the pre-industrial level, but in Italy the least estimates obtained by ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale) talk about an increase of 0,94 °C in the last 46 years.

For these reasons, the Italian government gives a lot of importance to environmental themes, trying to develop politics to support environmental sustainability. The clearest example is the registered rise of the number of installations for the production of electric energy which utilize renewable sources; the least available data speak about 49,4 TWh produced in 2007, equal to 15,7% of the worldwide electric production.

The interventions to improve the environmental sustainability are not yet enough to fill the gap between the directives of the Kyoto Protocol and the present situation; this problem doesn't appear only in Italy, which shows a negative situation such as many other industrialized countries with an advanced economy.

Italy won't be predictably in conditions to reach Kyoto's goals with only internal measures, and will recur to the credits generated by the international cooperation interventions (Clean Development Mechanism, Joint Implementation) defined by the Kyoto Protocol. In 2006, the greenhouse emissions resulted slightly less that 85 Mt higher than Kyoto's objective (+17,4%) [apat.gov]. For the first time, in 2006 the overall greenhouse emissions were inferior than those of the previous year, signaling a possible inversion of a tendency which lasted from 1996.

1.5 Sustainability in healthcare

The theme of sustainability regards not only private companies, but can also be extended to the public sector, for example healthcare.

Healthcare represents one of the highest expenditures in a country: for example Japan spent in 2005 8.2% of its GDP, Italy 8.9%, Norway 9%, Germany 10.7% and USA 15.2% [wikipedia.en].

Healthcare facilities are extremely complex structures, on the one hand because of the strong interaction between patients, health care providers and support staff, on the other hand because of the big range of activities of different nature which are constantly carried out, for example:

- the use of instruments designed for diagnostic and curative (invasive and non-invasive) procedures;
- the utilization of pharmaceutical, chemical, radiological and other agents for diagnosis, treatment, cleaning and disinfection;
- the use of appropriate disinfection and sterilization techniques;

- the provision of potable water and clean air for all operations;
- the nosocomial infection control.

In addition, as part of day-to-day operations, health care facilities generate a variety of wastes. Approximately 75-90% of the total waste stream is general health care waste, generated by administrative, housekeeping and maintenance functions. The remaining 10-25% of waste includes infectious, pathologic and chemical wastes that are considered hazardous in nature and create a variety of serious health risks. These wastes pose numerous hazards and must be appropriately managed to avoid damage to the environment and human health [IFC Environmental guidelines for healthcare facilities, 2003].

Acknowledging the examples shown above, it is very evident how healthcare activities are involved in considerations about sustainability, and in particular environmental and social sustainability. Economic sustainability has a minor role in the healthcare field: a public healthcare facility can't be compared with a usual company, since healthcare can be considered as one of the most important state services, financed through public taxes, and it's main purpose is not to generate the highest income possible, but to provide people with the prevention and treatment of illnesses.

1.6 Sustainability assessment methods

The present context provides different initiatives to analyze the sustainability of company activities and their involved elements: in particular, three mechanisms exist to help improving sustainability performances, trying to guarantee high sustainability standards. These mechanisms are:

- Laws and ad hoc regulations emanated by national and supranational institutions, where procedural and parametric bounds are imposed to regulate the calculation of the sustainability factors involved in the different company activities.
- Certifications developed by independent associations, which measure the level of sustainability performance of the companies requiring it. Some of them are developed to certify the products, some others to certify the company activities. Some certifications assign a reached performance level, while others certify that the imposed bonds are satisfied.
- Reference frameworks developed by independent associations to which companies can attain through self-regulation. They can be subject to the verify and the subsequent conformity recognition by independent entities, which are recognized by the associations owners of the framework.

The mechanisms illustrated above allow to evaluate the sustainability performances of different companies in a qualitative and in certain cases in a quantitative way. Some tools provide the possibility to obtain a benchmarking of different companies, because they are able to produce a numeric output of the reached level of sustainability, but in many cases these instruments examine only a very narrow portion of the wide range of aspects which should be considered for a complete sustainability assessment. In addition, many available instruments are qualitative self-assessment tools, so that the final sustainability estimate depends also on subjective components of the evaluator.

Regarding healthcare facilities, it doesn't exist any complete tool in literature, able to certify or assess its sustainability performances. As anticipated above, healthcare companies carry out a wide range of different activities, and to assess their overall sustainability every type of activity should be evaluated through opportune indicators.

After an accurate evaluation and description of the state of the art about sustainability, first generally and then specifically for the healthcare sector, we will develop with the present thesis work a model able to assess the overall sustainability of a healthcare facility, through the introduction of specific indicators which will examine the most important processes and aspects of such a structure. Every single one of them will be analyzed in a dedicated module, which will contain a list of possible sustainability indicators. The latter will be developed in such a way that will allow a benchmarking between different healthcare facilities and, in addition, that will suggest best practices for the improvement of the sustainability performances.

After having filled the different modules with the own values for all sustainability indicators, a healthcare facility will have the possibility to know its overall sustainability scoring and to compare it with the performances reached by other facilities. The possibility to provide a benchmarking is very important, since people are beginning to develop a certain sensitivity to healthcare-related sustainability themes: the possibility of knowing the sustainability scoring of a healthcare structure can influence for example the choice of the hospital where receiving an important surgical intervention. In addition, a healthcare facility which will obtain a high sustainability scoring will provide implicit information about, for example:

- its environmentally respectful use of materials, energy, products, instruments;
- the quality of the services provided to its main stakeholders, the patients, and to the other stakeholders;
- its continuous attention to economic factors in the purchase of equipment and outsourced services;
- its compliance with the laws and regulations in force.

1.7 Work contents

The present work will be structured in six chapters, that we briefly present below. The sequence of the treated themes will allow a good comprehension also to readers who aren't familiar with sustainability-related subjects. The contents of the work are the following:

- Chapter 1: presents the concept of sustainability, defining its subdivision in three dimensions and describing for each one of them the state of the art and the policies adopted by companies;
- Chapter 2: analyzes the state of the art of sustainability in various aspects. As first the industrial sustainability. Then the most important international sustainability certifications are presented, and how the governments try to face sustainability matters and goals. The state of the art in healthcare sustainability. As a conclusion some examples of sustainable healthcare facility are presented.
- Chapter 3: describes which are the most important activities and areas of interest of a healthcare facility; in this chapter we explain how and why a specific module containing sustainability indicators has been developed;
- Chapter 4: presents the different modules we developed for the assessment of the sustainability of the identified macro-processes and areas of interest. Every module consists in an exhaustive set of sustainability indicators, and the reason for the choice and the introduction of every indicator are clearly exposed in this chapter.
- Chapter 5: shows the implementation of the evaluation model in the hospital of Vimercate.
- Chapter 6: we provide some conclusions about the results obtained

CHAPTER 2 – State of the Art

The State of the Art of the sustainability offers a very wide range of arguments and point of view. Sustainability principles have been applied in a variety of context and it is not possible to consider all of them. The aim of this chapter is to give a complete idea of the main areas of interest of sustainability. In order to do this we divided the State of the Art in five parts:

- Industrial Sustainability
- Certifications for Sustainability
- Governments Policies about Sustainability
- Healthcare Sustainability
- Sustainable Hospitals

This subdivision is useful to trace a focusing path of the sustainability towards the healthcare sector. Starting with general matters like the Industrial Management of the Sustainability, the Certifications and the Government Policies, we will have the opportunity to know the typical matters, problems encountered and related solutions. The Healthcare Sustainability will present general projects applied by associations and organization, while the Sustainable Hospital are real State-of-the-Art documented examples of Healthcare projects with a strong attention to the sustainability.

2.1 Industrial Sustainability

As first we consider the general principles of sustainability applied in the industrial sector. In this area, as we will verify, the sustainability can be applied with the widest range of aspects. The explanation of how scientist, researchers and industries have worked in this direction is useful to have a general idea of the sustainability matters.

2.1.1 Automotive industry

A sustainable vision of the automotive industry passes through a whole life-cycle perspective, involving the phases of design, manufacture (and supply chain management), use and final disposal or "end of life vehicle".

A large automotive manufacturing industry is a powerful force in the creation of a organizational field, and can easily influence other businesses. Vehicle manufacturers have some of the largest and more professional purchasing departments, with particular care to cost reduction from their suppliers. The Life Cycle Assessment (LCA) methodology is one of the main strategies used in the automotive industry in order to empower the sustainability of the product, able to take into account the whole process.

2.1.1.1 Life Cycle Assessment

A product-design made through the LCA principles previews an appropriate choice of materials, a performance evaluation quantified against the performance of other materials, principally steel and aluminium. But radical change in the automotive industry may be required in order to respond to increasingly demanding environmental regulations worldwide [NIE 1999]. As an example, a central component of unsustainability in today's car industry is the internal combustion engine (ICE), associated with emissions, fossil fuel use and noise; therefore in recent years significant amounts of resources have been invested on the development of other propulsion systems. Nevertheless, the author underlines, generally, the technical improvement in the engine design have not entirely (or even largely) been directed at environmental benefits.

2.1.1.1 Lean production

A more sustainable automotive manufacturing often brings the name of lean production. The Toyota Lean production has got the main purpose to eliminate waste from all processes and activities, while in other automotive industries replacing glass fibers with natural fibers holds economic, environmental and social improvement potentials for the automotive industry. The application of curaua' fiber composites in the automotive industry bears economic potential due to the low life cycle costs and social advantages due to the high added value in the under-developed Amazon region in Brazil. In China, increasing pressures from different directions have caused the implementation of the green supply chain management (GSCM) practices, in order to improve environmental and economic performances. Unfortunately the GSCM has only slightly improved environmental and operational performances, and has not resulted in significant economic performance improvement.

2.1.1.3 Pollution

The use of the vehicles is directly connected with the emissions and the pollution of the environment. In the last decades several improvements where made to the internal combustion engines in order to decrease the emissions, in particular with the imposition of international standards upon the car manufacturers. The removal of petrol engine cars is possible through a hybrid petrol-electric power transition. An other theme connected with the use of vehicles is the type of consumer. In some nations the private consumer is a minority, and the majority is constituted by corporate or public sector buyers. Private users often buy used cars.

2.1.1.4 End-of-life Vehicles

As a conclusion we must consider the theme of disposal and end-of-life vehicles (ELVs). At the moment does not exist a study that analyze the ways in which over-supply of vehicles generates accelerated removal of cars from their useful functioning period. The first assumptions were that new technologies would have been able to outweigh the costs and the pollution of keeping in circulation old vehicles. Furthermore, in the 1990s, many industrial development showed that a ELVs management could involve different aspects like collection, treatment, reuse, and recycling of cars. European car manufacturers built alliances between them, while governments did not want to run the risk of causing unemployment or higher prices. Many are the case study present in literature. All of them show how different companies have faced problems of remanufacturing, recycling. In Canada a leading automotive dismantling company developed financial and life-cycle assessment models. In Europe was developed the TRENDS (TRansport and ENvironment Database System) a project for the prediction of waste produced from road vehicles, both at their end-of-life and during vehicle operation.

[Orsato, 2007]

2.1.2 Four company case studies in the UK precast concrete industry

The construction industry in the UK is under increasing legal and commercial pressure to become more sustainable; in the following we will analyse the results and key findings of four company case studies undertaken in the UK precast concrete industry, an important part of the UK construction products industry. Dunphy et al. suggest that managing for sustainability is critical to the development of corporate sustainability, and the four companies studied were not only engaging in the activities and developing the capabilities necessary to manage for sustainability, but had also progressed naturally to the 'efficiency' phase of corporate sustainability, as defined by Dunphy et al.

The overall research aim was to investigate how the leaders in corporate sustainability in the precast industry were managing for sustainability. Objectives in support of the research aim were to:

- identify the leaders in corporate sustainability in the precast industry;
- establish how these companies were managing for sustainability
- determine what changes have been made to their management structures, systems and competencies in order to manage for sustainability;
- investigate how these changes were made;
- assess how effective they were

The research objectives were met by undertaking a series of company case studies; these are recognised as a suitable research methodology for these types of explanatory questions focusing on contemporary events. These interviews reported a great amount of data that can be better understood knowing a series of key cross-cutting themes that were identified.

Seven themes were identified:

2.1.2.1 Compliance and management systems

The change process begins with compliance, managing for sustainability in each of the four companies studied was found to have begun with a compliance approach based on the development of ISO 14001 certified environmental management systems

2.1.2.2 From compliance to efficiency

The principal benefit of developing certified management systems identified by the interviewees was the development in each company of a continuous performance improvement culture, but this step naturally conducted to an efficiency phase, through a continuous and ongoing incremental change.

2.1.2.3 Monitoring performance and implementing improvements

The measurement of the performance reached was considered essential by the interviewees, in order to prioritise areas of improvement and to enable improvements target to be set. The legal compliance was considered the baseline performance and they always strived to be above this. A Plan-Do-Check-Act cycle was furthermore a need for progressive developments.

2.1.2.4 Eco-efficiency and socio-efficiency

The move to eco-efficiency must be supported by a corresponding move to socio-efficiency. For example, the interviewees all noted that their companies were now starting to broaden their sustainability focus to include: internal social issues such as staff training and development; local community relations; the performance of their suppliers; and the contribution of their products to sustainable construction.

2.1.2.5 Overcoming barriers to certification and change

The ISO 14001 certification has become a widespread administrative tool in the field of corporate response to sustainability. However, the companies must consider the high cost of this certification and are often unable to come to a decision for such a money outcome. All four companies in this study acknowledged that they had had to allocate additional resources to the development of their management systems and achieving certification, but the benefits were found to outweigh the costs.

2.1.2.6 Change agents

Senior management play an important change agent role by recognising the need to change and committing to support change, but other internal change agents then have to work to deliver that commitment. As the companies have progressed, day-to-day responsibilities have been devolved to factory-level teams, allowing the central teams to concentrate on the more strategic tasks. The companies successfully begun to develop an integrated approach to sustainability across different functions.

2.1.2.7 Education and training

All four companies were found to have initiated programmes of training to raise awareness and improve the competence of staff at all levels on sustainability issues. There was also a trend towards changing behaviours rather than simply enhancing technical skills; for example, one interviewee

stated ‘‘we developed the training necessary for every individual to have at least the basic knowledge to think about the environment, quality, and health and safety’’.
[Holton, 2009]

2.1.3 Cluster analysis: an empirical study on Shangai manufacturing industry

Since the reform and opening policy in 1978, the Chinese economy has undergone rapid growth and is now one of the largest economies in the world. As the largest city in China, Shanghai aspires to become the economic, financial, and trade center and positions itself as the economic powerhouse in China and in the East Asian region. In 2003, the government of Shanghai issued ‘‘Guidance to Manufacturing Industry Development (GMID)’’, which grouped the manufacturing industry into three categories: those encouraged to develop; those prohibited to develop; those restricted to develop. One of the central districts in Shanghai is studied, in which manufacturing used to play an important role over past decades. The manufacturing industry in the district is composed of 25 sectors which are resumed in table 1.

2.1.3.1 The cluster analysis

The research methodology employed was the cluster analysis. Cluster analysis previews a large number of techniques able to determine whether or not a data set contains distinct groups and, if so, to find the groups. Every object is regarded as a single point in a multi-dimensional space defined by the value of each of his attributes. The distance between two objects is measured to determine the similarity for the objects in terms of each of its attributes. Between two possible methods in hierarchical clustering, agglomerative hierarchical method and divisive hierarchical method the former is used. For every cluster identified four main variables and relative performance are considered:

- Industrial advantage - competition capability (V1)
- Social contribution - proportion of employees in the sector to the total number of employees in the manufacturing industry (V2)
- Environmental management - coefficient of environment protection (V3)
- Economic performance - market share (V4)

We will report only the results of the analysis, without considering the problems of data collection and variable choice reported in the article.

Four cluster were identified.

2.1.3.2 The four clusters

The cluster 1 contains only one sector, that is electronic and communication (ETC). This cluster presents a very high competition capability (V1) and economic performance (V4).

The cluster 2 contains seven sectors in total, that is, special purposes equipment (SPE), electric equipment and machinery (EEM), medical and pharmaceutical products (MPP), printing and record medium reproduction (PRM), ordinary machinery (OMC), instruments, meters, cultural and clerical machinery (IMC) and cultural, educational and sports goods (CES). Most of the sectors in this cluster are environmentally friendly. Their contribution to employment is larger than others except ETC in cluster 1.

The cluster 3 includes nine sectors: beverage production (BPD), timber processing, bamboo, cane, palm fiber and straw products (TBC), transport equipment (TEP), garments and other fiber products (GFP); textile industry (TTI), smelting and pressing of ferrous metals (SPF), leather, furs, down and related products (LFD), metal products (MPD) and plastic products (PPD). the values of all the variables are far lower than the averages. They are not environmentally friendly and their contribution to the economy of ABC is the smallest. On the other hand, their scale is far smaller than the average scale of similar sectors in Shanghai.

The cluster 4 includes eight sectors, that is, food processing (FPC), other manufacturing (OMF), furniture manufacturing (FMF), papermaking and paper products (PPP), nonmetal mineral products (NMP), smelting and pressing of non-ferrous metals (SPN), food production (FPD), raw chemical materials and chemical products (RCM). The sectors in cluster 4 present a great contribution to employment and the economic performance in the ABC district. Furthermore, the general competitive ability of these sectors is significantly large. Nevertheless, the coefficients of environment protection of these sectors need to be enhanced.

Sectors of the manufacturing industry in the ABC district

Number	Sectors	Abbreviation of sectors
1	Food processing	FPC
2	Food production	FPD
3	Beverage production	BPD
4	Textile industry	TTI
5	Garments and other fiber products	GFP
6	Leather, furs, down and related products	LFD
7	Timber processing, bamboo, cane, palm fiber and straw products	TBC
8	Furniture manufacturing	FMF
9	Papermaking and paper products	PPP
10	Printing and record medium reproduction	PRM
11	Cultural, educational and sports goods	CES
12	Raw chemical materials and chemical products	RCM
13	Medical and pharmaceutical products	MPP
14	Plastic products	PPD
15	Nonmetal mineral products	NMP
16	Smelting and pressing of ferrous metals	SPF
17	Smelting and pressing of non-ferrous metals	SPN
18	Metal products	MPD
19	Ordinary machinery	OMC
20	Special purposes equipment	SPE
21	Transport equipment	TEP
22	Electric equipment and machinery	EEM
23	Electronic and telecommunications	ETC
24	Instruments, meters, cultural and clerical machinery	IMC
25	Other manufacturing	OMF

Table 2.1 Sectors of the ABC district

2.1.3.3 Conclusions

As a conclusion the analysis provides information about how the different sectors should shape their future movements in order to approach sustainability goals. We noted that sectors in cluster 3 had very low values in the variable evaluation. Development of the manufacturing sectors in this group should be prohibited in the future. Hence, implementation of cleaner production technologies is necessary for the manufacturing firms in this sector. The sector in cluster 1 deserves top priority in development in the district. Firms in this sector are encouraged to implement cleaner production policy, for which the government might provide financial support.
[Zeng, 2008]

2.1.4 Decision-making and optimisation in petrochemical industry

Sustainability indicators are very important tools for evaluating the performance of industries and facilities. Different kinds of indicators are available, with a different level of complexity. The current trend in indicators research is the development of simple and informative indicators, and the avoidance of approaches that are too complicated. Complex indicators are difficult to implement in practice and consequently do not guide the decision-making process efficiently. The need for simple indicators is high in the planning of large and complex industries, such as the petrochemical industry. Examples of sustainability indicators could be divided into three sectors: environmental, economic and safety indicators.

2.1.4.1 Environmental indicators

Environmental indicators were used for example in the design process: the Waste Reduction algorithm (WAR) is a tool for design engineers that aids in evaluating the potential environmental impact of a chemical process. Other methodologies are the Life Cycle Analysis (LCA) and the Sustainable Process Index (SPI). These indicators require a large amount of data and their use is limited to a small number of processes. Simple indices can reveal planning problems that need further investigation. Examples of simple indices are CO2 emission and total energy consumption. In the petrochemical industry toxicity indicators are very important, like the LC50 (median lethal concentration50), LD50 (median lethal dose50) and TLV (threshold limit value). Simple ‘‘rank form’’ hazard indices were used by the National Fire Protection Association (NFPA) with a system that indicates the health, flammability and reactivity hazards of chemicals. The Indiana Relative Chemical Hazard Score (IRCHS) indicates how a chemical compares with others in terms of its capacity to impact human health, ecosystems or environmental health generally.

2.1.4.2 Economic indicators

Economic indicators are a way of describing the creation of wealth or value, and both human and financial capital can be considered. Economists look at the industry in terms of capital flow, where one of the primary aims is to create added value and through that wealth. Considering the nature and the size of the petrochemical network, the simplest measure possible that should be used is the added value, that provides a clear indication of the success of the industry. Another area of economic concern is the manufacturing strategy. Usually, the main step in developing a strategy is to prepare a list of all the products that are in the company’s portfolio for which the strategy is being prepared. One simple strategic tool used in planning and product selection is the bill of material (BOM). Another strategic tool used in planning and products selection is the Boston Consulting Group (BCG) Business Portfolio Matrix, but in this study the economic added value will be used as the economic component of the sustainability objective for planning a petrochemical industry.

2.1.4.3 Safety indicators

Safety indicators could be considered as part of all the three traditional meaning of sustainability: it is a part of environmental concerns when considering human toxicity, it is a part of economics when considering expenditures on health and safety, and it is represented in social indicators when considering work satisfaction. Useful industrial safety indices are The Emergency Response Planning Guideline (ERPG) values, which are intended to provide estimates of concentration ranges where one reasonably might anticipate observing adverse effects. Also, the Immediately Dangerous to Life and Health (IDHL) values, which are defined by NIOSH as exposure limits to airborne contaminants. A recent safety index developed by Al-Sharrah et al.(2007) starts from the basic definition of risk. This simple safety index is related to chemical accidents. The index is:

$$K = Freq \times Haz \times Inv \times Size$$

where Freq is frequency of accidents, the number of accidents per process per year; Haz the hazardous effect of a chemical, the number of people affected per tonne of chemical released; Inv the inventory of the chemical released, tonnes per accident; Size the plant size, the number of major processes in the plant. This index is simple yet it incorporates past experience and encourages the use of simple process with fewer inventories.

2.1.4.4 Model considerations

The study of this article presents in detail the main themes and problems related to the implementation of a petrochemical optimisation model with the formulation of three different objectives: environmental, economic and safety objective. The final form of the model used for the planning of a petrochemical network in Kuwait is a MILP (Mixed Integer Linear Programming) model with 70 continuous variables, 62 binary variables, 185 constraints and three objectives, which form a moderately sized model. The three objective functions were tested with the model separately, and then simultaneously, planning at first a test with a single objective, and secondly with multi-objective.

2.1.4.5 Single-objective and multi-objective tests

The results concerning the single-objective tests give a good indication that when environmental risk assessment is used in planning an industry, it is also directed towards safer operation but the economic gain is reduced. In addition, planning for economic gain will result in an environmental and safety risk double than minimum possible and vice versa. When using the multi objective

function, a better economic outcome was found than when the model was solved only with the environmental or safety objective. As a first conclusion we can say that accepting lower economic wealth does not mean a big loss, since we are looking for a plan with long-term safety and with a reduction in the negative effects on the environment and on humans, which will reduce expenditures on health and safety.
A short sensitivity analysis about the influences that uncertainty and fluctuation of the world's economy can produce on the model is presented. As a result it can be stated that the model is quite ''stable'' and its output and selection can accommodate the risks from variations in market.
[Al-Sharrah, 2010]

2.1.5 Sustainability issues in sheet metal forming

This paper mainly aims to summarise the state of the art of the technical literature about sustainability in each phase of a product life cycle, from a forming point of view. Actually, a lack of contributions is present in the technical literature, thus, the authors try to give a sort of holistic vision aimed to provide basic guidelines in order to help in identifying the possible solutions with regard to all the phases of a forming product life cycle. One of the main contribution this paper wants to give is to answer the question: which is the most correct framework allowing to take into account all the aspects having effects on sustainability of a sheet forming process?
The paper highlights that the problem could be divided into different sections, that are:

- Materials for weight reduction
- Recycling issues
- Efficiency in materials use: applications in sheet metal forming
- Technologies for lightweight materials manufacturing
- Forming processes environmental impact reduction

2.1.5.1 Materials for weight reduction

One of the main strategies in the direction of a more sustainable metal forming process is the choice of materials. Weight reduction is considered the main area of interest for a more sustainable forming process. Lightweight materials may offer weight reduction thanks to two different characteristics: the ones with lower density (aluminium and magnesium alloys) can ensure good strength performances by increased thickness without worsening weight performances, the ones with higher strength (advanced steels) allow good weight performances by reducing thickness. As far as aluminium production is concerned, several environmental issues have to be considered. For instance, bauxite residues from bauxite processing, emissions of airborne and waterborne pollutants, cathode waste and high-energy consumption. On the other hand, actually, the steel industry documents that vehicle mass can be reduced by 25% through the application of modern high strength and AHSS. When dealing with magnesium alloys, it is worth pointing out that they have a great potential to reduce vehicle weight, fuel consumption, and greenhouse gas emissions in vehicles use life. As regards atmospheric emissions and global impacts the Mg production process clearly shows a very bad performance.

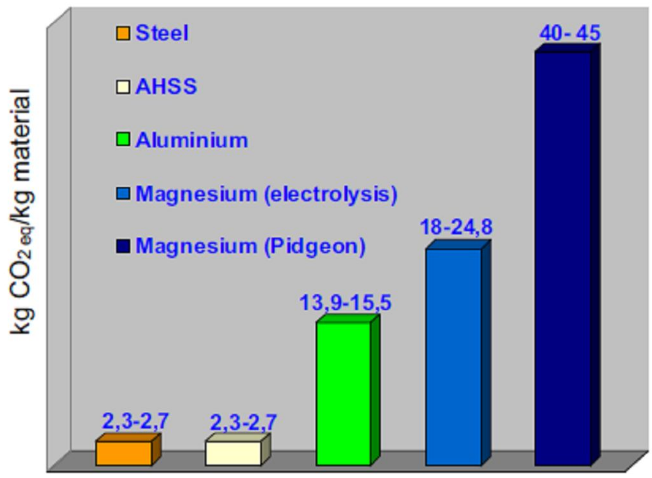

Figure 2.1: Average GHG emissions from primary production

2.5.1.2 Recycling issues

Secondly, recycling in manufacturing aims to reduce material waste in order to obtain other suitable materials. It is well known that iron and steel are still the world's most recyclable materials. Aluminium for instance is 100% recyclable every time it is recycled. Magnesium is also highly recyclable, consuming merely 5% of the amount of energy required to produce the primary metal. Other researchers investigated the possibility to substitute the direct recycling approach with a new technique based on the recycling directly from the chips by cold or hot pressing followed by hot extrusion avoiding the milling step. Other techniques of metal recycling are presented in detail and demonstrate a large and deep investigation of the theme.

2.1.5.3 Efficiency in material use

The third point, efficiency in material use, deals with the minimisation of material resources through techniques that allow the efficient use of material by "using" it where it is effectively needed for a given forming process. In sheet metal forming the use of tailor made semi-finished products enables the cost-efficient production of weight and load-optimized components. The recent technical literature concentrates on tailored blanks, and emphasises the important role of tailor rolled blanks and patchwork blanks with particular reference in light weighting performances. Other researcher are working on different kinds of mechanical processes in order to minimize the need of material. A relevant interest has arisen on patchwork blanks. A patch tailor welded blank (TWB) overlays one blank of material on top of another blank to add strength where it is needed. The two blanks are joined, usually by spot welds, before forming.

2.1.5.4 Technologies for lightweight materials manufacturing

Other important technologies related to point four (lightweight materials manufacturing) are the warm and hot stamping processes, the incremental forming, hydroforming, and superplastic forming.

2.1.5.5 Forming processes environmental impact reduction

As a conclusion we must consider the main strategies and focusing needed in order to reduce the impact of the metal forming processes. Firstly we must consider the process energy consumption. In a certain operation a comparison between two different processes eventually available could be necessary. If the energy source is a form of fossil fuel the GHG emissions must be monitored. Particular attention should be paid to the forming steps required in a manufacturing cycle. Reducing the number of forming steps implies reducing necessary tools, required energy, lubricants utilisation and so on. Anyway, the equipment necessary for some particular processes avoiding multiple steps may imply an increase in environmental impact. Furthermore in comparing environmental performances of a forming operation the tools to be used have to be taken into account.
[Ingarao, 2011]

2.1.6 Conclusions

This five studies belonging to the industrial area of interest are useful to determine a first focusing of issues and solutions of sustainability:

- Life cycle assessment of a product
- Pollution connected with the use of product
- Disposal of the products
- Compliance with normative and certifications
- Monitoring of results
- Education and training of personnel in sustainability issues
- Sustainability must consider effects on:

  - Industrial advantage
  - Social contribution
  - Economical performance
  - Safety
- Recycling of materials
- Reusing of materials
- Reduce waste
- Optimization of processes

These areas of interest present the majority of the matters connected with the sustainability management. In order to enact sustainable development practices the companies must analyze these issues and find the best solutions for their own business.

2.2 Certifications for sustainability

The second part of the State of the Art involves the sustainability certifications and normative applied by institutions to check the good behaviour of industries and organisations. This part gives a accurate idea of how a third-party institution elaborates an evaluation model of the sustainability and which are the main themes involved in the assessment.

2.2.1 Introduction

The importance of sustainability, underlined in the previous chapter, poses a fundamental problem to the management staff of a company: should sustainability be considered as a strategic variable? This theme has been widely deepened in the literature: yes, sustainability is a strategic variable, because it is able to offer a competitive advantage towards competitors.

Sustainability can't be applied to single isolated parts of the organization, but is transversal to all its activities (Figure 2.2).

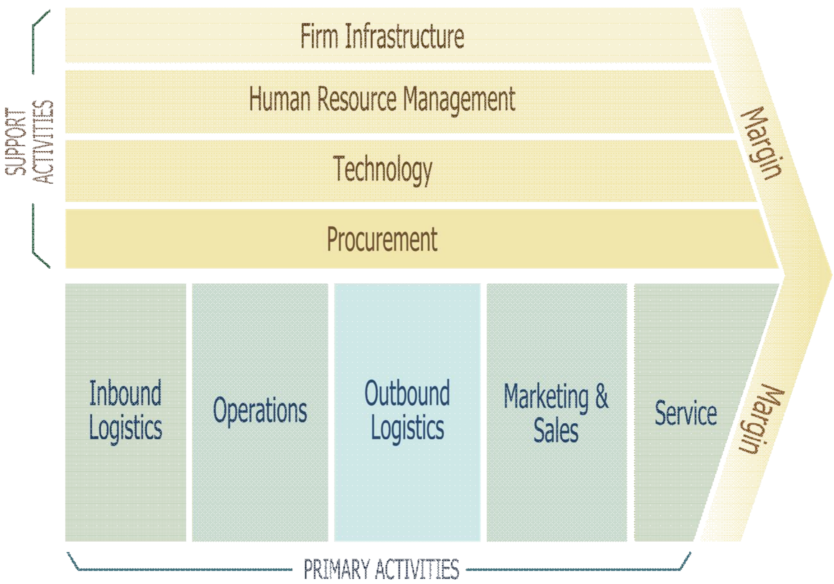

Figure 2.2 Porter's value chain and sustainability [wikipedia.en]

The variable "sustainability" has a strategic valence in its environmental meaning, because the other two dimensions of sustainability don't show such high criticalities as the relationship between man and environment [De Marchi, 2006]. The social dimension assumes a lower value in economically developed countries, because it is widely guaranteed by the institutions. The economic sustainability is guaranteed by the Value Creation Theory, which is now internalized in the modern economic culture.

Proactive companies in the field of sustainability try to minimize their environmental impact, to obtain in the long term some benefits but not only economic advantages towards their competitors. Virtuous companies in the filed of sustainability tend to anticipate with their behaviour environmental laws, which are becoming always more pressing.

Like all the variables with a strategic relevance, it is necessary to reach some precise objectives, to understand the factors that influence them and to finally verify the obtained performance level. Companies have to provide mechanisms for the evaluation of their own environmental performance or procedures, to verify that processes are faced with adequate measures to guarantee the environmental respect. To provide an answer to this necessity, many certifications were created, containing reference frameworks to plan and develop sustainable organizations.

The four main certifications, which are worldwide recognized, are EMAS, ISO 14001, GRI and BREEAM, and will be accurately described in the next four paragraphs. In paragraph 3.6 we will present a series of brands and initiatives promoted by non-profit institutions to certify the use of sustainable standards in the organizations. Some of these certifications are based on tecnical measurements, some others on the satisfaction of different standards regarding some specific processes.

2.2.2 EMAS

The Eco-Management and Audit Scheme (Figure 2.3) is a voluntary instrument created by the European Community. Organizations can voluntarily adhere to it, to evaluate and improve their environmental performances and to provide their public and the other stakeholders with information about their own environmental management.

The first EMAS n. 1836 regulation was emanated in 1993, and in 2001 it was substituted with the regulation n. 761. This regulation was then revised and substituted in 2009 with the new regulation n. 1221.

Figure 2.3 EMAS logo [arpab.it]

The environmental management system required by the standard EMAS is based on the ISO 14001 norm of 2004, which will be deepened in paragraph 3.3, whereas the relation with the stakeholders is guaranteed by the obligation to create and update an Environmental Declaration.

The Environmental Declaration contains:

- a clear description of the organization, its activities and products;
- environmental policies and environmental significant aspects of the organization;
- objectives and environmental targets;
- the company performances compared to the present environmental laws;
- the name and the accreditation number of the environmental inspector, the conformity evaluation organism, and the validation date.

The data and information contained in the Environmental Declaration must be precise, comprehensible, whitout ambiguities, comparable between the different businesses and must respect the norm requirements. The regulation n. 1221/09, about the voluntary adhesion of organizations to the EMAS system, introduces some key indicators which regard the following environmental themes.

- Energetic efficiency: the overall direct energy consumption (MWh), and the overall renewable energy consumption (in percentage).
- Material efficiency: the annual mass flow of used materials (tons), excluding water and energy.
- Water: the total annual water consumption (cubic metres).
- Waste: the total annual production (tons), divided by typology and the annual total dangerous waste production (kilograms or tons).
- Biodiversity: the land use (squared metres).

- Emissions: the total annual greenhouse gas emissions (CO_2, CH_4, N_2O, HFC, PFC and SF_6, expressed in tons of CO_2 equivalent), and the total annual emissions in the atmosphere of SO_2, NO_X and PM (kilograms or tons).

For every key indicator, the standard imposes a very precise component structure:

- a variable A indicates the consumption or total annual impact in a defined field;
- a variable B indicates the total annual production for the organization;
- a variable R represents the ratio A/B.

[ec.europa.eu]

2.2.3 ISO 14001

The ISO 14001 norm (Figure 2.4) was approved by CEN, Comité Européen de Normalisation, the 21st of August 1996, and then revised in 2004 to make it compatible with ISO 9001, the quality standard. It is part of the ISO 14000 series, which originated from the Environment Summit in Rio in 1992 and from the Uruguay Round negotiations, regarding the abolition of international trade barriers [quality.co.uk].

Figure 2.4 ISO 14001 logo [realnorth.co.uk]

The ISO 14001 norm specifies the requests of an EMS (Environmental Management System), which allows an organization to formulate an environmental policy and to establish some objectives, taking into account the legislative aspects and the information regarding significant environmental impacts. It is a voluntary instrument and doesn't establish any performance request, but its implementation requires the introduction of the environment between the strategic variables.

2.2.3.1 EMS (Environment Management Systems)

An EMS can be defined as the part of a company management system which faces the relationships between a company activity and the environmental context where it operates.

The interest for environmental management systems is a consequence of the international policies, which have transformed the environmental sustainability of a company in a competitiveness factor: a preventive logic was gradually developed, finalized to the promotion of environmental quality improving acitivities, and to the accident risks reduction for workers and workplaces [Lepore, 2003].

An environmental management system allows an organization to:

- have a punctual control on the ecological impacts of its activities;
- establish the environmental performance levels to be reached in the short, middle and long term, taking into account the trade-off between costs and benefits;
- evaluate the necessary resources and assign the responsibilities to reach the established goals;
- communicate the operative instructions to the various organizational levels, to minimize the environmental impact;
- communicate to stakeholders and shareholders the achieved results and the potential gaps compared to the established goals, to incentivate a continuous improvement.

2.2.3.2 Comparison between ISO 14001 and EMAS

The other reference standard for the creation of an EMS is the EMAS, *Eco-Management and Audit Scheme* (paragraph 3.2) regulation. EMAS is a system to which both public and private companies and organizations can voluntarily adhere, inside and outside the European Community, if they would like to evaluate and improve their own environmental efficiency and therefore their competitive advantage. Both the ISO 14001 norm and the EMAS regulation are voluntary instruments: an organization can decide, based on its own strategy, which norm to adopt.

In the first version of the ISO 14001 in 1996, some differences were present compared to EMAS regulation.

Because of the ISO 14001 update of the 15th of November 2004, which became effective in May of the following year, the two norms are highly compatible: the EMAS II regulation has fully incorporated the environmental management systems section of ISO 14001, described in paragraph 3.3.3. If an organization with ISO Environmental Certification would like to obtain the EMAS certificate, it will have to integrate some elements in its EMS, for example the editing of an Environmental Declaration: this instrument is used to establish a constant, clear and coherent communication, with the public and with the public administrations; however, the transition is gradual and not particularly onerous [arpa.veneto.it].

As shown above, the adhesion to EMAS is harder and more binding, and this causes a slight preference for the ISO 14001 certification.

2.2.3.3 The functioning of the ISO 14001 norm

The ISO 14001 norm was edited to be applied to organizations of different type and dimensions, and is based on the following main concepts:

1. it is applied to the organizations which would like to implement and improve an EMS;
2. the organization must assure its commitment to the environmental management and define its own environmental policy;
3. the organization must formulate an action plan for its own environmental policy, choosing between a self-evaluation or a self-declaration, ask the stakeholders for a confirmation of its own conformity and ask a third organization for a confirmation of its self-declaration;
4. the organization must develop its capabilities, and assign the resources and the necessary supports to achieve the finalities of its own environmental policy, the objectives and the preset goals;
5. the organization must measure, monitor and evaluate its environmental performances, and actuate the necessary corrective actions.

The norm doesn't establish environmental performance absolute requirements, it prescribes the commitment, the conformity to the law and to the appliable regulations, and the achievement of a continuous improvement [arpa.veneto.it].

The EMS described by the ISO 14001 norm is a model which represents the continuous improvement cicle of PDCA (Plan, Do, Check, Act), illustrated in Figure 3.4 and theorized by Shewart and Deming in the 50s.

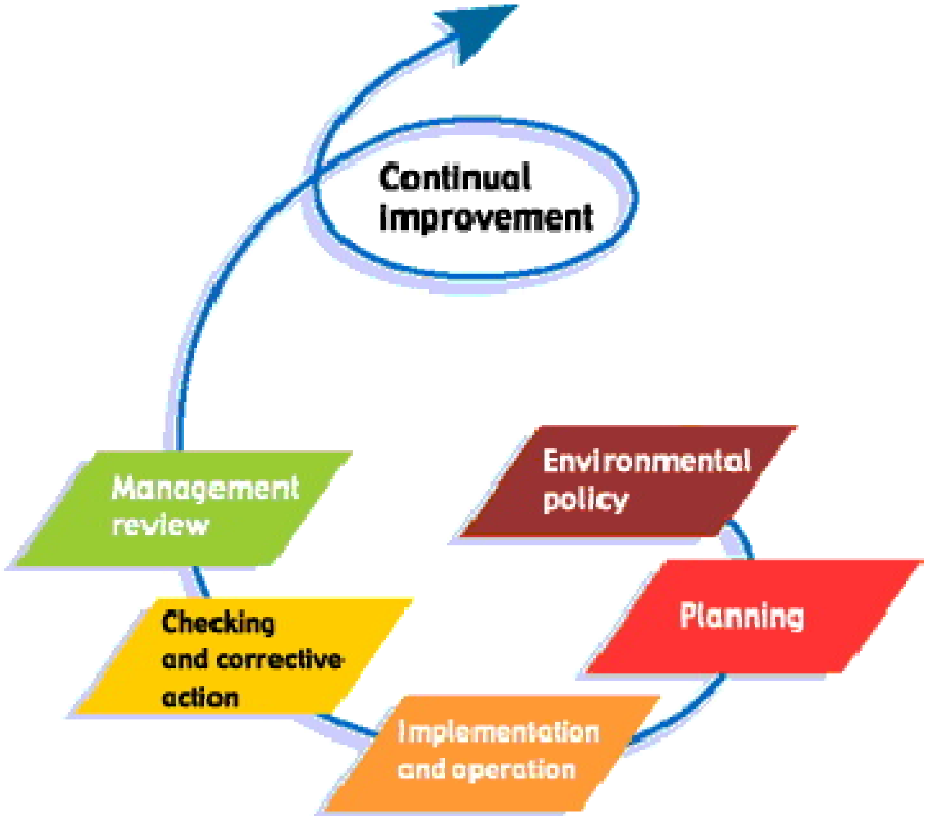

Figure 2.5 Deming wheel [europa.eu]

The essence of ISO 14001 norm consists in the continuous application of Deming PDCA wheel in the environmental management, allowing to obtain a continuous improvement of the business performances. The four phases of Deming wheel represent the categories of the ISO 14001 norm; the necessary steps to obtain the certification are divided exactly in four parts.

- ***Plan***: it means the identification of legal prescriptions, the individuation of significant environmental aspects, activities and products which can have relevant impacts on the environment (air, water, land, natural resources, flora, fauna, human beings and their interrelations), of the objectives and the goals which have to be coherent with the environmental policy of the organization.
    1. Definition of the environmental policy: consists in a public document, written by the company, describing the engagements made towards the environment. The managing staff must define the environmental policy of the organization and assure that:

- it is appropriate to the nature of the organization and its environmental impacts;
- it is oriented to the continuous improvement and to the pollution prevention;
- it respects the appliable legal prescriptions;
- it establishes the environmental objectives and goals;
- it is well documented and communicated to all the stakeholders.

2. Environmental aspects: the environmental impacts of the organization's single activities are accurately evaluated. It represents the base on which the environmental action program is built. Activities such as paper recycling or water recovery can influence positively the environmental impacts [Johnson, 1997].
3. Legal prescriptions: the organization must respect the environmental legislation and the connected norms, and request permissions or authorizations when necessary.
4. Objectives and goals: the organization must establish objectives with a general character (for example: improve efficiency), and goals with measurable performances and defined with a deadline (for example: reduce 10% of the energy consumption for the heating within the 31st of December of the current year). Objectives and goals should be established in accordance with: environmental policy, prescribed legal and regulation requirements, significant environmental aspects, technological possibilities, financial exigencies (for example, privileging environmental objectives which allow at the same time a cost reduction, through the improvement of the production system efficiency, and a waste reduction), commercial exigencies (compatible, for example, with the exigency to improve product quality) and stakeholder's point of view (suppliers, shareholders, employees, clients, local communities). The objectives and the fixed goals have to be realistic, not too ambitious and compatible with the business goals [geminieuropa.com].
5. Environmental management program: it represents the objectives and the goals individuated by the organization to monitor its environmental performances and continuously improve them.

- ***Actuation and functioning***: to assure the functioning of the EMS, it is necessary to define rules, responsibilities and authorities involved in the goal achievement. The personnel has to be trained for the execution of the activities required by the system, and has to be provided with the necessary equipment. In this phase, the activities of internal and external communication are defined, through the production of an adequate documentation system.

6. Structure and responsibility: it is necessary to subdivide the tasks between the involved employees and to worry about their coordination.
7. Education, awareness and competencies: every activity of an organization has an impact on the surrounding environment. For this reason, employees must be made aware of the environmental themes and incentivated in the research of solutions to reduce such impacts, sharing then the best practices with other workers.

8. Communication: internal communication, to share environmental virtuous behaviours; external communication, to show the obtained results and improve transparency towars the community and the other stakeholders.
9. Documentation of EMS: it is the report of the internal history of the organization and provides an objective evidence that the system complies with the norm. In addition, it is a reference instrument for the charged personnel regarding responsibility, roles and activities.
10. Documentation control: the management of the EMS documents is characterized by a high dynamism, because these documents have to be constantly updated when new norms appear. All documents have to be: approved before use, equal for all involved subjects, available to be consulted, readable, identifiable and retraceable.
11. Operational control: it represents all the necessary procedures to improve the environmental sustainability of the organization, and is the nucleus of the entire system. It considers environmental norms, present authorizations, significant environmental aspects, maintenance, supplying, resource consumption, waste production, emissions and discharge and anomalous situations found.
12. Preparation to emergencies and reaction: realistically foreseeable emergency situations are identified together with the significant evaluation of impacts, and the reaction to these events is activated in relation to the emergency typology. If the emergency is not foreseeable, the situation is faced with reference to the existing laws. Anyway, the organization is required to invest in prevention, through emergency plans and periodical tests to verify their functioning.

- ***Control and corrective actions***: foresees the monitoring of the objectives and goals, the calibration of the control systems, the management of non conformities to the environmental policy or to the norms, and the periodical check of the environmental management system.

13. Surveillance and measurement: the organization implements a continuous monitoring system of its objectives and goals, to evaluate the effectiveness of its own EMS. In this way, it is possible to evaluate punctually the consumption of resources, to inform precisely the employees about the performances, and to compare the system quality year after year.
14. Non-conformities, preventive and corrective actions: explicates how the non-conformities have to be managed in the course of the activity. When a non-conformity is revealed, it is firstly evaluated to identify its causes, and then permanently eliminated

choosing an adequate corrective action. The preventive action is a measure to eliminate potential non-conformities, acting in advance on their causes [iso.org].

15. Registrations: the environmental registrations, stored on a paper or electronic support, provide objective evidence of the activity, product or service conformity to which they refer, and of the effective functioning of the EMS, with reference to the established targets. Such registrations are taken under control following the criteria of identification, storage, availability and final destination; they have to be compiled in a readable way, have to report the date and the signature of the compilation's responsible and have to be stored to preserve them from damages, deterioration or loss [Johnson, 1997].
16. EMS Audit: the organization effects, with planned intervals, a check of the effectiveness and of the continuous improvement of the environmental management system, in relation to the conformity to the reference norm's requests and to the planned objectives. To assure the objectivity and impartiality of the process, the verification is carried out by personnel which is not involved in the examined activities.

- ***Act***: through a periodic re-examination, it is assured that the environmental management system continues being effective, and that continuous improvement actions are implemented.

17. Re-examination by the management staff: the EMS is periodically revised by the management staff to assure its suitability and its effectiveness over time. During this phase, all information from the system is considered: measurements, gaps from the objectives and the preset goals, corrective actions and audit results.

The adoption of the ISO 14001 environmental certification allows to realize a perfect monitoring of the norm in the environmental subject, to have a higher legal safety and to demonstrate attention and conformity to laws and regulations.

The most important potential benefits of an environmental management system are:

- the demonstration to customers of interest, diligence and responsibility in the management of environmental problems;
- the possibility to entertain relations with local communities and institutions;
- a higher easiness of obtaining permissions and authorizations;
- the saving of raw materials and energy;
- the satisfaction of the investors' needs, making the access to capitals easier;
- the possibility to obtain insurances at favourable conditions;
- the image and market quote improvement;
- the improvement of the cost control;

- a reduction of the accidents where the organization is responsible.

From a research conducted in 2008 by the "Istituto Superiore per la Protezione e la Ricerca Ambientale", the implementation of an EMS can create significant competitive advantages, in particular towards the less dynamic competitors, improving from one side the efficiency of the organization, from the other side its image and the relationships with the stakeholders such as customers, insurance companies, credit institutions and public institutions [ecos.it].

2.2.4 Global Reporting Initiative (GRI)

The GRI reporting framework is a worldwide recognized model for the reporting of the economic, environmental and social performance of an organization [globalreporting.org].

The sustainability reporting consists in the measurement, communication and responsibility assumption (accountability) towards the stakeholders, in relation with the organization performances about the implementation of a sustainable development.

The development of the guidelines and of the contents of the G3 Protocols was achieved by volunteers of the business world, non-governative organizations, syndicates, accounting employees, investors and academic world. Some of the remarkable companies which participated providing funds, contributes and competencies are Ford, Shell, RBC Financial Group, HP, Microsoft and many other important industrial groups from all over the world.

The report analyzes different aspects:

- carrying out benchmark and environmental sustainability performance analysis, in respect to laws, norms, codes, performance standards and voluntary initiatives;
- demonstrate how the organization influences and is influenced by the expectations in theme of sustainable development;
- compare the performance in the course of time, in a same organization and between different organizations.

[globalreporting.org]

2.2.4.1 Composition of the GRI framework

The GRI Reporting framework is composed of four parts, the first two regarding how the final report should be produced, the last two about what should be included in the report (Figure 2.6):

- Principles and Guidelines: it's the listing of the principles used to individuate the information and gather it. In this part, also the performance standard indicators have to be included, as well as the technical arguments which are specific for the report compilation.

- Protocols: for each performance indicator contained in the Guidelines, some indicator protocols exist, which provide information to compile the report properly and to assure coherence in the interpretation of the indicators.
- Sectorial supplements: they are an addition to the Guidelines, specific for a certain sector. Their use is to extend the final report or to suggest some interpretations of the standard indicators about some specific industrial fields.
- Technical Protocols: they are thought to make the comprehension of some report aspects easier, such as the definition of the analysis perimeter or to face the most common problems during the reporting process.

[globalreporting.org]

Figure 2.6 GRI Reporting Framework [thehub.ethics.org.au]

2.2.4.2 GRI application levels

The GRI specifies how to produce the sustainability report: companies can choose between different adhesion levels to GRI, follow the guidelines and publish the report compiled by the company itself (self-declaration), or increase the report credibility applying different control procedures by third agencies, such as insurances or the GRI itself. With "insurance", GRI means all those activities which can provide written conclusions about the report quality and the information included in it, as well as the data preparation process. These mechanisms allow a wide flexibility in the framework application, and offer an instrument which can be used by high-skilled and entry-level users.

The GRI proposes three levels (A, B and C), assigned on the basis of the deepening grade of the framework application. A plus sign is used in case that the organization decides to use an external insurance to compile the report (Figure 2.7) [globalreporting.org].

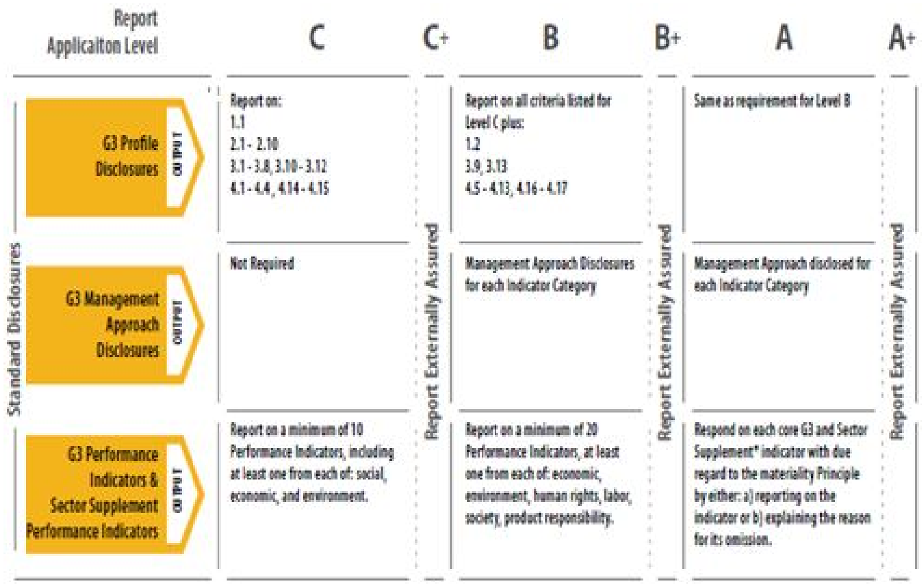

Figure 2.7 Criteria for the subdivision into different levels [globalreporting.org]

Once the deepening grade is decided, the organization can choose how to compile the report:

- third parties certification, which requires analysis and approval of the final report;
- approval of the final report by the GRI, sending the documentation to the organization which will provide to the analysis and recognition of the standard.

The mechanisms for the report certification are illustrated in Figure 2.8 [globalreporting.org].

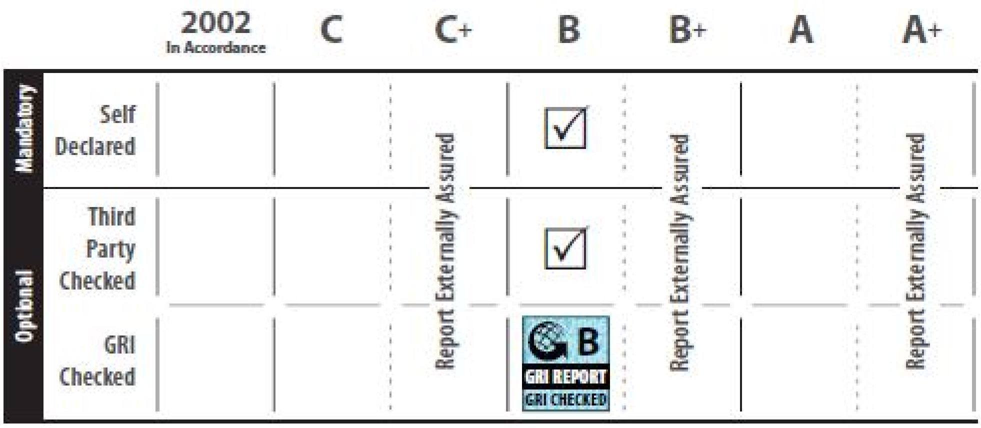

Figure 2.8 Communication grid for the achieved level [globalreporting.org]

2.2.4.3 GRI contents

Purpose of the GRI is also to provide clear and comprehensible information. Many data must be expressed in order to allow the full understanding of the entourage.

Three basic kinds of data are essential.

- Profile and strategy: general contest for the understanding of the company performances.
- Management modalities: the way used by a company to face a series of specific theme.
- Performance indicators: they provide information about the measurement of economic, social and environmental performances of the company. This represents the heart of the report [globalreporting.org].

The GRI framework supplies a wide range of indicators. As seen before, companies are supposed to decide the number and kind of indicators. They are divided into five macro-areas:

1. Economic indicators;
2. Environmental indicators;
3. Social indicators;
4. Other indicators;
5. Sector-specific indicators.

Every macro-area includes different categories which are specified by "Core" indicators. These were worked out with the aim to identify general measures which are supposed to be important for the majority of the companies. In the following paragraphs there will be a list of indicators divided by macro-areas, categories and specifying the "not Core" indicators with "*Add*" [globalreporting.org].

2.2.4.3.1 Economic performance indicators

The economic dimension of the sustainability concerns impacts on economic conditions of stakeholders and of local, national and global economic systems.

General economic performance:

1. Generated and delivered economic value, delivered and reinvested profits, donations, operational costs, employees remuneration;
2. Risks and opportunities due to climate changes with financial rebound;
3. Covering of obligations for pensions;
4. Benefits of considerable financing from public administrations.

On markets:

1. Politics and rate of expending connected with local suppliers;
2. Politics and rate of hiring of people living in local communities;
3. *Add*: Ratio between neo-hired medium salary and minimum local salary.

Indirect economic impacts:

1. Economic calculation of “pro bono” activities, public utilities services, infrastructural investments;
2. *Add*: indirect economic impact of the above mentioned activities.

[globalreporting.org]

2.2.4.3.2 Environmental performance indicators

The environmental aspect of sustainability considers the impact of a company on living natural systems, included earth, air, water and the ecosystem.

Raw materials:

1. Weight and volume of used raw materials;
2. Percentage of material coming from recycling process.

Energy:

1. Direct energy consumption, inside the organization, divided by primary source;
2. Indirect energy consumption, external to the organization, divided by primary source;
3. *Add*: energy saving due to bettering of physical systems and procedures in terms of efficiency;
4. *Add*: initiatives about renewable energies or high efficiency and consequent reduction of energy needs;
5. *Add*: initiatives about reduction of indirect energy consumption and reductions obtained.

Water:

1. Total needs of water;

2. *Add*: Hydric sources concerned with the water withdrawal;
3. *Add*: percentage and volume of water used and recycled.

Biodiversity:

1. Location and dimension of owned and managed grounds located in high biodiversity protected areas;
2. Description of the major impacts of the activity on high biodiversity protected areas;
3. *Add*: protected and restored habitats;
4. *Add*: strategies or actions directed to manage the impacts on biodiversity;
5. *Add*: species included in the red list IUCN (International Union for the Conservation of Nature) or in the national protected list that are located in the operating areas of the company.

Emissions, dumps and wastes:

1. Direct and indirect greenhouse-effect gas emissions, expressed as tonne of carbon dioxide equivalent;
2. Other indirect emissions;
3. Emissions of hazardous compounds for the ozone hole;
4. NO_x, SO_x and other significant air pollutants;
5. Wastewater produced, classified for quality and destination;
6. Total waste weight, classified for sort and management;
7. Sum of chemical compounds, pollutants, oils and fuel leakages;
8. *Add*: initiatives for greenhouse-effect gas and waste reductions and results obtained;
9. *Add*: weight of waste, classified as hazardous on the basis of the convention of Basel, that is moved and transported in foreign countries;
10. *Add*: status of the water habitats affected by the wastewater drainpipes and pollutants leakages (derived by the company).

Products and services:

1. Initiatives for the mitigation of the environmental impacts of products and services and their related results;
2. Percentage of sold products and their related packages materials that are reused or recycled.

Conformity, transport and general:

1. Monetary values of fines and sanctions apply to the non-keeping of environmental laws and rules;
2. *Add*: environmental impacts due to the product transport and to the employee transfers;
3. *Add*: total costs and investments for the environmental protection.

[globalreporting.org]

2.2.4.3.3 Social performance indicators

The social dimension of sustainability reflects the impacts of the organization on the social systems in which the organization works.

Employment:

1. Total number of employees, divided by contract type and territorial distribution;
2. Total number and personnel turnover rate, divided by age, sex and geographical area;
3. *Add*: expected benefits for the full-time workers with long term contracts, but not for the other categories.

Industrial relations:

1. Percentage of employees with a collective bargaining;
2. Minimum notice period for operational modifications.

Work health and safety:

1. Accidents at work, illness, absenteeism and death rate;
2. Educational programs, training, consulting, prevention and control of the work risks assessment;
3. *Add*: percentage of workers represented in the health and safety Committee;
4. Formal agreements with the health and safety unions.

Training and teaching:

1. Average value of vocational training hours for each employee;
2. *Add*: programs for the management and development of abilities supporting the internal careers and for the management of the final period of the own careers;
3. *Add*: employees percentage which regularly receive performance and career evaluations.

Diversity and equal opportunities:

1. *Add*: composition of the company organs of government and of the employees allocation based on sex, age, belonging to protected work categories, place of origin;
2. Relation between the basic salary of women and men belonging to the same category.

[globalreporting.org]

2.2.4.3.4 Other indicators

The GRI defines a series of indicators regarding subjects of great interest, useful to have a clear view of the situation of the organization. In this macro-area there are performance indicators on human rights, societies and product responsibilities. Many indicators are difficult to be measured because, in many contexts, there are not problems dealing with such performances.

To avoid a boring discussion on the indicators belonging to this macro-area, the indicators will not be listed, but only a description for each category will be done. However, this section forms part of the framework and contains also “Core” indicators; the decision about the exception of the list of the indicators has been taken because of their limited applicability and because of their limited contribution on sustainability measures of performance.

The first great category is about **human rights performance indicators**. Each organization has to consider human rights in making an investment practice and in selecting its own contacts.

Human rights that are generally acknowledged, are written in the ONU agreements and declarations, in the Vienna’s declaration and action program and in the ILO (International Labour Organization) declaration. The aim of the framework is to explain how the organization could fulfil the international standards on the above mentioned declarations. The main themes are: investment practices regarding human rights respect policies, non-discrimination, freedom on association and on collective labour agreements, juvenile labour, hard labour, formation on human and native populations rights.

The second category is the **society performance**; the considered indicators focus on the organization impacts and on the communities where the organization operates. The indicators illustrate how risks derived by the interactions with social institutions are managed. The performance deals with the following themes: effects of the organization on the community, corruption, political contributions in sustaining initiatives of some sustained groups, compliance with laws and rules.

The third category is the **product responsibility performance**. The aspects regarding products and services having health and safety influence on customers are tackled. It deals with the following themes: product life cycle assessment, non-conformity cases, products and services standard label, marketing communication in conformity with the rules of the countries where the organization operates, privacy respect.

[globalreporting.org]

2.2.4.3.5 Sector-specific indicators

As said before, in this macro-area, specific indicators for each sector, that is not contained in the general framework, are present. The GRI defines different sectors, so that it provides each organization with a defined sector supplement. A wide range of sector supplements is provided, for

example: oil and gas products, public agencies, telecommunications, financial services, food, raw materials and metals mining, logistics and transports, airports, cars, events, electricity and buildings. The principles, the mechanisms and the guidelines for the draft of the report are exactly alike the general ones, with the addition of the before presented macro-areas and of the ad-hoc indicators.
A list of additional indicators, holding as an example the sector “logistic and transports”, is reported.
Financial performance indicators:

- Register of controlled ships: number of ships controlled by the organization, divided by place of origin.

Environmental performance indicators:

- Register of the composition of the company fleet: number divided by typology and geographical area where the company means are used;
- Transport policies: initiatives for a sustainable transport, plans for the reduction and optimization of the journeys;
- Energy used: initiatives for improving the energetic efficiency on transport and for the using of renewable resources;
- Urban pollution: description of the initiatives and of the programs for the reduction of exhaust gas in the urban centres, in relation with the transport ways;
- Congestion: policies for mitigating the impacts of the transports on the congested traffic;
- Noise: initiatives for managing and reducing the acoustic pollution due to the transports;
- Development of infrastructures for the transport: initiatives for the improving of the infrastructures used for the transport and impact of the activity of the organization.

Social performance indicators:

- Policies and programs to determine the working hours, break hours and the devoted structures;
- Policies to make easier the keeping in touch with personal contacts for employees that are on a job journey;
- Policies and programs to inform the workers about the effects of the overuse of harmful and toxic substances;
- Number of car accidents, divided by typology and geographical area;
- Register of the car accidents occurred to the company means of transport, with a list of the undergone repairs;
- Policies to make accessible the postal service for the employees and for the company;

- Programs for the sensitization and information of the workers about the feasible policies for helping the populations that are under ecological disasters;
- Conformity of the selection criteria and collocation of the employees with the same standards that are recommended from the ILO for the sector-specific workers;
- Description of the programs of the organization directed to guaranteeing of a job continuity for the employees.

[globalreporting.org]

2.2.5 BREEAM

BREEAM (BRE Environmental Assessment Method) is the leading and most widely used environmental assessment method for buildings, with over 110.000 buildings certified and over half a million registered for certification. It is used all around the world and was released in May 2008.
It sets the standard for best practice in sustainable design and is used to describe buildings' environmental performances.
BREEAM provides clients with a market recognition for low environmental impact building. The standard can also assure that best environmental practice is incorporated into a building, and can inspire to find innovative solutions that minimise the environmental impact. In addition, it can demonstrate progresses towards environmental objectives and provide a tool to help reducing running costs and improve working and living environments.
BREEAM addresses environmental and sustainability issues and enables developers and designers to prove the environmental credentials of their buildings to planners and clients. The standard uses a scoring system that is transparent and supported by evidence-based research; it has a positive influence on the design, construction and management of buildings and sets and maintains a robust technical standard with rigorous quality assurance and certification [breeam.org].
The beneficiaries of the standard are:

- clients, planners, development agencies, funders and developers who use BREEAM to specify the sustainability performance of their buildings in a way that is quick, comprehensive, highly visible in the marketplace;
- property agents, who use it to promote the environmental credentials and benefits of a building to potential purchasers;
- design teams, which apply it as a tool to improve the performance of their buildings and their own experience and knowledge of environmental aspects of sustainability;
- managers, to reduce running costs, measure and improve the performance of buildings, empower staff, develop action plans and monitor and report performance at both single

building and portfolio level.

BREEAM covers the following building types: offices, retail, education, prisons, courts, healthcare, industrial buildings.

2.2.5.1 BREEAM's sections and scoring

BREEAM rewards performance about regulation which provides environmental, higher comfort or health benefits. BREEAM awards points or 'credits' and groups the environmental impacts into the sections below:

- Energy: operational energy and carbon dioxide (CO_2);
- Management: management policy, commissioning, site management and procurement;
- Health and Wellbeing: indoor and external issues (noise, light, air quality, etc.);
- Transport: transport-related CO_2 and location-related factors;
- Water: consumption and efficiency;
- Materials: embodied impacts of building materials, including lifecycle impacts like embodied carbon dioxide;
- Waste: construction resource efficiency and operational waste management and minimisation;
- LandUse: type of site and building footprint;
- Pollution: external air and water pollution;
- Ecology: ecological value, conservation and enhancement of the site.

The total number of points or credits gained in each section is multiplied by an environmental weighting factor which takes into account the relative importance of each section. Section scores are then added together to produce a single overall score.

Once the overall score for the building is known, this is translated into the following rating scale:

- Unclassified;
- Pass;
- Good;
- Very Good;
- Excellent;
- Outstanding.

[pdmconsultants.co.uk]

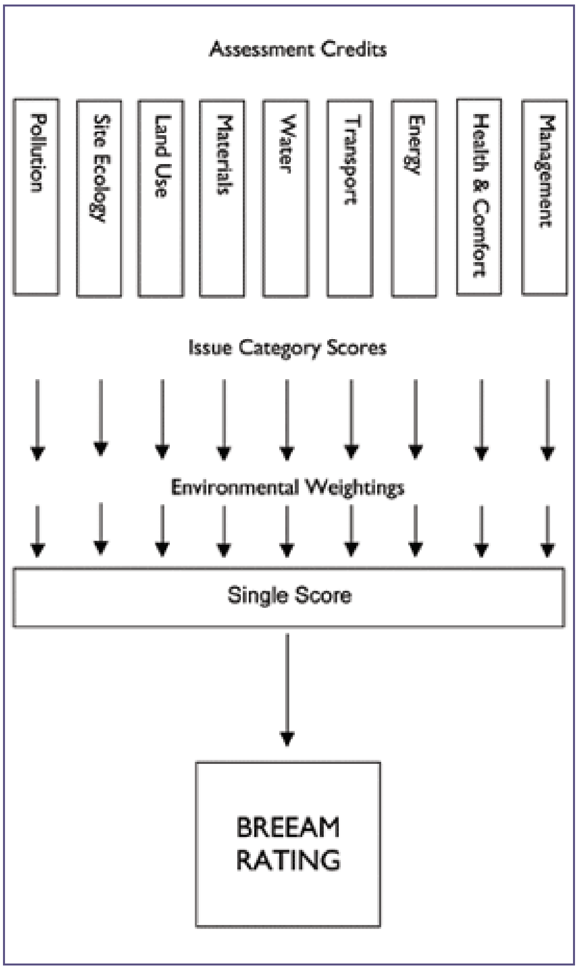

Figure 2.9 BREEAM scoring structure [pdmconsultants.co.uk]

2.2.5.2 BREEAM In-Use

BREEAM In-Use is a scheme to help building managers reduce the running costs and improve the environmental performance of existing buildings. It consists of a standard, easy-to-use assessment methodology and a 3rd party certification process, that provides a clear and credible route map to improving sustainability. BREEAM In-Use is currently relevant to all non-domestic buildings: commercial, industrial, retail and institutional buildings.

BREEAM In-Use has been developed to recognise and encourage better building management and targeted investment in existing buildings [breeam.org].

BREEAM In-Use is designed to:

- reduce operational costs;
- enhance the value and marketability of property assets;
- provide a route to compliance with environmental legislation and standards, such as energy labelling and ISO 14001;
- give greater engagement with staff in implementing sustainable business practices;

- provide opportunities to improve staff satisfaction with the working environment, with the potential for significant improvements in productivity;
- demonstrate the commitment to Corporate Social Responsibility (CSR);
- improve organisational effectiveness;
- provide a genuine badge of proven sustainability.

A BREEAM In-Use assessment is broken down into 3 parts (Table 2.2):

Part 1	*Asset performance* – the inherent performance characteristics of the building based on its built form, construction and services
Part 2	*Building management performance* – the management policies, procedures and practices related to the operation of the building; the consumption of key resources such as energy, water and other consumables; environmental impacts such as carbon and waste generation
Part 3	*Organisational effectiveness* – the understanding and implementation of management policies, procedures and practices; staff engagement; and delivery of key outputs.

Table 2.2 - BREEAM In-Use parts description [breeam.org]

The scheme enables organisations to self-assess the performance of their portfolio. Licensed BREEAM In-Use Auditors are trained to verify the self assessment.

Auditors may give support and advice to help their clients with the self assessment process. Post certification auditors may offer consultancy based improvements.

The assessment tool enables building managers to see the impact of their building and existing systems and initiatives, as well as the potential impact of any proposed changes. The BREEAM In-Use tool also enables Key Performance data to be uploaded and calculates performance against 12 key performance indicators including, for example, carbon dioxide emissions per employee, water consumption per square metre and proportion of waste recycled.

Assessment score	Assessment rating	Star rating
< 10	Unclassified	–
10 – 25	Acceptable	★
25 – 40	Pass	★★
40 – 55	Good	★★★
55 – 70	Very good	★★★★
70 – 85	Excellent	★★★★★
> 85	Oustanding	★★★★★★

Table 2.3 The BREEAM In-Use assessment scheme [bsria.co.uk]

2.2.5.3 Differences between BREEAM and BREEAM In-Use

In BREEAM a trained Assessor carries out the assessment and BRE certify it. BREEAM In-Use however is a self assessment scheme, so anyone can do the assessment and an Auditor trained by BRE certifies the assessment.

In BREEAM, it is the final rating (good, excellent, etc.) that is often used to provide a benchmark on the performance of that building. With BREEAM In-Use, it is possible to provide detailed benchmarking on individual aspects of building performance. Each question in the questionnaire will provide answers across a range of buildings and benchmark industry standards for that issue [breeam.org].

2.2.6 Other certifications

In this paragraph a series of certifications or trademarks which guarantee the conformity to sustainability standards will be presented. The survey of the certifications is always wider because of the great attentions that sustainability earns in the present market: some certifications have international validity, others are related to specific geographical areas, others estimate objective parameters, others attest the sustainability of the processes. Beside all available certifications, only the most significant, which often are on products or below the company documents, will be presented.

2.2.6.1 LEED

The LEED certification system (Figure 2.10), Leadership in Energy and Environmental Design, has been applied in more than 100 countries all over del world. It has been produced by the U.S. Green

Building Council (USGBC), a non profit association which promotes and provides a global approach to sustainability admitting virtuous performances related to human and environmental health.

This certification is in the field of the environmental sustainability.

Figure 2.10 LEED logo [mcfarlandarchitecture.com]

The USGBC is composed by more than 20 thousand members; besides a technical rule, the USGBC takes responsibility for the information and sensitization of the population about an eco-sustainable house building. The Italian GBC has the same structure as the American one, it performs the same duties on a national scale and is composed by 300 members. After 2 years of work, on 14th of April a LEED protocol for Italy will be presented.

The standard is mainly related to new buildings or to existing buildings under renovation. It is useful to indicate how to comply with the necessary requirements for the construction of environmentally sustainable buildings, whether from an energetic point of view or for the realization process.

The system is based on the attribution of credits for each requirement about the sustainability of the building. There are six categories where all standards that have to be considered are grouped together: sustainable sites, efficient water management, energy and atmosphere, materials and resources, quality of the internal environments, planning and innovation, regional priorities.

The specific certification level is related to a score that is obtained from the sum of the total credits achieved for each one of the six categories:

- 40-49 credits: Certificate;
- 50-59 credits: Silver;
- 60-79 credits: Gold;
- 80 or more credits: Platinum.

[gbcitalia.org]

2.2.6.2 SB100

The ANAB, Biological Architecture National Association, through a research developed in Italy but then harmonized with the main international systems, elaborated the SB100 certification, Sustainable Building in 100 actions (Figure 2.11). The system is based on the norm UE 91/2002 (construction energetic efficiency), with the aim to encourage the principles of sustainability for new construction techniques.

Figure 2.11 SB100 logo [D'Aniello, 2010]

SB100 is a software based on determination of the features needed for a suitable level of sustainability. The certificate highlights the environmental standards of the building, improving a wide range of parameters that are sometimes hard to recognize. Furthermore, the software generates an evaluation that allows to translate the extra-burden in competitive factors on real estate market.
The SB100 is a list of purposes and relative acts useful to reach them. The evaluation is integrated and systematic, with a checklist for the evaluation of the action efficacy. The objectives are resumed in three thematic fields, corresponding to the dimensions of the sustainable development:

- Ecological: energy, water, material and waste;
- Social: health, comfort, contest and information
- Economic: construction cost and management cost.

[D'Aniello, 2010]
The system is horizontal, suggesting a progression cycle which starts from the detection of the objectives, goes through the definition of the actions, and concludes with the check of the results.
The SB100 framework is divided into three parts:

- The **Guidelines** are a Decalogue with the objective to reach good sustainability results.
- The **Positive List** is a list of 100 actions useful to reach the objectives of the guidelines: every action is equipped with a table explaining everyone of these, the modality to assign a score, the legislative, normative and bibliographical recalls and information about local availability of products and tecnologies.

- The **Checklist** is a counter which allows us to check the efficacy of the actions performed, assigning a score on the basis of specific values: zero points for performances equal to law standards, 1 point if the performance is higher than law standards and -1 if it is lower. The checklist gives the possibility to sum the scores and to identify the building with a merit class through a number between 1 and 5, as shown in Figure 2.12 [sb100.it].

Figure 2.12 Reached class of sustainability [sb100.it]

2.2.6.3 Ecolabel

The Ecolabel is a ecologic quality european trademark (Figure 2.13, [CE n° 66/2010]) based on the recognition of the best product and services from the environmental point of view, so that they differentiate from other concurrents. The trademark certifies that the product has a low environmental impact through its whole lifecycle.

Figure 2.13 Ecolable logo [ec.europa.eu]

Also in this case, the objective is to certify the environmental performance. The trademark was designed for specific products or services, and cannot be applied to organizations or processes. Ecolabel is recognized all over the world even if the institution is referred to the Europen Community.

Products exposing the Ecolabel trademark are daily consumer goods made in respect of specific environmental directives. The concession is public and not an auto-certification of the producer. The product/service is verified by independent third parties. In Italy this job is done by the ISPRA. The definition of ecological principles is done through the LCA analysis [Cesarei, 2008].

2.2.6.4 Energy Star and EPEAT

The EPEAT (Electronics Products Environmental Assessment Tool, Figure 2.14) and Energy Star (Figure 2.15) certifications, were founded to measure energy performances of electrics products: the electric energy consumption is the first variable that they consider. The certified products are able to offer a good energetic efficiency. Whether one of these trademarks is present the respect of the environmental sustainability standards in the production and distribution phase are guaranteed.

The EPEAT is governed and managed by the GEC (Green Economy Council), which is part of an international program of the non-profit organization ISDF (International Sustainable Development Foundation), located in Portland, Oregon.

In the sphere of the EPEAT program, producers certify the conformity of their own products to a complete series of environmental criteria. The products are then assigned to the category Bronze, Silver or Gold on the basis of the criteria which they satisfy: for example, the Gold certified EPEAT products, have to be in accordance with all 23 compulsory criteria and with 75% of the optional criteria.

The criteria selected by the technical committee refer to the entire life cycle of the product, that means that they measure also the product management at the end of its life cycle, the production management, the materials selection and the packaging [epeat.net].

EPEAT®

Figure 2.14 EPEAT logo [epeat.net]

The Energy Star is a program developed jointly by the U.S. Environmental Protection Agency (EPA) and by the U.S. Department of Energy and was originally intended to certify products with reduced greenhouse-gas emissions in the production process and during their life cycle. The evolution of the model has made the Energy Star trademark an important recognition for products with high standards of energy efficiency. The certificate can be voluntarily requested, producers

must test the product following a list of clear criteria and then ask for verification of the measurements to the institute which operates in the territory [energystar.gov].
Over the past three years the two certifications are almost equivalent: each EPEAT certified product meets automatically Energy Star requirements.

Figure 2.15 Energy Star logo [energystar.gov]

2.2.6.5 FSC and PEFC

The FSC (Forest Stewardship Council, Figure 2.16) and PEFC (Programme for the Endorsement of Forest Certification, Figure 2.17), are both designed to recognize a correct and responsible management of forests and woods; certifications are obtained after the forest is independently controlled and evaluated according to certain sustainability criteria established and approved by the competent institutions. This is a certification typically developed to provide care for the environment, therefore environmental sustainability.
The FSC is an international non-governmental organization, independent and non-profit, that includes among its members a variety of groups and members, such as industries involved in the field, scientists and engineers, local communities that work together to improve the forests management across the world. This trademark can be found on products containing wood, or derived from it, which use raw materials deriving from forests that are controlled with technical analysis and precise measurements of the FSC working group in the area. The FSC principles and criteria for assessing sustainable forest management are steered into conservation, protected species, creation of repopulation cycles, useful percentages and respect of local communities [fsc-italia.it].

Figure 2.16 FSC logo [fsc-italia.it]

The PEFC system originated as a voluntary initiative of the private sector and not for gain, following a series of meetings of representatives of forest owners, coming from some promoting countries (Austria, Finland, France, Germany, Norway and Sweden). The system involves the establishment of a national PEFC structure (Organization Management) in different European countries, which, at the invitation of the forest owners, should involve all relevant stakeholders (trade associations, federations, etc.). The institutions of 13 European countries have therefore founded the association called “the Program” for the recognition of national forest certification schemes. Again, this certification can be awarded to products that use directly wood or derive it from a transformation process. The certification is awarded after checking the forest of origin of the wood and after verifying that it meets the criteria and indicators of SEM (Sustainable Forest Management). PEFC forest certification scheme in Europe is based on three fundamental principles: respect of the criteria and of the indicators defined in the European Ministerial Conferences on the protection of forests (Helsinki 1993, Lisbon 1998), implementation at a regional level or in groups, audits and certification being handled by an independent but accredited third party [pefc.it].

Figure 2.17 PEFC logo [pefc.it]

2.2.6.6 OHSAS 18001

The Occupational Health and Safety Assesment Series 18001 (Figure 2.18) is the international standard between the Health Management and the Job Safety Systems. Its last upgrade was published by the British Standard Institution (BSI) on July 2007. BSI is present in 120 nations and is one of the main organizations of services to the companies, with more than 80.000 customers.

Figure 2.18 OHSAS 18001 logo [csqa.it]

Health and safety are intended to be the conditions and the factors that influence or can influence health and safety of the employees, of the visitors and every other person interacting with the working environment [csqa.it].

The OHSAS 18001 certification verifies the voluntary application of a employee's health management system and is characterised by a high compatibility with other norms, for example the ISO 14000 and ISO 9001.

This management system has requirements like:

- Danger identification and risk evaluation;
- Actuation of the Deming Cycle (paragraph 3.3.3);
- Definition of tasks and responsibilities;
- Training and involvement of personnel;
- Monitoring and measuring of system performances.

2.2.7 Conclusions

In this paragraph were described the two main global certifications, ISO 14001 and EMAS; then we described GRI, the framework for a complete documentation about the sustainability, and BREEAM. Finally we provided a general description of the existing certifications. Below we report a picture displaying the three dimensions of the sustainability. We can see that the most represented dimension is the environmental sustainability, with a lot of certifications, while the other 2 aspects present a lack of references. The only certification that includes all the three sustainability aspects is GRI.

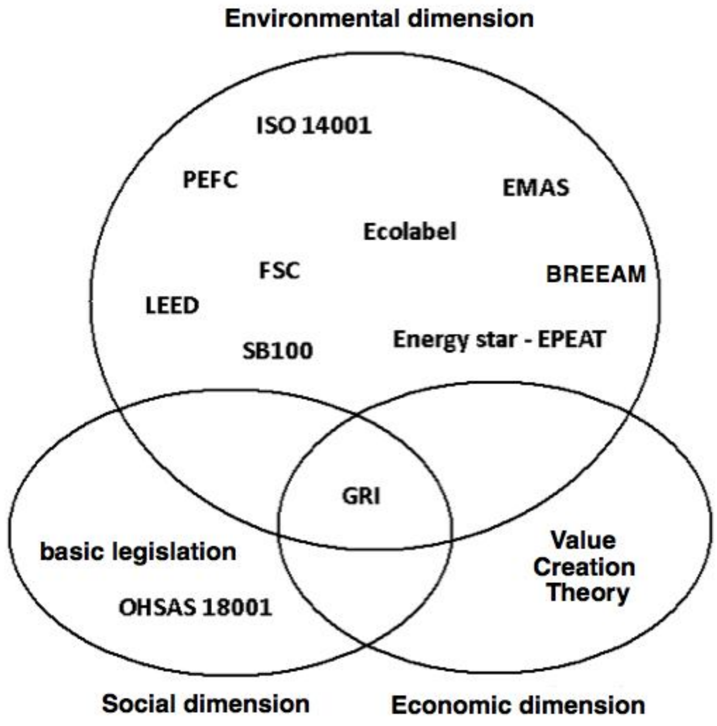

Figure 2.19 Certifications divided by their represented sustainability aspects

2.3 Governments policies about sustainability

In this third part the approach of governments and public institutions to the sustainability is generally considered and their policies analysed. In order to provide examples of sustainability strategies by general authority with great influence on the behaviour of industries and little organizations, some of the most relevant nations of the world are taken into account.

2.3.1 Introduction

The sustainability is a global question that involves the entire society and is often in opposition with the industrial policies. The application of severe environmental, social, and economical rules often presents evident shortcomings for industries and, for this reason, they are not well-regarded or suggested. Sustainability goals generally request large investments and a non secure return on investments (ROE).

In order to fight this trend it is important that great institutions, first of all governments, are in the front line with law, project, policies and program guidelines.

Economic and social sustainability programs are generally difficult to detect, because of their interpenetration with general financial policies and reforms. In order to simplify and specifically focus our work, we will analyse how environmental sustainability goals are faced by some states. In other words, in the following paragraphs we will provide an idea of how the governments are fighting the environmental crisis.

A little research about few representative governments is presented, with special regard to Europe and U.S.A.

The environmental sustainability question is wide and complex. A government could decide to face it with different strategies, not always marked under the name “sustainability”.

In order to find the correct information and to give a complete idea of what a government does or programmes we will analyse the following four areas of interest:

- Monitoring
- Industrial policies
- Environmental policies
- Education and sensitisation

With the concept of monitoring we intend the continuous and regular measuring of results, values and goals of the strategy or process.
As industrial and environmental policies we consider policies that departments apply for the industry and environment field.
Education and sensitisation is the effort made in order to teach to new generations how to fight the environmental crisis or sensitize the citizens on a "Sustainable Living".

2.3.2 Italy

The Italian Government does not present a specific sustainability policy for the industrial sector.
A project, called "Industry 2015", presents a general review about the Italian productive systems with a list of objectives for an increment of competitiveness and new laws for a better access to the credit by small-sized businesses.
The Ministry of the Economical Development presents some industrial innovation projects.
For example we have an announcement for financing a project on "Sustainable Mobility".

The Ministry of the Environment presented in 2002 the Environmental National Strategy for a Sustainable Development. The program is a eight years long policy (2002-2010) and detects the main objectives and actions for different areas of interest: climate, nature and biodiversity, quality of the environment and of the life, resources and waste management.

The Ministry of the Environment presented in 2007 the National Plan for Green Public Procurement (GPP).
The main objective of this Plan was to reach, by 2009, a level of "environmentally preferable" purchases in accordance with the highest European standards.

In the field of education we have a document, "Guidelines for the environmental education and sustainable development", produced by the Ministry of the Environment and sent to every school in Italy.
[www.minambiente.it], [www.sviluppoeconomico.gov.it]

2.3.3 Europe

In the last years the European Community has taken several measures to face the problem of a more sustainable lifestyle. In particular, the General Report 2009 presents a special focus on "Countering Climate change and saving energy".

This study is divided into three chapters:

- 20% by 2020 – The climate and Energy package
- Energy
- Copenhagen – What happened and what didn't happen

2.3.3.1 Climate energy package

In the first chapter we find an analysis of measures and matters about the objectives that the European Community established for the 2020.

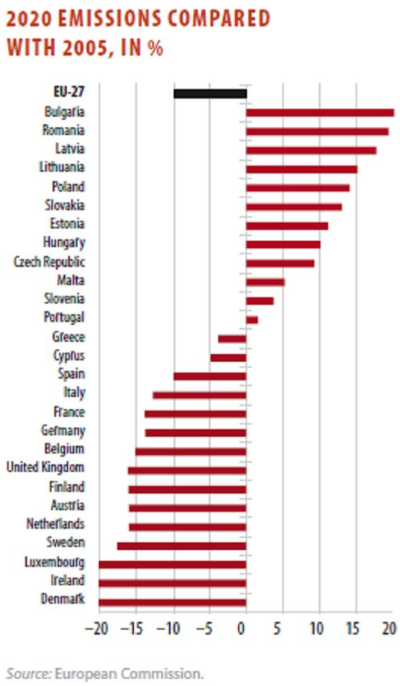

Figure 2.20 Emissions compared with 2005 [europa.eu]

We read:

"Ahead of the rest of the world, the EU has taken a lead with bold targets for 2020. It has promised to reduce its own greenhouse gas emissions by at least 20% from 1990 levels. It aims to increase the share of renewable energy sources in total energy consumption from its current 9 % to 20 %. And its ambitions for energy efficiency are to save primary energy consumption of 20 % against a 'business as usual' scenario. Turning these ambitions into realities has been a focus of EU activity during the whole of 2009. Commission President José Manuel Barroso described the package as 'the litmus test of Europe's ability to act for the benefit of its citizens."

The climate and energy package, adopted in principle in December 2008, and which came into force in April 2009, included:

- a directive to improve and extend the EU emissions trading system (2);
- a decision setting targets for each Member State to reduce its greenhouse gas emissions (3);
- a directive introducing a regulatory framework for carbon capture and storage (4);
- a directive on the promotion of the use of energy from renewable sources (5).

The package is complemented by two further legislative acts agreed at the same time:

- a regulation requiring a reduction in CO_2 emissions from new cars (6);
- a revised directive requiring fuel suppliers to reduce greenhouse gas emissions from the fuel production chain (7).

Figure 2.21 Key concepts [europa.eu]

The objectives are going to be reached through different means:

- **Emissions trading**
  An increasingly efficient trading system measures emissions in different sectors
- **Renewable energy**
  It is important to diversify energy production through different energy supplies
- **Carbon Capture and Storage**
  The EU has also agreed to explore the scope for mitigating their use through carbon capture and storage technologies that trap CO2 and store it underground.
- **Cleaner transport**
  Biofuel, electrical cars
- **Adapting to a changing climate**
  Gas emissions will remain in the atmosphere. We must plan for adaptation
- **Climate change as an opportunity**
  Meeting the climate challenge is also an opportunity, opening up prospects for new jobs, ‘green’ enterprise and strengthened EU competitiveness

2.3.3.2 Energy

In the second chapter, about Energy, we read:

“As the EU’s climate change and energy package makes clear, a major contributor to climate change is energy use, and a major factor in containing climate change is better energy use. Consequently, EU energy policy highlighted energy efficiency and renewable and alternative energy sources. At the same time, the EU acted to ensure that Europe’s continuing need for energy is satisfied, since competitive and reliable supplies are essential both for the wellbeing of EU citizens and for the competitiveness of EU business in world markets.”

A deeper analysis of this chapter shows that important steps for a “sustainable energy package” are:
- promoting the use of renewable energies
- the security of supply
- nuclear power as part of europe’s energy mix
- network between states
- liberalised energy market
- international cooperation
- development dimension

2.3.3.3 Copenhagen Conference

In the third chapter we find an analysis of the UN Climate Change Conference in Copenhagen:

“The outcome of the UN Climate Change Conference in Copenhagen in December was a disappointment. After two weeks of intense negotiations, on the final day some 30 countries — including the USA, China, India and Brazil, as well as some EU Member States and the European Commission — reached a limited ‘accord’. This contains a number of positive elements, including endorsement for the first time at global level of the 2 °C ceiling and commitments to mobilise climate financing for developing countries in amounts that are in line with the Commission’s proposals. Overall, however, the Copenhagen accord falls well short of meeting the EU’s level of ambition. Moreover, due to opposition from a handful of parties the conference merely noted the accord without formally endorsing it. As a consequence, renewed efforts will be needed to reach a legally binding global agreement at the next UN Climate Change Conference, to be held in Mexico City in November 2010.”

Globally we can say that the European Community has got a strong environmental policy and, in the field of energies, it aims to implement an industrial policy.

Emissions trading is a market-based approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants. It can be seen as an advanced method of monitoring.

2.3.3.4 Prosecutions on General Report 2010

The General Report 2010 generally confirms this strategies, but a short chapter about nuclear energy is also present. The European community remarks the problem of the final disposal of fuel and radioactive waste from nuclear plants, inviting all members to propose a program of waste disposal in order to take into account the redaction of a directive with internationally agreed safety standards.

The General Report 2010 reports the activity of the Cancun conference in November 2010. While the Copenhagen conference was a general disappointment, the Cancun conference seems to have traced some agreements that the EU welcomed and agreed, working close to the Council during the conference.

The general reports do not inform of education and sensitisation policies.

[europa.eu], [General report on the activities of the EU 2009], [General report on the activities of the EU 2010]

2.3.4 Germany

Germany is one of the front line nations at European level in sustainability.

Germany has got a specific program for sustainability which is published on the government site. It is “Nachaltigkeitstrategie” which means “National Sustainability Strategy”.

The document “Perspektiven für Deutschland” – “Trends in Germany” was worked out in 2002.

The report builds on the national sustainability strategy of April 2002 and takes it one step further. The report is based on pre-defined indicators. As well as analysing the status quo, it provides information about what has been achieved to date and about the sustainability objectives of the German government. The presentation incorporates the views of citizens and associations voiced during two consultation phases and at hearings.

In 2008, the German government uses 21 sustainability indicators to provide concrete information as to where we stand today on the road towards sustainable development. Germany can be proud of what it has already achieved, for instance in the field of climate protection and in reducing emissions of greenhouse gases. Furthermore the percentage of total power generated coming from renewable sources has developed positively, as has the consolidation of the national budget.

The indicators also, however, show those areas where ground must be made up. This applies, for instance, to the education sector.
In 2008 the German government adopted new objectives and indicators, which should enable it to define sustainable development still more precisely. These include indicators relating to smoking and obesity.
In the 2008 progress report, the German government focuses on climate and energy, the sustainable management of raw materials, the social opportunities posed by demographic change and food for the world.
In the following we will give an idea of how the German Government is moving through these themes.

2.3.4.1 Climate and energy

In this priority area, the German government has set itself ambitious goals. Energy productivity is to be doubled by 2020, emissions of greenhouse gases cut by 21 percent of the 1990 levels by 2008/2012, and power generated from renewable sources is to account for at least 30 percent of the total by 2020.

2.3.4.2 The sustainable management of raw materials

This priority area aims to enhance efficiency in the use of natural materials. The careful use of raw materials, the development of new materials, the improvement of recycling and the increased use of secondary raw materials and renewable raw materials will decrease the consumption of natural resources and reduce negative environmental impacts. The goal laid out in the sustainability strategy is to double raw materials productivity by 2020. The German government aims to achieve this partly by promoting research projects, and with the help of a programme to improve the efficiency of small and medium businesses in terms of the way they use materials.

2.3.4.3 Demographic change – a chance for greater social cohesion

The demographic change in Germany can no longer be halted. The German government intends to see this as an opportunity rather than a negative issue. It aims to strengthen civil society, foster greater inter-generational solidarity and encourage a culture of harmony. To this end the federal government has already launched a whole series of measures, including changes in fiscal law and reforming regulations governing the support available to individuals nursing relatives at home. To better publicise successful practical examples, the German government will be launching a competition that builds on the successful campaign "Citizens initiative sustainability”.

2.3.4.4 Food for the world

The chances of achieving the Millennium Development Goal of halving the number of hungry people in the world by 2015 has now been jeopardised by rising food and energy prices on the world market. The German government considers it a global challenge to take action in this respect. In the priority area of food for the world it thus looks both at short-term remedies and at ways of tackling the root causes of the trend in the long term. These causes include changing eating patterns, global population growth, the fact that many developing countries have neglected their agricultural sectors over the last few years, and the demand for agricultural crops to produce biofuels.

2.3.4.5 Conclusions

These four themes are an example of how the German Government analyses the Sustainability matter.

The German government intends to mainstream sustainability even more in its political activities. Every new piece of legislation and every ordinance is going to be reviewed for its impact in terms of sustainability by the German government. An amended version of the common rules of procedure of the German government will lay down this new approach.

The work of the State Secretary Committee for Sustainable Development is to be stepped up. Ministerial reports, inter-ministerial projects and the involvement of other actors including the federal states will in future ensure that the new approach is integrated into everyday political life.

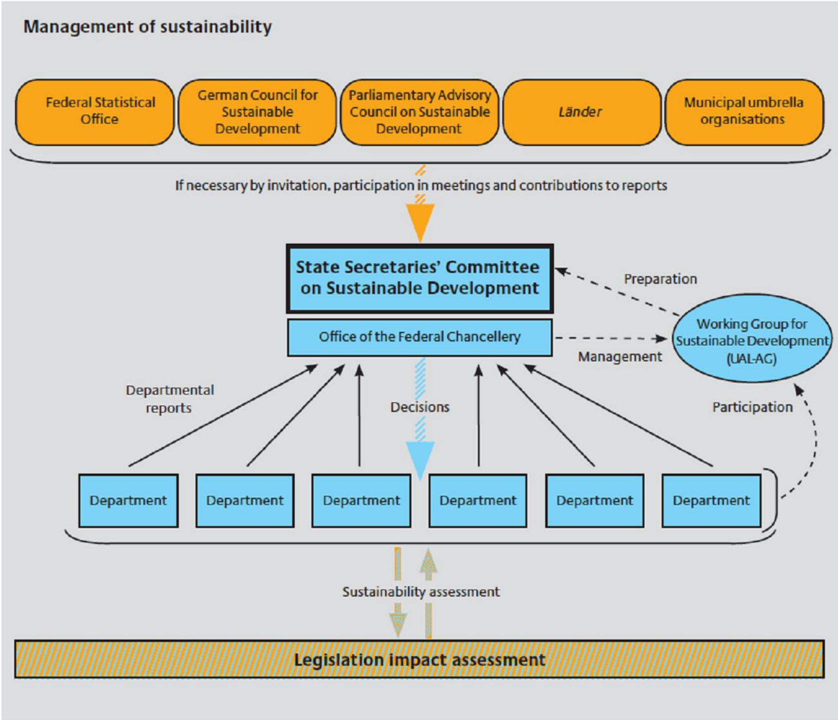

Figure 2.22 Structure of sustainability management

Finally the report focuses on cooperation and participation. It argues about a sustainable development which is not only the responsibility of the federal government. What is needed is a joint effort on the part of the federal government, civil society, the federal states and local authorities. This is why the German government invited the German Council for Sustainable Development, the Parliamentary Advisory Council on Sustainable Development in the German Bundestag, the federal states and the leading associations of local authorities to make their own contributions to this report.

The German Government has got a specific website called "*dialog-nachaltigkeit*" in german language, with forum and ideas of the citizens about sustainability. This media is a good example of education and sensitization of the public opinion.

[www.bundesregierung.de],[www.dialog-nachhaltigkeit.de], [Die Bundesregierung, Perspektiven für Deutschland, Unsere Strategie für eine nachaltige Entwicklung], [The Federal Government, Progress Report 2008 on the National Strategy for Sustainable Development],

2.3.5 Uk

The Uk government shows to have a good comprehension of the issue and a complete strategy for the environmental and green living. The website of the government is clear and easy to understand. A lot of sections give the possibility to find different ideas of green living, saving energy, recycling. This is a good way to communicate a life style and a significant educational effort. The actions of the citizens are considered to have great importance for a sustainable society, seen as a global question involving a specific lifestyle.

2.3.5.1 Monitoring

Uk government shows also to pay attention to the field of monitoring.
The government has got Sustainable Development statistics starting in 1990 and an amount of 68 indicators showing the trend of these ones. These ones are published in a document produced by National Statistics Compendium.

The 68 indicators in this publication - measures of everyday concerns including health, housing, jobs, crime, education and our environment - aim to provide an overview of progress across four themes:

• Sustainable consumption and production
• Climate change and energy
• Protecting natural resources and enhancing the environment
• Creating sustainable communities.

The indicators are not assessed in terms of whether targets have been reached or whether we are living sustainably, but instead on whether there has been improvement, deterioration or no change compared with how things were a few years ago.

As an example we report the following resuming table:

Indicator number and title		Change since 1990[1]	Change since 2003	Direction in latest year*
1. Greenhouse gas emissions		✓	✓	✓
13. Resource use		✓	✓	✓
18. Waste arisings		…	✓	✓
20. Bird populations	Farmland	✗	✗	✓
	Woodland	≈	✓	✓
	Seabird	≈	≈	≈
27. Fish stocks sustainability		✓	✓	✓
28. Ecological impacts of air pollution	Acidity	…	≈	…
	Nitrogen	…	≈	…
30. River quality	Biological	✓	≈	≈
	Chemical	✓	✓	✓
32. Economic output		✓	✓	✗
37. Active community participation		…	✗	✗
38. Crime		✓ 1991	✓	✓
40. Employment		≈	≈	✗
41. Workless households		…	≈	✗
43. Childhood poverty	Before housing cost	✓	≈	✓
	After housing cost	≈	≈	
45. Pensioner poverty	Before housing cost	✓	≈	✓
	After housing cost	✓	✓	✓
47. Educational attainment		✓	✓ 2004	✓
49. Health inequality	Infant mortality gap	✗ 1994	✓	✓
	Life expectancy gap	✗ 1991	✗	✗
55. Mobility	Walking / cycling	✗ 1995-7	✗	✓
	Public transport use	✓ 1995-7	✓	≈
59. Social justice		…	…	…
60. Environmental equality		…	…	…
68. Wellbeing		…	…	…

[1] Year as shown if not 1990 [2] Year as shown if not 2003

Table 2.23 : Monitoring indicators

2.3.5.2 Industrial and environmental policies

Uk government has founded in 2005 The Sustainable Development Commission, a Government's independent advisory body on sustainable development.

The last document, "Governing the Future", was generated on March 2011.

The Guide provides information and advice for governments who wish to reflect on progress and find more systemic ways of responding to the biggest challenges of the day.

A special consideration goes to the DEFRA:

The Department for Environment, Food and Rural Affairs (Defra) is a Government Department in the UK. It makes policy, legislation, and works with others to deliver our policies in areas such as:

- the natural environment, biodiversity, plants and animals

- sustainable development and the green economy
- food, farming and fisheries
- animal health and welfare
- environmental protection and pollution control
- rural communities and issues.

On November 2010 the Prime Minister launched a Business Plan in all departments. They are intended fundamentally to change the way that Departments are held accountable by the public for putting policies into practice.

In the DEFRA Business Plan Vision section we read:

"The environment is the natural foundation on which our society and economy are built. Our long-term prosperity, economic success and quality of life are enhanced by our environment.[…]
The Coalition is committed to being the greenest government ever.[…]
We will work in partnership with local communities and civil society to protect biodiversity, the countryside and the marine environment.[…]
We will work with the European Union and international partners to secure the UK's objectives and ensure that decisions are based on sound science and evidence.[…]"
[www.direct.gov.uk], [www.defra.gov.uk], [Measuring progress Sustainable development indicators 2010]

2.3.6 U.s.a.

In USA the sustainability issue can be analyzed considering two main aspects:
As first we can find an institution, the E.P.A., which operates since 1970 for the protection of the environment.
Secondly we must consider the Healthcare Reform is to be taken into account because of the wide impact in the American society.

2.3.6.1 The Environmental Protection Agency

The U.S. EPA (Environmental Protection Agency) began to operate for the sustainability in various ways, because 40 years age questions were different. Over its 36-year history, EPA has adapted to changing environmental issues, in order to make sustainability a key element of environmental policy.

The mission of EPA is to protect human health and the environment and the main focusing can be resumed with the following list:

- all Americans are protected from significant risks to human health and the environment where they live, learn and work;
- national efforts to reduce environmental risk are based on the best available scientific information;
- federal laws protecting human health and the environment are enforced fairly and effectively;
- environmental protection is an integral consideration in U.S. policies concerning natural resources, human health, economic growth, energy, transportation, agriculture, industry, and international trade, and these factors are similarly considered in establishing environmental policy;
- all parts of society -- communities, individuals, businesses, and state, local and tribal governments -- have access to accurate information sufficient to effectively participate in managing human health and environmental risks;
- environmental protection contributes to making our communities and ecosystems diverse, sustainable and economically productive; and
- the United States plays a leadership role in working with other nations to protect the global environment.

Here is a Timeline with the main accomplishments over the decades:

<u>1970s</u> - EPA is created. Congress passes modern environmental statutes, such as Clean Water Act and Clean Air Act. EPA sets early human health exposure levels. The Supreme Court affirms EPA's role in environmental protection enforcement.

<u>1980s</u> - The Superfund law is passed to clean up old, abandoned waste sites. EPA and communities begin emergency response planning in the event of environmental accidents. State begin to run their own hazardous waste programs. Risk science begins to help EPA set priorities.

<u>1990s</u> - The Clean Air Act Amendments set the stage for further protections, such as dust and soot. Pollution prevention reduces pollution before it begins. EPA partners with companies to explore and test innovative, voluntary approaches to environmental protection.

2000s - Mercury emissions, visibility rules further improve air quality. EPA responds to 9/11. Clean diesel engines cut emissions from trucks, off-road equipment, and especially school buses.

As we can see the EPA has got a strong experience in the field of sustainability, and her laws and acts have got rebounds in the industry field. Environmental policies, educational efforts and monitoring (pollution control) are part of EPA operations.
[www.epa.gov]

2.3.6.2 Healthcare Reform 2010

The Healthcare reform in the United States is an important step towards a more sustainable healthcare management. The reform passes through two main laws that president Barack Obama enacted. The Patient Protection and Affordable Care Act is intended to provide a phased introduction over four years of a comprehensive system of mandated health insurance with reforms designed to eliminate "some of the worst practices of the insurance companies". Consequently, the Health Care and Education Reconciliation Act of 2010 amended the PPACA and became law on March 30, 2010.
The reform is wide and complex, with political implications and different opinions. Therefore we gave in this short paragraph only few information about it.

2.3.7 Australia

Australian Government does not show a specific program for sustainability. Anyway, the Department of Sustainability, Environment, Water, Population and Communities is of great interest for our research in the field of environmental policies.

2.3.7.1 Annual Report 2009-2010

In order to find the main policies that this department applies we will analyse the Annual Report 2009-2010. In the following we present a short list of the projects mentioned:

Conserving our natural assets

Operation of the *Environment Protection and Biodiversity Conservation Act 1999*

Living and working sustainably

Operation of the *Hazardous Waste (Regulation of Exports and Imports) Act 1989*

Operation of the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989*

Operation of the product stewardship arrangements for oil including the *Product Stewardship (Oil) Act 2000*

Operation of the *Fuel Quality Standards Act 2000*

Adapting to a future with less water

Operation of the *Water Efficiency Labelling and Standards Act 2005*

Annual Report of the Commonwealth Environmental Water Holder

With regard to the environmental policies Australian government has got important focusing about Environment and Biodiversity.
[australia.gov.au], [www.environment.gov.au]

2.3.7.2 The EPBC Act

The ***Environment Protection and Biodiversity Conservation Act 1999*** (EPBC Act) is the Australian Government's key piece of environmental legislation which commenced 16 July 2000.
The purpose of the EPBC Act is to enable the Australian Government to join with the states and territories in providing a national scheme of environment and heritage protection and biodiversity conservation. Furthermore, the EPBC Act focuses Australian Government interests on the protection of matters of national environmental significance, with the states and territories having responsibility for matters of state and local significance.

The objectives of the EPBC Act are to:

- provide for the protection of the environment, especially matters of national environmental significance
- conserve Australian biodiversity
- provide a streamlined national environmental assessment and approvals process
- enhance the protection and management of important natural and cultural places
- control the international movement of plants and animals (wildlife), wildlife specimens and products made or derived from wildlife
- promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources

2.3.7.3 The Australia's Biodiversity Conservation Strategy 2010-2030

The Australian Government produced an ***Australia's Biodiversity Conservation Strategy 2010-2030***. A guiding framework for conserving nation's biodiversity over the coming decades.
The vision of this Strategy is that Australia's biodiversity is healthy and resilient to threats, and valued both in its own right and for its essential contribution to our existence.

The Priorities for action section identifies three national priorities for action to help stop the decline in Australia's biodiversity. These priorities for action are:

1. Engaging all Australians in biodiversity conservation through:
    - mainstreaming biodiversity
    - increasing Indigenous engagement
    - enhancing strategic investments and partnerships.
2. Building ecosystem resilience in a changing climate by:
    - protecting diversity
    - maintaining and re-establishing ecosystem functions
    - reducing threats to biodiversity.
3. Getting measurable results through:
    - improving and sharing knowledge
    - delivering conservation initiatives efficiently
    - implementing robust national monitoring, reporting and evaluation.

These objectives and actions shows also a special focus on education of Australians and monitoring of the results.
[Environment Protection and Biodiversity Conservation Act 1999]

2.3.7.4 Other projects

An important effort in sensitisation is the program Water for the Future, a special initiative with four main key priorities:

- Taking action on climate change
- Securing water supplies
- Using water wisely
- Supporting healthy rivers

The Department of Resources, Energy and Tourism enhances a strong business in renewable energy. Energy Programs like “Low Emissions Technology Demonstration Fund” or “Clean Energy Initiative” are present. The Energy Efficiency Opportunities Act 2006 (EEO) is a framework with the aim to improve the identification and evaluation of energy efficiency opportunities by large energy using businesses and, as a result, to encourage implementation of cost effective energy efficiency opportunities.

The Department of Innovation, Industry, Science and Research is slightly tended in the direction of sustainability. As an example we report some projects that are in evidence on the website:

Green Car Innovation Fund (GCIF)

In November 2008, the Australian Government announced the Green Car Innovation Fund (GCIF) as part of its A New Car Plan for a Greener Future. The $1.3 billion fund will provide assistance over ten years to design, develop and manufacture low-emission, fuel-efficient cars and components in Australia. Grants will be allocated through a competitive selection process that considers the innovative, technological, commercial and environmental merits of each proposal.

Sustainable Research Excellence in Universities (SREU)

The Sustainable Research Excellence in Universities initiative is targeted at addressing the gap in funding for the indirect costs of research. It augments the existing Research Infrastructure Block Grants (RIBG) Scheme, with the aim of raising the average support for the indirect costs of university research to 50 cents per dollar of direct competitive grant funding by 2014.

Few are the projects for a sustainable industry. [www.innovation.gov.au]

2.3.8 Conclusions

The governments considered in this chapter have different approach to sustainability. United Kingdom and Germany are of course the most efficient promoters of a green culture, a sustainable living. Their power is to move a message to the citizen. Other nations present projects, acts, organization which have the task to outline a way towards sustainability.

2.4 Healthcare Sustainability

Healthcare is a great part of a State's budget and involves a wide range of the population. Hospitals are large structures, essentials for the society, determining the quality of the Healthcare public sector. Hospitals and healthcare facility are supposed to have access to a large amount of resources and consequently to influence a large part of commercial activities (customers and suppliers) and correspondents management strategies.

In this section we will analyse the state of the art of the sustainability in the healthcare sector. Generally, we will try to show how institutions, societies, companies are trying to implement sustainable-management strategies for the healthcare field.
The purpose of the research was to identify the main articles describing the main works, policies and studies conducted on healthcare sustainability.
In order to identify and to distinguish the categories of the applications, and to pose in evidence the main field in which sustainability is analysed, we propose a resume of some articles:

2.4.1 WHO Clean Care is Safer Care

The World Alliance for Patient Safety is an evolving programme of the WHO, established to raise the profile of patient safety. In May 2002, the WHO World Health Assembly passed a resolution which urged countries to pay the greatest possible attention to patient safety. In October 2004, WHO launched the World Alliance for Patient Safety (WAPS). Every 2 years, the WAPS establishes a programme of work to address a patient safety issue relevant to all WHO Member States. These programmes are referred to global patient safety challenges, and the First Global Patient Safety Challenge, "Clean Care is Safer Care", is concerned with galvanizing global commitment and action on the reduction of health care-associated infection.

2.4.1.1 Objectives and implementation of the "Clean Care is Safer Care"

The program has three main objectives. Principally the challenge is to facilitate global awareness-raising about the healthcare-associated infection (HAI) issues. Globally, over 1.4 million people suffer from a HAI worldwide. Generally this challenge promotes actions on HAI in blood safety, injection and immunization safety, water and sanitation and safe emergency and surgical procedures. Secondly the challenge uses as vehicles the State Ministers, encouraging and promoting a country pledge at global level. At the moment 87 WHO Member States, representing 78% of the world's population, have signed this pledge.

Finally, the technical inputs and outputs have resulted in the production of the First WHO Guideline solely to focus on hand hygiene in health care.

Figure 2.24 Status of Country pledges, July 2008

The implementation is concerned with the institutionalization of hand hygiene through application of the WHO Guideline recommendations. To facilitate the execution of the tasks a multimodal strategy has been developed to address:

- System change
    - o Alcohol-based handrub at the point of care
    - o Access to soap and clean running water
- Training and education
- Monitoring and evaluation (including hand hygiene compliance monitoring)
- Reminders in the workplace
- Safety climate, including patient partnership Activity

2.4.1.2 Field testing

In general, the hand hygiene improvement methodology involves a long-term cycle of intervention activity, measurement, feedback and review, with a minimum 5-year strategy recommended.

A Field Testing strategy was applied, which has been made possible with the support of WHO Regional Patient Safety Focal Points and WHO representatives at the country level, as well as collaboration with expert technical and academic partners and professional associations.

Box 2

WHO region	Country	City	Hospital	Hospital wards
AFRO	Mali	Bamako	Hôpital du Point G	Pilot testing complete in nine units including medicine, surgery, emergency, anaesthesia and intensive care, gynaecology and obstetrics
AMRO/PAHO	Costa Rica	San Jose	Hospital Nacional de Niños	Targeted on sub-set of wards, including infectious disease
EMRO	Saudi Arabia	Riyadh	Riyadh Medical Complex	Hospital-wide.
	Saudi Arabia	Riyadh	King Abdulaziz Medical City, Saudi Arabia	Nine pilot areas including male and female surgical wards.
	Pakistan	Islamabad	Pakistan Institute of Medical Sciences (PIMS)	Medical, surgical and neonatal ICUs
EURO	Italy	National network	Network of ICUs	Pilot testing complete in 45 ICUs in partnership with WHO
SEARO	Bangladesh	Chittagong	Chittagong Medical College Hospital	Neonatal care, surgical, orthopaedics, paediatrics ICU, adult ICU, representing 450 beds.
WPRO	Hong Kong SAR	China	Queen Mary Hospital	Pilot testing is complete 3 additional sites Caritas Medical Centre Tuen Mun Hospital Yan Chai Hospital

Table 2.25 Official pilot sites

The official pilot sites are in front line with the implementation of the “CCSC”, but a high number of facilities had interest to participate in the field testing program. As a consequence, a parallel testing mechanism was implemented using a web-based technology. Any health care facility, anywhere in the world has been able to join the field-testing by enrolling as a complementary test site (CTS). The CTS could have only a limited support in the testing. However they have been able to ask questions about the implementation and evaluation. The results were successfully shared with other site tests.

2.4.1.3 Conclusions

As a result The First Global Patient Safety Challenge has generated significant momentum in the 3 years of its existence, largely by mobilising countries, healthcare leaders, patients and patient organizations, and technical experts to support the work through positive action.

At the global level there is a universal expansion of the application of system change to address hand hygiene improvement. More and more countries are moving towards alcohol-based handrubs as a central feature of their infection control strategy.

At the country level, the phenomenal buy-in from Ministries of Health to the country pledges demonstrates impressive political support for patient safety improvement. Thirty percent of pledge-countries have taken additional enhanced action through the initiation of national campaigns, with a central goal: a sustained change in the behaviour of individual health care workers towards better compliance with hand hygiene.

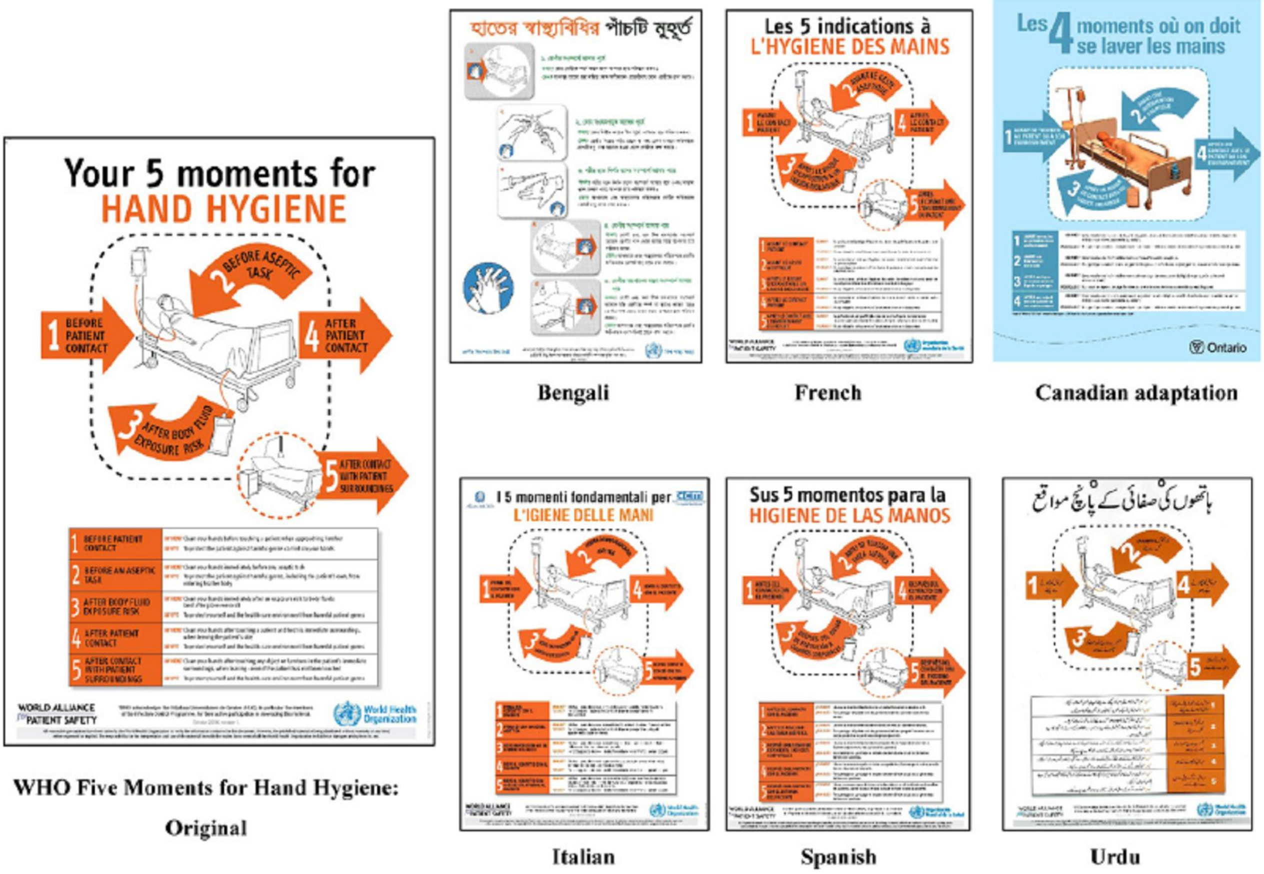

Figure 2.26 The different "My Five Moments for Hand Hygiene" posters

[Pittet 2008]

2.4.2 Healthcare without Harm and Society of Pediatric Nurses

Health Care Without Harm is an international coalition of 473 organizations in more than 50 countries who work together to transform the health care sector and the environment.

The Association was founded in 1996 after the U.S. Environmental Protection Agency identified medical waste incineration as the leading source of dioxin, one of the most potent carcinogens.

In response to this serious problem, 28 organizations came together in Bolinas, California to form the coalition Health Care Without Harm (HCWH). Since then, HCWH has grown into a broad-based international coalition of hundreds of organizations in 52 countries, with offices in Arlington, VA, Brussels, Buenos Aires and Manila.
General statements that the association underlines are:

- Health care facilities expend about twice as much energy per square foot as a commercial building
- Hospitals generate more than 2 million tons of solid waste per year—15 lb per patient
- Healthcare sector are the fourth largest sources of mercury discharge into the environment.

The health care sector can play a leading role in solving these problems. Due to its massive buying power, and its mission-driven interest in preventing disease, the health care sector can help shift the entire economy toward sustainable, safer products and practices.
Health Care Without Harm is at the center of this work to transform the health care sector worldwide, without compromising patient safety or care, so that it is ecologically sustainable and no longer a source of harm to public health and the environment.
[www.noharm.org]
In a short article, the Society of Pediatric Nurses proposes a list of measures able to make an hospital or an healthcare facility more sustainable.
First of all there is the Leadership in Energy and Environmental Design (LEED certification), which is a nationally accepted certification program that rates buildings on their design, construction, and operation of green building performance.
Secondly a list of steps based on the work "How to green an hospital" by eHow Health Editor:
• Recycle paper, cans, bottles, plastics, furniture, equipment, and other general products.
• Reuse packing and shipping materials, envelopes for in-house use, and choose water-saving and efficient laundry equipment.
• Control and reduce the use of contaminates such as mercury and polyvinylchloride used in many manufactured products including intravenous bags and tubing.
• Plant a healing garden.
Furthermore there is the possibility to look for supplies with minimal packaging, or packaging that can be recycled.

www.sustainablehospital.org is an informative site that provides health care facilities with ways to find alternative products that can be used to help reduce occupational and environmental hazards, maintain quality patient care, and reduce costs.
[The Greening of Healthcare]

2.4.3 Waste in China

2.4.3.1 Introduction

This paper discusses actions aimed at sustainable management of healthcare wastes (HCW) in China, taking into account the current national situation in this field, as well as the requirements deriving from the Stockholm Convention on Persistent Organic Pollutants and the WHO recommendations.
Incineration has until now been the most widespread adopted technology for the disposal of HCW, as it also neutralizes the infectivity of the wastes, which is the most hazardous medical waste property. However, if not correctly operated, incineration may lead to high levels of PCDD/PCDFs and heavy metal emissions. Non-incineration technologies, also called alternatives to incineration, are sterilization (steam, advanced steam, dry heat), microwave treatment, alkaline hydrolysis, biological treatment or in certain cases landfill disposal.
In China, the Stockholm Convention entered into force on November 11, 2004.

2.4.3.2 Disposal of HCW

According to the National Hazardous Waste and Healthcare Waste Disposal Facility Construction Plan, 331 centralized HCW disposal facilities are needed in municipalities across the country to ensure the safe disposal of HCW.
The National Plan has been developed following four main principles: (1) a reasonable distribution of centralized disposal plants is the starting point for suitable HCW management, while the installation of decentralized disposal capacity will gradually follow; (2) it is necessary to consider the need to install centralized HCW and hazardous waste disposal facilities together; (3) advanced, practical, mature, and reliable techniques for obtaining safe treatment and avoiding secondary pollution must be adopted; and (4) disposal facilities should be functionally complete.

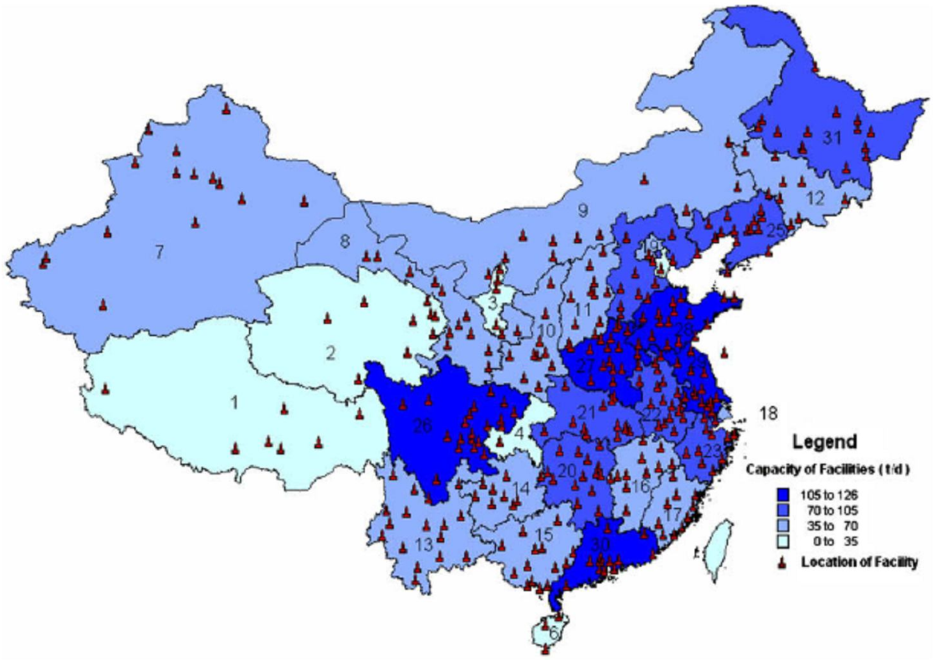

Figure 2.27 Geographical Distribution of Facilities and of the Disposal Capacity foreseen by the National Plan in China

By the end of 2007, 73 HCW projects foreseen by the National Plan have been authorized and will be in operation within a 3-yr period. By the end of 2008, a further 63 facilities will be completed. These projects account for 41% of the total of 331 National Plan projects. Moreover, considering that due to their poor techniques and technical conditions, over 50% of the existing 149 disposal facilities will soon be dismantled and reconstructed using the investment of the National Plan, the situation of HCW management in China will improve quite rapidly. The final implementation progress of the National Plan will continue for the period of the next 5 yr due to different situations of different regions in China.

2.4.3.3 Technical disposal

In China are developed different waste disposal technologies, which have advantages and shortcomings. They are listed in the following table:

Type	Factors	Advantages	Disadvantages	Pollutants emission	Scope can be treated
Incineration/ pyrolysis-gasification	• Turbulence and mixing • Moisture content of waste • Filling combustion chamber • Temperature and residence time • Maintenance and repair	• Mature and widely used technology • Volume and weight reduction • Unrecognizable waste • Complete disinfection • Heat recovery potential for large system • Broad applicability, acceptable for all waste types • Large scale system of waste • Related standards and specifications completed	• Public opposition • High investment and operation costs • High maintenance cost • Expensive control equipment required to reduce emissions • Skilled operator needed • Bottom and fly ash may be hazardous	PCDD/PCDFs SO_2, HCl, NO_x, Heavy metals, etc.	Acceptable for all waste types
High temperature steam-based	• Waste characteristics • Temperature and pressure • Steam penetration • Size of waste load • Length and number of treatment cycles • Degree of vacuum in the chamber	• Low investment cost • Low operating cost • Ease of biological tests • Low hazard residue • PCDD/PCDFs emission free	• Appearance, volume unchanged • Not suitable for all waste types, chemical waste and pharmaceutical waste can not be treated • Possible incomplete disinfection	Microorganisms, Odour, VOCs and others	Infectious waste, Pathological waste, Sharp objects
Microwave	• Moisture content of waste • Microwave strength • Duration of exposure • Extent of waste mixture	• Unrecognizable waste • Significant volume reduction • Absence of liquid discharge • PCDD/PCDFs emission free	• Mod-High investment cost • Not suitable for all waste types, chemical waste and pharmaceutical waste can not be treated • Possible incomplete disinfection	Microorganisms, Odour, VOCs and others	Infectious waste, Pathological waste, Sharp objects
Chemical	• Concerns for chemicals, temperature, • pH • Chemical contact time • Waste and chemical mixing • Recirculation vs flow-through	• Significant volume reduction • Unrecognizable waste • Rapid processing • Waste deodorization • PCDD/PCDFs emission free	• Mod -High investment cost • Not suitable for all waste types, chemical waste and pharmaceutical waste can not be treated • Possible incomplete disinfection • Need for chemical storage	Microorganisms, Odour, VOCs and others	Infectious waste, Pathological waste, Sharp objects

Table 2.6 Waste disposal technologies

In facts, no single technology offers a perfect solution to the complexity of medical waste disposal. Each technology has its advantages and disadvantages, and for non-incineration technologies, it is still necessary to determine which technology best meets the local waste management needs while minimizing the impact on the environment, enhancing occupational safety, and protecting public health.

Most of the existing HCW disposal facilities are not equipped with on-line continuous monitoring equipment. In the majority of the healthcare waste disposal facilities, the release concentration of PCDD/PCDFs is not measured. Finally, several existing HCW incinerators have emission values exceeding the regulatory limit, with an evident impact on the environment. As was already said, among the 147 incineration facilities, over 50% will be dismantled and reconstructed. However, most of the disposal facilities funded by the National Plan are still under construction.

2.4.3.4 Conclusions

In conclusion, HCW management is one of the most important parts of the implementation of the Stockholm Convention in China. In order to forge ahead with the development of related activities in this field, it is imperative to explore the mode of management and disposal that meets the requirement of the Stockholm Convention as well as satisfying China's needs, in order to contribute to sustainable and environmentally sound management. In terms of the regulatory aspects of HCW in China, it is very important to set up a lifecycle and holistic management system, as it is the only way to ensure the application of different types of technologies and the promotion of environmentally safe management. As far as technical aspects are concerned, on one hand it is important to improve research and to develop and promote PCDD/PCDFs-reducing technologies; on the other hand, non-incineration technologies should be promoted and replicated with the purpose of realizing a standardized system for HCW management in China. In addition, awareness and training also need to be enhanced, and a market oriented co-financing mechanism for the construction and operation of HCW disposal facilities should be encouraged to promote BAT/BEP implementation the in HCW field.
[Yang 2009]

2.4.4 Evaluation model for waste management and resources management

The paper presents guidelines that can be used by managers of healthcare facilities to evaluate and assess the quality of resources and waste management at their facilities and enabling the principles of sustainability to be addressed. The following key aspects are considered:

- general management
- social issues
- health and safety
- energy and water use
- purchasing and supply
- waste management
- waste transport
- recycling and re-use
- waste treatment
- final disposal

The guidelines are presented and the facility features associated with sustainable level (level 4) and unsustainable level (level 0). The test was conducted in a major London hospital.

2.4.4.1 The need for healthcare assessment

Waste management associated with healthcare facilities has only emerged as an important global issue in the last quarter of the twentieth century, when many national and international organizations provided information, data and advice in order to help countries working towards a better waste management. The limited work reported on the implications of sustainable development for healthcare facilities has not been helped by the absence of framework for assessing sustainability of healthcare services. This needs to be developed to provide key performance indicators that allow the current situation to be assessed. A set of indicators is provided in this paper in order to assess the current status at the facility and indicate the changes necessary to move towards more sustainable wastes and management resources.

2.4.4.2 Assessment guidelines

The method used to formulate the guidelines was based on the approach used in the "Guidelines for Landfill Evaluation" developed by the Working Group on Sanitary Landfill of the International Solid Waste Association. This used a simple table format, linking performance level to a range of key characteristics. However, the complexity of the healthcare sector is much higher. It was decided to use five different levels of sustainability, ranging from a "totally unsustainable manner and reluctance to change" to "a way that displays all the characteristics normally associated with sustainable development". Two different sets of indicator where identified: the first includes general features associated with healthcare facility management and resource utilization, the second set is more directly related to waste management and materials handling issues.

The metric used is:

- Level 0:
  Operating at totally unsustainable manner with reluctance to change
- Level 1:
  Generally operating in an unsustainable manner, although there is some evidence of awareness and willingness to change
- Level 2:
  Operating in a manner with some aspects that are considered sustainable and others that are considered unsustainable
- Level 3:

Generally operating in accordance with sustainable development, but some aspects not ideal

- Level 4:

  Operating in a way that displays all the characteristics normally associated with sustainable development

This categories are traduced in sinful matters for every set which was taken into account.

The first set includes consideration of:

- general management
- social issues
- health and safety
- energy and water use
- purchasing and supply

The second set includes:

- waste management responsibility, segregation, storage and packaging
- waste transport
- waste recycling and use
- waste treatment
- off-site disposal

For example in the set general management level 0 is represented by the following sentences:

- Management unaware of sustainable development (SD)
- No commitment to SD
- No mass balance undertaken
- Evidence of corruption
- Lack of awareness of best value
- No continuous improvement taking place
- No ISO 14001

50 groups of consideration were produced in order to consider the ten categories mentioned above with the five levels of assessment.

2.4.4.3 Applying the guidelines

A clear management strategy is necessary in order to deliver a beneficial improvement in healthcare waste and resources management at a healthcare facility. Typically the activities needed are the following:

- analysis of the current situation relevant to the 10 key sustainable development indicators identified in the guidelines
- classifying each indicator against an operating level (level 0 to level 4)
- prioritizing action to move key indicators to a higher level
- initiating a periodic review process

The major hospital of London has 638 beds and provides complex surgery and plastic reconstruction, treatment for trauma including head and neck injuries, open fractures, cancer and ophthalmology.

A summary of the assessment conducted in the hospital is the reported in table 2.7:

Characteristic	Assessment level	Additional comments
General Management	3	No framework to obtain best value or continued improvement. Management staff had some awareness of sustainable development. No ISO 14001 certification or Environmental Management System
Social issues	3	There is a consultative committee (Patient Advisory and Liaison Service)
Health and safety	3	Full H&S policy and full time advisor staff handling and moving waste were only supplied with basic overalls. Those working in ward areas have access to the gloves available for nursing staff. There is a lack of posters that could provide useful information.
Energy and water use	3	Appropriate for a facility of this type. Adequately served by public transport.
Purchasing and supply	1	Lack of control over purchasing of goods and services. Purchasing and supply policy exists but not effectively implemented.
Waste management. Responsibility, segregation, storage and packaging	3	Responsibility for waste management is clearly defined. Full time waste manager. Waste management policy in force. Segregation of wastes after disposal in HHCW and MSW receptacles was found to be very effective. The waste storage areas were well organized and the storage period does not exceed 24h as waste is collected twice per day. The major problem identified was the high level of MSW being disposed as HHCW
Waste transport	4	Transport is in accordance with current legislative requirements.
Waste recycling and reuse	1	There are no waste recycling schemes operating and no plans to implement any in the near future. Initiating recycling schemes was regarded as an added cost. Improving segregation/separation of MSW from the HHCW stream has the potential to significantly reduce waste management costs.
Waste treatment	4	Final disposal of HHCW by high temperature incineration.
Off-site disposal	4	MSW is disposed of into regulated landfills operating to appropriate standards.

Table 2.7 Main features of the evaluation model

For this hospital the “purchasing and supply” and the “waste recycling and reuse” sector are key areas for improvement, as these are assessed to operate in a unsustainable manner.

2.4.4.4 Conclusions

While sustainable development is relatively simple to define as “development that meets the needs of the present without compromising the ability of future generation to meet their own needs”, the achievement of more sustainable procedures in healthcare is often complex. This research was

aimed at identifying key factors that need to be addressed in order to improve the sustainability of healthcare facilities. The proposed guidelines contain 10 characteristics that need to be assessed to give performance indicators ranging from level 0 to level 4. This provides a useful way of formalizing an assessment of sustainable development operating at a particular healthcare facility. It has been used at a major hospital in London and clearly identified key areas where improvements were required.
[Townend 2005]

2.4.5 25 rules

This article provides us a series of rules in order to improve the sustainability of healthcare buildings:

1. INVESTIGATE SOLAR WATER HEATING
2. REDUCE WATER CONSUMPTION
3. PERFORM A RECOMMISSIONING OF LABORATORY AIR SYSTEM
4. INVESTIGATE FUEL CELLS AND MICROTURBINES
5. START A RECOMMISSIONING PLAN
6. PUT VFDS ON ALL MOTORS 3 HP AND HIGHER
7. START A SUSTAINABILITY PROGRAM
8. START A SUSTAINABILITY EDUCATION PROGRAM
9. INVESTIGATE DESICCANTS
10. INVESTIGATE YOUR HVAC ECONOMIZERS
11. FIND CHILLED WATER SHORT CIRCUITS
12. SEAL STEAM LEAKS
13. GET RID OF YOUR OLD REFRIGERANTS
14. MAKE SURE YOUR ROOFS REPEL WATER
15. COMPLETE A SUSTAINABILITY AUDIT
16. INSTALL SECURE BICYCLE PARKING AREAS AND SHOWERS
17. REVIEW LIGHT POLLUTION
18. INVESTIGATE WIND TURBINES
19. INVESTIGATE ALTERNATIVE PAVEMENTS
20. REDUCE VEHICLE IDLING AROUND YOUR FACILITY
21. INVESTIGATE DIESEL OXIDATION CATALYSTS (DOCS) FOR VEHICLES
22. REMOVE OLD DEVELOPMENT LAB PIPING
23. RECYCLE CARDBOARD

24. RECYCLE FLUORESCENT LAMPS
25. REVIEW CLEANING AGENTS

Sustainability represents a huge opportunity for hospital facility managers. No hospital can be sustainable simply by greening new construction. Sustainable operations are foundational for greening hospitals overall. Sustainability can empower facility management to improve patient outcomes, elevate staff confidence and retention rates, reduce energy consumption, and lower the overall impact that a hospital organization produces on the environment.
[Steven, 2008]

2.4.6 Green Guide for Health Care

The Green Guide for Health Care is a health care sector's quantifiable sustainable design and facilities operations toolkit integrating environmental and health principles and practices into the planning, design, construction, operations and maintenance of their facilities. The Guide provides the health care sector with a voluntary, self-certifying metric toolkit of best practices that designers, owners, and operators can use to guide and evaluate their progress towards high performance healing environments.

2.4.6.1 Objectives of the Green Guide for Health Care

The Green Guide is not intended to establish regulatory requirements, nor to be viewed as a minimum standard for design, construction or operations. It is designed to serve as a voluntary educational guide for early adopters of sustainable design, construction, and operations practices, to encourage continuous improvement in the health care sector, and to provide market signals to catalyze a richer palette of strategies for those who follow the early adopters. As the general level of green building practice rises, it is anticipated that the *Guide* will be updated to encourage continued leadership and higher levels of rigor associated with creating high performance healing environments.
The Green Guide for Health Care is specifically customized for buildings that are predominately institutional occupancies as defined by the local building code, such as acute care hospitals, where regulatory requirements have created particular needs. Medical office buildings, clinics and other buildings where health concerns are dominant are also encouraged to use the Green Guide.

2.4.6.2 Structure of the Green Guide for Health Care

The Green Guide for Health Care is divided into two sections: Construction and Operations. The Construction section targets new construction projects and major renovations, while the Operations section is designed as a continuous improvement tool for existing operational facilities.
In this article we analyse only the Operation section because of the best bearing on the subject.
The Green Guide Operations section is organized in accordance with commonly understood areas of responsibility in health care organizations. Each area corresponds to a specific operation in the organization and each credit to a distinct aspect of the operation of health care facilities.
The areas of interest are the following:

- Integrated Operation & Education (2 credits)
- Sustainable Sites Management (9 credits)
- Transportation Operations (5 credits)
- Facilities Management (46 credits)
- Chemical Management (11 credits)
- Waste Management (9 credits)
- Environmental Services (8 credits)
- Food Service (17 credits)
- Environmentally Preferable Purchasing (22 credits)
- Innovation in Operations (7 credits)

For each area there is a number of credits, that is from 2 credits for the Integrated Operation & Education area to 46 credits for the Facilities Management area. The total number of credits is 136.
Each credit is exhaustively described in the Guide.
The description has the following structure:

- **Intent -** Summarizes the credit goal
- **Health Issues** - Identifies specific health concerns addressed by the credit.
- **Credit Goals** - Itemizes the specific steps to achieve the credit including threshold goals.
- **Suggested Documentation** - Suggests documentation to monitor and baseline performance and to benchmark achievement of the Credit Goals. The Green Guide is a voluntary self-certifying document that does not offer third party certification.
- **Reference Standards** - Identifies the standards and referenced documents that establish the basis of the Credit Goal criteria.
- **Potential Technologies & Strategies** - Suggests helpful information to support the credit Intent and Credit Goals. Products and materials are referenced in order to provide suggestions for consideration in some applications.

- **Resources** - Cites selected information sources associated with the Credit Intent, Credit Goals, and Potential Technologies and Strategies.

As an example we provide the credit list of the Sustainable Sites Management area:

Sustainable Sites Management						9 Points
Y	?	N	NA	Credit 1.1	Site Management: Building Exterior & Hardscape Management Plan	1
Y	?	N	NA	Credit 1.2	Site Management: Integrated Pest Management, Erosion Control & Landscape Management Plan	1
Y	?	N	NA	Credit 2.1	Reduced Site Disturbance: Protect or Restore Open Space or Habitat	1
Y	?	N	NA	Credit 2.2	Reduced Site Disturbance: Structured Parking	1
Y	?	N	NA	Credit 3	Stormwater Management	1
Y	?	N	NA	Credit 4.1	Heat Island Reduction: Non-Roof	1
Y	?	N	NA	Credit 4.2	Heat Island Reduction: Roof	1
Y	?	N	NA	Credit 5.1	Connection to the Natural World: Outdoor Places of Respite	1
Y	?	N	NA	Credit 5.2	Connection to the Natural World: Exterior Access for Patients	1

Figure 2.28 Credit list of the Sustainable Site Management section [www.gghc.org]

In order to understand the style and the contents of a credit we report a short explanation of the credits number 2.1 and 2.2:

Title	Intent	Credit Goals
SSM 2.1 Reduced Site Disturbance: Protect or Restore Open Space or Habitat	Conserve existing natural site areas and restore damaged site areas to provide habitat and promote biodiversity.	• Protect or restore natural habitat area as follows: Natural Habitat Area Required = (Site Area) (.15 – Site Size Factor) ÷ (Floor Space Ratio) • Improving and/or maintaining off-site areas with native or non-invasive adapted plants can contribute toward earning GGHC SSM Credit 2.1. Every 2 square feet offsite will be counted as 1 square foot on-site. Off-site areas must be documented in a contract with the owner of the off-site area that specifies the required improvement and maintenance of the off-site area.
SSM 2.2 Reduced Site Disturbance: Structured Parking	Conserve existing natural site areas and restore damaged site areas to provide habitat and promote biodiversity.	• Achieve SSM Credit 2.1. AND • Ensure that minimum 50% of total installed parking spaces meet one or more of the following criteria: • Onsite structured parking • Off-site structured parking • Shared existing off-site surface parking

Table 2.8 Example of a credit explanation

As we can see the credits mainly represent suggestions about how to enhance the sustainability of the healthcare facility.

2.4.6.3 Conclusions

The Green Guide for Healthcare presents the important peculiarity of being complete, exhaustive, involving a wide range of aspects and providing a deep analysis of the facility. However, we think that the absence of a third parties analysis makes the evaluation poor and unaffordable, suffering a lack of objectivity. [GGHC, 2008]

2.4.7 LEED in Healthcare

The Thesis in Architecture by Andrea Marchelle Hill at Texas A&M University discusses about the LEED (Leadership in Energy and Environmental Design), one of the most important standard applied to Healthcare facilities. The study presents four case studies of LEED health centers whose medical staff and administrators evaluate the perceivable green building features applied to their facility.

In the following, after presenting the selection method and some other preliminary question, we will describe the four case study analyzed, the results and some conclusions.

2.4.5.1 Selection method

Case studies were selected from the U.S. Green Building Council database of LEED certified buildings, LEED certified hospitals and health clinics. In the summer of 2006 when the study began, there were seven LEED certified health centers in the United States. All of the LEED certified health centers were asked to participate in the study. However three of the health centers were not able to participate in the study because of various reasons. Four LEED certified health centers agreed to participate in this study.

2.4.5.1.1 Data collection and analysis

LEED score cards were identified for each case. The LEED score cards show the points received for the use of the site, water, resources, materials, energy, indoor air quality control and green housekeeping. A survey was developed to assess the perceivable LEED building features used in the health facilities. Questions that were used were one-dimensional; for example something that can be measured either more or less or yes or no.

A box of fifteen paper surveys and privacy envelopes was sent to the contact at each LEED certified health center (fifteen employees where chosen to take the survey). The respondents were then asked to complete the survey and return it sealed in the privacy envelope to the health center contact.

The credits from the following LEED sections are included in this study:

- Sustainable Sites
- Water Efficiency
- Materials and Resources
- Indoor Environmental Quality
- Innovation and Design Process
- Energy & Atmosphere

We provide an example of a LEED Score Card for the Patrick Dollard Discovery Health Center.

LEED

LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN

The Patrick H. Dollard Discovery Health Center

Project Name, LEED® Project # 0077

LEED Version 2 Certification Level: CERTIFIED

October 25, 2004

27 Points Achieved — Possible Points: 69

Certified 26 to 32 points Silver 33 to 38 points Gold 39 to 51 points Platinum 52 or more points

Y		7 Sustainable Sites	Possible Points: 14
Y	Prereq 1	**Erosion & Sedimentation Control**	
1	Credit 1	**Site Selection**	1
	Credit 2	**Urban Redevelopment**	1
	Credit 3	**Brownfield Redevelopment**	1
	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
	Credit 4.3	**Alternative Transportation**, Alternative Fuel Refueling Stations	1
1	Credit 4.4	**Alternative Transportation**, Parking Capacity	1
1	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1	Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
1	Credit 6.1	**Stormwater Management**, Rate and Quantity	1
	Credit 6.2	**Stormwater Management**, Treatment	1
1	Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1
	Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
	Credit 8	**Light Pollution Reduction**	1

Y		2 Water Efficiency	Possible Points: 5
1	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
	Credit 2	**Innovative Wastewater Technologies**	1
	Credit 3.1	**Water Use Reduction**, 20% Reduction	1
	Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Y		4 Energy & Atmosphere	Possible Points: 17
Y	Prereq 1	**Fundamental Building Systems Commissioning**	
Y	Prereq 2	**Minimum Energy Performance**	
Y	Prereq 3	**CFC Reduction in HVAC&R Equipment**	
2	Credit 1.1	**Optimize Energy Performance**, 20% New / 10% Existing	2
	Credit 1.2	**Optimize Energy Performance**, 30% New / 20% Existing	2
	Credit 1.3	**Optimize Energy Performance**, 40% New / 30% Existing	2
	Credit 1.4	**Optimize Energy Performance**, 50% New / 40% Existing	2
	Credit 1.5	**Optimize Energy Performance**, 60% New / 50% Existing	2
	Credit 2.1	**Renewable Energy**, 5%	1
	Credit 2.2	**Renewable Energy**, 10%	1
	Credit 2.3	**Renewable Energy**, 20%	1
1	Credit 3	**Additional Commissioning**	1
	Credit 4	**Ozone Depletion**	1
	Credit 5	**Measurement & Verification**	1
1	Credit 6	**Green Power**	1

Y		3 Materials & Resources	Possible Points: 13
Y	Prereq 1	**Storage & Collection of Recyclables**	
	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
	Credit 1.2	**Building Reuse**, Maintain 100% of Existing Shell	1
	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
1	Credit 2.1	**Construction Waste Management**, Divert 50%	1
	Credit 2.2	**Construction Waste Management**, Divert 75%	1
1	Credit 3.1	**Resource Reuse**, Specify 5%	1
	Credit 3.2	**Resource Reuse**, Specify 10%	1
	Credit 4.1	**Recycled Content**	1
	Credit 4.2	**Recycled Content**	1
1	Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
	Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
	Credit 6	**Rapidly Renewable Materials**	1
	Credit 7	**Certified Wood**	1

Y		7 Indoor Environmental Quality	Possible Points: 15
Y	Prereq 1	**Minimum IAQ Performance**	
Y	Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	
	Credit 1	**Carbon Dioxide (CO_2) Monitoring**	1
1	Credit 2	**Increase Ventilation Effectiveness**	1
	Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
	Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
1	Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
1	Credit 4.2	**Low-Emitting Materials**, Paints	1
1	Credit 4.3	**Low-Emitting Materials**, Carpet	1
1	Credit 4.4	**Low-Emitting Materials**, Composite Wood	1
	Credit 5	**Indoor Chemical & Pollutant Source Control**	1
1	Credit 6.1	**Controllability of Systems**, Perimeter	1
1	Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
	Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
	Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
	Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

Y		4 Innovation & Design Process	Possible Points: 5
1	Credit 1.1	**Innovation in Design**: Exemplary Performance EAc6	1
1	Credit 1.2	**Innovation in Design**: Green Housekeeping	1
1	Credit 1.3	**Innovation in Design**: Sustainability Education	1
	Credit 1.4	**Innovation in Design**:	1
1	Credit 2	**LEED® Accredited Professional**	1

Figure 2.29 Patrick Dollard Discovery Health Center LEED Score Card

Each topic is analyzed with a specific method. Figure 2.29 displays a score card for a single topic. The answers are mainly forced in a grid of satisfied, somewhat satisfied, somewhat dissatisfied, dissatisfied and not applicable to the facility. The answers are then translated into an ordered number scale and the numbers are added to give an overall score. Satisfaction with a particular aspect within a topic is represented by a (1), a dissatisfaction is represented by a (-1). The far left column 'R' represents the respondent. In the bottom row, 'Total', satisfaction or dissatisfaction with the aspect is represented with a positive or negative number. The total number in the column is irrelevant. A positive number represents satisfaction while a negative number represents dissatisfaction. The column, '#12 Overall Satisfaction', is the individual results for question #12 in the survey, which asks the overall satisfaction with each topic.

	Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Dissatisfied	N/A
Amount of Staff Parking					
Bike Storage Area					
Shower facilities					
Access to Public Transportation					

R	Staff Parking	Bike Storage	Shower Facilities	Access to Public Transportation	#12 Overall Satisfaction	Score for each Respondent
R1	-1	n/a	n/a	-1	1	*-1*
R2	1	1	n/a	n/a	n/a	*2*
R3	1	1	1	1	n/a	*4*
R4	1	n/a	n/a	n/a	1	*2*
R5	1	n/a	n/a	n/a	1	*2*
R6	1	1	n/a	n/a	1	*3*
R7	1	n/a	n/a	-1	n/a	*0*
R8						*0*
R9						*0*
R10						*0*
R11						*0*
R12						*0*
R13						*0*
R14						*0*
R15						*0*
Total	5	3	1	-1	4	*12*

Figure 2.30 The Patrick Dollard Discovery Health Center's Satisfaction with Transportation Issues

2.4.5.2 Case Study

In the following map we show the location of the four healthcare facilities which were be considered in this study.

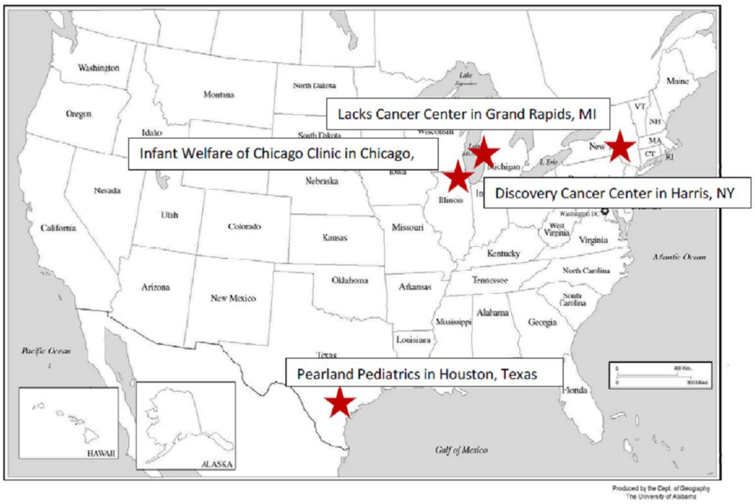

Figure 2.31 Locations of the Four LEED Certified Health Centers

2.4.5.2.1 Patrick H. Dollard Discovery Health Center

The Patrick Dollard Discovery Health Center is a suburban facility.

Figure 2.32 Patrick H. Dollard Discovery Health Center

The following list reports general information about the facility:

Owner: The Center for Discovery

Architect: Guenther 5 Architects PLLC

Building Type: New Construction, Ambulatory Diagnostic Treatment Facility

Size: 28,000 sqft

Building Location: Harris, NY

Recognition: LEED Certified

The exterior image of the Patrick Dollard Discovery Health Center in 2.32 give an idea of the natural light sources for the interior spaces. The Patrick H. Dollard Discovery Health Center received a total of twenty-seven LEED points earning the title CERTIFIED green building. A wide variety of materials like laminate, wood, ceramic, and glass are maintained using green housekeeping strategies. Occupant Evaluation of LEED Certified Health Center survey was given to fifteen full time employees, at the Patrick H. Dollard Discovery Health Center, seven responded.

2.4.5.2.2 Richard J. Lacks Cancer Center

The Richard J. Lacks Cancer Center is one of two LEED certified health centers in this research located in a metropolitan area.

Figure 2.33 Richard J. Lacks Cancer Center

Here is a list of general information about the facility:

Owner: St. Mary's Health Care
Architect: Trinity Design (now HKS Architects)
Building Type: New Construction
Size: 170,000 sqft
Building Location: Grand Rapids, MI
Recognition: LEED CERTIFIED

The Richard J. Lacks Cancer Center received a total of thirty LEED points earning the title CERTIFIED green building. The Occupant Evaluation of LEED Certified Health Center survey was given to fifteen full time employees, at the Lacks Cancer Center, fourteen responded.

2.4.5.2.3 Angel Harvey Infant Welfare Society of Chicago

The Angel Harvey Infant Welfare Society of Chicago is the second case study located in a metropolitan area.

Owner: Infant Welfare Society of Chicago
Architect: SMNG-A Architects
Building Type: New Construction clinic
Size: 40,000 sqft
Building Location: Chicago, IL
Recognition: LEED CERTIFIED

The Angel Harvey Infant Welfare Society of Chicago health center received a total of thirty-one LEED points earning the title CERTIFIED green building. The OccupantEvaluation of LEED Certified Health Centers survey was given to fifteen full time employees, at the Angel Harvey Infant Welfare Society of Chicago health center, fifteen responded.

Figure 2.34 Angel Harvey Infant Welfare Society of Chicago

2.4.5.2.4 Pearland Pediatrics

Pearland Pediatrics is located in a suburban area of Houston, Texas.
General information about the facility are:

Owner: Pearland Pediatrics

Architect: Browne Penland McGregor Stephens Architects

Building Type: New Construction Pediatric facility

Size: 10,388 sqft

Building Location: Pearland, TX

Recognition: LEED CERTIFIED

Pearland Pediatrics is the only case in this research that received indoor environmental quality daylight and view credits. The Pearland Pediatrics facility received a total of twenty-seven LEED points earning the title CERTIFIED green building. The Occupant Evaluation of LEED Certified Health Centers survey was given to fifteen full time employees, at the Pearland Pediatrics, thirteen responded.

Figure 2.35 Pearland Pediatrics

2.4.5.3 Results

The following table displays a resume of the results obtained from the four facility assessed.

S = Satisfaction D = Dissatisfaction

LEED CATEGORIES	DISCOVERY HEALTH CENTER	PEARLAND PEDIATRICS
TRANSPORTATION	S	S
Transportation 4.1		
Transportation 4.2		
Transportation 4.4		
EXTERIOR LIGHTING	S	S
Exterior Lighting 8.0		
LANDSCAPE	S	S
Landscape 1.1		
Landscape 1.2		
RECYCLING	S	S
Storage & Collection of Recyclables		
WATER EFFICIENCY	S	S
Water Use Reduction 3.1		
Water Use Reduction 3.2		
INDOOR AIR QUALITY	S	S
Minimum IAQ Performance PR 1		
Environmental Tobacco Smoke Control PR 2		
Carbon Dioxide Monitoring 1		
Increase Ventilation Effectiveness 2		
Indoor Chemical & Pollutant Source Control 5		
ADJUSTABLE SYSTEMS	S	S
Controllability of Systems, Perimeter 6.1		
Controllability of Systems, Non-Perimeter 6.2		
TEMPERATURE	S	D
Thermal Comfort 7.1		
Thermal Comfort 7.2		
DAYLIGHT & VIEWS	S	S
Daylight & Views 8.1		
Daylight & Views 8.2		
GREEN HOUSEKEEPING	S	S
Green Housekeeping		

Table 2.9 Table of results: Discovery Health Center and Pearland Pediatrics

S = Satisfaction D = Dissatisfaction

LEED CATEGORIES	LACKS CANCER CENTER	INFANT WELFARE SOCIETY OF CHICAGO
TRANSPORTATION	S	S
Transportation 4.1		
Transportation 4.2		
Transportation 4.4		
EXTERIOR LIGHTING	S	S
Exterior Lighting 8.0		
LANDSCAPE	S	S
Landscape 1.1		
Landscape 1.2		
RECYCLING	S	S
Storage & Collection of Recyclables		
WATER EFFICIENCY	S	S
Water Use Reduction 3.1		
Water Use Reduction 3.2		
INDOOR AIR QUALITY	S	D
Minimum IAQ Performance PR 1		
Environmental Tobacco Smoke Control PR 2		
Carbon Dioxide Monitoring 1		
Increase Ventilation Effectiveness 2		
Indoor Chemical & Pollutant Source Control 5		
ADJUSTABLE SYSTEMS	S	S
Controllability of Systems, Perimeter 6.1		
Controllability of Systems, Non-Perimeter 6.2		
TEMPERATURE	S	S
Thermal Comfort 7.1		
Thermal Comfort 7.2		
DAYLIGHT & VIEWS	S	S
Daylight & Views 8.1		
Daylight & Views 8.2		
GREEN HOUSEKEEPING	S	S
Green Housekeeping		

Table 2.10 Table of results: Lacks Cancer Center and Infant Welfare Society of Chicago

The evaluation show that the only unsatisfactory topic are the temperature for Pearland Pediatrics and the indoor air quality for the Infant Welfare Society of Chicago.
All of the cases in this study received different LEED credits. Each case represented is distinct enough to be considered a pioneer in the way they achieved the LEED certification. Pearland Pediatrics is a pioneer for achieving both daylight & view credits IEQ 8.1 and 8.2. The Richard J. Lacks Cancer Center was the only case to receive both IEQ thermal comfort credits 7.1 and 7.2 and WE water use reduction credits 3.1 and 3.2. The Angel Harvey Infant Welfare Society of Chicago received the most success with alternative transportation. The Patrick Dollard Discovery Health Center was the only facility to receive both IEQ controllability of systems credits 6.1 and 6.2.

The LEED evaluation is precise and covers a wide range of aspects. The assessment is conducted with an extended number of point of view because of the fifteen persons involved in the evaluation. This practice avoids or minimizes the subjectivity of the evaluation.
The evaluation is mainly focused on the building and provides a complete evaluation of this. However there is a lack of in-depth analysis towards the different sector of the healthcare facility, and his activities.
[Hill 2009]

2.5 Sustainable Hospitals

The fifth and last part of this state of the art is mainly focused on the sustainable healthcare architecture. The construction of healthcare facilities with sustainable design and green-perspective priorities mainly begun in North America, in the first decade of this century. The creation of the USGBC (United States Green Building Council) in 1993 by Mike Italiano, David Gottfried and Rick Fedrizzi gave a great motivation to the development of the Sustainable Architecture.
Since this beginning point the stimulus found extension and continuity in other European countries, which began to apply sustainability principles in the construction of big and public facilities.

2.5.1. Meyer Hospital, Florence

The pediatric hospital of Florence uses sustainable technologies to realize a daylight, child-centered design. The hospital replaces an older facility and is arguably the most ambitous of the five demonstration hospital built under the European Union Hospitals Project. The hospital is an independent health institute of the National Health System. Its overall objectives were the reduction and control of solar radiation and the provision of natural ventilation and natural cooling of the external building surfaces using evaporative principles.
The combination of a shading and ventilation system can keep the building temperature 10°C above ambient. Passive cooling and ventilation techniques are used as much as possible, and air-conditioning is used only when necessary. A sun space area has the function of a buffer for the building. Heated air is used to create solar drafts, providing a natural airflow through the building. Trees are planted around the hospital, and the grass covers the roof. The respiration of the vegetation provides a cool microclimate.

The main features are:
Building type: New acute-care construction and renovation
Size: Building 33600 sq-m; site 7,2 ha
Design energy intensity: Projected from models: 188 kWh/sq-m
Program description: 152 bed children’s hospital
Completion date: 2007
Recognition: EU Hospital Project

Figure 2.36 The Meyer pediatric Hospital in Florence [inhabitat.com]

The key building performance strategies are:

Site

- Old-growth trees on-site incorporated into parkland plan
- 5000 sq-m green roof integrates building with site

Energy

- High performance envelope, including 6 cm of external wall insulation
- 35% energy demand reduction below baseline through heat pump heating and cooling systems
- 36 kW photovoltaic embedded glass system in solarium
- Daylight expected to provide 36% lighting energy savings below standard practice (about 60% reduction from prior hospital use if operated as modelled)

Materials

- Low-VOC (volatile organ compounds) surface paints
- Wood windows frames, doors, ceilings, siding and trim
- Pre-patina copper cladding in Tuscan tradition

Environmental Quality

- 3,42 sq-m of double glazed windows in every patient room
- Skylights, courtyards, and sun pipes (light ducts) serving up to three floors provide daylight to deeper plan areas

- Daylight corridors precluding need for electrical light during morning hours
- Motorized blind control glare

Economic saving are expected to be around 92000 € per year. After an initial investment of 1.5 million € the payback time is estimated in 17 years, or 11 years when EU financial support of 500000 € is included. The emission reduction is expected to be 899 tons of CO_2, 0,77 tons of SO_x, 7,91 tons of NO_x per year.
[Guenther, 2008] pagg 315-318

2.5.2 Dell Children's Medical Centre, Texas

The Dell Children's Medical Centre is a LEED certified building. In 2009 the hospital received the first LEED Platinum certification in the world from the U.S. Green Building Council. Furthermore the hospital is a Green Guide for Health Care Pilot Project.
This replacement hospital building is the first development parcel on the former municipal airport. The project was to reintegrate the scarred brownfield site into the surrounding residential communities while constructing a large complex of buildings. This required a creative approach to site planning, energy and water-demand reduction, and other resource-conscious design considerations.

The main features of the building are listed in the following:
Building type: New acute-care hospital
Size: Building 42300 sq-m; site 12,9 ha
Design energy intensity: Excluding process and plug load, 222 kBTUs/sq-ft/yr
Program description: 169 bed acute-care children's hospital
Completion date: 2007
Recognition: Green Guide for Healthcare pilot

Figure 2.37 Dell Children's Medical Center of Central Texas [www.architetturaecosostenibile.it]

The main key building performance strategies are:

Site

- Brownfield remediation
- Xeriscaping and native planting

Water

- 30% potable water reduction in fixtures through use of dual-flush toilets and low-flow devices

Energy

- 35% improvement in source energy efficiency through the use of a CCHP (combined cooling, heat and power)-generating facility
- Additional 15 percent energy-demand reduction attributable to a range of system enhancements, including air intakes through courtyards, distributed air-handling units, heat-recovery technology, and variable frequency motors and drives

- Roof shape and slope accommodates future installation of photovoltaic panels

Materials

- 92% percent of construction and demolition waste recycled through aggressive site source separation program
- 47000 tons of airport paving material removed and reprocessed
- Local, regional and recycled content materials utilized; exterior features regionally quarried stone
- Coal fly ash as replacement for Portland cement

Environmental Quality

- Extensive access to daylight and views for patients and staff
- Low-emitting materials installed throughout building's interior
- Chemical-free termite control: physical barrier method
- Integrated pest management policy

One of the most important features of the project is the gas-fired Combined Cooling, Heat and Power plant, developed with Austin Energy. The plant dramatically increases the efficiency and reduces emissions as compared to conventional grid-based electricity. A 35% energy demand reduction is obtained through the coupling with the ability to utilize the waste heat for thermal energy needs.

A photovoltaic technology did not meet the agreed upon payback guidelines, anyway a roof angled and oriented for future installation is part of the design.

The seven plan-enclosed courtyards function as air-intake locations, resulting in intake air up to 3°C cooler than conventional rooftop intakes. They also increase daylight penetration into the interior.

[Guenther, 2008] *pagg. 100-101, 197, 271, 274, 289-292, 305*

2.5.3 Basel Centre for Spinal Cord and Brain Injuries, Basel

The REHAB Centre is built in the style of the neighbourhood and puts a premium on patient privacy. All beds are on one floor to make it easier for patients in wheelchairs to get around. Here patients learn how to cope with life changes after a severe injury. Patients may stay for as long as eighteen months, therefore the building is organized like a small town.

The main features of the building are:

Building type: New rehabilitation hospital

Size: 22894 sq-m

Program description: 92 bed private inpatient and outpatient spinal cord and brain injury rehabilitation clinic

Completion date: 2002

Figure 2.38 REHAB Basel Centre for Spinal Cord and Brain Injuries [archrecord.construction.com]

The key building performance strategies are:

Site

- Kitchen and ornamental gardens on-site
- Expansive views of countryside and cityscape from rooftop painting workshop and library
- 80 meters wheelchair training course and playing field

Energy

- Ample daylight makes daytime artificial light in patient rooms unnecessary
- Green roof functions as insulation
- User-controlled passive ventilation through large, operable windows and sliding doors

Materials

- Untreated oak, larch, ironwood, and waxed pine used for exterior cladding, brise-soleils, and interior wall and ceiling panelling
- Sealed oak floors

Environmental Quality

- Transparent plastic spherical skylights measuring 2 meters in diameter embedded in patient room ceilings minimize the need for artificial lights during daylight hours

- Patient rooms located around the perimeter of the second story open to wood decks via sliding glass doors
- Five courtyards within the orthogonal plan correspond to various therapy areas, bring daylight to all parts of the building, and contribute to wayfinding with identifiable planting and water features
- Privacy and shade provided by oak brise-soleils wrapping building, supplemented by textile windows shade

This building shows his better features in the conception of a space where untreated materials are mixed with large natural spaces creating a noninstitutional ambiance.
Furthermore, to meet the Swiss energy code's high standards, the building capitalizes on energy savings achieved through passive solar techniques and natural ventilation.
[Guenther, 2008] *pagg. 333-336*

2.5.4 Weitakere Hospital, Auckland

The Waitakere Hospital is located in urban Waitakere City. This structure serves 180000 patient per year. His main characteristic are the attention to day lighting, natural ventilation, patient preferences, water conservation and energy savings.

The building has the following main features:
Building type: Renovation/addition
Size: 14700 sq-m
Design energy intensity: 366 kWh/sq-m/yr
Program description: 120 bed and ambulatory care addition to an existing hospital
Completion date: 2005
Recognition: New Zealand Ministry for the Environment Green Ribbon Award for storm water management system

Site

- Storm water management system uses 450 m of linear swales to collect storm water from surrounding 18 ha

Water

- Dual-flush toilets
- High capacity gutters rainwater, which is stored in six 250m^3 cisterns for toilet and sewage conveyance, reducing roof-generated storm water by 70%

Energy

- Filtration permits partial air circulation in lieu of full fresh air hospital clinical areas, saving heating and cooling energy
- Occupancy-sensor lighting, high efficiency ballasts, and more localized switches for task-specific lighting
- Use of natural ventilation instead of air-conditioning in assessment, treatment, and rehabilitation areas and public spaces
- Operable windows in patient rooms and on corridors
- Added insulation
- Small-scale solar water-heating demonstration installation in the hospital's cultural health area
- High efficiency HVAC features efficient motors and low-pressure loss ducts; central plant variable air volume (VAV) air-conditioning system

An important feature that can distinguish this hospital from others is the storm water management system and the rainwater collection. High capital costs for these plants were initially provided by loans and grants from the Energy Efficiency and Conservation Authority for energy strategies and Infrastructure Auckland for storm water measures.

The estimated annual reduction in annual carbon dioxide emissions is 476 tons, while overall energy consumption was reduced by an estimated 772000 kWh for electricity. The estimated payback time is about four years.

[Guenther, 2008] *pagg. 276-279*

CHAPTER 3 – Proposal of a Healthcare Sustainability Metrics

3.1 Introduction

The health care sector includes a diverse range of healthcare facilities and activities, ranging in size from large general and specialist hospitals to small medical and dental offices and clinics [IFC Environmental guidelines for healthcare facilities, 2003].
A hospital, in the modern sense of the word, is an institution for health care providing patient treatment by specialized staff and equipment, and often, but not always, providing for longer-term patient stays.
Some patients go to a hospital just for diagnosis, treatment, or therapy and then leave (outpatients) without staying overnight; others stay overnight or for several days or weeks or months (inpatients). As previously mentioned, hospitals usually are distinguished from other types of medical facilities by their ability to admit and care for inpatients, whilst the others are often described as clinics: because of this reason, hospitals show a higher complexity, and will be the object of the present work. The best-known type of hospital is the general hospital, which is set up to deal with many kinds of diseases and injuries, and normally has an emergency department to deal with immediate and urgent threats to health. A general hospital typically is the major health care facility in its region, with large numbers of beds for intensive care and long-term care and specialized facilities for different surgical and medical activities: for example, surgery, plastic surgery, childbirth, bioassay laboratories, etc. Some hospitals have their own ambulance service [wikipedia.en]. In the present work, the terms "healthcare facility" and "hospital" will be considered as synonymes, since hospitals represent the most complex type of healthcare facilities and our work will be focused on them.

Healthcare facilities are very complex structures, and many different activities are carried out: surgical activities, diagnostic-clinical activities, internistic activities, laboratory activities. Below we provide some examples for every one of them:

- internistic activities: haematology, endocrinology, neurology, oncology, pneumology, infectivology, gastroenterology;
- laboratory activities: biochemistry, pathological anatomy, neurophysiopathology, nutrition sciences, legal medicine, medical genetics, microbiology;
- surgical activities: heart surgery, neurosurgery, vascular surgery, maxillofacial surgery, thoracic surgery, plastic surgery, radio surgery;
- diagnostic-clinical activities: radiographic exams, CAT (Computerized Axial Tomography) scans, PET (Positron Emission Tomography) scans, echographic exams, blood tests, urine analysis, hair analysis.

Healthcare facilities often include different wards with own surgical units and characteristic processes. However, some functions and services are common for every facility, independently of the precise nature of their departments and the peculiarities of the supplied performances. It is important to underline that patients can be considered the major stakeholders of healthcare facilities, and every process should always be patient-oriented. The most important service functions and aspects which can be considered valid for every medical facility are:

- patient-related aspects;
- materials management service;
- hospital pharmacy;
- sterilization processes and surgical instrument management;
- hospital food service;
- laundry processes and management;
- medical waste management;
- logistic processes;
- building-related aspects;
- energy-related aspects.
- office processes;

As shown in Figure 1, hospital activities interact differently with most service functions listed above. We will consider office processes and patient-, building- and energy-related aspects and their associated sustainability considerations as regarding the healthcare facility as a whole, without examining their specific interactions with every single hospital activity.

In this chapter we will expose a brief description of the service functions and aspects listed above: for every one of them, which offers the possibility of improving sustainability related themes, we will develop a sustainability checklist. The composition of the single checklists will provide a tool for the sustainability performance assessment of a whole healthcare facility, and allow to generate an overall sustainability score. This will allow a benchmarking between different medical facilities, that means it will be possible to compare their sustainability performances, generating a ranking.

Patient-related aspects					
Office processes					
	Internistic activities: I	**Laboratory activities: L**	**Surgical activities: S**	**Diagnostic-clinical activities: N**	**Different wards: D**
Central Sterile Supply Department, surgical instrument management, Surgical Block: S	SI	SL	SS	SN	SD
Laundry processes and management: L	LI	LL	LS	LN	LD
Hospital food service: H	HI	HL	HS	HN	HD
Materials management service: M	MI	ML	MS	MN	MD
Hospital pharmacy: H	HI	HL	HS	HN	HD
Medical waste management: M	MI	ML	MS	MN	MD
Logistic processes: L	LI	LL	LS	LN	LD
Building-related aspects					
Energy-related aspects					

Figure 3.1: The most important, generally valid service functions and aspects of healthcare facilities

3.2 Patient-related aspects

Patients are the most important stakeholders of healthcare facilities, and therefore every aspect of the design and management of hospitals should be focused on them.

It is possible to distinguish between inpatients and outpatients. Outpatients are patients who are not hospitalized for 24 hours or more but who visit a hospital, clinic or associated facility for diagnosis or treatment. Treatment provided in this fashion is called ambulatory care. Inpatients, on the other hand, are admitted to the hospital and stay overnight or for an indeterminate time, usually several days or weeks [wikipedia.en]. Today healthcare facilities can't be considered as circumscribed entities, because the interaction between hospitals and patients is not limited to the only physical administration of healthcare treatments and performances, but thanks to information technology a communication with remote locations is always possible: for example, the booking of medical performances through hospital websites from home or through public outpatient services such as medical booking centres.

Information technology has become not only a simple way to simplify the interactions between hospitals and their patients, but it is nowadays taken for granted and contributes in a large way to the customer satisfaction: the choice of the hospital where a person may have an important surgical operation or receive a simple ambulatory service is taken considering also the completeness of the available information about different hospitals, if possible browsing comfortably their websites from home.

The patient satisfaction is not more dependent only on the quality of the received medical performances, but a lot of other services have become always more important. For example, the accessibility to hospital structures is a critical element for the evaluation of their social sustainability. As written above, the main hospital stakeholders are obviously patients, but it is not possible to ignore also the exigencies of other hospital users, for example the medical staff, other employees and the people who are visiting the patients. Accessibility means the easiness to reach the hospital, the different departments, the ambulatorial services, the patient rooms. To have a satisfying accessibility are needed not only external infrastructures, such as near transportation means stops or dedicated roads to optimize the car flow, but also a well planned internal signage, and if possible an efficient internal transportation system.

Of course, the main percentage of the customer satisfaction depends on the perceived quality of the received medical performances and of the stay in the hospital. This quality is related with different factors, for example the availability for patients of descriptive material about their disease, the presence of a warm environment and good human relationships with the medical staff and the other hospital employees.

Different building characteristics can improve the patient-related sustainability of a hospital, which can be considered social sustainability, for example the presence of parking spaces for different kinds of vehicles, the presence of big green areas and the possibility to have a diffused natural lightning in patient rooms.

A robust service infrastructure in the neighbourhood of the hospital (restaurants, hotels, supermarkets, means of transport, banks, etc.) is also of great importance for its social sustainability.

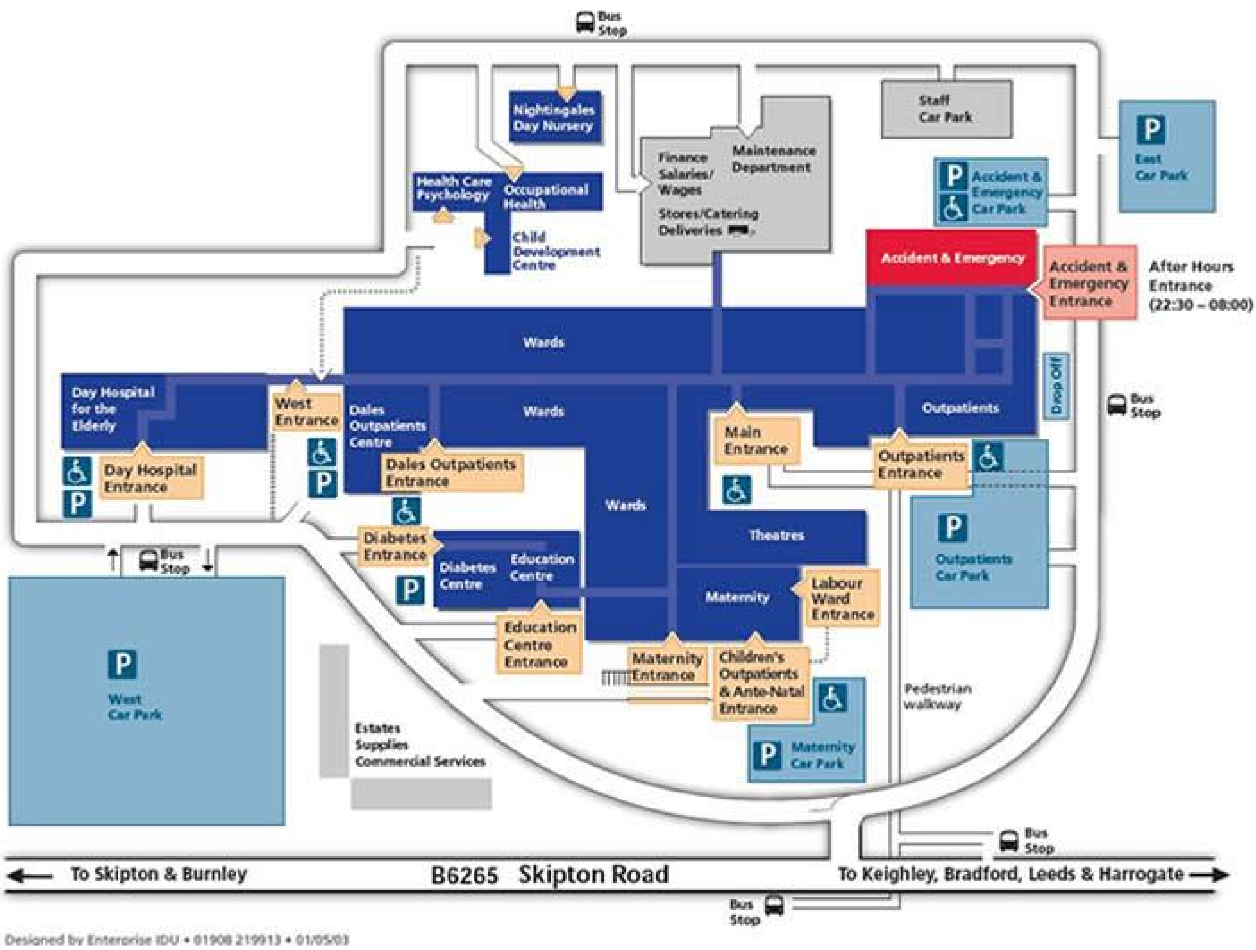

Figure 3.2: Example of hospital map: all access points to the hospital are clearly indicated (Airedale NHS Hospital, England) [airedale-trust.nhs.uk]

3.3 Materials management service

Materials management is concerned with planning, organizing and controlling the flow of materials from their initial purchase through internal operations to the service point through distribution [Selvaraj].

The materials management service manages the programmation and the execution phases of the contracts related to goods and services supply. In particular, it examines the requests of goods and services deriving from the various operative units, emits purchase orders, liquidates the supplier invoices for the effectuated purchases and verifies the respect of the contractual provisions by the service suppliers (cleanings, laundry service, catering service, various transportations, vigilance, waste transportation, etc.). The outsourced services are punctually and constantly controlled, maintaining direct contacts with the referents of the contracting societies and applying specific control parameters.

The service, in addition, manages the warehouse of the medical and non-medical material (receipt of goods, loading and unloading, transportation and distribution of the goods to the requiring operative units and services), the activities of relocations and porterage. The printing service, which provides the printing of the various internal forms and documents requested by the direction office, is under the direct control of the material management service [ulss.tv.it].

Materials managers contribute in many ways to patient safety. They provide clinical staff with uniform systems and products at the appropriate time and place. Materials management also provides staff education before an item arrives on the unit. When evaluating products, safety and clinical efficacy is the first priority, followed closely by price: this ensures the best care is being delivered [ulss.tv.it].

To effectively address patient safety, materials managers must integrate safety into their existing product evaluation and value analysis processes. Clinicians must be involved from the onset to help assess the operational impact of any system and product. All products entering the system should be evaluated for their impact to patient safety.

Another safety issue to consider is new products and stock outs. When evaluating an item with unique properties and practice needs, it is important to consider if patients and/or clinicians will be placed at risk if the product suddenly is not available and an alternative product is introduced. If this is the case, the evaluating committee may want to consider something that is not so irreplaceable.

Materials managers also need to educate theirselves about regulatory issues regarding patient safety. New products are arriving daily, and it is the materials manager's job to make sure that evaluation systems are in place to determine the difference between what is usable and contributes to patient safety and what is unnecessary [Knight 2011].

<u>Further functions of the materials management service:</u>

- the organization and the direct control of activities related to the handling of materials in occasions such as relocations, acquisitions, divestitures and disposal of goods and materials;
- the administrative management and the control of the whole telephone traffic (fixed and mobile telephony) of the personnel and of the hospital units and services of all departments;
- the assistance to hospital units and services for the reparations of small and average size machinery and equipment;
- the collaboration with the direction offices and the warehouse in the drafting of the necessary specifications to formulate competitive tenders for outsourced hospital services;
- the management of the vehicle fleet with the insurance of all internal and external transportation means, not only the sanitary (transports with ambulances, transport of blood or biological samples), but also the administrative ones (post connection, shuttle services, institutional services, etc.);
- the participation to the organization and management of the different events programmed by the healthcare structure;
- the execution of the activities of reception and sending of external post and its internal distribution;
- the continuous updating of the hospital signage

[ospedalebambinogesu.it]

3.4 Hospital pharmacy

The hospital pharmacy's role is to provide, at all times, an adequate supply of safe, effective and good quality drugs in appropriate dosage forms, consistent with the needs of the patients. The hospital shall maintain a pharmaceutical service that conforms with ethical and professional standards and legal requirements [scribd.com].

Pharmacies within hospitals differ considerably from community pharmacies. Some pharmacists in hospital pharmacies may have more complex clinical medication management issues, whereas pharmacists in community pharmacies often have more complex business and customer relations issues.

Because of the complexity of medications including specific indications, effectiveness of treatment regimens, safety of medications (i.e., drug interactions) and patient compliance issues (in the hospital and at home), many pharmacists practicing in hospitals gain more education and training in various disciplines of pharmacy after their pharmacy studies: those pharmacists are often referred to as clinical pharmacists.

Hospital pharmacies can usually be found within the premises of the hospital, and usually stock a large range of medications, including specialized medications. Most hospital medications are unit-dose, or a single dose of medicine [wikipedia.en].

The hospital pharmacist must frequently respond to the need for special dosage forms and formulations not available in the market, for example compounding sterile products for patients like intravenously given medications. This requires an adequate understanding of the principles involved in the preparation of pharmaceutical dosage forms, and involves the concepts of biopharmaceutics, bioavailability/bioequivalence, stability, microbiology and techniques of medication administration. In some instances, as in the case of intravenous admixtures, the pharmacist must be familiar with patient variables such as electrolyte and fluid balance, and other factors such as personal hygiene, environmental control, and equipment performance. Because these complex processes require adequate training of personnel, quality assurance of products and adequate facilities, several hospital pharmacies have decided to outsource high risk preparations and some other compounding functions to specialized companies.

Other important objectives of the pharmacy service are to rationalize drug utilization and procurement in collaboration with the medical staff, to render effective and efficient professional service to in and out-patients of all economic levels, and to utilize resources of the hospital pharmacy in the development and improvement of the profession as a whole. Hospital pharmacists must also conduct and support medical and pharmaceutical researches, maintain the appropriate

information sources and develop mechanisms of evaluating and transmitting information to the institution's professional staff and patients [scribd.com].
The high cost of medications and drug-related technology, combined with the potential impact of medications and pharmacy services on patient-care outcomes and patient safety, make it imperative that hospital pharmacies perform at the highest level possible [wikipedia.en].

Development and provision of patient-oriented services:
Hospital pharmacies are developing a wide spectrum of clinical services, which have become part of the overall pharmaceutical services, although they may not be directly associated with drug dispensing. Fundamental to these clinical services is the pharmacist's knowledge of drugs, diseases, patient and drug variables, and his ability to interact closely on a personal basis with other health professionals and patients. Examples of these services include:

- drug information, which encompasses the collection, organization, retrieval, interpretation and evaluation of the applicable literature in appropriate fashion;
- collection of the pharmacy patient data base;
- patient education;
- monitoring and auditing of therapeutic regimens;
- drug-use review;
- monitoring and reporting of specific adverse drug reactions to decrease their incidence;
- performing other similar functions designed to improve patient care by maximizing drug use. Clinical functions may also extend to the pharmacist's role in primary care, as well as in the management of chronic care patients.

[wikipedia.en]

3.5 Central Sterile Supply Department (CSSD), Surgical instrument management, Surgical Block

One of the most important objectives of hospital structures' modernization is improving quality of care, which is to a high extent related to hygiene conditions. At this level, one of the major challenges is to prevent nosocomial infections.

In general, surgical instruments and medications that enter an already aseptic part of the body (such as the bloodstream, or penetrating the skin) must be sterilized. Sterilization destroys all microorganisms on the surface of an article or in a fluid to prevent disease transmission associated with the use of that item. The use of inadequately sterilized critical items represents a high risk of transmitting pathogens [Rutala, 2008].

The concept of what constitutes "sterile" is measured as a probability of sterility for each item to be sterilized. This probability is commonly referred to as the sterility assurance level (SAL) of the product and is defined as the probability of a single viable microorganism occurring on a product after sterilization. SAL is normally expressed a 10^{-n}. For example, if the probability of a spore surviving were one in one million, the SAL would be 10^{-6}. In short, a SAL is an estimate of lethality of the entire sterilization process [Rutala, 2008].

Sterile supplies or instruments (i.e., sterile devices) are either designed for single use or for re-use. Single use materials are already sterilized when purchased, while reusable devices needed for surgical operations are generally sterilized in centralized sterilization facilities. Examples of such instruments include scalpels, hypodermic needles, artificial pacemakers, biopsy forceps and implanted medical devices. Sterilization is also essential in the manufacture of parenteral pharmaceuticals [wikipedia.en].

The sterilization of RMD (reusable medical devices) is a high-quality process, which ensures that sterilized devices can be safely used during any subsequent surgical case. French legal requirements (e.g. Standard AFNOR FD S98-135, 2005) provide a detailed description of the sterilization processes.

Even though this is a cyclic process, its first step is the use of the sterile device in the operating room. After use, the medical supplies are transported to the sterilization central service where all items (i.e., instruments) are thoroughly cleaned, inspected and assembled if necessary. All items must then be packaged individually or grouped in packages before sterilization. The following step is the packages' sterilization. The last process step is the storage of the sterile RMD for future use. Before surgical case, a nurse will pick up sterile RMD in the storage to fulfill the requirements of the surgical case, transport them to the operating room and unpack them only there. This is the final process step [Reymondon, 2007].

Most medical and surgical devices used in healthcare facilities are made of materials that are heat stable and therefore undergo heat, primarily steam, sterilization. However, since 1950, there has been an increase in medical devices and instruments made of materials (e.g., plastics) that require low-temperature sterilization [Rutala, 2008].

Surgical instruments are usually arranged in kits, and every kit is dedicated to a specific type of surgical intervention. The instruments have to be constantly checked for functionality, they must always belong to the correct kit, they must be technologically updated and always adapted to the evolution of the surgical techniques. On regular deadlines, the composition of the surgical kits should be redesigned with the participation of the surgeons and of the theatre nurses, to identify instruments that are not effective or not coherent with the intervention to which the kit is dedicated, or to integrate the kits with instruments to face potential unexpected complications during the interventions.

To guarantee an effective and effcient management of the surgical instruments, surgical instruments should be accurately traced in all their movements, which are not only from the different operations theatres to the sterilization centre, but in some cases also to external societies which are responsible for their maintenance and repair, for example if surgical scalpels need to be reground. To implement a capillary tracking system for the optimization of the surgical instrument management, the use of technologies such as RFID (Radio Frequency IDentification) can offer remarkable advantages [Tamagno, 2008].

The surgical block represents the core unit of a healthcare facility, since it contains the rooms and equipment needed to perform surgical interventions. It offers various possibilities to implement best practices able to improve various sustainability aspects. A fundamental problem in designing the surgical block is constituted by the paths, which must ensure at the same time functionality, safety and protection from contamination. It is necessary to avoid an overlap between septic and aseptic paths, through a careful assessment of the degree of asepsis that each of them requires.

With the evolution of technology, increasingly sophisticated equipment has been introduced and the operating room has been radically transformed, becoming a complex organism in all of its aspects.

3.6 Hospital food service

Patient meals are an integral part of hospital treatment, and the consumption of a balanced diet is crucial to aid recovery. Even so, it is well established that up to 40% of patients may be undernourished on admittance to hospital; a situation which is not always rectified during their stay. The relevance and importance of patient meal service, when compared to many clinical activities, is not always appreciated and is often seen as an area where budgetary cuts will have the least impact [Hartwell, 2006].

Foodservice operations can be classified into three main styles:

- Integrated foodservice systems: both food production and foodservice are carried out as part of a single operation.
- Food manufacturing systems: production of meals is separate from the service of those meals, thus there is a decoupling of service from production, such as in hospitals.
- Food delivery systems: the operation involves little or no food production and focuses only on the service of continuously assembled or regenerated meals. Here there is decoupling and production lining.

[Edwards, 2004]

Hospital foodservice can present especially complex features and is often considered a very complicated process in the hospitality sector with many interrelated factors. The siting of hospital wards, often at considerable distances from the kitchen, adds an additional logistics burden, and in consequence, a long stream of possible delays between production, service, delivery and consumption. This stretched, continuous and staggered food cycle has potential negative effects on the safety and quality of food [Edwards, 2004].

Access to a safe and healthy variety of food is a fundamental human right. Proper foodservice and nutritional care in hospitals has beneficial effects on the recovery of patients and on their quality of life.

Hospital foodservice does not operate in isolation but requires the cooperation and integration of several disciplines to provide a positive patient experience. The main theme with regard to foodservice management is the fragmentary nature and difficulty of communication between the kitchen and wards: foodservice managers have to rely on kitchen porters for the delivery of food to the ward; ward staff has to communicate with foodservice staff; dietitians/doctors must provide nurses with communications about any concern regarding patients. The post of hospital foodservice manager is essential to oversee the whole meal process from kitchen to consumption. Rapid turnover of patients also prioritises clinical considerations [Edwards, 2004]. The provision of a foodservice system that optimises patient food and nutrient intake together with minimising waste, in the most cost effective manner, is therefore seen as essential to improve the overall sustainability of the system.

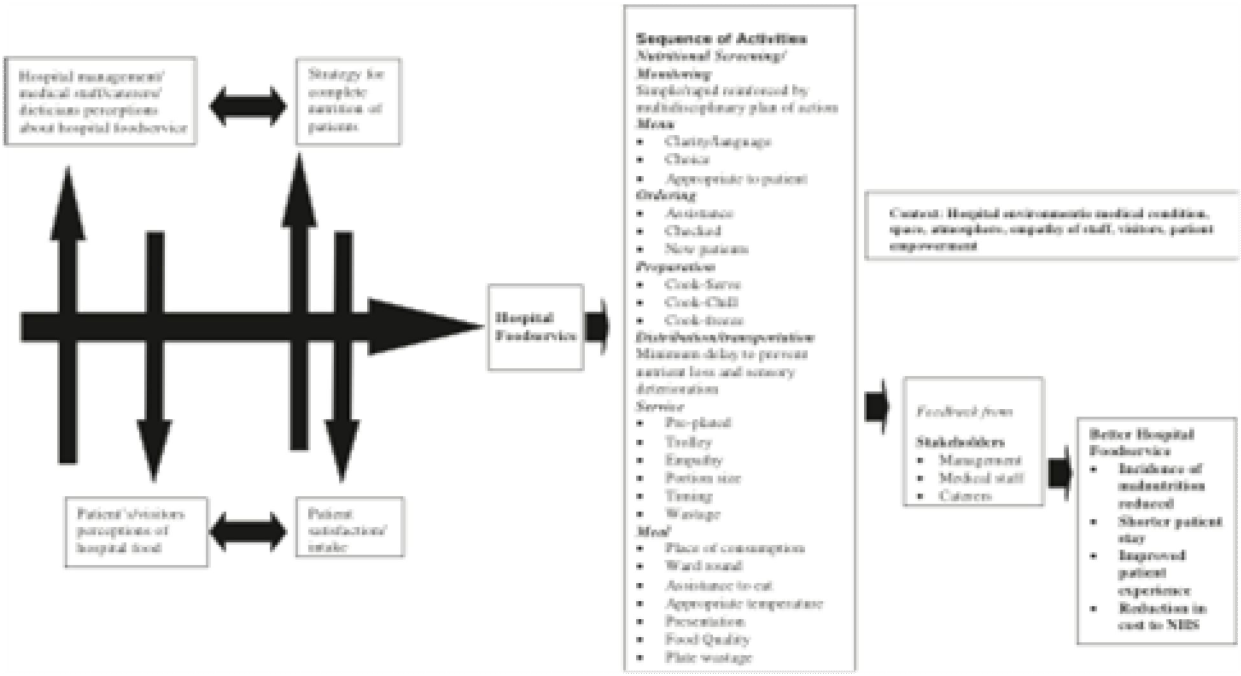

Figure 3.3: Conceptual model of hospital foodservice [onlinelibrary.wiley.com]

3.7 Laundry processes and management

The spread of microorganisms constitutes a big problem in the hospital/healthcare sector. Used linen is a major potential source of infection, it is likely to be contaminated and it may contain sufficient moisture to allow microbes present to continue to multiply in the warm hospital environment [South Tees Hospitals Infection Control Team, 2007].

The laundry is one of the intervening factors in the fight to eliminate any source of microbiological contamination and the risk of recontamination to the patients [Girbau].

Laundry service is responsible for providing an adequate, clean and constant supply of linen to all users. Hospital laundry management has become a fundamental point in any attendance centre. It is not only a matter of having the necessary linen available for both the patients and the professionals in the centre, but also that all the linen from a sanitary centre has to be considered to be contaminated by germs and must be treated in such a way that at the end of the cycle it can be supplied to the users and nurses free of any infectious pathogenic agent.

The term "hospital linen" includes all textiles used in the hospital including mattresses, pillow covers, blankets, bed sheets, towels, screens, curtains, doctors coats, theatre cloths and table cloths. Cotton is the most preferred and frequently used material. The hospital receives all these materials from different areas like operation theatre, wards, outpatient departments and office areas. The operation theatre linen materials need special care since it has to be washed & sterilized carefully.

The main purpose of the laundry department is to provide clean material to the patients and ensure that hygienic conditions are maintained in the process. A reliable laundry service is of utmost importance to the hospital: in today’s medical care facilities, patients expect linen to be changed daily [Krishna Veni, 2004].

Transference of microorganisms in laundry is primarily through contact, and all stages of linen management must be considered including storage, handling, bagging, transportation and laundering. Incorrect handling, laundering and storage of clean and used or dirty linen can pose as an infection hazard, therefore it is essential that all linen and laundry is adequately washed, dried and stored correctly in order to prevent and control the spread of infection.

[Community Health Oxfordshire Clinical Quality and Governance Group, 2010].

The responsibility of the laundry department not only involves managing the technical operations, but also making other decisions. This includes the determination of the type of linen to be purchased, the quantity necessary to be kept in stock and the establishment of quotas for various places where they are used. The functions of the laundry services are, among others:

- collecting soiled linen from various places;

- sorting the linen;
- inspecting and repairing or replacing damaged materials;
- distributing clean linen to the respective user departments;
- maintaining different types of registers.

Handling of linen in the ward:

All used linen should be enclosed as soon as possible in bags which are impermeable to microbes, and be handled with minimum disturbance to avoid dispersal of organisms. Once enclosed in a suitable bag, it can be safely transported within the hospital. How linen is managed, handled and processed to minimise bacterial contamination is very important to the successful treatment of the patient.

Used linen should not be carried across the department increasing the risk of dissemination of bacteria into the air, onto the floor, staff uniforms and bodies, or placed onto the floor or bedside table. To reduce the risk of cross-infection a linen skip must be taken to the patient’s bedside and the used linen carefully removed to avoid unnecessary agitation and directly placed into the appropriate bag. Clean and dirty laundry should be transported in vehicles used exclusively for this purpose. The interior of vehicles after transporting dirty linen will require cleaning with detergent and water. Trolleys for clean linen in transit should be covered with a washable or disposable cover [South Tees Hospitals Infection Control Team, 2007].

3.8 Medical waste management

Medical waste, or hospital waste, or healthcare waste, are all the types of wastes produced by hospitals, clinics, doctor offices, and other medical and research facilities [Congress of the United States, 1988].

It is possible to distinguish between two macro categories of medical waste:

- most of it (75-90%) is similar to domestic waste: this fraction, referred to as healthcare general waste, is made of paper, plastic packaging, food preparations, etc. that haven't been in contact with patients;
- a smaller proportion (10-25%) is infectious/hazardous waste that requires special treatment. This fraction, referred to as healthcare risk waste, poses risks both to human health and the environment [healthcarewaste.org].

In hospitals, different kinds of therapeutic procedures (i.e. cobalt therapy, chemotherapy, dialysis, surgery, delivery, resection of gangrenous organs, autopsy, biopsy, paraclinical tests, injections etc.) are carried out and result in the production of infectious wastes, sharp objects, radioactive wastes and chemical materials. Medical hazardous waste may carry germs of different diseases; it may contain highly toxic metals, toxic chemicals, pathogenic viruses and bacteria, which can lead to pathological dysfunctions of the human body. It presents a high risk to doctors, nurses, technicians, sweepers, hospital visitors, patients and the personnel who handle it, and poses a threat to public health and environment [Rao, 2004].

The safe disposal and subsequent destruction of medical waste is a key step in the reduction of illness or injury through contact with this potentially hazardous material, and in the prevention of environmental contamination [Hassan, 2008].

The proper management of health-care waste depends largely on good administration and organization as well as active participation by trained and informed staff [healthcarewaste.org].

The management of waste must be consistent from the point of generation to the point of final disposal. The path between these two points can be segmented schematically into the following steps.

- Step 1: waste minimization

  This first step comes prior to the production of waste and aims at reducing as much as possible the amount of healthcare waste that will be produced by setting up an efficient purchasing policy and having a good stock management, for example.
- Step 2: segregation and containerization

  The correct segregation of waste at the point of generation relies on a clear identification of the different categories of waste and the separate disposal of the waste in accordance with the categorization chosen.

- Step 3: intermediate storage (in the healthcare facility)

  In order to avoid both the accumulation and decomposition of the waste, it must be collected on a regular daily basis. This area, where the larger containers are kept before removal to the central storage area, should both be close to the wards and not accessible to unauthorized people such as patients and visitors.

- Step 4: internal transport (in the healthcare facility)

  Transport to the central storage area is usually performed using a wheelie bin or trolley. Wheelie bins or trolleys should be easy to load and unload, have no sharp edges that could damage waste bags or containers and be easy to clean. Ideally, they should be marked with the corresponding coding color.

- Step 5: centralized storage (in the healthcare facility)

  The central storage area should be sized according to the volume of waste generated as well as the frequency of collection. The facility should not be situated near to food stores or food preparation areas and its access should always be limited to authorized personnel. It should also be easy to clean, have good lighting and ventilation, and be designed to prevent rodents, insects or birds from entering.

- Step 6: external transport

  External transport should be done using dedicated vehicles. They shall be free of sharp edges, easy to load and unload by hand, easy to clean and disinfect, and fully enclosed to prevent any spillage in the hospital premises or on the road during transportation.

  The transportation should always be properly documented and all vehicles should carry a consignment note from the point of collection to the treatment facility.

- Step 7: treatment and final disposal

  Infectious waste can be subject to different treatment options.

[healthcarewaste.org]

3.9 Logistic processes

The main task of all hospitals is the improvement of the patient's state of health. The provision of the medical treatment and patient care - core processes of the hospital create demand for patient-related support services. These secondary processes can be of medical or non-medical nature. Additional services summarized in tertiary processes are not directly linked to patients, but are necessary for proper operation of the healthcare facility. Hospital logistics is coordinated cross-departmental with the flow of goods and information as well as a part of patient care. Examples of logistics tasks can be found in secondary and tertiary processes:

- patient-related medical secondary processes: patient logistics, drug management, laboratory logistics, management of medical goods, logistics of sterile goods, information and documents, disposal of hazardous waste;
- patient-related non-medical secondary processes: food management, management of linens, management of beds;
- patient remote tertiary processes: management of administration demands, mail service, disposal of non-hazardous waste.

Logistics accounts for a sizeable portion of a hospital's operating budget: studies have shown that from 30% to 46% of hospital expenses are invested in various logistical activities [Etienne, 2003].

In hospitals, logistics cover not just support services such as purchasing, stores and the pharmacy, but also health care services such as patient care units and operating rooms. Logistics is a complex process. The people involved vary with the type of products in question: for example, stores manage medical and office supplies; the pharmacy looks after pharmaceutical products; food services manages the procurement and processing of food products.

Many activities that could be carried out by support personnel are often performed by health care personnel. The result is that the internal supply chain within a hospital is often highly fragmented.

Two major management methods are applied by hospitals:

- Certain products, called inventory products, are managed and stored in the hospital's stores (or pharmacy) before being distributed to specific departments.
- Other items, called non-inventory or direct purchase products, are ordered directly by specific departments from the purchasing department, which oversees the purchases as needed and delivers them upon receipt to the departments. The latter are generally not stored in the institution's stores.

Pharmaceutical products, meanwhile, are divided under two main headings: general products and prescription drugs. The inventory and non-inventory distinction doesn't apply to pharmaceuticals

because all requisitions must go through the pharmacy.
[Etienne, 2003]

Automated logistic processes:

In healthcare facilities it is possible to identify two main automated logistic processes: automated material transport and automated drug management.

In many processes of hospital logistics, material transport plays a decisive role. According to requirements, hospital material transport is either scheduled (planned) or on-demand (un-scheduled). Compared to industrial applications, the quality of material transport in healthcare facilities must be the highest: wrong or inaccurate deliveries could have fatal implications for patients, hospital employees and visitors. Examples of automated logistic processes are:

- pneumatic tube systems;
- track vehicle systems;
- automated guided vehicles (AGV) systems.

[swisslog.com]

Another important logistic process is the automated drug management. Drug management in hospitals is typically a manual process: the preparation of the individual patient's daily medication is managed by nurses on the wards. Therefore, hospitals operate many drug storages in several departments. In addition, the preparation processes in the hospital pharmacy are characterized by manual handling. An example of automated drug management is the use of a pharmacy robot for automated storage and medication dispensing of bar-coded unit doses. Automated drug management in the hospital pharmacy (pharmacy automation) and on hospital wards supports and increases patient safety [swisslog.com].

3.10 Building-related aspects

Sustainable building or green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's lifecycle: from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort [epa.gov].
The green building originated from the need and desire for more energy efficient and environmentally friendly construction practices [wikipedia.en].
Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by:

- efficiently using energy, water, and other resources;
- protecting occupant health and improving employee productivity;
- reducing waste, pollution and environmental degradation.

For example, green buildings may incorporate sustainable materials in their construction (reused, recycled-content, or made from renewable resources); create healthy indoor environments with minimal pollutants (e.g. reduced product emissions); and/or feature landscaping that reduces water usage (e.g. by using native plants that survive without extra watering).
Green building brings together a vast array of practices and techniques to reduce and ultimately eliminate the impacts of new buildings on the environment and human health. It often emphasizes taking advantage of renewable resources, e.g., using sunlight through passive solar, active solar, and photovoltaic techniques and using plants and trees through green roofs, rain gardens, and for reduction of rainwater run-off [wikipedia.en].
In a healthcare organization, sustainable building can contribute to creating a healing and healthy environment. This extends beyond the medical care provided to the physical environment in which a patient is treated. Implementing green building strategies in health care facilities, such as using non-toxic building products during construction and operation of the facility and incorporating healing features into the design of the facility, is an intuitive step in creating an optimal patient care environment [cms.h2e-online.org].
Healthcare facilities have unique programming criteria that guide design decisions and material, product and equipment specifications. Understanding the complex of human health implications of these decisions is critical. For example, the Academy of Architecture and Health cites a research indicating that natural lighting, indoor landscaping, rooftop gardens, solariums, and small atria have a health impact on hospital staff and can improve the feeling of well being and medical outcomes in

patients. They recommend maximizing views of nature and landscaping from all patient environments, and increasing the use of skylights, interior transom windows, and natural light [cmpbs.org].

In addition, healthcare facilities undergo a high rate of change, as interior spaces are reconfigured, remodeled and outfitted with new furnishings and equipment reflecting changes in management and delivery systems. The result is an enormous amount of waste.

While the practices, or technologies, employed in green building are constantly evolving, there are fundamental principles that persist from which the method is derived:

- Siting and Structure Design Efficiency
- Energy Efficiency
- Water Efficiency
- Materials Efficiency
- Indoor Environmental Quality Enhancement
- Operations and Maintenance Optimization
- Waste and Toxics Reduction

The essence of green building is an optimization of one or more of these principles. Also, with the proper synergistic design, individual green building technologies may work together to produce a greater cumulative effect [scottsdaleaz.gov].

On the aesthetic side of sustainable architecture and design, there is the philosophy of designing a building that is in harmony with the natural features and resources surrounding the site [wikipedia.en].

3.11 Energy-related aspects

Health care buildings account for 11 percent of all commercial energy consumption [eia.doe.gov]. As utility buildings are meant, for example: offices, shops, hotels, restaurants, educational establishments and care institutions.

In order to analyse the energy consumption of a hospital in greater detail it is necessary to identify the larger energy consumers within the hospital. The great majority of the energy used within a hospital is purchased from outside in the form of natural gas and electricity. A small proportion is bought in as diesel oil. The energy bought in is converted by a number of conversion systems into the most important internal flows of energy, namely heat, cold, electricity and compressed air. These energy flows are used for among others the following applications:

- Heat is used in the form of steam and in the form of hot water. Steam is used for example for the kitchens, humidification in HVAC (Heat, Ventilation and Air Conditioning) systems and sterilisation. In addition steam is used to transport heat over longer distances. Hot water is used in the form of central heating and tap water. In many cases heat is transported from the heat generating station in the form of steam and then converted locally into central heating or hot tap water. Gas-fired boilers or cogeneration systems generate the heat.
- Electricity is used for a wide variety of purposes. The largest electricity consumers in a hospital are lighting, cooling machines, air compressors, circulation pumps, HVAC fans, medical equipment and office equipment.
- Compressed air can be divided into two main categories, namely medical and technical air. Medical compressed air refers to direct treatment and care of patients. Examples include breathing apparatus and surgical tools driven by compressed air. Medical compressed air is subject to very high standards for availability and quality. Other compressed air that is not directly related to patients falls under the heading of technical compressed air. Examples include HVAC control systems, workshop applications or keeping containers under pressure.
- Cold mainly takes the form of ice water and is used for the great majority in climate control systems, for cooling and drying the ventilation air.

The healthcare sector is one in which a lot of information is generally available concerning energy consumption. This offers many opportunities for energy benchmarking, i.e. comparing the energy consumption of different hospitals. The parameter used for comparison in benchmarking is very important. The two techniques most commonly used for benchmarking are the energy consumption per square meter or per bed. With regard to these techniques it is important to bear in mind that they are based on technical characteristics of the building. One difficulty that stands in the way of benchmarking is the degree of outsourcing in the hospital: some hospitals contract out e.g. their catering or laundry activities, which of course leads to a lower energy consumption by the hospital itself [scribd.com].

Sustainable energy is the provision of energy such that it meets the needs of the present without compromising the ability of future generations to meet their needs. Energy efficiency and renewable energy are said to be the *twin pillars* of sustainable energy [Prindle, 2007].

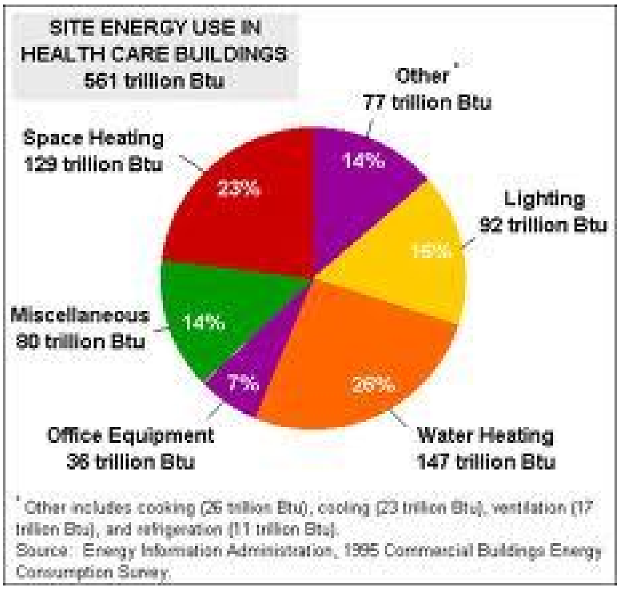

Figure 3.4: Energy consumption of U. S. healthcare facilities in 1995, expressed in BTU (British Thermal Units), and its percentage distribution between its different uses [eia.doe.gov]

3.12 Office processes

Office processes offer a big opportunity to improve the sustainability of a hospital, even though their dimensions are small compared to the different hospital departments: the presence of many workstations with monitors and printers, and the use of big quantities of paper influence heavily the environmental sustainability of a healthcare facility. In addition, the nature of the carried out activities requires a very careful planning of the workstations, which must guarantee optimal working conditions to all users.

One of the most used resources for office processes are technological devices, for example computers. In particular, monitors are very critical components because of their energy consumption: for example, while beeing in standby they continue consuming electric power. This peculiarity concerns also other hardware devices.

Another important aspect of office processes is the ergonomics of the workstations. The International Ergonomics Association defines ergonomics as follows:

"*Ergonomics is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.*" [iea.cc].

Proper ergonomic design is necessary to prevent repetitive strain injuries, which can develop over time and can lead to long term disability [Lawrence Berkeley National Laboratory, 2009].

Many elements have to be evaluated:

- equipment: monitors, keyboards, tables and chairs;
- environment: space, light, noise, heat, humidity;
- computer-worker interface: used software, available information.

Another typical area where it is possible to operate to improve sustainability is stationery material, such as ballpoint pens, highlighters, binders, staplers, and many others. Many "green" products are available, and their use is desirable to improve environmental sustainability.

Also the use of toner for printers offers an occasion to make considerations about environmental sustainability. Toner is a very thin dust containing carbon, iron oxydes and resin, and it is used in laser printers and photocopiers. During printing or copying processes volatile organic compounds, particulate, ozone and formaldehyde are released to the environment [epa.gov]. When toner cartridges are exhausted, it is very important to follow the regulations about how to collect them and how to successively dispose them to ecologic platforms, or entrust specialized companies the task of their collection and disposal.

Other important polluting products, which are intensively used in office devices, are batteries. Batteries contain heavy metals such as nickel, lead, mercury and cadmium, which can damage the environment and human health and don't become harmless when the batteries run down. Because of the small dimensions of batteries, they are often disposed together with generic waste, generating a heavy environmental damage. It is important to adequately collect exhausted batteries in appropriate holders and to use rechargeable batteries.

While unrechargeable batteries are unsustainable because of an intrinsic toxic content, other products are unsustainable because of the nature of their source: for example, paper. Even though the use of integrated information systems is becoming nowadays always more important, offices continue using paper to carry out their basic activities: a recent analysis about the information flows, involving 13 countries, has discovered that about 90% of European employees has the perception that a lot of internal printings could be avoided [100ambiente.it]. It is necessary to promote a continuous digitalization of information, and if paper is absolutely needed, it is important to obtain it with respect of the environment, for example it should be recycled or produced through controlled cultivations.

Office processes show another important peculiarity: the generation of lots of waste. To improve environmental sustainability, a separate collection of all different kinds of waste must be carried out. A special area with different waste containers is very useful, and an accurate signage should favour the correct use of the containers.

Under the point of view of social sustainability, offices could show a potential problem: crowding. This matter has to be taken seriously into account to guarantee a good air quality and an adequate working place for all employees. ASHRAE for example (American Society of Heating, Refrigerating and Air-Conditioning Engineers), an association which gathers more than 50000 engineers in North America, has tried to define the highest potential number of employees in a given area, to guarantee a correct air flow [ashrae.org].

CHAPTER 4 – Healthcare Sustainability Metrics Modules

In this chapter we will report a detailed description of the indicators that we developed for the evaluation model.
The indicators were found out after a deep research in the state of the art and main features of healthcare facilities, hospital, pharmacies. The investigation was conducted also comparing the features of companies whose business is not specifically healthcare, but presents many points of contact (Laundries, Canteens, Software developers, Building societies, Educational associations).
This comparison allowed us to provide an evaluation model which involves different levels of sustainability and favours a integrated view of the hospital management.

The Chapter is divided into eleven paragraphs corresponding to a module. In every paragraph the main areas of interest of the module are presented and every indicator is underlined. Some indicators presents sub-indicators. At the end of the explanation the evaluation criteria is displayed. Sometimes the evaluation criteria is grouped for a set of indicators which present a common criteria (typically Yes/No).

At the end of this work we annexed the “Attachment 1”, which contains a general prospect of the evaluation model with all the indicators listed and shortly described.

4.1 Patient-related aspects

As already mentioned, patients can be considered the major stakeholders of healthcare facilities. They not only receive strictly medical care, but also interact in different ways with the various healthcare functions and services. For example, they can book medical visits from home or from remote locations, they receive a constant treatment by the hospital food service, their comfort depends on various logistic services and their satisfaction is also related with the quality of the human relations with the very heterogeneous personnel they come in contact with.

The patient-related aspects involve social, economic and environmental sustainability of healthcare facilities: as we have explained in the first chapters of the present work, the three dimensions of sustainability are always interconnected.

We have identified the following 5 main sections, which constitute together our module about patient-related aspects:

1. List of services
2. Central Booking Center (CBC)
3. Customer satisfaction
4. Internet website
5. Hospital accessibility

Each one of the areas listed above has been developed in an appropriate set of sustainability indicators.

4.1.1 List of services

The list of services can be usually found in paper format at hospitals receptions, and it contains a complete description of the services provided by a healthcare facility, as well as all the useful information for a potential patient and for the visitors. To verify what is the most important information expected about a healthcare facility, we have decided to examine the lists of services of 10 Italian facilities, from different regions:

Lombardia, Milano, Ospedale Niguarda [ospedaleniguarda.it]
Liguria, Genova, Azienda Ospedaliera Villa Scassi [villascassi.it]
Toscana, Siena, Azienda Ospedaliera Universitaria Senese [ao-siena.toscana.it]
Emilia Romagna, Reggio Emilia, Arcispedale S. Maria Nuova [asmn.re.it]
Lazio, Roma, Azienda Ospedaliera Sant'Andrea [ospedalesantandrea.it]
Sicilia, Agrigento, Azienda Ospedaliera S.Giovanni di Dio [agrigento-hospital.it]
Friuli Venezia Giulia, Pordenone, Azienda Ospedaliera Santa Maria degli Angeli [aopn.sanita.fvg.it]
Basilicata, Potenza, Ospedale San Carlo [62.110.218.6]

Puglia, Foggia, Azienda Ospedaliero-Universitaria Ospedali Riuniti [ospedaliriunitifoggia.it]	
Piemonte, Alessandria, Azienda Ospedaliera Santi Antonio e Biagio e Cesare Arrigo [ospedale.al.it]	

Table 4.1: List of the considered facilities

This small survey has underlined that a sufficiently complete list of services must include the following information, expressed as the indicators listed below:

1.1 Number of hospital beds

In some lists of services only one single aggregate number of all available beds is indicated, whereas in other cases this number is specified for each hospital ward. This second case is more useful, because it offers an idea about the dimensions of the wards, and therefore about the most developed strenght points and specialities of that facility.

Indicator evaluation:

- Number of beds specified for each ward (1 point),
- Number of beds as an aggregate value for the whole facility (0.5 points)
- Number of beds omitted (0 points)

1.2 Information about the medical performances

The most immediate comparison between healthcare facilities can be effectuated evaluating the available information about ambulatory and inpatient performances. Therefore, this information should always be included, and it is contained in the following two sub-indicators:

1.2.1 Ambulatory performances

1.2.2 Inpatient performances

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

1.3 General facility plan

A facility plan provides a first immediate overview of the structure, useful to help getting acquainted with it. The most useful indications which should not be missing are:

1.3.1 Location of the main access ways

1.3.2 Location of the main hospital blocks, the single wards and ambulatories

1.3.3 Location of the reception desks

1.3.4 Location of the rest areas

1.3.5 Location of the toilets

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

1.4 Indication of the visiting times for every single ward

Usually, the visiting times vary with the different wards.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

1.5 Information about how to reach the facility

The richness of possible solutions to reach a healthcare facility can contribute to its choice by a potential patient. The process of healing can be positively influenced by the human support the patient can rely on: a facility which can be easily reached offers to patient's acquaintances, relatives and friends the opportunity of more frequent visits, thus improving the social sustainability for patients as well as for visitors. An accurate list of services should include information about the possibility to reach the facility:

1.5.1 By car

1.5.2 By railway

1.5.3 By airplane

1.5.4 By means of public transport

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

1.6 Information about the presence of internal means of transport

Internal means of transport contribute to improving the social sustainabilty of a healthcare facility, and a complete list of services should also include information about their presence. The most diffused means are:

1.6.1 Internal shuttle service

It is used especially in large facilities, where the hospital blocks are distributed on a wide area, to simplify the movements of the visitors and the facility personnel.

1.6.2 Escalators

They are very important for helping patients, especially in debilitated conditions, reach the different facility floors.

1.6.3 Elevators

They perform the same function as the escalators, but in addition they allow the transportation of hospital beds, hospital trolleys and other materials.

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

4.1.2 Central Booking Center (CBC)

The Central Booking Center (CBC) is an administrative office in the healthcare sector, usually located at the reception of hospitals or clinics, where it is possible to book physical examinations or medical performances and pay them. It has many peripheral totem counters, located for example in pharmacies or in very frequented places such as shopping centres, to allow the booking and the payment of services from remote locations. The Central Booking Centers of many different healthcare facilities and their associated peripheral totem counters constitute a network. A software manages the functionality of all totem counters and Central Booking Centers in a specific geographical area, and schedules the bookings in the different healthcare facilites: in reference to the desired medical performance, the first available place is assigned to the nearest healthcare facility or to the preferred one. Usually, call centers are available to improve the ease of booking medical performances, and it is possible to be comfortably guided from home in the booking process of the desired care services, by an operator.

Some Central Booking Centers have activated also a web booking service, thus making always more unnecessary one's physical presence at the facility for the desired bookings [wikipedia.it].

Obviously, not every healthcare facility's CBC is part of a geographical network which connects many CBCs, but the most facilities only have a Central Booking Center located at their physical receptions, and maybe offer in addition online booking services.

We conducted a small survey about the CBC services offered by the following twenty Italian healthcare facilities, to identify what can be the offered services:

Milano, Ospedale Niguarda [ospedaleniguarda.it]
Genova, Azienda Ospedaliera Villa Scassi [villascassi.it]
Siena, Azienda Ospedaliera Universitaria Senese [ao-siena.toscana.it]

Reggio Emilia, Arcispedale S. Maria Nuova [asmn.re.it]
Roma, Azienda Ospedaliera Sant'Andrea [ospedalesantandrea.it]
Agrigento, Azienda Ospedaliera S.Giovanni di Dio [agrigento-hospital.it]
Pordenone, Azienda Ospedaliera Santa Maria degli Angeli [aopn.sanita.fvg.it]
Potenza, Ospedale San Carlo [62.110.218.6]
Foggia, Azienda Ospedaliero-Universitaria Ospedali Riuniti [ospedaliriunitifoggia.it]
Alessandria, Azienda Ospedaliera Santi Antonio e Biagio e Cesare Arrigo [ospedale.al.it]
Bergamo, Ospedali Riuniti di Bergamo [ospedaliriuniti.bergamo.it]
Genova, Azienda Ospedaliera Universitaria S. Martino [hsanmartino.it]
Firenze, Azienda Ospedaliera Meyer [meyer.it]
Ferrara, Azienda Ospedaliero-Universitaria Arcispedale S. Anna [ospfe.it]
Roma, Azienda Ospedaliera San Camillo - Forlanini [scamilloforlanini.rm.it]
Siracusa, Azienda Ospedaliera Umberto I [ospedaleumbertoprimo.it]
Trieste, Ospedali Riuniti di Trieste [aots.sanita.fvg.it]
Cagliari, Azienda Ospedaliera G. Brotzu [aobrotzu.it]
Ancona, Azienda Ospedaliero-Universitaria Ospedali Riuniti Umberto I, G.M. Lancisi, G. Salesi [ao-salesi.marche.it]
Torino, Azienda Ospedaliera Molinette-S. Giovanni Battista [molinette.piemonte.it]

Table 4.2: List of the considered facilities

We have identified the following indicators:

2.1 Booking modalities offered

A wide range of booking modalities strongly contributes to the social sustainability of the considered healthcare facility, because it simplifies the interaction with it improving its accessibility to the public. Since the possibility of booking at hospital receptions is obviously taken for granted, we have identified the following sub-indicators:

2.1.1 Call center booking

It is the most effective booking modality, because it allows the real-time interaction with an operator, and the possibility of knowing immediately when the booked service will be performed.

2.1.2 E-mail booking

This very comfortable way of booking shows the inconvenience of a non real-time interaction with the operators.

2.1.3 Online booking, through pre-filled forms

It is similar to the e-mail booking, but since the released data are already organized in an orderly way, the management of the form requests by the operators is facilitated, thus increasing the probability of a quick reply.

2.1.4 Totem counters booking

Totem counters represent a very interesting way of booking medical performances, since it is possible to obtain a complete list of the hospitals able to perform the desired services, and to know the available dates for each facility.

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

2.2 Central Booking Center opening on Saturdays

Often it is desirable to book the needed care services at the hospital receptions, to have a first look at the facility where maybe one is planning to receive a surgical intervention. Because it can be difficult for a potential patient to visit a desired facility during the working week, reception openings on Saturdays are very important to improve the social sustainability of a certain hospital or clinic. Between the 20 examined facilities listed in table 4.2, only 5 receptions open on Saturdays.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

4.1.3 Customer satisfaction

Customer satisfaction, a business term, is a measure of how products and services supplied by a company meet or surpass customer expectations [wikipedia.en].

We have considered customer satisfaction as the patients' satisfaction, since patients can be undoubtedly considered the major stakeholders of healthcare facilities, and therefore it is of utmost importance to meet optimally all their needs. Patients' satisfaction depends on the quality not only of the received medical care, but also of lots of other factors that contribute to make the patient's permanence in the hospital as comfortable as possible, or at least easy to tolerate. Very important factors are for example the possibility of patients to be entertained with activities able to distract them from the thought of their hospitalization.

We have identified 7 indicators that we consider fundamental for the customer satisfaction:

3.1 Presence of dedicated elevators depending on the type of users

The present indicator, which refers to an aspect of social sustainability, contributes to the customer satisfaction not only of patients, but also of the complete healthcare and non-healthcare personnel.

Non-healthcare personnel are all the employees whose activities are not strictly related with the patients' care, such as for example the cleaning service and the material transport service. Dedicated elevators improve the overall efficiency of the internal services, avoiding reciprocal interferences. The indicator evaluates if there are dedicated elevators for the following categories:

- patients;
- healthcare personnel;
- material transport service;
- cleaning service.

Indicator evaluation:

- Dedicated elevators for all categories (1 point)
- Dedicated elevators for 2 or 3 of the listed categories (0.5 points)
- General purpose elevators (0 points)

3.2 Humanization of healthcare environments

This indicator refers to a practice which improves strongly the social sustainability of the facility, since healthcare environments are often considered as cold and unwelcoming. The colour not only helps identifying objects, but is also an effective mean of communication. For this reason, healthcare facilities' environments should be painted in such a way that they are perceived as comfortable and welcoming, and the patients and the personnel should feel at ease in them. The colour and the light distract the patients from the pain and from themselves. Jorrit Tornquist, professor of Industrial Design at the Polytechnic University of Milan, has elaborated a new chromatic project for the Niguarda Hospital, using different colours for the different hospital environments [nuovoniguarda.ospedaleniguarda.it]. In particular, he has proposed the following best practices, that we consider as important social sustainability indicators:

3.2.1 Painting of the patient rooms with colours able to arouse feelings of good mood and well-being

3.2.2 Painting of the surgical block environments and of the operating rooms whit colours which minimize the negative afterimage of blood

3.2.3 Painting of the dressing rooms with colours which minimize the patients' sense of discomfort and estraneity

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

3.3 Presence of green elements with a height of at least 40 cm

The installation of internal green elements, such as plants in pots, guarantees to the patients a lower level of psychological discomfort [Gilhooley, 2002]. In addition, the air recycling function performed by green plants through the chlorophyllian photosynthesis is well known. Through the chlorophyl, the solar energy (light) transforms CO_2 and water in a specific type of sugar, glucose, fundamental for the plant's life, which chemical formula is: $C_6H_{12}O_6$. As a by-product of the reaction, 6 molecules of 0_2 are built and emitted to the atmosphere.

The indicator will assign a positive scoring if medium size plants are present in patients' rooms: by medium size we mean plants with a height of at least 40 cm.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

3.4 Possibility for the patients of filling a questionnaire of customer satisfaction

To improve their provided services and performances, healthcare facilities should pay attention to patients' feedbacks, and gather them in a possibly accurate and complete way: therefore, a questionnaire of customer satisfaction is indispensable.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

3.5 Customer satisfaction questionnaire considered aspects

The present indicator contains a list of the aspects which we consider the most crucial for the evaluation of the patients' satisfaction. For every sub-indicator listed below, the scoring is 1 if it is included in the questionnaire, otherwise 0.

3.5.1 Facility accessibility

This sub-indicator should be detailed including for example an evaluation about the easiness/difficulty of booking medical visits, of using parking spaces, of orienting oneself through the internal and external signage, etc.

3.5.2 Waiting times for the supply of the various services

Examples of what this sub-indicator should include are the queue at the counters, the waiting lists, the waiting times to pick up medical examinations.

3.5.3 Perceived comfort of the patients' permanence in the facility

The adequacy of the environments, the perceived quality of the cleaning services, the pleasantness of the meals should be considered.

3.5.4 Quality of the human relationships between the patient and the medical, nursing and technical personnel

The patient should be asked about the perceived quality of the received information, of the overall hospital organization, of the professionalism of the personnel, etc.

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

3.6 Patient entertainment

Patients' permanence in a healthcare facility represents an emotionally and physically difficult experience, therefore some initiatives should be undertaken to lighten it. We have identified 3 simple sub-indicators which contribute to this request:

3.6.1 Collective entertainment initiatives

This sub-indicator should include for example the organization of small theatrical performances, the screening of movies, the participation to small group activities.

3.6.2 Presence of monitors or multimedia systems for a one-to-one interaction with the patient

Examples of such systems are patient bedside entertainment systems, such as the ones of MEDIVista, a company which produces information and entertainment systems.

Figure 4.1: MEDIVista patient entertainment system [slipperybrick.com]

3.6.3 Possibility of an internet access

The internet access can be provided through the same type of systems illustrated in the picture above.

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

<u>3.7 Availability for the patient of informative material about his pathology</u>

It is very helpful for a patient to be adequately informed about the nature of his pathology and the possible care, and this should happen in a possibly accurate and accessible way. There are 2 ways to provide patients with the necessary information: the diffused distribution of informative material, and the use of totem counters in the facility, where qualified personnel provides patients with the required information and follows them during their hospitalization time. Therefore, the two sub-indicators are:

3.7.1 Distribution of material in paper or in electronic format

3.7.2 Presence of totem counters

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

4.1.4 Website

Nowadays, most hospitals use websites to promote their services. The success of websites is linked to the following reasons:

- A website provides an instant visual presentation:
  it provides a visualization element and is always available to anyone with Internet access;
- A website can be found through search engines:
  there is a good possibility to find a website through a search engine such as Google.
  Between 80-95 percent of all website traffic usually comes from search engines;
- A website is always available:
  no other medium for being available 24/7/365 even compares to a website. With the modest cost of developing a website and putting it online, there is nothing even close to being as cost effective;
- A website is interactive:

website visitors have the ability to control and interact with a well designed website. For example, it is possible to take a virtual tour of a hospital;

- A website can target each visitor specifically:
  every visitor's needs are met with an effective website design. By strategically planning a website, it is possible to customize each area to the type of website visitor who can benefit from it;
- A website is easily updated:
  unlike printed materials, websites can be changed on a minute by minute basis if needed;
- A website saves on printing and mailing costs:
  by making printed materials available on a website, it benefits both the healthcare facility and the website visitors. They have instant access, so they do not have to wait for your mail to arrive, and you save on printing and mailing;
- A website improves customer relations:
  if a customer is deciding between a certain healthcare facility and a competitor, an effective website could mean the difference.

[cbscreative.com]
We have identified some important sustainability-related aspects of websites, that we have summarized in the following indicators:

4.1 Presence of a sustainability balance

A sustainability balance sheet is a document which describes the efforts undertaken to improve the social, economic and environmental sustainability of the healthcare facility. It offers to hospital customers the possibility of appreciating the sustainability policies adopted by the facility, allowing to assess the interest of the management staff in pursuing the normative evolutions regarding sustainability-related themes.
For example, Niguarda Ca' Granda Hospital of Milan describes in its sustainability balance sheet the application of the international GRI (Global Reporting Initiative) framework criteria [annual2008.ospedaleniguarda.it].
Indicator evaluation:

- Yes (1 point)
- No (0 points)

4.2 Online version of the list of services

As already described, lists of services contain a complete description of the services provided by a healthcare facility, as well as all the useful information for a potential patient and for the visitors. They can be usually found in paper format at hospital receptions; an online available version could be very useful, allowing to be accurately informed about all the performed services by a click. Between the 20 examined healthcare facilities listed in table 4.2, only 14 have an online available version of the list of services on their websites, thus showing that this type of service can't be taken for granted yet.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

4.3 Number of necessary clicks to enter the list of services strarting from the homepage

Since lists of services are the most useful documents to read on a hospital website, the access to them should require the least possible number of clicks. Below we show the number of necessary clicks to reach the lists of services included in the websites of the 20 healthcare facilities we examined, and which are listed in table 4.2. Where the columns are absent, it means that the online version of the list of services is not available.

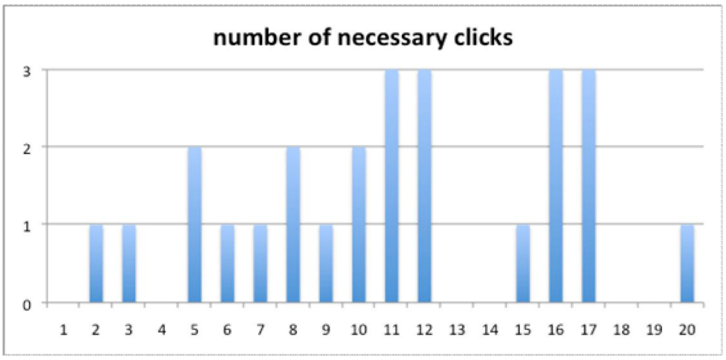

Figure 4.2: Number of necessary clicks to reach the list of services from the hospital homepage

Indicator evaluation:

- 1 click (1 point)
- 2 clicks (0.5 points)
- 3 clicks (0 points)

4.4 Availability of a sitemap

A sitemap is a web page that lists the pages on a website, typically organized in hierarchical fashion. This helps visitors find pages on the site. Sitemaps also act as a navigation aid, by providing an overview of a site's content at a single glance [wikipedia.en].

Indicator evaluation:

- Yes (1 point)
- No (0 points)

4.5 Presence of contact information

The website of a healthcare facility should include all useful phone numbers for the customers, but in most cases only a switchboard for general requests is available, and it is not possible to call the single hospital wards to ask for more detailed informations. For this reason, we have chosen the following two sub-indicators:

4.5.1 Availability of a switchboard

4.5.2 Availability of the phone numbers of the different wards

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

4.6 Availability of the organization chart

This indicator refers to a practice of transparency by the management staff, and thus represents a concept related to the social sustainability.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

4.7 Availability of the personnel professional profile

For a reason of transparency, the customers should be able to read the doctors' and nurses' profiles.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

4.1.5 Accessibility

By the word "accessibility" we mean on the one side the level of effectiveness of the connections of the healthcare facility with streets and transport services, on the other side its "usability". The word "usability" represents the extent to which a product (e.g., device, service, environment) can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use [wikipedia.en].

We have identified 3 main indicators, which we have detailed in different sub-indicators.

5.1 External accessibility

By "external accessibility" we mean the possible ways to reach the healthcare facility.

5.1.1 Accessibility from highways

The social sustainability of a healthcare facility is strongly conditioned by the easiness of reaching it: the accessibility from highways represents a great advantage. We have decided to divide the distance ranges from the facility to the highway entrances as follows:

- short distance: less than 3 km;
- medium distance: between 3 and 10 km;
- long distance: more than 10 km.

The evaluation recompenses the proximity of the facility to a highway entrance, not only because this generates less urban traffic, but also because transportations on urban routes are responsible of higher CO_2 emissions.

Indicator evaluation:

- Less than 3 km (1 point)
- Between 3 and 10 km (0.5 points)
- More than 10 km (0 points)

5.1.2 Accessibility by railway services

Railway services represent an effective alternative to private means of transport. Some important healthcare facilities represent poles of excellence which are able to attract people living far away: for example, the Niguarda Ca' Granda Hospital Milan attracts people coming from all Italian regions. The proximity of a healthcare facility to a railway station is able to encourage medium- and long-distance travels, offering also to people who don't have a car the possibility of reaching the facility. Railway services can be integrated by means of public transport. We have decided to quantify the proximity of railway stops to the facility as follows:

- low distance: less than 10 km;
- medium distance: between 10 km and 60 km;
- long distance: more than 60 km.

Indicator evaluation:

- Less than 10 km (1 point)
- Between 10 and 60 km (0.5 points)
- More than 60 km (0 points)

5.1.3 Accessibility by means of public transport: underground, tram, bus

Means of public transport represent a very useful solution to visit healthcare facilities frequently: for example, visits to patients can be strongly encouraged if underground, tram and bus services are available. We consider a distance of 600 metres from the facility's main entrance to an underground, tram or bus stop as easily walkable, in a reasonable time and without an excessive effort. The indicator rewards the presence of stops of the highest number of different means of public transport, in a range of 600 m.

Indicator evaluation:

- Three means of transport (1 point)
- One or two means of transport (0.5 points)
- None (0 points)

5.1.4 Accessibility by a dedicated shuttle service

A shuttle service, connected to the main external public transport services, can guarantee an optimal hospital accessibility.

Sub-indicator evaluation:

- Yes (1 point)
- No (0 points)

5.2 Presence of internal means of transport

Healthcare facilities can include big different blocks which are located far away from each other. In addition, most buildings include different floors. Hospital activities implicate a strong interaction between different wards, laboratories and technical services, thus requiring an effective horizontal and vertical mobility: internal means of transport can be mostly helpful for the patients and the various personnel. As already explained in the section "list of services", there are 3 types of internal means of transport:

- shuttle service
- escalators
- elevators

Below we describe briefly the characteristics of these different systems:

5.2.1 Shuttle service

A shuttle service effectuates stops at the most important hospital access points, strongly reducing the required time to reach all different hospital structures.

5.2.2 Escalators

Escalators help patients and personnel moving between the different floors, but because they don't allow the transportation of hospital trolleys and heavy materials, they can't substitute the presence of elevators in the facility.

5.2.3 Elevators

They are used by medical personnel to transport hospital beds between the different floors, for example when a patient has to be carried to the operating room, and the most various medical and technological materials. Some facilities have elevators for patients and healthcare personnel and elevators for visitors and non-healthcare personnel.

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

5.3 Internal signage

Signage is any kind of visual graphics created to display information to a particular audience [wikipedia.en]. For hospital users, which include a various mixture of people from different social backgrounds, precise and eye-catching information signs are vital for providing help with finding the right directions and at the same time serve to provide a sense of security. However, the hospital signage in most hospitals is hard to recognise amongst the complex hospital building structure [Huelat, 2007].

Internal signage is constituted by: floor signage, wall-mounted signage, suspended signage. In the following pictures are represented examples of the three different signage types.

Figure 4.3: Floor signage [boralv.se]

Figure 4.4: Wall-mounted signage [graceharborindustries.com]

Figure 4.5: Suspended signage [siedle.de]

5.3.1 Floor-, wall-mounted- and suspended signage

This indicator is a measure of the social sustainability of the facility, and we have decided to distinguish between the presence of one single generic signage type, two generic types or three types between the following: floor-, wall-mounted- and suspended signage.

Indicator evaluation:

- Three types of signage (1 point)
- Two types of signage (0.5 points)
- One type of signage (0 points)

5.3.2 Application of specific chromatic patterns to identify each floor

Chromatic patterns can be used as an effective way to communicate, and if they are used as a complement to the written information, they contribute in simplifying the accessibility of the facility [Rigon, 2004].

5.3.3 Tactile maps for partially-sighted and unsighted persons

They offer an essential contribution to the social sustainability of healthcare facilities, allowing people with visual disabilities to orient in such complex buildings [Rigon, 2004].

5.3.4 Acoustic signallers in elevators for partially-sighted and unsighted persons

They can provide information for example about the reached floors and the services available there.

For the 3 sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

4.2 Materials management service

The materials management service involves the purchasing, organizing, controlling of materials for the majority of the activities in the facility. In particular the module could be divided into different aspects:

- Packaging and cases
- Reuse and recycling
- Management software
- Purchasing
- General

4.2.1 Packaging and Cases

In order to guarantee a sustainable materials movement the kind of packages used are of great importance. Sustainability indicators try to check the presence of green packages. Green packages are generally identified as made with recycled materials, or adequate to be recycled, reused, biodegradable and without toxic substances.

The assessment will determine the presence of these packages and if they are collected in specific containers that allow a specific treatment.

1.1 Green packages (recycled, recyclable, biodegradable, reusable, without toxic substances)

The sustainability of packages is generally indicated with symbols or certifications. For example the packages made with recycled materials are identified by the symbol:

Figure 4.6: The international recycling symbol [wikipedia.com]

Some suppliers and manufacturers report on the packages a “green dot”, that is the license symbol of a European network of industry-funded systems for recycling the packaging materials of consumer goods.

Figure 4.7: The Green Dot symbol [wikipedia.com]

The presence of this symbols identifies a typical “green package”.
It is not simple to identify and quantify the amount of green packages present. Therefore the indicator tries to understand if the procurement process considers and incentivizes materials with this kind of packages.

1.2 Specific containers for the disposal of green packages

The presence of green packages is not enough for the sustainability of the materials management sector. The packages must be divided and disposed in the appropriate way in function of their properties.
Generally not many are the green packages and it is useful that the green ones are disposed in specific containers for recyclable materials.

For these indicators the evaluation is:

Yes (1 point)

No (0 points)

4.2.2 Reuse and recycling

The reuse and recycling of the products allows the facility to save money for the purchasing of the materials and the transportation of them.

2.1 Reuse and recycling policy

A sustainable idea of the materials management foresees the use of recycling and reuse policies.
The more diffused reuse and recycling policies are connected with the use of paper and printing tools, a recent research by Lexmark says [www.adnkronos.com].
However, we think that many other policies involving other sectors are possible.

The evaluation is the presence of a reuse and recycling policy:
Yes (1 point)
No (0 points)

4.2.3 Management software

3.1 Management software for orders and procurement

Many IT solutions are available for the management of the orders and procurement. The key benefit for organisations using procurement software include ease of administration and potential long-term cost savings. Having a single interface for procurement related management information cuts down the time and effort required to monitor organisational spending. The use of such software also allows procurement managers to control the vendors used by the wider organisation so all employees take advantage of negotiated rates and other terms of service.

The main advantages of a procurement and orders software are:

- reduction of paper consumption
- real time management of orders and deliveries
- ensures that nothing is ordered without correct approval

3.2 Management software for materials management warehouse

As for the orders and procurement software a great amount of solutions for the warehouse are available. The main advantages of a warehouse management software are:

- reduction of paper consumption
- real time management of stock and materials levels
- management of the expiration dates

3.3 Traceability of consumer goods with RFID or BARCODE systems

The consumer goods con be quickly identified with the use of a electronic code (RFID or BARCODE). The electronic identification eliminates errors of reading by operators and allows more particularized classification and faster identification.

The evaluation for these indicators is:
Yes (1 point)
No (0 points)

4.2.4 Purchasing

4.1 Distance of supplier facilities

In order to decrease the amount of kilometres that the suppliers must cover in order to reach the final destination a facility should choose suppliers which are as near as possible. This practice is not directly connected with the sustainability of the hospital, but shows without doubt a good behaviour towards the environmental sustainability.
Because of the extremely high number of suppliers that a hospital requires, and the consequently very hard work of locating every supplier, we think that a good performance in the administration could be the general intention of choosing suppliers which can operate as near as possible.

4.2 Green procurement

The term "Green Procurement" or "Green Sustainable Procurement" foresees the introduction of environmental (minimum impact on water, energy, waste) and social (work conditions) criteria about procurement policies. The GSP is connected with environmental certifications, Eco-design, LCA and is promoted by the Agenda 21 of the UN, the World Summit on Sustainable Development of Johannesburg, the VI° Environment Action Programme and the Environment Action Strategy of the CIPE - Italian Environment Ministry.
The realization of the GSP entails that, at the moment of the choice, the acquisition of low impact goods is favoured. This kind of product could be identified by checking these properties:

- reducing the use of natural resources
- reducing emissions in air or land
- reducing risks for the environment and human health
- reducing waste production
- long life

- possibility of reusing

The product must present at least one of this properties in order to be classified as a green product. [www.ambiente.unimore.it]

The evaluation of these indicators is

Yes (1 point)

No (0 points)

4.2.5 General

5.1 Short term materials rotation rate

The rotation rate is an important indicator of performance of the warehouse management. In particular the rotation rate of the short term materials should be as high as possible, in order to guarantee that the materials have low probability to reach the expiry date.

The evaluation is about the presence of this indicator

Yes (1 point)

No (0 points)

5.2 High value materials rotation rate

High value materials in a warehouse represent a concentration of economical value. The rotation rate should be high in order to avoid the permanence of materials in the stockroom.

The evaluation is about the presence of this indicator

Yes (1 point)

No (0 points)

5.3 Annual inventory

The inventory activity is primarily connected with specifying the shape and percentage of stocked goods. The performing of an inventory every year is a good practice useful to increase the efficiency of the warehouse and to prevent errors or waste of materials.

The evaluation is about the performing of an annual inventory:

Yes (1 point)

No (0 points)

5.4 Stock materials level monitoring

The stock materials need to be monitored and scheduled. In every moment the materials management should be able to check and communicate the level of materials present in the stockroom. This allows the purchasing division to realize a more precise and efficient ordering policy, minimizing the wastes.

The evaluation is:

Yes (1 point)

No (0 points)

4.3 Hospital Pharmacy

The hospital pharmacy is the healthcare service which comprises the art, practice, and profession of choosing, preparing, storing, compounding, and dispensing medicines and medical devices, advising healthcare professionals and patients on their safe, effective and efficient use.
[www.eahp.eu]
The evaluation of sustainability in a hospital pharmacy can be focused on different aspects.
A hospital pharmacy is substantially a laboratory with machines and instruments that should satisfy energy saving and safety requirements.
An other aspect that must be considered is the management and safety of medications which could be improved with ad hoc management software.
Finally is of great interest the purchasing management and the education of personnel.
The evaluation of the hospital pharmacy module is divided into five parts:

- Machine and equipment
- Preparation and delivery of medications
- Medication safety
- Purchasing
- Education

4.3.1 Machine and equipment

<u>1.1 Certified machines</u>
The certifications of the machines and the equipment in a laboratory is fundamental and of great importance. The Energy Star is the most common certification and devices carrying the Energy Star logo, such as computer products and peripherals, kitchen appliances, buildings and other products, generally use 20%–30% less energy than required by federal standards. [www.energystar.gov]
An other certification which is quite diffused in Europe is the TCO certification, which is particularly focused on office applications like monitors and printers.
This indicator has the function to evaluate how the ensemble of the machine and the equipment in the laboratory are respondent to eco-efficiency principles. It is not easy to evaluate the effective savings of power and other resources that the machines are able to perform, because of the strong connection that the utilization of them presents with the different activities of preparation. We consider a good indicator the purpose of the ward to concentrate the purchasing of the machines and

the general equipment on certified component, able to realize a significant saving of energy and resources.

The evaluation of the indicator is the following
Yes (1 point)
No (0 points)

1.2 Pharmacy equipment in compliance with ISO 11418:2005

The ISO 11418 is a very specific norm that defines the most important features of containers and accessories for pharmaceutical preparation. In particular, the normative, subdivided in various sections (ISO 11418-1, ISO 11418-2 and so on), takes into account the design, dimensions, materials and requirements different kind of bottles.
[www.iso.org]
The evaluation is:
Yes (1 point)
No (0 points)

4.3.2 Preparation and delivery of medications

The preparation and delivery of medications is a central matter for the management of the hospital pharmacy. Many advanced IT technologies are available and the utilization of these can give a great effort to the pharmacy in order to reach a efficient and safe delivery of all medications. The IT technology is not enough and a series of specific methodologies are required in order to improve the organization of the pharmacy.

2.1 Unit-dose distribution system

The unit-dose distribution system consist in the preparation of a unique package which contains all the medications that a patient must receive for his therapy. The nurses only have to deliver the package to the patients and the probability of mistakes is quite zero. This methodology is characterized by a great efficiency, minimization of errors and great savings for the hospital pharmacy.
The management of the chemotherapy is an important example of the unit-dose distribution system. Because of the high level of accuracy required in the prescription of medications in chemotherapy, the system provides a great improvement in the delivery safety of the medications.
[www.aospterni.it] [www.sifoweb.it]

2.2 Use of the RFID or BARCODE system for the identification of medications and packages

The RFID system is part of the new IT technology that can contribute to a more efficient hospital management. The pharmacy generally manages a great amount of medications every day and the RFID or BARCODE system allows the personnel to quickly recognize a medication and the relative quantity with a simple electronic tool. The data received can be quickly transmitted to a computer and than registered in a database.
[www.highperformacepharmcy.com]

Figure 4.8: Barcode and RFID Medication Administration System [www.gizmag.com]

2.3 Medication returns managed by pharmacy

If a medication is not correctly delivered to the patient it is important that it comes back to the pharmacy. As a first step the hospital could foresee a bin on the floor where all unused medications are stored. Secondly, the medications should be verified by the pharmacy staff for integrity and then relocated in the pharmacy for future use. This practice guarantees economical savings, medications safety and efficiency.
[www.highperformacepharmcy.com]

2.4 Centralized warehouse

In many hospitals, the single departments are provided with drug warehouses. The transition is from a system of replenishment of the single department stocks to a system with a central warehouse that distributes individual prescriptions to all departments. In this way, it is possible to get a more precise planning of the needs of the various drugs and health products; in addition, an efficient centralized procedure for the drug purchases can contain the costs while maintaining a high product quality and uniformity. The various members of the logistics network are able to monitor the status, availability and location of all materials in real time.

The benefits of a centralized warehouse are:

- rationalization of spaces and drug handling;
- optimization and acceleration of loading and unloading operations;
- minimization of stocks;
- proper management of deadlines;
- check real-time stock situations (both of the department and the central warehouse);
- reduce the inventory of the department warehouse;
- automatically perform the material requests.

[incasgroup.com]

2.5 Automatic warehouse

The automatic warehouse consist of a store which is equipped with a management software able to record inputs and outputs of medications. This warehouses are generally divided into different compartments and one of this can generally contain:

- A single kind of medication in the original package
- A single kind of medication divided in unit-dose
- The therapy of a single patient divided in unit-dose

The most common automatic warehouse is the first one.

[www.sifoweb.it]

For example, SWISSLOG is one of the leading companies in the production of this type of technologies, and offers *BoxPicker*, a high-density automated pharmacy warehouse for the storage and dispensing of medications and supplies.

[swisslog.com]

The use of automated warehouses allows a long-term improvement in the economic sustainability of a healthcare facility, because it is possible to optimize all handling processes, strongly reducing the amount of wasted time for drug handling actions.

Figure 4.9: Example of automated dispensing equipment [www.inboundlogistics.com]

2.6 Regular control of stock areas

The areas where medications are stored needs to be controlled and their operational efficiency must be kept under control. The temperature and the humidity of these areas is of particular interest for the pharmacy management, in order to keep a high level of safety of the medications.

The evaluation of this indicator is the presence and scheduling of regular control of the stock areas by authorized and competent personnel.

For these indicators the evaluation is

Yes (1 point)

No (0 points)

4.3.3 Medication safety

3.1 One therapy sheet

The one therapy sheet is a paper which contains all the information about the therapeutic process of a patient. In this document the prescription of the doctor and the administration by the nurse are both reported. This simple instrument can resolve many problems of communication, medication errors and, if correctly used, can assure the complete traceability of the medication.

[www.sifoweb.it]

3.2 Management software of the medication warehouse

The medication warehouse should have a computerized management in order to realize a good and complete interface between identification systems and automatic warehouse. The presence of a management software must be taken into account.

3.3 Computerized prescribed order entry (CPOE)

The computer prescribed order entry is process of electronic entry of medical practitioner instructions for the treatment of patients. This order are communicated to a computer network to the departments like the pharmacy. The main features of this system are:

- Ordering

Orders are standardized across the organization and are communicated to all departments.

- Patient-cantered decision support

The ordering process includes a display of the patient's medical history and evidence-based clinical guidelines to support treatment decisions.

- Patient safety features

The CPOE system allows real-time patient identification, drug dose recommendations, adverse drug reaction reviews, and checks on allergies and test or treatment conflicts.

- Intuitive Human interface

The order entry workflow corresponds to familiar "paper-based" ordering to allow efficient use by new or infrequent users.

- Portability

The system accepts and manages orders for all departments at the point-of-care, from any location in the health system (physician's office, hospital or home) through a variety of devices, including wireless PCs and tablet computers.

3.4 The entire process is computerized

Automated drug warehouses can be combined with unit dose drug management solutions. The overall process can be so summarized:

- the physician prescribes the therapy for each patient, during the visit turns, through a suitable software installed on portable or tablet PC connected to the local area network via wireless communication and integrated with the computerized clinical folder;
- the prescribed therapies are received in real time by the hospital pharmacy where the individual patients’ therapies are prepared; therapies, daily or according to the timetables

of administration, are sent to the departments;

- at central level the hospital pharmacy produces the drugs unit doses (repackaging); unit doses are stored in special automatic units able to prepare the individual therapies;
- the cycle ends with the drug administration to the patient.

[gruppogiglio.it]

Examples of unit dose drug management solutions are also offered by SWISSLOG:

- *PillPick* provides a comprehensive approach for unit dose packaging, medication dispensing and pharmacy inventory management. The system bar-codes packages, stores and dispenses unit dose medications. Unit doses are automatically placed into bar-code labeled bags and sealed.
- *DrugNest* is a high-density pharmacy robot for automated storage and medication dispensing of bar-coded unit doses.

The philosophy of repackaging personalized drug unit doses from bigger drug packages allows a strong reduction in the production of drug waste, since it avoids that drug packages are left open or thrown away when not yet exhausted. The result is a high improvement in the economic sustainability. The Pescara Hospital, for example, has obtained a reduction of 30% in the costs of the administered drugs after having implemented a unit dose drug management system. The annual saving has reached 3 million Euros [goinfoteam.it].

This indicator rewards the use of an automated drug warehouse in combination with a unit dose drug management solution.

3.5 Percentage of wrong medications

Episodes of wrong medications are possible when managing a high number of people's therapy. The percentage of wrong medications in a hospital should be quite zero. Anyway, the hospital must take into account the management of this problem.

The causes could be:

- not complete information about the patient
- delivery errors

This indicator asks if the healthcare facility foresees a reporting of the wrong medication rate and a causes-seeking of it.

The evaluation for these indicators is:

Yes (1 point)

No (0 points)

4.3.4 Purchasing

4.1 Distance of suppliers

In order to decrease the amount of kilometres that the suppliers must cover in order to reach the final destination a facility should choose suppliers which are as near as possible. This practice is not directly connected with the sustainability of the hospital, but shows without doubt a good behaviour towards the environmental sustainability.

Because of the extremely high number of suppliers that a hospital requires, and the consequently very hard work of locating every supplier, we think that a good performance in the administration could be the general intention of choosing suppliers which can operate as near as possible.

4.2 Average replenishment time

The replenishment time of the pharmacy warehouse represents an important variable of efficiency and safety of the medication delivery. We consider the best option to be a replenishment time of a week.

The evaluation is:

Every week (1 point)

Every two weeks (0.5 points)

Every three weeks (0 points)

4.3 Existence of replenishment minimum

The presence of a replenishment minimum imposed by the suppliers generates higher costs for the pharmacy and less efficiency when ordering a limited quantity. The absence of a replenishment minimum goes towards a more “lean” procurement policy.

For this indicator the evaluation is:

Yes (0 points)

No (1 point)

4.4 Medications delivery frequency

The medications need to be frequently delivered to the wards. If the hospital pharmacy presents a centralized pharmacy management (central warehouse) the delivery takes place every day. If the delivery of the medications is not centralized, but divided between the wards, the delivery could be less frequent. However, a more frequent delivery minimized stock times and errors of delivery.

We consider as best value a daily delivery time.

The evaluation of this indicator is:

Every day (1 point)

Every two days (0.5 points)

More than every two days (0 points)

4.3.5 Education

5.1 Education about themes of medication safety

The medication safety matters are the core of a sustainable pharmacy management. In order to maintain a good staff qualification about medication safety a program of update courses must be organized and approved by the administration of the hospital.

The evaluation is:

Yes (1 point)

No (0 points)

5.2 Regular meeting between manager, pharmacists and technicians

In order to increase the communication level between workers and managers an activity of regular meeting should be taken into account. This practice allows problem solving through reporting of inefficiencies and quality objectives between the different levels of competencies.

The evaluation is about the frequency of the meeting:

Once a month=1

Once every three months=0,5

Less than every three months = 0

4.4 Central Sterile Supply Department (CSSD), Surgical instrument management, Surgical Block

In the present module we provide indicators to assess the sustainability of the activities and environments which guarantee the possibility of performing surgical interventions: the management and the sterilization of surgical instruments and the Surgical Block. Regarding the present module, we couldn't establish a reasonably weighted evaluation metrics for several proposed indicators. We have generally defined with X, Y and Z particular evaluation range values which we weren't able to define at the moment. Their determination requires the availability of a sufficient number of data, which will be generated in future, after a reasonable number of our model's tests in healthcare facilities.

4.4.1. Central Sterile Supply Department (CSSD)

Proper sterilization of reusable surgical instruments is critical in a hospital environment. Over their lifetime, such instruments are used on a progression of patients: inadequate destruction or inactivation of pathogens (bacteria, fungi, viruses, spores and other microorganisms) left on an instrument by one patient can result in serious adverse clinical outcomes, including death, in the next patient.

Sterilization destroys all microorganisms on the surface of an article or in a fluid to prevent disease transmission associated with the use of that item. As already anticipated, the concept of what constitutes "sterile" is measured as the probability of sterility for each item to be sterilized, which is commonly referred to as the sterility assurance level (SAL) of the product: it represents the probability of the survival of a single viable microorganism occurring on a product after sterilization. SAL is expressed in the following way: for example, if the probability of a spore surviving were one in one million, the SAL would be 10^{-6} [Rutala, 2008]. There are a number of different sterilization technologies available. Different norms exist which certify appropriate levels of sterilization, and appropriate sterilization techniques on an instrument-by-instrument basis, for example:

- EN 13060: Small steam sterilizers (2004)
- EN 14180: Sterilizers medical purposes - Low temperature steam & Formaldehyde sterilisers - Requirements & testing (2003)

[Pistoiesi, 2005]

Device manufacturers also make recommendations about the sterilization methods that work best with their products. Medical instruments can show different criticality levels:

- Low risk (noncritical items):
  Noncritical items are items that come into contact with normal and intact skin as stethoscopes or with the inanimate environment (e.g. walls, floors, ceilings, furniture, sinks, etc.). Cleaning with a detergent and drying is usually adequate.
- Intermediate risk (semi-critical items):
  Semi-critical items are items that do not penetrate the skin or enter sterile areas of the body, but that are in close contact with mucous membranes or with non-intact skin. Cleaning followed by high level disinfection is usually adequate. Examples include respiratory equipment, flexible endoscopes, laryngoscopes, specula, endotracheal tubes, thermometers, and other similar instruments.
- High risk (critical items):
  High risk items are items that penetrate sterile tissues such as body cavities and the vascular system. These items are called critical items because of the high risk of infection if such an item is contaminated with any microorganism before penetrating the tissue. Cleaning followed by sterilization is required. Examples of high-risk items include surgical instruments, intra-uterine devices, vascular catheters, implants, etc.

[trophon.com.au]

Sterile Processing Departments are typically divided into four major areas to accomplish the functions of decontamination, assembly and sterile processing, sterile storage, and distribution.

- In the *decontamination area*, reusable equipment, instruments and supplies are decontaminated and disinfected. Decontamination reduces the microbial charge by immersing the objects in adequate chemical solutions, to avoid infection risks for the operators which will proceed with the following disinfection treatments [fadrischio.unito.it]. Disinfection is a next step for the inactivation/destruction of pathogenic organisms which are present on the instruments: the goal is for the pathogens to be removed or inactivated to an acceptable level. Personnel working in the decontamination area should wear protective clothing, which includes a scrub uniform covered by a moisture-resistant barrier, shoe covers, rubber or plastic gloves, and a hair covering. The most used disinfection methods are:

  1. Chemical Disinfectants:
     - Chlorine and Chlorine Compounds
     - Formaldehyde

- Glutaraldehyde
- Hydrogen Peroxide
- Iodophors
- Ortho-phthalaldehyde (OPA)
- Peracetic Acid
- Phenolics
- Quaternary Ammonium Compounds

2. Other inactivating agents:
   - Ultraviolet Radiation (UV)

     The wavelength of UV radiation ranges from 328 nm to 210 nm (3280 A to 2100 A). Its maximum bactericidal effect occurs at 240–280 nm. Inactivation of microorganisms results from destruction of nucleic acid.
   - Pasteurization

     Pasteurization is a process of heating an object and then cooling it immediately. Its purpose is to destroy all pathogenic microorganisms. However, pasteurization does not destroy bacterial spores. It is a recognized alternative to chemical disinfection.
   - Flushing- and Washer-Disinfectors

     They clean by flushing with warm water, possibly with a detergent, and then disinfect by flushing the items with hot water or with steam. Because this machine empties, cleans, and disinfects, manual cleaning is eliminated, fewer disposable items are needed, and fewer chemical germicides are used.

   [Rutala, 2008]

• Clean items are received in the *assembly and sterile processing area* from the decontamination area and are then assembled and prepared for issue, storage, or further processing (like sterilization). Used supplies and equipment should be collected and taken to the Decontamination Area in the Sterile Processing Department in a way that avoids contamination of personnel or any area of the hospital. Equipment should be covered and supplies should be moved in covered carts, closed totes or containers, or closed plastic bags. After the instruments have been cleaned and inspected, they are typically assembled into sets or trays according to recipe cards that detail instructions for assembling each set or tray. Instruments and other items that are prepared for sterilization must be packaged so that their sterility can be maintained to the point of use.

• After assembly or sterilization, items are transferred to the *sterile storage area* until its time for them to be issued.

- Several major functions are carried out in the *distribution area*: case cart preparation and delivery, exchange cart inventory, replenishment and delivery, telephone-order and requisition-order filling, and patient care equipment delivery.

[urmc.rochester.edu]

Sterilization methods:

Reliable sterilization depends on the contact of the sterilizing agent with all surfaces of the item to be sterilized. Selection of the agent to achieve sterility depends primarily upon the nature of the item to be sterilized. Time required to kill spores in the equipment available for the process then becomes critical. The most diffused sterilization methods are the following:

- *Steam*

  Heat destroys microorganisms. Pressure, greater than atmospheric, is necessary to increase the temperature of steam for thermal destruction of microbial life. Death is caused by the denaturation and coagulation of protein or the enzyme-protein system within the cells.
- *Ethylene Oxide*

  The use of ETO is recommended for sterilizing heat- and moisture-sensitive medical devices. Ethylene oxide (EtO) is a chemical agent that kills microorganisms, including spores, by interfering with the normal metabolism of protein and reproductive processes (alkylation) resulting in death of cells.
- *Dry Heat*

  Dry heat in the form of hot air is used primarily to sterilize anhydrous oils, petroleum products, and bulk powders that steam and ethylene oxide gas cannot penetrate. Death of microbial life by dry heat is a physical oxidation or slow burning process of coagulating the protein in cells.
- *Microwaves*

  The no-ionizing radiation of microwaves produces hyperthermic conditions that disrupt life processes. This heating action affects water molecules and interferes with cell membranes. Metal instruments can be sterilized if placed under a partial vacuum in a glass container.
- *Formaldehyde Gas*

  Formaldehyde kills microorganisms by coagulation of proteins in cells. Used as a fumigant in gaseous form, formaldehyde sterilization is less efficacious than other methods of sterilization. It should only be used if steam under pressure would damage the item to be sterilized and ethylene oxide and glutaraldehyde are not available.
- *Hydrogen Peroxide Plasma*

Hydrogen peroxide is activated to create a reactive plasma or vapour. Plasma can be produced through the action of either a strong electric or magnetic field, and interacts with the cell membranes, enzymes, or nucleic acids to disrupt life functions of microorganisms.

- *Ozone Gas*

  Ozone, a form of oxygen, sterilizes by oxidation, a process that destroys organic and inorganic matter. It penetrates membranes of cells causing them to explode.

- *Chemical Solutions*

  Liquid chemical agents provide an alternative method for sterilizing heat sensitive items, if a gas or plasma sterilizer is not available, or the aeration period makes ethylene oxide sterilization impractical. To sterilize items, they must be immersed in a solution for a required time. The most used chemicals are: peracetic acid, glutaraldehyde, and formaldehyde.

- *Ionizing Radiation*

  Ionizing radiation produces ions by knocking electrons out of atoms. These electrons strike an adjacent atom and either attach themselves to it, or dislodge an electron from the second atom. The ionic energy that results becomes converted to thermal and chemical energy. This energy causes the death of microorganisms by disruption of the DNA molecule, thus preventing cellular division and propagation of biologic life.

  [urmc.rochester.edu]

We have identified the following list of sustainability indicators for the Central Sterile Supply Department (CSSD).

1.1 CO_2 emissions associated with the transport service for one sterilization order

To evaluate the sustainability of the means of transport used to carry the surgical kits to the CSSD and from the CSSD back to their final destination, we have decided to consider the CO2 emissions associated with one transport of a generic sterilization order.

Indicator evaluation:

- Less than X (1 point)
- Between X and Y (0.5 points)
- More than Y (0 points)

1.2 Quality control and monitoring

In a complex system such as a sterilization department, quality control and monitoring are absolutely unavoidable. The multitude of machines of different type and the criticality of the carried out activities require that all processes are meticulously monitored and that inefficiencies are detected as soon as possible to avoid imperfect sterilization of surgical equipment. The present indicator can be divided in the following two sub-indicators:

1.2.1 Record of the number and nature of the encountered problems

Every single problem of any nature which can appear in the sterilization department must be recorded, to recognize recurrent situations and develop adequate action plans to solve them.

1.2.2 Check of the surgical instruments before delivering the sterilized kits

Every sterilized surgical kit must be adequately and carefully checked, before being delivered to the surgical block.

1.2.3 Meetings with the personnel and reports on a regular basis

The personnel must always be informed and updated about the quality control and monitoring procedures and their results, to be able to give its contribution in the most effective way.

1.3 Information about autoclaves

Each autoclave should be equipped with a special registration to allow to recover all the information on the cycles carried out in time. It is also required that the registration system permits to rebuild, after a long time, all the necessary information related to the processing of material related to individual performances.

The registration concerning the autoclaves must contain the following information:

- instructions book provided by the supplier after the installation of the machine;
- copy of the manual about the correct execution of sterilization procedures;
- daily cards containing information about the performed sterilization cycles;
- cards containing weekly machine checks;
- cards containing exhaustive quarterly machine checks;
- card (or register) containing all maintenances and inspection tests.

[Azienda Ospedaliera della Provincia di Pavia, 2003]

Indicator evaluation:

- all elements present (1 point)
- one or more elements missing (0 points)

1.4 Packaging of surgical instruments with medical-grade or polypropylene/kraft paper

Surgical instruments which need to be sterilized have first to be specifically packaged. The purpose of the packaging operation is:

- allowing the removal of air, and therefore the penetration and the contact of the sterilizing agents with the surface of the objects to be treated;
- reducing the risk of contaminating the sterilized material when the sterilized package is opened;
- preserving the sterilization of the treated material until its use;
- beeing practical, easy and economical.

The operator has to choose the packaging material which is appropriate to the sterilization typology adopted and to the maintaining of the sterility.

- Medical-grade paper is produced with bleached cellulose, is free from unpleasant smells both in dry and wet state, doesn't release hairs or fibers during its normal use and doesn't contain toxic materials which could be released during its use. Medical-grade paper is appropriate for some specific types of surgical instrument kits, bowls and cups.
- Polypropylene/kraft paper is produced in the form of bags or rolls of "coupled", produced by the union of medical paper and a plastic film. The plastic film must be resistant to delamination. This type of paper is adequate for the packaging of medium size surgical sets.

1.4.1 Packaging with a double orthogonal layer

This technique of packaging allows the opening of the package without compromising the sterility of the contained items, guaranteeing an effective protection, easy opening and an aseptic extraction of the contents. The envelopes should be sealed using process indicator tapes, which use a chemical element, usually represented by chromophore ink, capable of changing its colour after exposure to temperature. From the regulatory point of view, process indicators must meet the requirements of EN 867 [Azienda Ospedaliera della Provincia di Pavia, 2003].

Sub-indicator evaluation:

- Yes (1 point)
- No (0 points)

1.4.2 Application of adhesive labels containing the information on the outside of the envelopes

The use of markers, pens or stamps on the paper alters its permeability.

1.4.3 Protection of sharp or cutting material through appropriate supports

To avoid damages to the envelopes and the operators, sharp instruments must be covered with gauzes or perforated rubber caps [Azienda Sanitaria Locale 3, Regione Piemonte].

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

1.5 Packaging of surgical instruments in sterilization containers with filters

Containers are made of steel, aluminium or other heat resistant materials, rectangular or squared; they have paper or woven filters, placed on the cover or both on the cover and on the bottom of the containers. This type of packaging is adequate for large surgical sets and textile materials. The following sub-indicators suggest aspects which contribute to the improvement of the economic sustainability of the sterilization processes, avoiding the necessity of repeating sterilization processes.

1.5.1 Substitution of the paper filters after each sterilization cycle

Paper filters can optimally sustain only one single sterilization cycle.

1.5.2 Updating of the number of effectuated sterilization cycles

The duration of woven filters is not standard, but depends on the frequency of their use, on the conditions of the sterilizing machines and of the material to be sterilized. Approximately 60 cycles can be made with a fully functional sterilizing machine, but the manufacturer's instructions about the exact number of tolerable sterilization cycles have to be carefully followed.

1.5.3 Presence of a chemical indicator in every single container

Depending on the dimensions of the single containers, more units can be usually loaded in a sterilizing machine. Chemical process indicators use one or more chemical elements to detect the reaching of the sterilization conditions. For example, for a steam autoclave, the process parameters are temperature, pressure and time: when all parameters have reached the desired level, the indicators turn. To assure that the correct sterilization conditions have been obtained in every container, each unit must have a dedicated indicator
[Azienda Ospedaliera della Provincia di Pavia, 2003].

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

1.6 Tracking information on each sterilized package

Every single unit which has to be sterilized must include the following information:

- sterilization and/or expiration date
- description of the article if not visible
- name of the operator who packaged the unit

- number of the autoclave's progressive cycle
- autoclave cycle type

[Azienda Ospedaliera della Provincia di Pavia, 2003]

Indicator evaluation:

- all elements present (1 point)
- one or more elements missing (0 points)

1.7 Sterilized material storage

Sterilized material must be stored in appropriate cabinets to guarantee its optimal conservation. We have listed the following sub-indicators, which represent useful indications for a correct storage.

1.7.1 Cabinets exposure to direct light sources

Exposure to direct light sources must be avoided, because it can generate localized heat with the risk of damaging the packages' surfaces.

Sub-indicator evaluation:

- No (1 point)
- Yes (0 points)

1.7.2 Use of rubber bands for the assembly of more packages

The use of rubber bands is not advisable, because of the risk of small lesions on the packages' surfaces, which could compromise the sterilization of their contents.

Sub-indicator evaluation:

- No (1 point)
- Yes (0 points)

1.7.3 Use of coating materials which allow an easy cleaning of floors and walls

Dust deposits must be constantly avoided, and therefore appropriate coating materials must be chosen to simplify cleaning procedures.

1.7.4 Limited access to the warehouse

Every access to the warehouse must be recorded and authorized singularly.

1.7.5 Storage of the material optimized according to the sterilization date

This expedient allows to use the material sequentially with the date of sterilization, avoiding the expiry of the sterilization conditions.

[Dallapé, 2006]

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

1.8 Sterilization processes management software

Informative systems can provide the monitoring and the management of all technological equipment, and therefore the entire sterilization process (activity of the washers, thermowelders and autoclaves) [Dallapé, 2006].

Indicator evaluation:

- Yes (1 point)
- No (0 points)

1.9 Water consumption per processed sterile unit

The present indicator provides an estimate of the water efficiency of the sterilization department.

Indicator evaluation:

- Less than X (1 point)
- Between X and Y (0.5 points)
- More than Y (0 points)

1.10 Annual energy consumption / annual number of processed sterile units

The present indicator provides an estimate of the energy efficiency of the sterilization department.

Indicator evaluation:

- Less than X (1 point)
- Between X and Y (0.5 points)
- More than Y (0 points)

1.11 Saturation of the sterilization machines

The present indicator evaluates the saturation level of the autoclaves: a high level of saturation indicates that the various machines are used in an effective way. The saturation level is estimated by comparing the average number of sterile units nominally processable by each machine daily with the real average value of daily processed units.

Indicator evaluation:

- More than 70% (1 point)
- Between 30% and 70% (0.5 points)
- Less than 30% (0 points)

1.12 Regular training and education about the new sterilization procedures

The personnel of the sterilization department must be regularly trained through updated courses about state of the art sterilization technologies and techniques.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

4.4.2 Surgical instrument management

The surgical instrument management is a complex task in every healthcare facility: surgical interventions require the use of many different instruments, which are organized in specific kits and which require to be sterilized after each use. To give an idea about the number of instruments present in surgical kits, consider that the only "tonsil surgery kit" includes about 75 instruments.

Below we report the indicators we have identified to evaluate the sustainability of surgical instrument management activities. These indicators refer mostly to economic sustainability aspects, because they try to provide best practices able to reduce the instruments' management costs.

<u>2.1 Tracking system adopted</u>

The traceability of surgical instruments can be guaranteed through different technologies available on the market. The most diffused tracking systems are the following:

- *Completely manual tracking systems*

  It is possible to distinguish between two alternatives: with or whitout a mean of identification.

  - The first solution consists simply in writing on a book all the movements of every single instrument, and presents a lot of disadvantages: time-consuming, high error probability, impossibility to track and recognize the single instrument in a univocal way, recomposition of the surgical sets only by experienced and trained personnel;
  - The second solution also consists in writing on a book all the movements of every single instrument, but with the help of non-univocal identification systems such as coloured adhesive tapes applied on the posterior extremity of each instrument. The disadvantages are the same as the previous solution, but in addition it exists also a risk of dirt accumulation.

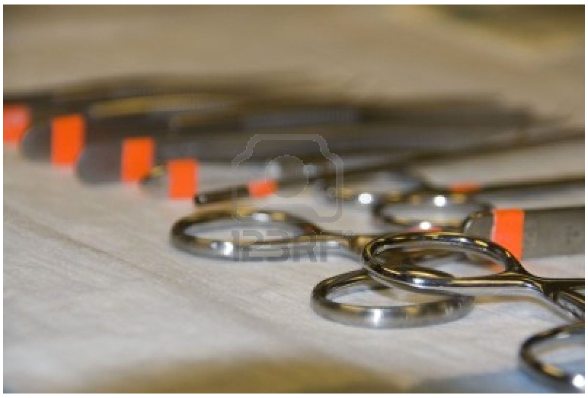

Figure 4.10 Coloured adhesive tapes applied on the posterior extremity of a surgical instrument [Tamagno, 2008]

- *Barcode systems*

A barcode is an optical machine-readable representation of data, which shows data about the object to which it attaches. Originally, barcodes represented data by varying the widths and spacings of parallel lines, and may be referred to as linear or 1 dimensional (1D). Later they evolved into rectangles, dots, hexagons and other geometric patterns in 2 dimensions (2D). Although 2D systems use a variety of symbols, they are generally referred to as barcodes as well. 2D barcodes allow the storage of a higher quantity of information and are more suitable for the tracking of objects characterized by many different details. An important example of 2D barcodes are *DATAMATRIX* codes: they are two-dimensional matrix barcodes, consisting of black and white "cells" or modules arranged in either a square or rectangular pattern, able to encode alphanumeric information [wikipedia.en]. These patterns can be applied on an object, and a *DATAMATRIX* reader acquires the information, from a wide range of angles, through an illumination system and an integrated internal optical system.

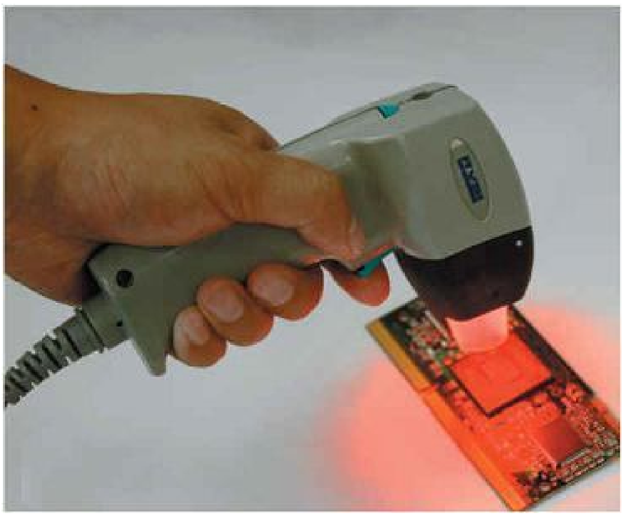

Figure 4.11 : DATAMATRIX reader scans and acquires a code applied on an electronic plate [hte.net]

DATAMATRIX codes can be obtained through 3 different techniques:

- *INFODOT*: it consists on an adhesive tag, with the identification code printed, which is applied on the surface of the surgical instrument. The system is economical but short-lasting, because it can come unstuck and get lost, representing a danger for the patient. In addition, it is neither interactive nor modifiable, because it is not possible to vary the printed information.
- Laser: the code is engraved on the surface of the instrument through a laser source. This solution is economical but short-lasting, because the laser heat damages the protective layer of the INOX steel, causing it to be corroded over time. As the *INFODOT* system, engraved codes are obviously neither interactive nor modifiable.
- Micro-Percussion: the code is obtained through the action of a high-speed rotating tungsten carbide drill, in a rapid and economical way. The engraved code is long-lasting, but the disadvantages are the same as those of the previous solutions.

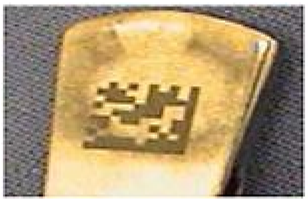

Figure 4.12 Example of laser engraved DATAMATRIX code [Tamagno, 2008]

- *RFID systems*

  Radio-frequency identification (RFID) is a technology that uses communication via electromagnetic waves to exchange data between a terminal and an electronic tag attached to an object, for the purpose of identification and tracking. Radio-frequency identification involves readers and tags (also known as *labels*).

  Most RFID tags contain at least two parts: one is an integrated circuit for storing and processing information, modulating and demodulating a radio-frequency (RF) signal, and other specialized functions; the other is an antenna for receiving and transmitting the signal.

  RFIDs are easy to conceal or incorporate in other items. RFID solutions can be integrated in a software for the surgical instrument management and the identification of the single surgical instruments, and present different advantages:

- tags have longer life than the surgical instruments;
- interactivity, possibility to modify the on-board stored information.

RFID tracking solutions offer more advantages compared to barcode systems, in particular because of the possibility of easily and economically reprogramming the information stored in the tags. Therefore, the availability of such a tracking solution receives a higher scoring.

Indicator evaluation:

- RFID (1 point)
- Barcode (0.5 points)
- Manual tracking (0 points)

2.2 Traceability detail level

The present indicator evaluates if the tracking is performed for each surgical instrument, or at a lower level, tracking only the single kits. The tracking of the single surgical instruments allows a higher accuracy in their management.

Indicator evaluation:

- Single instruments tracked (1 point)
- Single surgical kits tracked (0 points)

2.3 Redesign of surgical kits

Surgical kits may include instruments which show incorrect working and performance, are worn, obsolete or inadequate to the technical evolution. Therefore, it is of utmost importance that regular updates of the kits are performed. A single inadequate instrument can cause the stop of an entire kit if it can't be immediately replaced, and a surgical intervention risks being temporally postponed. Such a condition could cause also delays on the following programmed interventions [Lorenzo Sala].

2.3.1 Existence of an updating plan of the surgical kits

An updating plan requires an accurate examination of every single instrument present in a surgical kit, the removal of inadequate instruments and their substitution with new and/or more modern ones.

Sub-indicator evaluation:

- Yes (1 point)
- No (0 points)

2.3.2 Considered aspects in the updating plan

The following represent the most important characteristics of the surgical instruments to consider during periodical kits updates.

- *Removal of redundant instruments*

Surgical kits may contain different exemplars of the same instruments. Even though this multiplicity can be useful during surgical interventions, it may represent a useless redundancy. If a kit is redundant, that means it is underutilized, some instruments undergo different sterilization cycles without having been utilized for a surgical intervention. This generates avoidable process costs and contributes to incrementing the wear of the instruments, reducing their lifecycle and increasing the probability of the necessity of their maintenance.

- *Removal of incoherent instruments*

Every surgical kit is dedicated to a specific type of surgical intervention, and consequently assembled. If instruments are unused because of their inappropriateness to the surgical intervention of the respective kit, they should be removed.

- *Removal of technically obsolete instruments*

Technically obsolete instruments are not compatible with the modern surgical techniques anymore, because of lacks in their design, ergonomy and quality of the employed materials, which may result insufficient with regard to the present safety norms.

- *Removal of excessively worn instruments*

Worn instruments represent a risk for patients, because they are more fragile in their worn zones. Worn instruments must undergo maintenance treatments. For example, worn scalpels must be sharpened: when the repeated maintenance processes have significantly altered the working surfaces, the instruments should be removed from the kits.

Sub-indicator evaluation:

- All aspects considered (1 point)
- One or more aspects not considered (0 points)

2.3.3 Participation to periodical redesigns of surgical kits

Surgical kits must always be adequate to the nature of the intervention they are dedicated to, and to the evolution of surgical techniques. Different hospital personnel, having frequent contacts with the surgeons, can offer a valid contribution to the choices made while redesigning surgical instrument kits: their perception in regard to the adequacy of a surgical kit may differ consistently from surgeons' perceptions. The professional figures considered are: charge nurses, instrumentalist nurses, technicians from the sterilization department. The present sub-indicator rewards the participation to surgical kits redesigns by the most possible internal professional figures.

Sub-indicator evaluation:

- 3 professional figures (1 point)
- 2 professional figures (0.5 points)
- 1 professional figure or none (0 points)

2.4 Packed or single-use instruments

If kits are uncomplete or include some instruments with any type of problem, the preparation of the operating table may be subject to delays, because it is necessary to find the missing instrument(s), and the surgical procedure may be modified. In these cases, single-use surgical instruments are generally available, or packed surgical instruments in sealed envelopes.

2.4.1 Possibility of using packed and single-use instruments

Even though packed and single-use instruments have the aim of compensating the lack of instruments in surgical kits, we consider positive the possibility of using them, in case of necessity.

Sub-indicator evaluation:

- Yes (1 point)
- No (0 points)

2.4.2 (Annual budget spent for packed or single-use instruments) / (Number of surgical kits available)

The better surgical kits are designed, the less packed or single-use instruments are needed. The present sub-indicator rewards the presence of well designed and updated surgical kits.

Sub-indicator evaluation:

- Less than X (1 point)
- Between X and Y (0.5 points)
- More than Y (0 points)

2.5 Location of the warehouses containing packed and single-use instruments

Surgical kits may be not correctly dimensioned, or contain instruments which are obsolete or in bad condition. In this case, single-use or packed instruments are usually available and stored in apposite warehouses, located on the inside or on the outside of the operating room. If the location is outside, the higher amount of time required to take an instrument in case of necessity presents an obvious disadvantage, and may cause problems while performing a surgical intervention.

Indicator evaluation:

- Inside of the operating room (1 point)
- Outside of the operating room (0 points)

2.6 Presence of multiple exemplars of the most frequently maintained instruments

Some instrument types are particularly subject to wear, and are sent to maintenance statistically more often than other types: for example, scalpels' blades have to be always perfectly sharp.

Surgical kits should always include replacement exemplars of such instruments, to avoid being stopped because of their incompleteness.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

2.7 Presence of additional surgical instruments in the kits, to face predictable clinical complications

Surgical kits are specific for each type of surgical intervention. In case of clinical complications during an intervention, they may be faced using instruments taken from other specialized surgical kits. It can happen that the following programmed surgical intervention is temporally postponed, because it requires the use of that same kit which has been opened for the previous intervention, and that has been already sent to the Central Sterile Supply Department (CSSD). The presence of additional surgical instruments in the kits, which can be sent to the CSSD department after their use, avoids the necessity of opening other kits to face clinical complications, lowering the management costs of surgical instruments.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

2.8 Tracking of the instruments sent to maintenance

Surgical instruments which were sent to maintenance need a following sterilization process; subsequently, they are integrated in their respective surgical kits. The instrument management software used must include the possibility of tracking accurately the instruments sent to maintenance, to avoid uncertainties during the recomposition of the kits in the Central Sterile Supply Department (CSSD).

Indicator evaluation:

- Yes (1 point)
- No (0 points)

2.9 Periodical lubrication of the joints subject to friction

Some instruments show parts which have a reciprocal motion, for example surgical forceps. The joints have to be periodically lubricated, to minimize the instruments' wear.

Indicator evaluation:

- Yes (1 point)

- No (0 points)

2.10 Surgical instrument management software

The scheduling of the surgical kits' use depends on the programmation of the various surgical interventions in the different operating rooms: a surgical instrument management software is needed to accomplish this task.

Indicator evaluation:

- Yes (0 points)
- No (1 point)

4.4.3 Surgical Block

The surgical block contains the core structures of healthcare facilities, those needed to perform surgical interventions. As it appears evident, the most important requirement is the asepsis of the most critical environments. We have identified the following sustainability indicators, which refer to all three sustainability aspects.

3.1 Use of specific modular self-supporting wall and covering systems

Modular wall and covering systems guarantee an optimal and flexible use of the areas assigned to critical hospital wards, where bacterial contamination must be controlled: they allow the reconfiguration of the rooms' layout with a reduced effort. For example, *SHD ITALIA*, a leading company in the production of modular construction systems for healthcare applications, underlines, in addition to the reduced costs and the hygienic warranty of this type of solutions, the following advantages:

- Versatility: in case of layout reconfiguration, it is possible to reorganize the planimetry of different surgical block rooms without interfering with the adjacent rooms. During the construction processes, the system allows to change frequently the project without significative complications.
- Flexibility: when the different surgical block modules have been completed and are active, it is possible to perform maintenances without stopping the room activities, to modify the different service systems for normative adaptations, to implement integrated systems for the management of equipments, to adapt the rooms because of the necessity of environmental protection against ionizing rays propagation, to modify the operative layout because of changes of the healthcare facility management exigencies.

- Innovation, visual impact and environmental comfort: modern prefabricated systems are highly engineered and industrialized and allow to obtain the best visual impact and environmental comfort to the working personnel, thanks to the use of high esthetical quality materials.

[shd.it]

This indicator offers a positive scoring if the surgical block has been built with a modular and reconfigurable structure.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

3.2 Single- or general-purpose operating rooms

The present indicator evaluates if each operating room is designed to perform a specific surgical intervention or a restricted family of interventions (single-purpose rooms), or if every type of intervention can be performed (general-purpose rooms). This second type can guarantee higher performances in terms of sustainability, because the basic medical equipment can be used for a much wider range of medical tasks.

Indicator evaluation:

- General-purpose (1 point)
- Single-purpose (0 points)

3.3 Airborne contamination

The nature of the air flow is very important in operating rooms. Asepsis has to be maintained, and the contamination risk from adjacent rooms has to be avoided. Different solutions are available to satisfy this exigencies. We have listed them through the following sub-indicators:

3.3.1 Presence of laminar air flow conditioning systems

Applying a laminar air flow in the operating room, it is possible to isolate the operating table from the surrounding air, offering high benefits to patients. The much lower post-surgical infection risk causes a highly reduced stay in hospital. This solution can be obtained with special ceiling fans generating a vertical air flow, with low turbulence (laminar flow) and low speed, maintaining the air over the operating table completely sterile.

3.3.2 Presence of surface-sliding doors

This type of doors helps eliminating air turbulence caused by swinging doors, and allows all surfaces to be washed.

3.3.3 Existence of separate paths for non-sterilizable equipment and clean material

This expedient allows to avoid the risk of contaminating clean material, improving the overall asepsis level of the surgical block.

3.3.4 Use of lamps with low aerodynamic profile

Their use helps maintaining the laminar air flow conditions in the operating room [coluccidesign.com].

3.3.5 Application of the UNI E02058560 norm

This norm was released the 5th April 2006 and deals with surgery operating theatre ventilation and air-conditioning systems for contamination control. It refers to their design, construction, commissioning, qualification, management and maintenance
[ediliziainrete.it].
For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

3.4 Colours of the internal walls and furnishings

In a situation of considerable discomfort for the patient, it is important to reassure him. This may be primarily obtained thanks to positive human relationships, but also channelling the energies of the patient towards creativity and optimism. Sensory stimulation, carried out through a comfortable, rich and warm environment, helps maintaining mental and physical balance, encouraging the proper healing process. The use of colour is therefore of particular significance, since colour is the most immediately noticeable aspect of the surrounding environment
[coluccidesign.com].
This indicator assigns a positive scoring if psychological-related aspects of colors on patients where considered during the design and construction of the surgical block.
Indicator evaluation:

- Psychological effects considered (1 point)
- Psychological effects not considered (0 points)

3.5 Application of minimally invasive surgery technologies

Minimally invasive surgery (also called laparoscopic surgery) is a modern surgical technique in which operations are performed through small incisions (usually 0.5–1.5 cm). The key element in laparoscopic surgery is the use of a laparoscope, an instrument through which structures within the abdomen and pelvis can be seen. It uses images displayed on TV monitors for magnification of the surgical elements. Minimally invasive surgery belongs to the broader field of endoscopy [wikipedia.en]. It can be performed either manually by the surgeon, or by robots.

Robot-assisted surgery was developed to overcome limitations of minimally invasive surgery. Instead of directly moving the instruments, the surgeon uses a computer console to manipulate the instruments attached to multiple robot arms. The computer translates the surgeon's movements, which are then carried out on the patient by the robot. Robotic systems can include many features, such as for example integrated tremor filters and the ability for scaling of movements (changing of the ratio between the extent of movements at the master console to the internal movements of the instruments attached to the robot). The console where the surgeon operates is physically separated from the operative workspace. Since the surgeon does not need to be located immediately near to the patient while operating, it can be possible for specialists to perform remote surgery on patients [wikipedia.en].

The following are significative examples of robotic devices:

- *Da Vinci* - *Da Vinci®* is a platform for minimally invasive surgery produced by *INTUITIVE SURGICAL*: the surgeon operates through two small robotic arms, looking through a camera. Both the arms and the camera are inserted into the patient through trocars, with a diameter ranging from about 7 to 12 mm.
- *CyberKnife* - *CyberKnife®*, manufactured by *ACCURAY*, is a stereotactic radiosurgery system. The robot has six freedom degrees and six linear accelerometers. The positions of the points to be irradiated are automatically detected by a system which uses stereoscopic images; the points of interest are automatically reached by the robot. This technology eliminates the need for rigid stereotactic frames, ensuring greater patient comfort.
- *PathfinderTM* - *PathfinderTM* is a commercial robot produced by *ARMSTRONG* for the positioning of instruments in stereotactic neurosurgery. The registration process is done automatically and the accuracy achieved, for interventions on the skull, is sub-millimetric.
- *Mini RCM* and *PAKY* - *Mini RCM* and *PAKY* have been designed and built by Professor Dan Stoianovici of the Johns Hopkins Brady University of Urology. *Mini RCM* is a robotic arm that provides a pivot point for remote surgery. *PAKY* has the task of inserting a needle for the calculus removal in a minimally invasive way.

  [dimec.unige.it]
- Robot-assisted endoscopes

  Endoscopy has developed technologies for non-invasive surgery: the surgeon works on the human body without touching it directly, but visiting its interior through the use of optic fibers and miniature instruments. Robot-assisted endoscopy allows an unlimited precision, using computerized mechanical interfaces [wikipedia.it].

The present indicator rewards the practice of minimally invasive surgery techniques and in particular of robotic surgery.

Indicator evaluation:

- Practice of robotic surgery (1 point)
- Practice of minimally invasive surgery (0.5 points)
- Minimally invasive surgery not practiced (0 points)

3.6 Domotic technology

In the last years, domotic audio-video technologies where introduced in the operating rooms. Domotic devices can be helpful for the patient who can be entertained during preparation and during the surgery, and also for the medical staff as they offer the possibility of an immediate equipment inspection and management.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

3.7 Application of the IEC 60601-1-9 norm

Released in July 2007, the new international standard IEC 60601-1-9 for Environmentally Conscious Design of Medical Electrical Equipment is a collateral standard to the General Standard IEC 60601-1, and has been developed drawing on extensive practical experience at Philips Medical Systems and Siemens Medical Solutions. The Part 9 standard asks manufacturers of medical devices to consider the environmental impacts of their devices throughout the product's entire life cycle and to minimise these where possible. The standard also requires that the manufacturer provides information to the user on how to use the product in the most environmentally sensitive way [wikipedia.en].

Indicator evaluation:

- Yes (1 point)
- No (0 points)

3.8 Surgical block management software

Interesting products exist on the market, able to manage the most important surgical block processes. For example *CHCA*, a company which has been developing and implementing innovative computerized solutions adapted to healthcare management since 1992, produces the software *OPERA* [chca.ca]. The most important aspects which should be considered by the software are:

- operating rooms allocation and management;
- surgical interventions planning;
- staff management;
- electronic medical records management.

A quality surgical block management software is able to allow a healthcare organization to offer better patient care at lower costs, thus improving the economic sustainability.

The present indicator rewards the use of a surgical block management software, which considers the highest possible number of the listed aspects.

Indicator evaluation:

- 3 or 4 aspects considered (1 point)
- 1 or 2 aspects considered (0.5 points)
- Software not used (0 points)

3.9 Annual electric power consumption / annual number of surgical interventions performed

This indicator evaluates the effectiveness of the electric power use in the surgical block, integrating the various consumption contributions due to all different electrical systems.

Indicator evaluation:

- Less than X (1 point)
- Between X and Y (0.5 points)
- More than Y (0 points)

4.5 Hospital Food Service

The food service division can be considered with a high level of sustainability if the management of the foods tries to satisfy the principles of safe and hygienic food handling, serving of genuine foods and respect of cultural and general diversities.

In particular the module will consider the aspect of general machines and equipment and their respect of energy saving normative.

The purchasing of the foods should pay attention to the distance and the quality of the suppliers.

The menus management is important in order to satisfy the need of the very wide range of patient.

A particular attention to the waste management is proposed.

Finally the delivery of foods and the management of them with a specific software is analyzed and assessed.

The module is divided into six parts:

- Machine and equipment
- Purchasing of foods
- Menus
- Waste management
- Food delivery
- Management software
- Personnel

4.5.1 Machine and equipment

<u>1.1 Certified machines</u>

The certifications of the machines in a food service facility is fundamental and of great importance. The Energy Star is the most common certification and devices carrying the Energy Star logo, such as computer products and peripherals, kitchen appliances, buildings and other products, generally use 20%–30% less energy than required by federal standards. [www.energystar.gov]

An other certification which is quite diffused in Europe is the TCO certification, which is particularly focused on office applications like monitors and printers.

This indicator has the function to evaluate how the ensemble of the machine and the equipment in the kitchen are respondent to eco-efficiency principles. It is not easy to evaluate the effective savings of power and other resources that the machines are able to perform, because of the strong connection that the utilization of them presents with the different activities of preparation. We consider a good indicator a general context of certified machines and the purpose of the ward to concentrate the purchasing of the machines and the general equipment on certified components, able to realize a significant saving of energy and resources.

4.5.2 Purchasing of foods

2.1 Use of local foods

A recent trend that the hospital facility are trying to implement is the use of local foods.

Local foods are fresh, genuine. A shorter transportation is required, improving the delivery sustainability and the quality of the food (shorter time of freezing).

The use of local foods in a hospital facility can also have a great impact on local communities, incentivizing the development of local producers.

Examples of 0 km food purchasing in a hospital are located in Adria (RO, Italy) and San Donato Milanese (MI, Italy). These two hospitals, respectively Ospedale di Adria Santa Maria Regina degli Angeli and Policlinico San Donato, founded the 0 km project on the collaboration with local associations and local producers of fruit and vegetables.

[www.vita.it], [www.yourself.it]

The evaluation of this indicator is:

Yes (1 point)

No (0 points)

2.2 Cooked foods prepared into the kitchen

Cooked foods present their best quality if they are served after the cooking, without freezing times and re-heating procedures which are sources of costs and consumption raisings.

The evaluation is:

Yes (1 point)

No (0 points)

2.3 Km of food transportation by external societies

The transportation of foods should be as short as possible in order to guarantee high quality foods and to apply for a sustainable management.

The evaluation is:

< 5 km=1

5 ÷ 10 km=0.6

10 ÷ 15 km=0.3

>15 km =0

2.4 Nutritional analysis made by an expert or by a team in collaboration with the hospital

The nutritional analysis is fundamental for the production and approval of menus. An expert should be assumed in order to conduct critical analysis of the food typologies, time and way of delivery. The collaboration of a team of nutritionists with the hospital food delivery personnel is the best solution, affording high quality of the service and communication between food experts and staff.

The evaluation is:

Yes, by a team (1)

Yes, by an expert (0,5 points)

No (0 points)

2.5 Suppliers apply the HACCP principles

HACCP principles guarantee an optimal and safe management of the foods. In particular seven discrete activities are necessary to establish, implement and maintain an HACCP plan:

1. Conduct a hazard analysis. Identify hazards and assess the risks associated with them at each step in the commodity system. Describe possible control measures.
2. Determine the Critical Control Points. A critical control point is a step at which control can be applied and is essential to prevent or eliminate a food safety hazard, or reduce it to an acceptable level.
3. Establish critical limits. Each control measure associated with a CCP must have an associated critical limit which separates the acceptable from the unacceptable control parameter.
4. Establish a monitoring system. Monitoring is the scheduled measurement or observation at a CCP to assess whether the step is under control, i.e. within the critical limits specified in Principle 3.
5. Establish a procedure for corrective action, when monitoring at a CCP indicates a deviation from an established critical limit.
6. Establish procedures for verification to confirm the effectiveness of the HACCP plan. Such procedures include auditing of the HACCP plan to review deviations and product dispositions, and random sampling and checking to validate the whole plan.

7. Establish documentation concerning all procedures and records appropriate to these principles and their application.

[www.fao.org]

While the food service of the hospital must apply the HACCP because of the law, not all the suppliers are supposed to apply HACCP principles. An accurate investigation of the suppliers credits must betaken into account by the hospital administration.

The evaluation is:

Yes (1 point)

No (0 points)

4.5.3 Menus

<u>3.1 Menus customized by ward</u>

The customization of the menus is an important example of patient service useful to ensure the best food provision. The ward customization of menus consists of a food supply different from ward to ward.

<u>3.2 Menus customized by patients</u>

The patient customization of menus foresees that every patient can receive different meals from the others. There is no standardization and every patient receives a different meal. The meal is however controlled by the nutritional analyst that predisposes a grid of possible meals for the patient in function of his therapy.

<u>3.3 Consideration of feedback from staff</u>

The feedback of the staff is useful for the administration of the food service in order to check the efficiency of the delivery process and the propriety of the machineries and instrumentation used for the food transportation.

The evaluation for these indicators is:

Yes (1 point)

No (0 points)

4.5.4 Waste management

4.1 Reusable dishes and flatware

In order to maintain a sustainability policy the employment of reusable dishes and flatware must be taken into account. Many solutions are available:

- traditional dishes in ceramic
- steel dishes
- hard plastic dishes
- steel flatware
- hard plastic flatware

The use of reusable materials can considerably reduce the amount of waste per meal and the costs of the food management.

4.2 Composting of food waste

Organic food waste are useful to produce plant food for the agriculture sector. The hospital generates a large amount of food waste concentrated in one structure. The management and transportation of this material is easy and cost-efficient. A collaboration of the hospital with local food supplier is a virtuous practice that should be taken into account.

4.3 Recycling of paper and plastic

Even if the meals are served with reusable dishes and flatware, an amount of plastics and paper is to be considered in the final disposal of food waste. All the materials coming from the end of a meal should be collected and differentiated in order to enact a recycling policy of them.

4.4 Monitoring of not served meals

In a hospital where some hundred of beds and relative patients are present there is the possibility that a percentage of meals remains not served or not consumed. We consider a good practice of the hospital a frequent monitoring of the phenomenon in order to minimize the waste of resources.

The evaluation for these indicators is:

Yes (1 point)

No (0 points)

4.5.5 Food delivery

5.1 Cultural problems considered (international patient)

The hospital food service should be able to satisfy any kind of patient. Religious and cultural differences must not represent a barrier to the normal feeding of the patient which needs a correct nutrition in order to reach a complete healing. An advanced food system comprises the preparation of special foods for people coming from other continents. Particular requirements like the impossibility of eating meat or other substances should be kept into account.

The evaluation is:
Yes (1 point)
No (0 points)

5.2 Use of cold chain system

The cold chain system is a temperature-controlled supply chain. An unbroken cold chain is a continuous series of storage and distribution activities which maintain a specific temperature range. It is used to help extend and ensure the shelf life of products such as fresh agricultural produce, frozen food, photographic film, chemicals and pharmaceutical drugs. The cold chain could be managed by a quality management systems, which should analyze, measure, control, document and validate the process. In order to do this a series of instruments is of great importance:

- refrigerator trucks, refrigerator cars and refrigerated warehouse for
- insulated shipping containers or other specific packaging
- temperature data loggers and RFID tags help monitor the temperature history of the product and can determine the remaining shelf life
- documentation of the entire process

The evaluation of this indicator is:
Yes (1 point)
No (0 points)

5.3 Bacteriological monitoring of the served meals

A bacteriologic monitoring program is not requested by any normative. However the transportation of meals through the wards could take a long time, favouring a bacteriological degradation. Food-borne pathogens can multiply if food is not maintained at an appropriate temperature and if there are delays between food preparation and distribution. [Réglier, 2005]

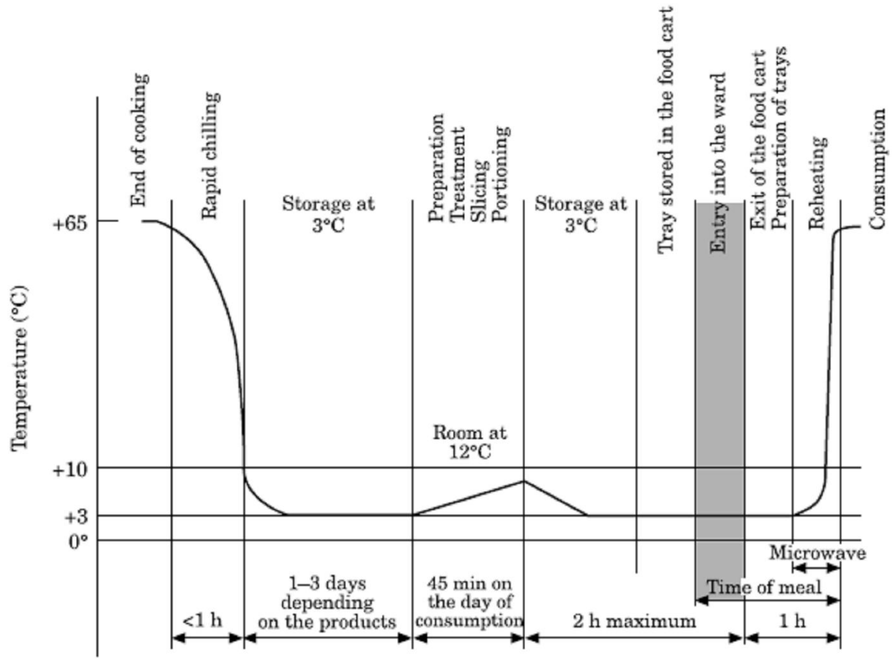

Figure 4.13 : The cold chain in the central kitchen of the hospital. The recommended time and temperature are indicated for each stage from the end of cooking until consumption [Réglier 2005]

A bacteriological control is a good practice that the hospital can put in act in order to keep under control the cold chain process and HACCP principles efficacy.

The evaluation is about the frequency of this test:

Twice a year = 1

Once a year = 0,5

Never = 0

<u>5.4 Hospital food service is ISO 22000 certified</u>

The ISO 22000:2005 specifies requirements for a food safety management system where an organization in the food chain needs to demonstrate its ability to control food safety hazards in order to ensure that food is safe at the time of human consumption.

ISO 22000 specifies requirements to enable an organization

- to plan, implement, operate, maintain and update a food safety management system aimed at providing products that, according to their intended use, are safe for the consumer
- to demonstrate compliance with applicable statutory and regulatory food safety requirements
- to evaluate and assess customer requirements and demonstrate conformity with those mutually agreed customer requirements that relate to food safety

- to effectively communicate food safety issues to their suppliers, customers and relevant interested parties in the food chain
- to ensure that the organization conforms to its stated food safety policy
- to demonstrate such conformity to relevant interested parties
- to seek certification or registration of its food safety management system by an external organization, or make a self-assessment or self-declaration of conformity to ISO 22000 [www.iso.org]

The evaluation is:
Yes (1 point)
No (0 points)

<u>5.5 Assessment of the staff efficiency in the delivery process</u>

An inadequate kitchen staffing level may lead to outbreaks. Recurring themes in outbreak investigations are inadequate levels of staffing in the hospital kitchen, poor training, low wages and lack of support from managers. It is ironic that very high standards of working are required from ancillary workers to prevent outbreaks of foodborne disease in hospitals, yet their remuneration does not necessarily reflect this. [Lund, 2009]
The staff efficiency should be kept under control with assessments and investigations in order to guarantee the safety and quality of the food service.

The evaluation is:
Yes (1 point)
No (0 points)

<u>5.6 Transportation trolley with heating system</u>

The transportation of foods could take a long time in the wards and the last patients could receive a cold meal, which has lost his features or was exposed to insalubrious air. Many solutions are available for a safe transportation of meals which comprises the heating of the foods.

Figure 4.14 : Food delivery trolley equipped with heating system [www.electrolux.com]

Yes (1 point)

No (0 points)

5.7 Transportation trolley with complete solutions of meal preservation

Some solutions go beyond the heating of the meals and provide a complete HACCP management of the foods: a minimized bacterial proliferation through the automatic food heating or cooling.

Figure 4.15 : Food delivery trolley equipped with HACCP system [www.electrolux.com]

The evaluation is:

Yes (1 point)

No (0 points)

4.5.6 Management software

6.1 Availability of a management software

The management software for the food service is useful to provide a service of automatic ordering of the meals and a system of communication between the nutritional analysts and the operating staff (chefs).

6.2 Management software can consider desires of patients, nutritional requirements, diets and intolerances

The software management of the foods can be useful to take into account the requirements that a patient can expose. Special diets of intolerances are an example, but also nutritional requirements for the particular diagnosis or general preferences of the patient. The patient could have the possibility of choosing into a range of meals selected for his situation.

The evaluation for these indicators is:
Yes (1 point)
No (0 points)

4.5.7 Personnel

7.1 Personnel training in good manipulation practices (food safety)

The staff operating in the wards represents the last component of the food delivery chain. As a consequence an in-depth knowledge of the manipulation matters of foods should be possessed by the personnel. This knowledge can be generally and correctly acquired with the participation to update courses on basic practices and new technique and technologies.
We consider as fundamental the approval of a training program for the staff.

7.2 HACCP or similar update courses

HACCP certification organizations (for example TÜV) organize HACCP update courses. The participation to these course or similar is a good practice that the facility can propose to the staff.

For these indicators the evaluation is:
Yes (1 point)
No (0 points)

4.6 Laundry processes and management

The sustainability of the laundry services covers a wide range of aspects.

As first we can consider the machines and the equipment that compose the laundry and certify the compliance with energy saving principles.

Secondly we have to take into account the purchasing of materials, washing tools and articles.

The consumption of energy and of water is fundamental and a management software could help to implement a better supervision of the process.

The particular layout of the laundry could give a more accurate idea of how the laundry is structured.

An evaluation of the quality standards, the process control, the sustainability and safety of transportation methodologies is performed.

The management software of the laundry is also taken into account.

Other general parameters were considered as a final evaluation.

The module is divided into nine parts:

- Machine and equipment
- Purchasing of materials
- Consumption
- Layout
- Quality control
- Process control
- Transportation
- Management software
- General

4.6.1 Machine and equipment

<u>1.1 Certified machines</u>

The certifications of the machines in a laundry is fundamental and of great importance. The laundry presents very high costs and use of resources connected with the consumption voice. The Energy Star is the most diffused certification and devices carrying the Energy Star logo, such as computer products and peripherals, kitchen appliances, buildings and other products, generally use 20%–30% less energy than required by federal standards. [www.energystar.gov]

An other certification which is quite diffused in Europe is the TCO certification, which is particularly focused on office applications like monitors and printers.

This indicator has the function to evaluate how the ensemble of the machine and the equipment in the laundry are respondent to eco-efficiency principles. It is not easy to evaluate the effective savings of power and other resources that the machines are able to perform, because of the strong connection with the different activities of washing and drying. We consider a good indicator a general context of certified machines and the purpose of the ward to concentrate the purchasing of the machines and the general equipment on certified components, able to realize a significant saving of energy and resources.

1.2 Washing machines are in compliance with ISO 8230:2008 (safety requirements)

The ISO 8230 normative is divided into three parts which consider different aspects:

- ISO 8230-1 specifies common safety requirements for dry-cleaning machines. It is applicable to dry-cleaning machines of all sizes intended for industrial and commercial use for the cleaning of articles made of textile, leather, furs and skins, using exclusively either perchloroethylene or combustible solvent as the cleaning medium. deals with all significant hazards arising from the use of the dry-cleaning machine, where “use of the dry-cleaning machine” comprises both intended use and foreseeable abnormal situations and includes commissioning, use and maintenance. It defines the common safety requirements for dry-cleaning machines and is intended to be used in conjunction with ISO 8230-2 and ISO 8230-3.
- ISO 8230-2 specifies safety requirements for dry-cleaning machines that exclusively use perchloroethylene (or “perc”) as their cleaning medium. It deals with the main significant hazards specific to the use of perc, which can lead to the inhalation of unhealthy vapours, to perc contact with the skin (including of the feet) or eyes of the machine operator and those of other personnel and members of the public, as well as to water and ground contamination.
- ISO 8230-3 specifies safety requirements for dry-cleaning machines that use a combustible solvent (CS) as their cleaning medium. It deals with the main significant hazards specific to the use of CS

1.3 Washing machines are in compliance with ISO 9398:2003 (technical requirements)

The ISO 9398 normative is divided into four parts which consider different aspects:

- ISO 9398-1:2002 defines the characteristics of flatwork ironing machines and gives the usual test methods for determining these characteristics with regard to machine capacity, power consumption and hourly productivity. It is applicable for use as a reference in the drafting of purchasing orders for flatwork ironing machines having a contact surface area greater than 0,25 m^2

- ISO 9398-2:2002 defines the characteristics of batch drying tumblers and gives the usual test methods for these characteristics with regard to machine capacity, power consumption and productivity. It is applicable for use as a reference in the drafting of purchasing orders for batch drying tumblers whose net usable cage volume is greater than 160 dm^3 (litres)
- ISO 9398-3:2002 defines the characteristics of washing tunnels and gives the usual test methods for determining machine power consumption and hourly productivity. It is applicable for use as a reference in the drafting of purchasing orders for washing tunnels.
- ISO 9398-4:2002 defines the characteristics of washer-extractors and gives the usual test methods for these characteristics with regard to machine capacity, power and water consumption, and hourly productivity. It is applicable for use as a reference in the drafting of purchasing orders for washer-extractors whose net usable cage volume is greater than 60 dm (litres).

[www.iso.org]

The evaluation of these indicators is:
Yes (1 point)
No (0 points)

4.6.2 Purchasing of materials

<u>2.1 Purchasing choices of chemical products follow sustainability principles</u>

The solvents and detergents used in the laundry process could be hazardous and the employee exposure to hazardous chemicals, such as pesticides, disinfectants, and hazardous drugs in the workplace is to be avoided. An interesting normative about this matter is produced by the Occupational Safety & Health Administration (OHSA) in the United States. The purpose of the standard 1910.1200 is *"to ensure that the hazards of all chemicals produced or imported are evaluated, and that information concerning their hazards is transmitted to employers and employees. This transmittal of information is to be accomplished by means of comprehensive hazard communication programs, which are to include container labeling and other forms of warning, material safety data sheets and employee training."*

[www.ohsa.gov]

A good behaviour of the hospital is to collect information and make a complete assessment of the different possible products in order to address the purchasing choices towards safety and low environmental impact solutions.

2.2 Suppliers are ISO 9001 – ISO 14001 – OHSAS 18001 certified

The three certifications mentioned above involve the Quality Management Systems (ISO 9001), the Environmental Management Systems (ISO 14001) and the Occupational Health & Safety Management Systems (OHSAS 18001). This certifications are indicators of affordability, quality and sustainability of the suppliers. A good evaluation and choice of suppliers should take into account this parameters.

For these indicators the assessment is:
Yes (1 point)
No (0 points)

4.6.3 Consumption

3.1 Consumption monitoring (water, gas, electricity, water softening, compressed air)

One of the highest cost entries and components of unsustainability in a hospital laundry is the consumption of natural resources. Water is used for the washing procedure and a consequent water softening process has to be taken into account. Gas consumption is connected with the heating of water and vapour production. Electricity and compressed air utilization is connected with general services. The monitoring of consumption costs and expenditures are a good practice that the hospital can enact in order to improve the resources utilization control of the hospital.

3.2 Program of consumption efficiency continuous improvement

A further practice able to enhance the consumption control is a program of continuous improvement of the washing process efficiency through the years. The improvement could realize in economic savings, best efficiency ([performance]/[consumption]). An improvement objective must be fixed and reached, with the support of new purchasing solutions and new technologies updates.

3.3 Water properties are regularly checked

The water properties are of great importance for a good washing process. In particular, problems connected with the hardness of the water must be taken into account. Hard water is cause of different diseases:

- Dinginess or greying, yellowing
- General soil build-up
- Weakening of fibers causing tears
- White or gray streaks on coloured fabrics

Calcium and magnesium are the primary minerals that contribute to water hardness. The use of detergents and other solutions can make the water softer, in favour of a optimal laundry process. [www.bae.ncsu.edu], [www.bottegadellacqua.it], [laundry.about.com]

However, this indicator has the purpose to evaluate the practice of monitoring of the water properties.

The evaluation of these indicators is:

Yes (1 point)

No (0 points)

4.6.4 Layout

4.1 Separation between clean and soiled linen with physical barrier or air flux

The soiled and clean linen must be separated in order to prevent the diffusion of bacteria. The separation could be obtained with two main methods:

- a physical barrier obtained through a wall
- a air flux directed from the clean area to the soiled area

The physical barrier guarantees a better separation and less risk of contamination.

The air flux is an intermediate solution.

The evaluation for this indicator is:

Physical barrier (1 point)

Air flux (0,5 points)

No separation (0 points)

4.6.5 Quality control

5.1 Record of problems and malfunctions encountered

The reporting of the problems encountered in the laundry processes or resources management is a good practice against the repeating of errors, useful to strengthen the experience of the staff and to increase the communication level between the workers.

5.2 Regular reporting of personnel activities

Personnel activities like meetings, problems and absences need to be reported in order to improve the communication between the different level of the staff. Furthermore a record should be available for the consultation of managers and controlling activities.

The evaluation for these indicators is:

Yes (1 point)

No (0 points)

4.6.6 Process control

6.1 Maintenance plan for the laundry

The laundry is a complex industrial plant equipped with machines and control systems. A planned maintenance activity is of great importance and guarantees:

- long life of machines
- improvement of operational safety and quality condition
- fewer machines breakdown
- reduced costs of repair

[www.maintenanceworld.com]

The evaluation of this indicator is:

Yes (1 point)

No (0 points)

6.2 Maintenance of the laundry equipment with supplier contract

The maintenance should be put in act by an external society which offers specific competencies, adequate instrumentations, correct and certificated procedures

A good practice of the hospital is to have a specific contract for the maintenance of the laundry machinery and equipment.

The evaluation of this indicator is:

Yes (1 point)

No (0 points)

6.3 How is the maintenance made?

Three kinds of maintenance are possible:

- **Corrective maintenance** can be defined as a maintenance task performed to identify, isolate, and rectify a fault so that the failed equipment, machine, or system can be restored to an operational condition within the tolerances or limits established for in-service operations. This is the most commonly used maintenance approach, but it is easy to see its limitations. When equipment fails, it often leads to downtime in production, and sometimes damages other parts. In most cases, this is expensive. Also, if the equipment needs to be replaced, the cost of replacing it alone can be substantial.
- **Preventive maintenance** can be described as maintenance of equipment or systems before fault occurs. Preventive maintenance activities include partial or complete overhauls at specified periods, oil changes, lubrication and so on. In addition, workers can record equipment deterioration so they know to replace or repair worn parts before they cause system failure. The ideal preventive maintenance program would prevent all equipment failure before it occurs.
- **Predictive maintenance** (**PdM**) techniques help determine the condition of in-service equipment in order to predict when maintenance should be performed. This approach offers cost savings over routine or time-based preventive maintenance, because tasks are performed only when warranted. The main value of Predicted Maintenance is to allow convenient scheduling of corrective maintenance, and to prevent unexpected equipment failures. The key is "the right information in the right time". By knowing which equipment that needs maintenance, the maintenance work can be better planned (spare parts, people etc.) and what would had been "unplanned stops" are transformed to shorter and less "planned stops" thus increasing plant availability.

The three kinds of maintenance are presented in order of better efficiency, safety and cost savings.

The evaluation for this indicator is:

Predictive (1 point)

Preventive (0,5 points)

Corrective (0 points)

4.6.7 Transportation

7.1 Soiled linen enclosed in specific bags

The soiled linen must be closed in specific bags in order to minimize the diffusion of bad odours and prevent the contamination of the air. In figure 4.16 we report an example of specific bags:

Figure 4.16 : Soiled linen bags [soiledlinenbags.com]

7.2 Waterproof bags for infected linen

The infected linen should be enclosed in waterproof bags in order to prevent the leakage of organic liquids.

Figure 4.17: Red impervious bags for infected linen [soiledlinenbags.com]

7.3 Separation between soiled linen and infected linen

Though the infectious linen is soiled linen, a good practice is to differentiate treatment of general soiled linen and infectious linen. Infectious linen generally present higher risk of contamination.

7.4 Water soluble membrane laundry bags for infected linen

In order to avoid contact between laundry staff and infected linen a special kind of bags are produced. To eliminate unnecessary handling of soiled or infected garments and to reduce the effects of unpleasant odours, the water soluble membrane laundry bags are ideal for containing clothing destined for home washing or single garment laundering at a hospital. Garments are placed into the bag and sealed.

The bag is then placed unopened into the washing machine. During the initial wash cycle, the soluble membrane dissolve, releasing the contents of the bag into the washing machine. Once the wash cycle is complete, the clean bag contents can be discarded safely in any municipal waste stream.

Figure 4.18 : Water soluble membrane bags [www.monosol.com]

[www.monosol.com]

7.5 Chromatic differentiation of linen containers

The linen bags or containers must be distinguished each other in order to improve the safety of the laundry process and prevent errors of treating.

7.6 Infected linen is clearly distinguished from the other

The infectious linen is the most dangerous kind of soiled linen and must be clearly distinguished from the other kind of linen bags. For example many hospital facilities use a red bag for the infectious linen.

7.7 RFID or BARCODE identification of uniforms

The uniforms circulating in the hospital are a great number and the washing process must take in account the traceability of all these. The RFID or BARCODE technology is useful for a easier identification process. Each uniform could be fitted with an RFID chip with the size of a button or a BARCODE tag.

For these indicators the evaluation is:

Yes (1 point)

No (0 points)

4.6.8 Management software

The laundry processes often present high management complexity because of the linen mix and of the great amount of them. A management software is advisable because it generally helps the staff with the laundry process, increases the reachable scheduling complexity and minimizes errors and mistakes.

8.1 Management software with productivity analysis

A typical laundry software should offer a service of productivity analysis, that is, the statistical control of the number of textiles processed. This analysis can help to keep under control the efficiency of the process and the reaching of the productivity objectives (textiles per hour).

8.2 Management software with consumption analysis

The management software could also take into account the consumption monitoring (water, gas, detergents). This monitoring activity needs the presence of flow control unit like those presented in figure 4.19. Supporting the productivity analysis, the consumption monitoring enables the calculation of efficiency statistics [washed kg/consumption].

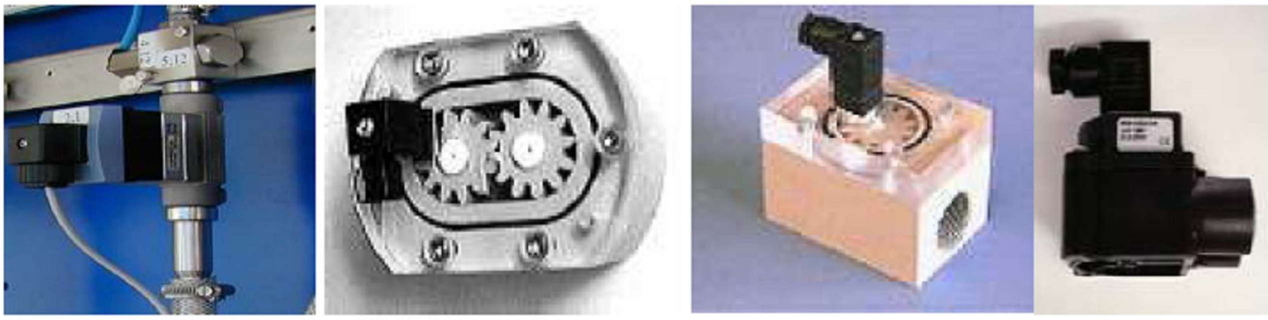

Figure 4.19 : Flow control unit used for product consumption monitoring [www.laundry-sustainability.eu]

8.3 Software with linen identification RFID or BARCODE

The software provides a complete analysis of the laundry process if it recognizes the textiles identification by RFID or BARCODE systems.

The evaluation is:

Yes (1 point)

No (0 points)

4.6.9 General

9.1 Training and educational program for exposure to infections

The main risks connected with the laundry processes are connected with the exposure to infections of the staff. The possibility of contamination can be avoided or eliminated with the implementing of the necessary safety measures. A deep knowledge is required to the staff in order to prevent any risk and to improve the laundry safety.

The participation of the staff to update courses of risk prevention is therefore advisable and an adequate training program should be approved by the administration.

The evaluation is:

Yes (1 point)

No (0 points)

9.2 Monitoring of linen repurchasing rate

It is well known that an amount of linen get lost in the laundry management. A frequent monitoring of the linen repurchasing rate, with the objective to reduce it is considered a good practice of the healthcare facility.

The indicator is:

Yes (1 point)

No (0 points)

9.3 Laundry is internal

Recent experiences demonstrate that an off-site laundry service offers better services to an healthcare facility than an internal laundry service. Therefore we consider a good behaviour of the hospital the use of an external laundry facility.

The evaluation is:

Yes (0 point)

No (1 points)

9.4 Number of uniform for every doctor

The number of uniform for every doctor is useful for the calculation of indicator 9.7.

9.5 Uniform repurchasing rate

The uniform repurchasing rate is a performance indicator of the laundry management.

The evaluation is:

0-10% (1 point)

10% - 20% (0,5 points)

20% - 30% (0 points)

9.6 Automatic delivery of the uniforms

The automatic delivery of the doctor uniforms is an important tool that minimizes the errors of delivery and the employment of staff for the delivery.

The automatic delivery is obtained with a conveyor that holds all the uniforms. The conveyor rotates and delivers the locker-bag automatically at the receiving slot when employees swipe their ID cards or enter the ID number on the pad. Employees can only access their own bag while the others are blocked, they put their belongings into the locker bag after changing and place the bag back on the conveyor. [www.rkconveyors.com]

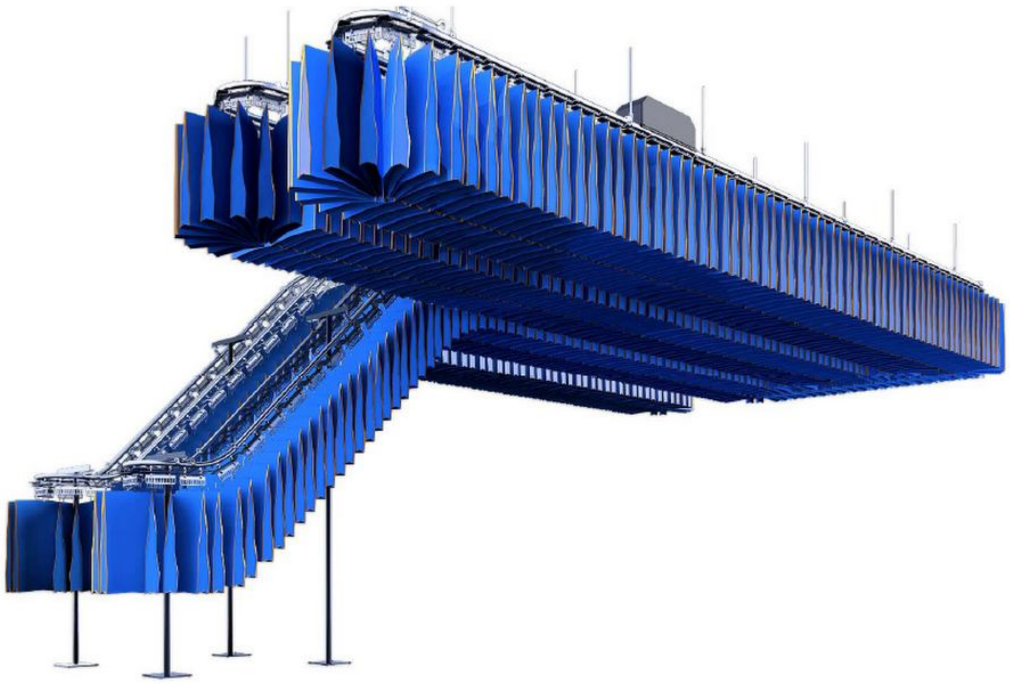

Figure 4.20 : Uniform conveyor [www.rkconveyors.com]

The evaluation is:

Yes (0 point)
No (1 points)

9.7 Trend of [washed kg per year]/[global consumption per year] between different years

This value is useful to compare the efficiency of the laundry service through the years, providing an important indicator of performance.

4.7 Waste management

Hospitals generate large amounts of waste that falls into diverse categories. Medical waste of different composition is produced in hospitals, medical offices and laboratories for analysis, the examination of samples of blood and tissue, etc. Most of it has characteristics similar to those of municipal waste, and therefore can be disposed of together with it. Other specific medical waste, instead, requires special treatment.

Healthcare waste can be divided in the following categories:

1. waste that can be disposed of together with conventional residential refuse;
2. hazardous not infectious waste;
3. hazardous infectious waste;
4. not hazardous waste;
5. waste requiring special disposal methods.

1. Waste that can be disposed of together with conventional residential refuse

This type of waste must not be contaminated with any biological fluids. It must come from wards that don't treat patients with infectious diseases. Typical contents are:

- waste coming from hospital kitchens and food preparations;
- left-over food from staff canteens and patient wards (patients not affected by infectious diseases);
- paper material from administration offices;
- developed X-rays;
- packing material.

All of these can be grouped with residential refuse in terms of disposal and, as such, can be disposed of or recycled under the same regulations. If necessary they may be sterilized or disinfected as a precautionary measure. If facilities are available for waste separation than paper, plastic and silver from X-rays can be recuperated, and the remaining waste buried in landfills or incinerated [Giroletti, 1993].

2. Hazardous not infectious waste

Hazardous not infectious waste includes items that due to their quantity, concentration or characteristics may cause or significantly contribute to increased mortality or an increase in serious, irreversible or incapacitating reversible illnesses. Hazardous waste poses a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Examples include some cleaning and disinfecting chemicals, dental amalgam, disinfectants, fluorescent lamps, laboratory reagents, pharmaceuticals, and radiology/imaging chemicals [mntap.umn.edu].

3. Hazardous infectious waste

Hazardous infectious waste includes items that have the potential to transmit infectious diseases. Examples include laboratory waste, blood, regulated body fluids, sharps, and research animal waste that have not been decontaminated [mntap.umn.edu].

4. Not hazardous waste

Not hazardous waste is built by bulky and not bulky metallic material, glassware, sharps, orthopedic casts; it also includes blood bags and blood, and substances for the preservation of blood.
In addition, to this category belong:

- expired medicines and waste from the laboratories of health services that do not have hazardous characteristics;
- plasters, bandages, gloves, masks, boots, disposable gowns which are not visibly contaminated with blood;
- not hazardous chemical substances.

5. Waste requiring special disposal methods

Special waste is considered medical waste which require particular technical and organizational measures for its disposal. It is critical waste which needs special care through all its steps: from the production to the collection, the intermediate storage and transport and, finally, the treatment. Examples of special waste in the healthcare sector are batteries of medical electronic devices, solvents, photographic chemicals [Ufficio federale dell'ambiente, delle foreste e del paesaggio UFAFP. 2004].

Below we expose a set of sustainability indicators, able to provide a sustainability assessment about the most important healthcare waste management topics. The indicators are divided in three categories:

- Healthcare waste typologies
- Waste disposal companies
- General

4.7.1 Healthcare waste typologies

The present category includes particular indicators, which require to compare the current year values with the average values of the previous 3 years:

(indicator value$_{\text{current year}}$) / (indicator value$_{\text{previous 3 years}}$)

They assign a positive scoring if the ratios are <1 or >1, depending on the indicator type: the comparison with the average value of the previous 3 years provides useful information about the behaviour of the healthcare facility in relation to sustainability subjects.

1.1 Hazardous infectious waste

We have identified the following 3 sub-indicators:

1.1.1 Percentage on the total annual amount of waste

The comparison with the previous year's values provides a useful information, because not hazardous waste is often disposed of as if it were hazardous infectious waste, with increased costs and complications [Osservatorio Nazionale sui Rifiuti]. Healthcare facilities should try to minimize these errors. The total amounts can be expressed in kilograms or tons.

1.1.2 Mass-specific disposal costs

As for the previous sub-indicator, the waste amount can be expressed in kilograms or tons. Hazardous infectious waste must undergo sterilization processes for its disposal: if the specific disposal costs have decreased compared to the previous year, it means that the healthcare facility has found better economic conditions with the disposal providers, improving its economic sustainability.

For the sub-indicators listed above, the evaluation is the following:

- Value$_{\text{current year}}$ / Average value$_{\text{previous 3 years}}$ <1 (1 point)
- Value$_{\text{current year}}$ / Average value$_{\text{previous 3 years}}$ >1 (0 points)

1.2 Hazardous not infectious waste

Hazardous not infectious waste can be sent either to recovery or to disposal.

1.2.1 Percentage of waste sent to recovery

The present sub-indicator assigns a positive scoring if the percentage amount of waste sent to recovery has increased in comparison to the previous year. We have decided to let the environmental aspect of sustainability prevail over the economic one: even if recovery costs might be higher than disposal costs, we consider an environmental impact reduction preferable to a cost reduction.

Sub-indicator evaluation:

- $Value_{current\ year}$ / $Average\ value_{previous\ 3\ years}$ >1 (1 point)
- $Value_{current\ year}$ / $Average\ value_{previous\ 3\ years}$ <1 (0 points)

1.2.2 Mass-specific disposal costs

This sub-indicator rewards a reduction in the mass-specific disposal costs compared to the previous year, in other words the ability of finding more convenient disposal contracts with the specific companies.

1.2.3 Mass-specific recovery costs

This sub-indicator rewards a reduction in the mass-specific recovery costs compared to the previous year, in other words the ability of finding more convenient recovery contracts with the specific companies.

For the sub-indicators listed above, the evaluation is the following:

- $Value_{current\ year}$ / $Average\ value_{previous\ 3\ years}$ <1 (1 point)
- $Value_{current\ year}$ / $Average\ value_{previous\ 3\ years}$ >1 (0 points)

1.3 Not hazardous waste

As the hazardous not infectious waste, not hazardous waste can be sent either to recovery or to disposal.

1.3.1 Percentage of waste sent to recovery

If the percentage amount of waste sent to recovery has increased in comparison to the previous year, the present sub-indicator assigns a positive scoring.

1.3.2 Percentage of disposal costs spent for the public disposal service

Not hazardous waste can be disposed of also through public disposal services. We consider an increase in the use of public services positive in terms of sustainability, since it stimulates an increase of their efficiency, making their service of higher interest also for other healthcare facilities [Osservatorio Nazionale sui Rifiuti].

Sub-indicator evaluation:

- $Value_{current\ year}$ / $Average\ value_{previous\ 3\ years}$ >1 (1 point)
- $Value_{current\ year}$ / $Average\ value_{previous\ 3\ years}$ <1 (0 points)

1.3.3 Mass-specific disposal costs

This sub-indicator rewards the ability of finding more convenient disposal contracts with the specific companies.

1.3.4 Mass-specific recovery costs

This sub-indicator rewards the ability of finding more convenient recovery contracts with the specific companies.

For the sub-indicators listed above, the evaluation is the following:

- $\text{Value}_{\text{current year}}$ / Average $\text{value}_{\text{previous 3 years}}$ <1 (1 point)
- $\text{Value}_{\text{current year}}$ / Average $\text{value}_{\text{previous 3 years}}$ >1 (0 points)

1.4 Waste that can be disposed of together with conventional residential refuse

This type of waste can be sent either to recovery or to disposal.

1.4.1 Percentage of waste sent to recovery

If the percentage amount of waste sent to recovery has increased in comparison to the previous year, the present sub-indicator assigns a positive scoring.

1.4.2 Percentage of disposal costs spent for the public disposal service

We consider an increase in the use of public services positive in terms of sustainability, since it stimulates an increase of their efficiency, making their service of higher interest also for other healthcare facilities [Osservatorio Nazionale sui Rifiuti].

Sub-indicator evaluation:

- $\text{Value}_{\text{current year}}$ / Average $\text{value}_{\text{previous 3 years}}$ >1 (1 point)
- $\text{Value}_{\text{current year}}$ / Average $\text{value}_{\text{previous 3 years}}$ <1 (0 points)

4.7.2 Waste treatment companies

Healthcare facilities outsource different waste disposal services, and the contracting companies must guarantee specific standards complying to existing norms. Below we present the most significative indicators we have identified.

2.1 Certifications

Different certifications can prove that companies follow best practices related to internal processes and pursue environmental performances. Choosing to collaborate with companies showing these requirements, healthcare facilities demonstrate their commitment and interest for sustainability related aspects. Some of the certifications presented below have been already introduced in the first chapters of the present work.

2.1.1 UNI EN ISO 9001

The *ISO 9000* family of standards relates to quality management systems, and is designed to help organizations ensure they meet the needs of customers and other stakeholders. *ISO 9001* deals with the requirements that organizations wishing to meet the standard must have. *ISO 9001:2008 Quality management systems - Requirements* is a document of approximately 30 pages which is available from the national standards organization in each country [wikipedia.en]. It defines minimum quality system requirements for design/development, production, installation and servicing. It applies to manufacturing and service businesses engaged in all these activities [iso.org].

ISO 9001 is by far the world's most established quality framework, currently being used by more than one million organizations in 178 countries worldwide, and sets the standard not only for quality management systems, but management systems in general.

It helps all kinds of organizations to succeed through improved customer satisfaction, staff motivation and continual improvement. In addition, *ISO 9001* is designed to be compatible with other management systems standards and specifications, such as *BS OHSAS 18001 Occupational Health and Safety* and *ISO 14001 Environment.* They share many principles and can be integrated seamlessly through Integrated Management [iso.org].

2.1.2 UNI EN ISO 14001

The *ISO 14000* environmental management standards exist to help organizations:

- minimize how their operations (processes etc.) negatively affect the environment, for example cause adverse changes to air, water, or land;
- comply with applicable laws, regulations, and other environmentally oriented requirements;
- continually improve in the above.

ISO 14001 is part of a family of 16 international *ISO 14000* standards designed to assist companies in reducing their negative impact on the environment. *ISO 14001*, as with other *ISO 14000* standards, is voluntary. The fundamental principle and overall goal of the *ISO 14001* standard is the concept of continual improvement. The norm is based on the Deming cycle, the Plan-Do-Check-Act methodology [Lepore, 2003].

2.1.3 OHSAS 18001

OHSAS 18001 is an internationally recognized assessment specification for occupational health and safety management systems. The norms can be adopted by any organization wishing to implement a formal procedure to reduce the risks associated with health and safety in the working environment for employees, customers and the general public, and represents a reference point for social sustainability-related themes.

OHSAS 18001 has been designed to be compatible with *ISO 9001* and *ISO 14001*, to help organizations meet their health and safety obligations in an efficient manner.

The following key areas are addressed by *OHSAS 18001*:

- Planning for hazard identification, risk assessment and risk control
- Structure and responsibility
- Training, awareness and competence
- Consultation and communication

- Operational control
- Emergency preparedness and response
- Performance measuring, monitoring and improvement

[bsigroup.com]

2.1.4 EMAS

The Eco-Management and Audit Scheme is a voluntary instrument created by the European Community. It introduces some key performance indicators (KPIs) which regard, among others, the following environmental themes:

- Energetic efficiency: the overall direct energy consumption (MWh), and the overall renewable energy consumption (in percentage).
- Material efficiency: the annual mass flow of used materials (tons), excluding water and energy.
- Water: the total annual water consumption (cubic metres).
- Emissions: the total annual greenhouse gas emissions (CO_2, CH_4, N_2O, HFC, PFC and SF_6, expressed in tons of CO_2 equivalent), and the total annual SO_2, NO_X and PM (kilograms or tons) emissions in the atmosphere.

2.1.5 UNI EN ISO 16001

The present norm represents the European standard for Energy Management Systems. It is based on Deming's Plan-Do-Check-Act cycle, and presents requirements for establishing an energy policy with concrete objectives: actions to reduce and monitor energy use, verifying energy savings and planning improvements are put in place. The norm offers a comprehensive set of guidelines to meet carbon emissions reduction requirements, and is based on regulatory compliance and has the same structure as ISO 14001.

The norm can be easily integrated to existing Quality, Safety and/or Environmental Management Systems, therefore considering all three aspects of sustainability [bureauveritas.it].

2.2 Services included in the subscribed treatment contracts

Companies providing healthcare waste disposal can offer different useful basic services, which we list in the following sub-indicators. We consider a high number of outsourced services positively, because it offers to a company highly specialized in the waste treatment the possibility of continuously improving its core processes.

2.2.1 Provision of waste containers

Since there exist many typologies of healthcare waste, there exist various types of waste containers which must be provided for their collection.

Figure 4.21 : Different types of waste containers [allstarbiomedicalservices.com]

2.2.2 *Waste collection and packaging*

Planning and scheduling of waste collection processes in a healthcare facility can be optimized if outsourced to specialized companies. After its collection, waste must be packaged: the aim of a good waste packaging is to ensure that little or no hazard is presented to personnel involved in handling, transporting or disposing of the waste.

- Non-risk waste:

  The majority of non-risk waste is of a domestic nature and requires no specific packaging measures. It is disposed of as domestic or commercial waste, usually in black plastic sacks, bins, skips or containers. Also included in this category are those wastes which, while assessed as non-infectious, may be regarded as potentially offensive. Such material, from an infection control perspective, does not need any special treatment or packaging prior to disposal.

- Risk waste:

  Two different types of packagings are used for healthcare risk waste, bags or sacks, and rigid containers in the form of bins or sharps boxes. The bags are made of plastic film or, sometimes, plastic or wax-coated paper. Rigid containers are generally made from plastic, but corrugated cardboard is also used. The bags are used to hold soft materials that do not contain sharp objects or liquids. Rigid containers are used for other forms of waste and for waste containing small amounts of free liquids. Rigid containers are also used for infectious substances and other risk wastes, such as used sharps, pharmaceuticals and cytotoxic material which may be inherently hazardous.

[Department of Health and Children, Ireland, 2010]

2.2.3 Waste transportation

Rules aimed at improving safety in the transportation of all types of dangerous goods have been agreed internationally for different modes of transport. These set down very specific requirements for the classification, packagings, labelling and documentation of dangerous goods as well as the training of personnel involved in the transport of such dangerous goods

[Department of Health and Children, Ireland, 2010].

2.2.4 Storage and handling of healthcare waste on site

Storage on-site normally consists of waste sub-collection stations or areas dispersed throughout the hospital and a central waste store or marshalling yard to which all streams of the hospital's waste are periodically brought. After permanent sealing and tagging, primary healthcare risk waste packaging should be stored in the designated sub-collection area at the point of origin (e.g. ward, clinic) until collection. Primary healthcare risk waste packages must not be stored loose in corridors or other locations accessible to unauthorised personnel. Wheeled bins should be parked with brakes on in the designated healthcare risk waste storage area, so that primary healthcare waste packages can be placed in them directly after sealing and tagging

[Department of Health and Children, Ireland, 2010].

2.2.5 Recovery

Some companies are specialized in both waste disposal and recovery, representing optimal partners for healthcare facilities [Osservatorio Nazionale sui Rifiuti].

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

2.3 Waste weighting modalities

The waste disposal costs depend on the quantity of produced waste, therefore the exact determination of the waste weight is essential. A precise waste weighting is a practice which influences the economic sustainability of a healthcare facility, because it avoids the possibility of a wrong weight determination by third waste disposal companies.

There are three different waste weighting modalities:

- exact weighting is effectuated at the healthcare facility, before delivering the waste to third companies;
- weighting is assumptively effectuated at the healthcare facility;
- weighting is effectuated by waste treatment companies (outsourced).

The first of the three listed alternatives represents the best solution, even though it may be more expensive; it is inadvisable to effectuate only a presumed weighting, to guarantee the highest possible transparency [Osservatorio Nazionale sui Rifiuti].

Indicator evaluation:

- Exact weighting (1 point)
- Presumed weighting (0.5 points)
- Weighting outsourced (0 points)

2.4 Sale of waste X-ray plates

Waste X-ray plates can be sold to specialized companies, which provide to the recovery of the silver contained in them [Osservatorio Nazionale sui Rifiuti].

Indicator evaluation:

- Yes (1 point)
- No (0 points)

4.7.3 General

In the present category we show some other important indicators which involve sustainability-related aspects of the healthcare waste management.

3.1 Total waste production in kg/bed/day

The present indicator represents the patient- and time-specific waste amount produced by a healthcare facility. Since it is not possible to establish "sustainable" reference values, because the waste amount depends on the specific activities which are carried out in the single facility, we suggest to compare the value of the current year with the value of the previous year, to verify if an improvement has taken place.

Indicator evaluation:

- $Value_{current\ year} / Value_{previous\ year} < 1$ (1 point)
- $Value_{current\ year} / Value_{previous\ year} > 1$ (0 points)

3.2 Training courses for the healthcare personnel about healthcare waste-related topics

Training courses organized at healthcare facilities are very important to make the personnel aware of sensitive waste-related topics, such as for example the minimization of the produced waste and the correct waste handling. The present indicator impacts on both the social and the economic sustainability: on the first one because it reduces the risks for the personnel to actuate wrong behaviours, on the second one because its aim is the optimization of the waste management processes, which implies an overall cost reduction.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

3.3 Sustainability interventions

Below we show some indicators aimed at improving the sustainability through waste-related practices.

3.3.1 Introduction of new waste separate collection modalities in the current year

The present sub-indicator rewards the introduction of any new type of separate collection method introduced in the considered year, and involving any type of healthcare waste.

3.3.2 Lyfe Cycle Assessment (LCA) considerations about materials and equipment supplies

A life cycle assessment is a technique to assess each and every impact associated with all the stages of a process from cradle-to-grave (i.e., from raw materials through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling). LCA’s can help avoid a narrow outlook on environmental, social and economic concerns. The goal of LCA is to compare the full range of environmental and social damages assignable to products and services, to be able to choose the least burdensome one. At present it is a way to account for the effects of the cascade of technologies responsible for goods and services [wikipedia.en].

3.3.3 Preferential use of chlorinated plastics-free materials and equipment

Chlorinated plastics contain chlorine/chloride, and are found for example throughout the building material industry in resilient flooring, wall covering, wiring and cable sheathing. Although chlorinated plastics, such as for example PVC (polyvinyl chloride), don't have direct toxicity, they present waste management problems by acting as a source of organic-bound chlorine to the waste stream. The formation and release of hazardous substances can result under certain recycling and disposal processes, including the formation of products of incomplete combustion, particularly during certain substandard processes such as open burning. Of particular concern is the potential for the formation of chlorinated dioxins and furans under these conditions, which represent highly toxic environmental toxins [chemsec.org].

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

3.4 Presence of dedicated paths for the waste evacuation from the wards

Paths for the waste evacuation must be different from the paths used for the transport of other clean material, to avoid the risk of its contamination.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

3.5 Solvents, reagents, expired pharmaceuticals and other chemical risk liquids

Below we present some sub-indicators related to the transport of chemical products.

3.5.1 Use of trolleys equipped with containment vessels

During the waste transport from the wards to the temporary storage units, it is important to use trolleys equipped with containment vessels for liquid materials, capable of receiving any spillage of material.

3.5.2 Presence of impermeable bags on the internal side of the waste containers

Impermeable bags represent an additional barrier to the eventual spillage of liquid waste material, and represent a precaution in favour of the environmental and social sustainability: liquid spillages could seriously compromise the safety of the surrounding environment.

3.5.3 Application of labels to waste containers and drums also in case of intermediate storage

Well readable labels and warnings allow to univocally recognize waste containers and their level of dangerousness.

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

3.6 Waste-related data

Below we show some sub-indicators which impact on both the environmental and the economic sustainability.

3.6.1 Waste management software

An informative system can help for the monitoring and for an optimized management of the internal waste flows, significantly reducing waste management costs.

3.6.2 Detail of internal waste-related data at single ward level

A high detail level in the knowledge of single internal waste sub-streams can considerably increase the quality and the effectiveness of the overall waste management.

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

3.6.3 Tracking modalities of the waste containers

The present sub-indicators evaluates if the waste containers are tracked manually, or using barcode or RFID solutions:

- Manual tracking consists in writing on a book all the movements of every single container, and presents a lot of disadvantages: time-consuming, high error probability, impossibility to track and recognize the single container in a univocal way. It is possible to use non-univocal identification systems such as coloured adhesive tapes applied on the surface of the containers
- A barcode is an optical machine-readable representation of data, which shows information about the object to which it attaches. Originally, barcodes represented data by varying the widths and spacing of parallel lines, and may be referred to as linear or 1 dimensional. Later they evolved into rectangles, dots, hexagons and other geometric patterns in 2 dimensions
- Radio-frequency identification (RFID) is a technology that uses communication via electromagnetic waves to exchange data between a terminal and an electronic tag attached to an object, for the purpose of identification and tracking

RFID tracking solutions offer more advantages compared to barcode systems, in particular because of the possibility of easily and economically reprogramming the information stored in the tags. Therefore, the availability of such a tracking solution receives a higher scoring.

Sub-indicator evaluation:

- RFID (1 point)
- Barcode (0.5 points)
- Manual tracking (0 points)

4.8 Logistic processes

Logistic processes represent one of the core activities in healthcare facilities, since many different logistic tasks have to be carried out: for example, the transport of patient beds and of all medical and non-medical equipment between the different hospital wards. Modern technological solutions allow to improve the economic, environmental and social sustainability of logistic tasks, allowing an optimization of the storage and transport activities. The use of personnel to carry out repetitive tasks can be avoided thanks to the use of modern internal transport and warehousing technologies. Below we show a list of indicators allowing a sustainable management of logistic processes.

4.8.1 Internal automated transport systems

Material transport processes in a healthcare facility can be on-demand or scheduled. For example, transport of drugs, specimens, samples, blood products or sterile goods require an immediate response; scheduled material transport is usually for larger volumes within special containers. Typical logistic processes with scheduled material transport include the transport of food, linens or waste.

The following sub-indicators represent the current available technologies for the healthcare materials transport automation.

<u>1.1 Pneumatic tube system</u>

Pneumatic tube systems are systems in which cylindrical containers, called carriers or capsules, are propelled through a network of tubes by compressed air or by partial vacuum. Pneumatic tube networks gained great prominence in the late 19th and early 20th century for businesses or administrations that needed to transport small but urgent packages over relatively short distances (within a building, or, at most, within a city). Some of these systems grew to great complexity, but they were eventually superseded by more modern methods of communication and courier transport, and are now much rarer than before. However, in some settings, such as hospitals, they remain of great use, and have been extended and developed further technologically in recent decades. Modern systems reach speeds of around 7.5 m/s. Further, modern systems can also be computer-controlled, allowing, among other things, the tracking of any specific capsule. Varying air pressures also allow capsules to brake slowly, making the systems suitable for fragile contents [wikipedia.en].

Swisslog is the leading world provider of pneumatic tube systems; modern carriers can contain a weight of up to 7 kg each [swisslog.com].

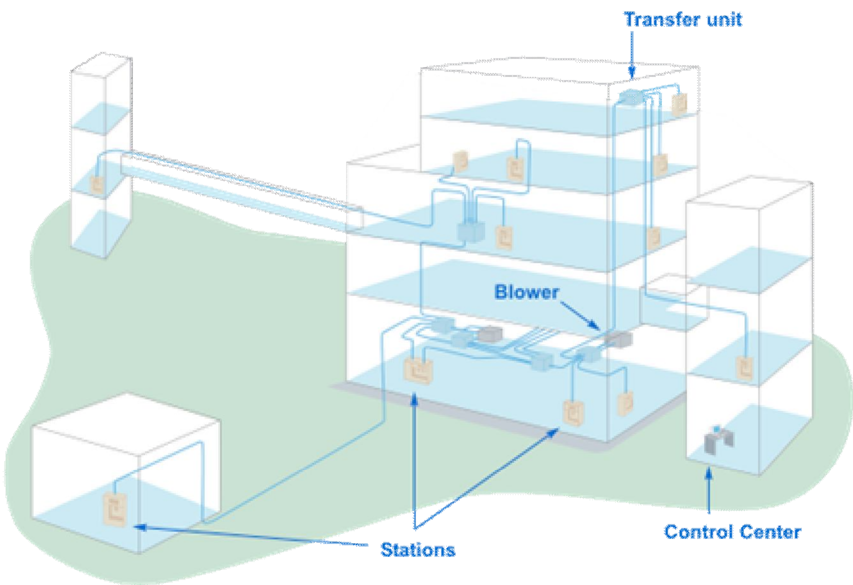

Figure 4.22 : Functional scheme of a pneumatic tube system [swisslog.com]

A pneumatic tube system is composed by the following elements:

- Blower: system blower packages provide vacuum and pressure to move carriers throughout the tube system.
- User stations: stations are combined sending and receiving units, each featuring a control panel.
- Transfer units: transfer units are switching devices used at branching points in a system to direct the path of a carrier from one route into another to its final destination.
- Control center: system control centers are used by hospital engineering and operation departments to configure the system, monitor system operations, schedule system operations and troubleshoot system errors.
- Carriers: carriers are the transporting "vehicles" for medical items within the hospital. Carriers are available in various lengths, can be tracked with RFID systems and can be for example leak resistant or antimicrobial, depending on the transported material.

Examples of transported materials are: materials and supplies, documentation, pharmaceuticals, laboratory specimens, blood products, sensitive medical items.

1.2 Automated guided vehicles

An automated guided vehicle (AGV) is a mobile robot, most often used in industrial applications to move materials around a manufacturing facility or a warehouse. In the last years, AGV technologies have been successfully applied also in the healthcare sector. AGVs increase efficiency and reduce costs by helping the automation of materials transport.

AGVs can work with different navigation modalities:

- Wired: A wired sensor is placed on the bottom of the robot and facing the ground. A slot is cut in the ground and a wire is placed approximately 1 inch below the ground, building a path. The sensor detects the radio frequency being transmitted from the wire, and the AGV follows the path.
- Guide tape: Many AGVs use tape for the guide path. The tapes can be one of two styles: magnetic or coloured. The AGV is fitted with the appropriate guide sensor to follow the path of the tape.
- Laser target navigation: The wireless navigation is done by mounting retroreflective tape on walls, poles or machines. The AGV carries a laser transmitter and receiver on a rotating turret. The laser is reflected by the retroreflective tapes, and distances are automatically calculated and stored into the AGV's memory.
- Gyroscopic navigation: A computer control system directs and assigns tasks to the vehicles. Transponders are embedded in the floor of the work place. A gyroscope is able to detect the slightest change in the direction of the vehicle and corrects it in order to keep the AGV on its path.
- "Natural features navigation": Navigation without retrofitting of the workspace is called "natural features navigation". One method uses one or more range-finding sensors, such as a laser range-finder, as well as gyroscopes and/or inertial measurement units.

[wikipedia.en]

Automated guided vehicles can move routine and on-demand deliveries of bulk materials. They offer many benefits, such as redirecting operating costs through scheduled transport, reducing the potential for injury by eliminating manual transport, and ensuring the timely delivery of materials.

Figure 4.23 : A Swisslog AGV carrying a healthcare trolley [swisslog.com]

AGVs can be extremely helpful for the materials management in healthcare facilities, since they can be used for the transport of trash, linens, meals and various supplies. A central computerized control system can coordinate an entire AGV fleet, automating the logistic processes of a healthcare facility dramatically.

1.3 Electric track vehicles

Track Vehicle Systems transport medium sized materials weighing up to 14 kg at 1 m/s [swisslog.com]. Containers designed to hold specific contents are mounted on individually powered vehicles travelling at walking speeds within a network of tracks running overhead and behind walls in healthcare facilities.

Typical applications are the movement of routine and non-routine items such as blood, laboratory specimens, X-rays, documents, pharmaceuticals, medical records [swisslog.com].

Figure 4.24 : Swisslog UNICAR electric track vehicle system [swisslog.com]

1.4 Autonomous mobile robots

Autonomous mobile robots (AMRs) provide either on-demand or scheduled transport of payloads weighing up to 50 pounds, thereby filling the materials transport void between a pneumatic tube system (on-demand light loads) and an automated guided vehicle system (scheduled heavy bulk loads). Autonomous mobile robots have a sophisticated obstacle avoidance system and can interface with automatic doors. Added features, including elevator interfaces and a lockable payload compartment, allow the robots to navigate multiple floors and departments throughout the entire hospital. The primary benefit of AMRs is increased operational efficiency. They can automatically return to charging dock when not in use.

Figure 4.25 : Swisslog autonomous mobile robots [swisslog.com]

The automation solutions proposed through the technologies shown above can strongly improve the economic sustainability of a healthcare facility, since they allow an analytical optimization of the logistic processes. The sub-indicators presented reward the use of the described transport systems in the considered facility.

1.5 Planning and optimization of internal transport systems

Effective internal transport systems represent a lever to influence the economic sustainability. A low saturation level of the handling vehicles, or strong inefficiencies can cause a waste of resources that lowers the sustainability of a healthcare facility. An external engineering consulting company, with a solid experience, can produce a real optimization of complex transport solutions. The paths for the transport activities of goods must be as short as possible during a typical displacement action and, in addition, they must be derived from a study aimed at optimizing internal traffic and reducing interferences between the moving vehicles and human operators, in order to increase the safety of employees at work.

The evaluation will be positive if, in the last 10 years, projects were developed by external consultants to optimize the use and the number of material handling means, or to introduce new internal automatic transport solutions [tesina warehousing].

1.6 Use of electric ambulances for internal transports

Electric ambulances allow a strong improvement in the overall environmental and economic sustainability performances of a healthcare facility, because of the total absence of harmful emissions and the extremely low costs of the battery charges. For example, *Blu Vision Electric Vehicle* produces fully electric ambulances, with 30 to 60 kW engines and a fuel cost up to only 1.3 € / 100 km [ambulanze.it].

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

4.8.2 Material storage

The above listed sub-indicators describe useful practices to improve the effectiveness of the material storage in a healthcare facility.

2.1 Use of automated storage/retrieval systems

An automated storage and retrieval system (ASRS or AS/RS) consists of a variety of computer-controlled methods for automatically placing and retrieving loads from specific storage locations [wikipedia.en]. These loads can be medical items or items of different nature.

Automated warehouse systems allow an optimized integration of the storage logic (loading and unloading of goods) and the paths of automated transport means, ensuring high economic and environmental performances through an optimal resource use. An example of application of automated warehouse solutions is the Niguarda Hospital Ca' Granda Milan: different automated warehouses are installed in its logistic and technological pole.

Sub-indicator evaluation:

- Yes (1 point)
- No (0 points)

2.2 Warehouse Management System (WMS)

A warehouse management system, or WMS, aims to control the movements and storage of materials within a warehouse and process the associated transactions, including sending, receiving, put-away and picking. The system also directs and optimizes stock put-away based on real-time information about the status of bin utilization [wikipedia.en].

The present sub-indicator evaluates if a WMS is used in the facility, and if it is integrated with the facility's general software platform.

Sub-indicator evaluation:

- Presence of a WMS integrated with the general platform (1 point)
- Presence of a WMS not integrated with the general platform (0.5 points)
- WMS not used (0 points)

2.3 Traceability technology adopted for the hospital assets

Healthcare facilities must face the complex task of managing an enormous range of different assets to provide daily care: their location must be ideally known in real-time, to make them immediately available for all the required applications.

The layout of a typical hospital with multiple floors and numerous departments doesn't make it easy for medical engineering teams to manage their inventory of equipment. Nurses also often spend a considerable portion of their time searching for medical equipment.

A hospital wide RFID asset tracking system can provide high benefits, allowing to quickly locate the nearest available device. Benefits are represented not only by the time saving, but also by a higher asset utilisation due to their increased visibility. This can lead to greater efficiency levels and ultimately significant steps can be achieved in the overall financial performance of a hospital, improving its economic sustainability [harlandsimon.co.uk].

Sub-indicator evaluation:

- RFID (1 point)
- Barcode (0.5 points)
- Manual tracking (0 points)

2.4 Identification codes readable by human operators

The present sub-indicator evaluates if the stored material shows, in addition to the barcode labels or RFID tags, codes which are clearly readable by human operators. In this way, the described redundancy can compensate in case of malfunctioning of the electronic reading systems.

Sub-indicator evaluation:

- Yes (1 point)
- No (0 points)

2.5 Use of the Voice Picking technology

The main objective of Voice Picking is the use of voice as a mean of communication between the Warehouse Management System and the operator.

Voice Picking uses voice recognition technology: the operator is equipped with a terminal fixed on his belt or in his pocket, he receives vocal orders through an headset and validates or transmits information through a microphone. It is possible to include controls in the process (the operator must vocally confirm the prepared quantity, the picking adress, etc.).

The benefits of Voice Directed Picking on the productivity are significant:

- the operator is more focused on his missions;

- the operator piloting is made step by step;
- both hands are available;
- it is not necessary to the operator to remove its gloves;
- it is not necessary to print documents;
- picking errors are reduced;
- warehouse productivity savings;
- unnecessary movements reduction (the information is real time communicated);
- reduction of training effort (more intuitive technology);
- reduction of accidents risk (in certain environments).

Considering the aspects listed above, we can deduce that Voice Picking technologies has significative impacts on both the social and the economic sustainability, on the one side by simplifying the operator tasks, on the other side by optimizing the picking procedures, producing cost savings [free-logistics.com].

2.6 Restricted access to storage area

Storage area must be secured with a lock and key; the access must be possible during normal working hours, but limited to authorized personnel.

2.7 Planning of the storage logic

In the effort to reduce costs, optimize resources and therefore increase the sustainability, the physical structure of the warehouse must be taken into account: factors such as the number and height of the shelves, the number of the veins, the distance between the shelves and the input or output zones directly influence the duration of the warehousing activities and consequently their costs. The criteria for the storage of goods can follow the logic of random allocation in the spaces available, or use optimization logics. For example, products and materials of medical and non-medical nature having expiry dates must be stored with a FEFO (First Expiry, First Out) criterion, to avoid the necessity of eliminating expired material causing a waste of resources.

The evaluation will be positive if, in the last 10 years, projects were developed by external consultants to better manage the material storage [tesina warehousing].

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

4.8.3 Patient management

In modern healthcare facilities, the patient can pass through many "productive areas" to complete its diagnostic and therapeutic procedures, such as, for example: emergency room, ambulatory, surgical block, intensive care, acute and post acute inpatient areas. Governing and planning the management of these areas is increasingly important in order to avoid potential negative impacts on safety, effectiveness and efficiency of care processes, such as:

- delays in the performance delivery;
- long waiting times;
- inappropriateness of the care setting;
- prolonged hospital stays;
- resources waste;
- activities overload, leading to increased stress in staff;
- increase of the error probability.

[Bensa]

<u>3.1 Patient management software and tracking</u>

Patient management softwares are built to be used throughout an entire healthcare facility. Through real time data and visibility, they give the appropriate personnel the tools needed to more efficiently manage patient throughput. Wasted time and efforts are reduced, because the organization is provided with the ability to manage the simultaneous logistics of every patient as they move through the hospital.

Different solutions are available on the market. For example, *CARE LOGISTICS™* is a company specialized in softwares for the healthcare sector. The modules included in a typical software are:

- Bed management:
  Allows to visualize, in real time, the current status and bed availability in all units, and patients that are ready to be admitted to a unit.
- Nursing:
  Allows nursing units to quickly determine bed availability and plan for the next admission or discharge.
- Environmental services:
  Provides the ability to manage the entire housekeeping workflow.
- Transport:
  Provides clinical personnel the ability to request transports for their patients.
- Lenght of stay management:

Allows to set, within the system, both the geometric and target hospital length of stay, giving all providers the ability to better target when the patient is anticipated to be discharged.

Managing patient logistics requires the possibility of tracking the patients: the two most diffused technologies are RFID and barcode. RFID solutions present more advantages compared to barcode systems, for example the use of passwords to access to reading procedures, and to detect and correct reading errors [rfid-soluzioni.com]. RFID tags are programmable, and the contents of their internal memory can be rewritten, allowing a wider range of usability compared to the barcode alternative. Regarding this second solution, when an information content is printed in a tag, it can't be modified. RFID and barcode tags can be easily applied on specific bracelets, comfortably wearable by the patients.

The present sub-indicator rewards the use of a patient management software by the healthcare facility, and in particular its association with a RFID based technology.

Sub-indicator evaluation:

- Use of a patient management software associated with RFID tracking (1 point)
- Use of a patient management software associated with barcode tracking (0.5 points)
- Patient management software not in use (0 points)

3.2 Bed management software and tracking

Beds represent an important resource, and reporting bed availability is essential for all hospitals. Due to the physical size of many hospitals it is often difficult to establish exactly how many beds are free at a particular time of day.

Some specialized companies can provide hospitals with the ability to manage bed availability using RFID location based solutions. For example, *HARLAND SIMON* offers a suite allowing bed management staff to access a single system to establish bed availability, perform elective planning and request bed status.

The system provides a full range of planning and management services which can be used to improve the efficiency and reduce costs [harlandsimon.co.uk].

As for the patient management, the bed management requires the use of RFID or barcode tracking solutions. The present sub-indicator rewards the use of a bed management system, associated with an RFID-based tracking system.

Sub-indicator evaluation:

- Use of a bed management software associated with RFID tracking (1 point)
- Use of a bed management software associated with barcode tracking (0.5 points)
- Bed management software not in use (0 points)

3.3 Use of electronic patient charts

The patient chart is a record of the patient's stay in the hospital: it documents all procedures, treatments and medicines administered to the patient during his/her stay in the hospital. It is the one central place where therapists, nurses and doctors communicate in writing the care of the patient [docstoc.com]. Today electronic patient charts are available, and the present sub-indicator rewards their use.

Sub-indicator evaluation:

- Yes (1 point)
- No (0 points)

3.4 Monitored correspondences

The patient management can be performed either constantly monitoring the only single patients, or the correspondences between beds and patients, or more the correspondences between beds, patients and electronic patient charts. The present sub-indicator rewards the most complex performed tracking correspondence, which allows a higher level of management of the patient logistics.

Sub-indicator evaluation:

- Bed-patient-electronic chart correspondences (1 point)
- Bed-patient correspondences (0.5 points)
- Simple patient tracking (0 points)

4.8.4 Safety

4.1 Safety Management System (SMS)

A safety management system (SMS) is an organizational system pursuing the objectives of corporate health and safety, designed with the most appropriate ratio between costs and benefits. It allows to gain significant improvements also in management-related themes. The most comprehensive standard is the Occupational Health & Safety Assessment Series 18001 (OHSAS 18001), that we already discussed in the previous chapters.

Adopting a SMS is not a legal requirement, but a voluntary choice of taking responsibility for the own and other's safety. Adopting a SMS reduces the potential costs related to the occurrence of accidents, lowering their probability [wikipedia.en]. As the theme is suggested but not required by law, we decided to include an indicator that will get a positive scoring if the existence of a SMS is verified within the healthcare facility.

4.2 Safety courses

In order to minimize the risk of accidents which can occur during logistic activities, it is necessary to promote training and education for employees.

Below we report a brief description of some of the most diffused available courses:

- Courses about work-related stress: stress is the second work-related health problem, affecting 22% of the workers from the 27 EU Member States, and can potentially cause physical and psychological injury.
- Courses about the manual handling of loads: if the use of forklifts is not necessary, the movement of small- and medium-size unit loads can be performed manually.

[ispesl.it]

The assessment will reward the facilities which organize optional courses during the calendar year, involving the staff and facilitating his attendance.

Sub-indicator evaluation:

- Courses organized (1 point)
- Courses not organized (0 points)

4.3 Injury Frequency Rate (IFR)

A comprehensive assessment of the injuries related to logistic activities must monitor not only the trend in the frequency of injuries of the employees involved in warehousing activities, but also the activities undertaken by the organizations to prevent them.

The Injury Frequency Rate index is very common. It is always linked to a reference period, usually choosing the calendar year if less aggregated data are not available.

In literature, two alternative methods exist for its calculation, to ensure the ability to obtain it independently of the available data. The first method relates the number of accidents with the hours worked; this ratio is then multiplied by a factor 1000000 to make the result more readable.

$$IFR_A = (\text{number of injuries / hours worked}) * 1000000$$

Forumula 1 - Injury Frequency Rate$_A$

A second method available for calculating the frequency of accidents relates the number of accidents with the number of employees employed during the reported period, and the ratio is then multiplied by one thousand (Formula 1). This procedure is easier to calculate and, in the absence of data about the hours worked, also allows to process the index [sicurweb.it].

$$IFR_B = (\text{number of injuries / number of employees}) * 1000$$

Formula 2 - Injury Frequency Rate$_B$

Sub-indicator evaluation:

The IFR is evaluated considering its values in a reference period compared to the average IFR value during the first 3 previous years:

- IFR lower than 40% of average $IFR_{3\ \text{previous years}}$ (1 point)
- IFR between 40% and 80% of average $IFR_{3\ \text{previous years}}$ (0.5 points)
- IFR higher than 80% of average $IFR_{3\ \text{previous years}}$ (0 points)

Below we show a summarizing table about the sustainability indicators regarding the logistic activities:

4.9 Building-related aspects

The building module considers aspects related to the structure of the healthcare facility, focusing on the building architecture and relative plants.

As a first topic we consider the presence of certifications for the building and construction materials. The evaluation connected with the plants installed in the building is about the hygienic services and the rooms.

Indoor air quality issues and normative are considered, with the matters of energy efficiency.

The outdoor of the building is taken into account through evaluation of parking and green areas.

Finally, the safety of the building is connected with evacuation plans and general normative.

The module is divided into seven parts:

- Construction materials and general certifications
- Water and hygienic services
- Rooms
- Indoor air quality
- Energy efficiency
- Parking areas
- Safety

4.9.1 Construction materials and general certifications

<u>1.1 Energy class of the building</u>

The first indicator for the building module concerns the energy classification of the buildings.

The classification takes his origin from the European directives 2002/91/CE and 2006/32/CE which gave indications about reducing the energy consumption and the GHG emissions.

Every nation has acknowledged the directive into a specific normative. In Italy the 2006/32/CE was acknowledged by the D.Lgs. 115/2008, which introduces the UNI TS 11300.

The UNI TS 11300 was born with the objective to create a single calculation methodology able to delineate the energy performances of the buildings. It is divided into four parts:

- UNI TS 11300 Part 1
Thermal energy demand for the climate control in summer and winter.
- UNI TS 11300 Part 2
Primary energy demand and efficiency for the climate control winter and the production of sanitary water.
- UNI TS 11300 Part 3
Primary energy demand and efficiency for the climate control in winter.

- UNI TS 11300 Part 4
Utilization of renewable energies and other methods for the heating and the preparation of hot sanitary water.
[11300.cti2000.it]

This four parameters are used to establish the class of the building. In the figure 4.26 we can see the classification range and the values of the energy consumption connected with each level.

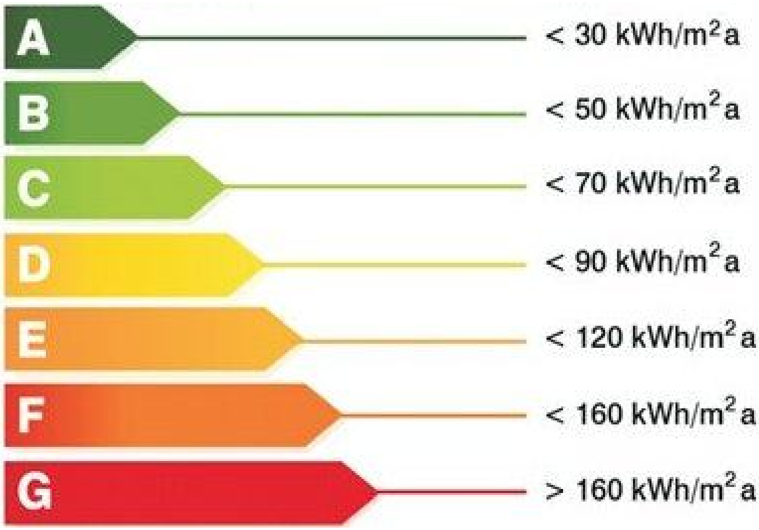

Figure 4.26 : Energy classification

The evaluation is:
Class A = 3 points
Class B = 2 points
Class C = 1 point
Class D or lower = 0 points

<u>1.2 Certifications of the building</u>
The hospital facility could have gained an international certification for sustainable building. In this thesis we analysed some of the most important certifications in Chapter 2. We report a short resume of the three main official building recognition.

LEED
The system is based on the attribution of credits for each requirement about the sustainability of the building. There are six categories where all standards that have to be considered are grouped

together: sustainable sites, efficient water management, energy and atmosphere, materials and resources, quality of the internal environments, planning and innovation, regional priorities.
The specific certification level is related to a score that is obtained from the sum of the total credits achieved for each one of the six categories:

- 40-49 credits: Certificate;
- 50-59 credits: Silver;
- 60-79 credits: Gold;
- 80 or more credits: Platinum.

[gbcitalia.org]

BREEAM

BREEAM rewards performance about regulation which provides environmental, higher comfort or health benefits. BREEAM awards points or 'credits' and groups the environmental impacts into the sections below:

- Energy: operational energy and carbon dioxide (CO_2);
- Management: management policy, commissioning, site management and procurement;
- Health and Wellbeing: indoor and external issues (noise, light, air quality, etc.);
- Transport: transport-related CO_2 and location-related factors;
- Water: consumption and efficiency;
- Materials: embodied impacts of building materials, including lifecycle impacts like embodied carbon dioxide;
- Waste: construction resource efficiency and operational waste management and minimisation;
- LandUse: type of site and building footprint;
- Pollution: external air and water pollution;

Ecology: ecological value, conservation and enhancement of the site.
[pdmconsultants.co.uk]

SB100

The SB100 is a list of purposes and relative acts useful to reach them. The evaluation is integrated and systematic, with a checklist for the evaluation of the action efficacy. The objectives are resumed in three thematic fields, corresponding to the dimensions of the sustainable development:

- Ecological: energy, water, material and waste;
- Social: health, comfort, contest and information

- Economic: construction cost and management cost.

The SB100 framework is divided into three parts:

- The **Guidelines** are a Decalogue with the objective to reach good sustainability results.
- The **Positive List** is a list of 100 actions useful to reach the objectives of the guidelines.
- The **Checklist** is a counter which allows us to check the efficacy of the actions performed, assigning a score on the basis of specific values: zero points for performances equal to law standards, 1 point if the performance is higher than law standards and -1 if it is lower. [sb100.it].

The evaluation is:

1.2.1 A generic certification of sustainability is present Yes (1 point)
No (0 points)

1.2.2 LEED certification Yes (1 point)
No (0 points)

1.2.3 BREEAM certification Yes (1 point)
No (0 points)

1.2.4 SB100 certification Yes (1 point)
No (0 points)

1.3 Insulated roof

The insulation of the roofs is useful to minimize the need of energy for heating and cooling of the facility. Especially in summer, the sun beating on the roof contributes to an high level of heating of the building. The cooling costs and consumption could be very high.

An insulated roof works with low-transmittance materials in order to reduce the amount of heating able to cross the roof in both direction (exiting in winter and entering in summer).

For example the **cool roof** is a roofing system that can deliver high solar reflectance (the ability to reflect the visible, infrared and ultraviolet wavelengths of the sun, reducing heat transfer to the building) and high thermal emittance (the ability to radiate absorbed, or non-reflected solar energy). Most cool roofs are white or other light colours.

Or a **green roof,** that is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane.

Figure 4.27 : Example of a green roof [en.wikipedia.org]

1.4 Insulated walls

As for the roof, the walls can contribute to decrease the amount of energy required to keep under control the temperature of the building.

There are essentially two types of building insulation:

- Convective and conductive insulation

  These insulators block conductive heat transfer and convective flow either into or out of a building. The denser a material is, the better it will conduct heat. Because air has such low density, air is a very poor conductor and therefore makes a good insulator. Insulation to resist conductive heat transfer uses air spaces between fibers, inside foam or plastic bubbles and in building cavities like the attic.

- Radiant insulation

  Radiant barriers work in conjunction with an air space to reduce radiant heat transfer across the air space. Radiant or reflective insulation reflects heat instead of either absorbing it or letting it pass through. However, much greater insulation can be achieved through the addition of convective or conductive insulators.

The most diffused materials used as convective and conductive insulators are the cellulose, glass wool, rock wool, polystyrene, urethane foam, wood fibre, plant fibre, plant straw or animal fibre.

Figure 4.28 : An insulated wall with wool rock

The evaluation for these indicators is:

Yes (1 point)

No (0 points)

4.9.2 Water and hygienic services

2.1 Water saver in shower and sinks

Shower and sinks represent the most diffused water source in the facility. Sinks are placed in the corridors, wards, laboratories, operating rooms. Showers are less diffused in a hospital but a great number of shower heads are available for many purposes.

There are systems able to reduce water consumption only using a faucet aerator (sinks) or a water saver shower head (showers). In the following we will analyze the two kinds of water saving solutions:

- Sinks

  The aerator, the screw-on tip of the faucet, ultimately determines the maximum flow rate of a faucet. Aerators are inexpensive to replace and they can be one of the most cost-effective water conservation measures.

Figure 4.29 : Water saving faucet aerator [wostech.en.made-in-china.com]

- Showers

There are two basic types of low-flow showerheads:

- Aerating showerheads mix air with water, forming a misty spray.
- Laminar-flow showerheads form individual streams of water.

Figure 4.30 : Water saving shower heads [www.grohe.it]

These solutions can help achieving a 25% to 60% water saving. [www.energysavers.gov]

2.2 Collection of rainwater from roofs

Also called Rainwater Harvesting, it is the accumulating and storing, of rainwater for reuse, before it reaches the aquifer. It has been used to provide drinking water, water for livestock, water for irrigation, as well as other typical uses given to water. Rainwater collected from the roofs of houses, tents and local institutions, can make an important contribution to the availability of drinking water. There are a number of types of systems to harvest rainwater ranging from very simple to the complex industrial systems. The rate at which water can be collected from either system is dependent on the plan area of the system, its efficiency, and the intensity of rainfall.

The main components of a rainwater harvesting system are the following:

- Catchments: the catchment of a water harvesting system is the surface which directly receives the rainfall and provides water to the system.
- Coarse mesh at the roof to prevent the passage of debris
- Gutters: channels all around the edge of a sloping roof to collect and transport rainwater to the storage tank.
- Conduits: pipelines or drains that carry rainwater from the catchment or rooftop area to the harvesting system.
- First-flushing: a first flush device is a valve that ensures that runoff from the first spell of rain is flushed out and does not enter the system.
- Filter: used to remove suspended pollutants from rainwater collected over roof.
- Storage facility: there are various options available for the construction of these tanks with respect to the shape, size and the material of construction.
- Recharge structures: rainwater may be charged into the groundwater aquifers through any suitable structures like dugwells, borewells, recharge trenches and recharge pits.

[www.rainwaterharvesting.org]

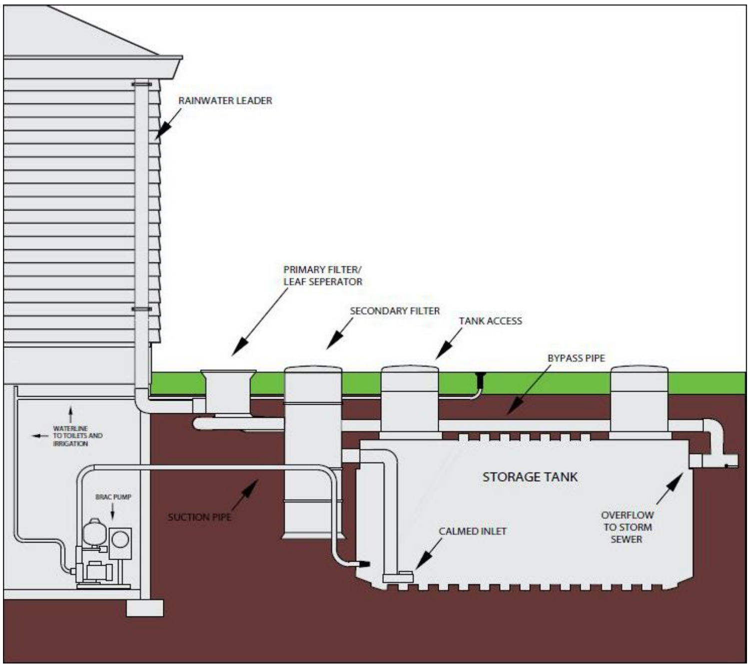

Figure 4.31 : General scheme of a rainwater harvesting system [solarconduit.com]

2.3 Rainwater used for irrigation, sanitary, cleaning

Using purified potable water for purposes like flushing toilets or irrigating landscape could be a waste of a valuable resource. Stored water can substitute piped drinking water for many uses where a high level of purity is not required. A hospital facility typically presents large requirements of general water. Furthermore, the presence of a large green area could increase this kind of needs.
[www.portlandonline.com]

The evaluation for this indicators is:
Yes (1 point)
No (0 points)

4.9.3 Rooms

3.1 Natural light optimized in order to decrease artificial light consumption

Maximizing the amount of natural daylight helps reduce the amount of artificial light that the building needs to produce. This saves energy costs for lighting and, depending on the climate, also helps with temperature control. For hospitals there is the added benefit of natural light creating a healing environment and a welcoming atmosphere to work and reside in.
[sustainability.curtin.edu.au]

Advanced solutions for natural daylight maximization are the tubular rooflight systems: used to bring natural daylight into internal rooms and spaces that have no, or insufficient, windows.
A tubular rooflight consist of a roof-mounted clear polycarbonate dome or skylight connected to a tube with an internal mirrored finish providing optimum specular reflectance. Natural daylight enters the dome or skylight and is reflected down the tube and into the room through a ceiling mounted diffuser.

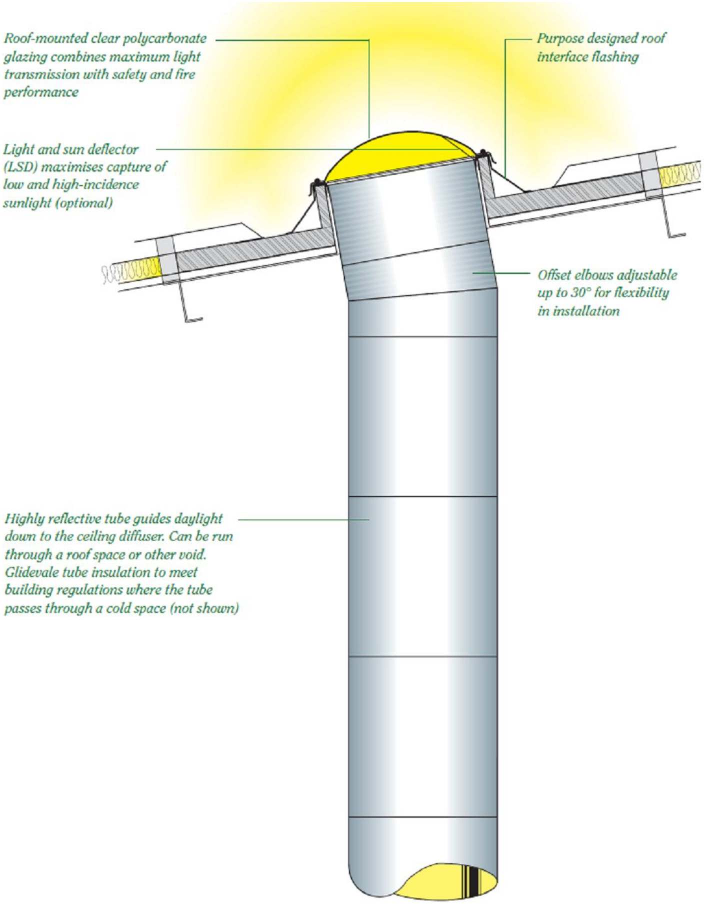

Figure 4.32 : Tubular rooflight [www.passivent.com]

Rooflight flashings are used to catch the light from the roof and bring it to the under floors.

Figure 4.33 : Roof flashings [www.passivent.com]

Figure 4.34 : Light diffusers [www.passivent.com]

[www.passivent.com]

The evaluation for this indicator is:

Yes (1 point)

No (0 points)

3.2 Kind of room lamps

In order to reduce the electricity consumption it is important to choose the right lamp for the specific purpose.

The traditional **incandescent lamps** are the most diffused in the world. However, their use is generally warned. These lamps are the cheaper at the moment of buying, but they present high consumption rate and a short life. Their luminous efficacy is between 10-15 lumen/watt and the life is about 1000 hours.

The **halogen incandescent lamps** can be divided in two great families:

- very low voltage lamps

  Their voltage is 6-12-24 V and they need a voltage converter. They are also available in the IRC (Infrared Coating) version. These lamps present a product-life of 4000-5000 hours.

- standard voltage lamps

  They an be used as the normal incandescent lamps without voltage converters.

Their luminous efficacy is between 15-25 lumen/watt and the life is about 2000-4000 hours.

The fluorescent lamps can be divided in two main families:

- **fluorescent compact lamps**

  They present a high luminous efficacy, between 50-120 lumen/watt and a product life of about 10000 hours.

- **fluorescent tubular lamps**

  They present a high luminous efficacy, between 50-75 lumen/watt and a product life of about 10000 hours. Furthermore their luminance can be regulated with a electronic “dimming” tool between 10% and 100%.

The **LED lamps** can contribute to an energy saving of about 80% if compared with the traditional incandescent lamps. The product life of this lamps is between 50000 and 100000 hours. The maintenance costs are very low and the heating level during exercise is almost zero. The absence of lead and mercury allows the disposal in the undifferentiated waste.
[www.enea.it]

The evaluation is presented with a table:
Incandescent light bulb (0 points)
Halogen (0.25 points)
Fluorescent compact (0.5 points)
Fluorescent tube (0.75 points)
Led (1 points)

3.3 Cleaning companies are ISO 14001 certified

ISO 14001:2004 specifies requirements for an environmental management system to enable an organization to develop and implement a policy and objectives which take into account legal requirements and other requirements to which the organization subscribes, and information about significant environmental aspects. It applies to those environmental aspects that the organization identifies as those which it can control and those which it can influence.
The use of the ISO 14001 by the cleaning company is a substantial guarantee that the cleaning operations in the hospital facility are executed with a particular attention to the environmental matters, without compromising the environmental policy of the hospital.

The evaluation is:

Yes (1 point)

No (0 points)

4.9.4 Indoor air quality

4.1 Air quality requisites

The quality of the indoor air must be kept under control because of the high number of people operating in a hospital and the high level of bacterial diversity which is there present. The sources of indoor environmental contaminants are not always easy to identify but are generally defined as:

- carbon dioxide (CO_2)
- tobacco smoke
- molds and bacteria
- cleaning products
- copy machines
- pesticides
- vehicle exhaust

An important solution to the indoor environmental quality are the Heating Ventilation Air Conditioning (HVAC) systems. The HVAC of a building supplies and removes air either naturally (windows) and/or mechanically to and from a space. It consist of mechanical parts which should provide air to building occupants at a comfortable temperature and humidity that is free of harmful concentrations of air pollutants.

However HVAC systems alone can act as sources of pollutants. If these systems are not appropriately maintained, ventilation air filters can become saturated leading to potential microbial growth and odor concerns. Microbial growth can also result from stagnant water in drain pans or from uncontrolled moisture inside of air ducts and cooling coils. Another important source of indoor contaminants are the

[www.cdc.gov]

The respect of air indoor requisites or referring to indices like the Indoor Air Quality Index is considered a good behaviour of the healthcare facility administration.

In the following we report an index given by an association located in Abingdon (UK).

COLOR CODE	CO PPM	CO_2 PPM	VOCs PPM	RADON pCi/L	FORMALDEHYDE ppm	MOLDS
Green	<3	<1,000	<1	<4.0	<.05	"Normal" spore types and levels
Yellow	3-<9	1000-<1,200	1-<10		.05-<.1	Elevated levels common molds
Red	9-25	1,200-5,000	>10	4.0+	.1-<.3	Elevated levels of hydrophilic molds (Stachybotrys, Chaetomium, etc.)
Black	>25	>5,000			.3+	

Table 4.3 Air Quality Index

[www.iaqindex.com]

4.2 Soundproof materials

The noise reduction in a hospital facility increases the comfort of the rooms and generates a quality improvement of the indoor environment. The hospital should be quite and peaceful places where people rest and recuperate from illness or medical treatment. However the equipment of the hospital and the presence of many people is often source of noise and this can affect the health of patient or cause a delay of healing.
[www.acousticontrol.com]
This indicator has the purpose to check the availability of soundproofing materials on floor and walls, or the presence of other solutions in order to decrease the amount of noise in the facility.

4.3 Low VOC materials

Chemicals and related odours can be sources of Indoor Air Quality problems in buildings. Odours are organic or inorganic compounds and can be both pleasant and unpleasant. Some odours can be health hazards and some are not. While most chemical contaminants originate from within the building, chemicals can be drawn into a building from the outdoors as well.
Volatile Organic Compounds (VOCs) are common chemical contaminants found in facilities and office environments and are a source of odours. VOCs are organic (containing carbon) chemicals

that can easily evaporate into the air. Many products found in the facilities environment may have the potential to release VOCs. Examples include:

- Caulks, sealants, and coatings
- Adhesives
- Paints, varnishes and/or stains
- Wall coverings
- Cleaning agents
- Fuels and combustion products
- Carpeting
- Vinyl flooring
- Fabric materials & furnishings
- Air fresheners and other scented products
- Personal products of employees like perfume, shampoos, etc.

[www.cdc.gov]

The indicator has the purpose to identify the presence and the choice of low VOC materials for example concerning carpets, flooring, wall coverings, office furniture, and paints.

The evaluation for these indicators is:

Yes (1 point)

No (0 points)

4.9.5 Energy efficiency

5.1 High efficiency lighting systems

High efficiency lighting systems are intended to be systems of light regulation in function of the effective light available in the room or of the presence of people.

Figure 4.35 : Hybrid lamp [www.passivent.com]

The hybrid lamp incorporates a light sensor which is programmed to turn on when the light level inside the room drops below a certain level. Luminaire turns on with optional ‘soft start’, allowing a gradual increase in light output and adjustment to the required level. This lamp incorporates a lighting controller, lux sensor and PIR presence detector. When the unit determines there is adequate natural light available, the lamp is automatically turned off. When light levels fall, the lamp is switched back on and its output continues to be regulated by the daylight sensor. The programmable PIR presence detector will turn off the lamp when the space is unoccupied irrespective of the light level.
[www.passivent.com]

5.2 Passive solar heating on south exposures

In passive solar building design, windows, walls, and floors are designed to collect, store, and distribute solar energy in the form of heat in the winter and reject solar heat in the summer. The passive solar design or climatic design, unlike active solar heating systems, does not involve the use of mechanical and electrical devices.
The ideal way of employing passive solar heating is to install a conservatory to the southern side of the house and ensuring that there is:

- a way to draw the warmed air into the house
- sufficient available insulation to close the conservatory during the night when it is not needed for heating
- suitable covering or ventilation to stop overheating during the summer

[www.solarkent.co.uk]
An example of a solar heating system principle is reported in the following picture:

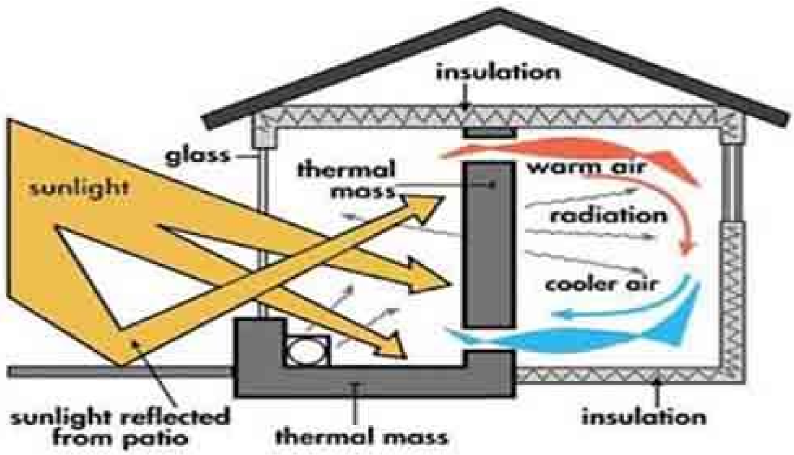

Figure 4.36 : Principle of the passive solar heating design [www.alternative-heating.com]

5.3 Internal painting useful to increase natural light and decrease artificial light consumption

Internal painting of the facility can influence the amount of light present. The use of clear paintings maximizes the reflection of the light on the walls and minimizes the need of electricity for artificial lighting during the day.

The evaluation for these indicators is:

Yes (1 point)

No (0 points)

4.9.6 Parking areas

Some specific requirements of parking areas allow to improve both the social and the environmental sustainability at the same time.

6.1 Parking areas for handicapped

The availability of parking area for disabled must be taken into account. In particular, the parking areas must be foreseen near the main entrance of the hospital or the entrance for patients and visitors, in order to minimize the amount of meters that a handicapped person must cover in order to reach his destination in the hospital structure.

Furthermore there is the possibility to provide to handicapped temporary parking permits.

The evaluation is:

Yes (1 point)

No (0 points)

6.2 Parking for bicycles

The availability of bicycles parking areas can increase the mobility in the local area through sustainable and non pollutant means like bicycles.

The evaluation is:

Yes (1 point)

No (0 points)

6.3 Dedicated parking areas for personnel, visitors and patients

The presence of parking areas dedicated to specific categories of people increases the availability of places because of a higher differentiation and is in favour of a more organized parking management.

The evaluation is:
Yes (1 point)
No (0 points)

6.4 High number of services near the hospital

This indicator evaluates if the facility is located in a territory which facilitates the access and the integration with the local communities. Considering a circular area of 5 km radius, the presence of the following services has to be checked: school (infant or primary school), municipal building, bank, post office, fire station, restaurant, superstore, laundry, bar, etc. The indicator rewards the availability of the highest number of different services possible.

The evaluation is:
More than nine 9 services (1 point)
Between 3 and 9 services (0.5 points)
Less than 3 services (0 points)

6.5 Extension of the green area around the hospital

Green areas contribute in helping patients during their care process, influencing positively their psychological attitude towards their permanence in the hospital, by creating a relaxing and familiar environment.
[dunamisarchitettura.com]
As green area we mean the area surrounding a healthcare facility or included in its perimeter. We have decided to consider the following proportions:

- low: green area / total area ≤ 0.1
- medium: 0.1 < green area / total area ≤ 0.3
- high: green area / total area > 0.3

The evaluation is:
[Green area]/[Total area] > 0.3 (1 point)
0.3 > [Green area]/[Total area] > 0.1 (0.5 points)
[Green area]/[Total area] < 0.1 (0 points)

4.9.7 Safety

<u>7.1 Evacuation plan ISO 23601-2009 certified</u>

The approval of a certified evacuation plan guarantees the best efficiency in case of emergency happening in the hospital.

ISO 23601:2009 establishes design principles for displayed escape plans that contain information relevant to fire safety, escape, evacuation and rescue of the facility's occupants. These plans are intended to be displayed as signs in public areas and workplaces.

[www.iso.org]

Figure 4.37: An example of fire escape plan ISO 23601 certified [www.iso.org]

<u>7.2 ICS 11.140 Hospital equipment</u>

The ICS (International Classification for Standards) 11.140 is a group of standards involving the general equipment of a hospital. In particular the 11.140 includes normative for hospital beds, surgical tables, medical garments, medical gloves and containers for sharp disposal.

In detail:

- ISO 10282:2002
  Single-use sterile rubber surgical gloves
- ISO 11193-1:2008
  Single-use medical examination gloves -- Part 1: Specification for gloves made from rubber latex or rubber solution

- ISO 11193-2:2006
  Single-use medical examination gloves -- Part 2: Specification for gloves made from poly vinyl chloride
- ISO 21171:2006
  Medical gloves -- Determination of removable surface powder
- ISO 22609:2004
  Clothing for protection against infectious agents -- Medical face masks -- Test method for resistance against penetration by synthetic blood (fixed volume, horizontally projected)
- ISO 22882:2004
  Castors and wheels -- Requirements for castors for hospital beds
- IEC 60601-2-52:2009
  Medical electrical equipment -- Part 2-52: Particular requirements for the basic safety and essential performance of medical beds
- IEC 80601-2-35:2009
  Medical electrical equipment -- Part 2-35: Particular requirements for the basic safety and essential performance of heating devices using blankets, pads or mattresses and intended for heating in medical use

It is hard to test that the healthcare facility can have all these certification. We consider a good behaviour of the hospital the knowledge of this ICS and the purpose to apply it in the choices of equipment purchasing.

The evaluation is:
Yes (1 point)
No (0 points)

4.10 Energy-related aspects

The energy issue is mainly concerned with the evaluation of the energy resources of the hospital, dealing with the hospital facility and with the transportation means.
The monitoring of the energy consumption is fundamental for the management of a sustainable policy.
The presence of programs and opportunities for people operating and living in the hospital are considered.
The trends of energy consumption are analyzed as a global evaluation.
The energy module is divided into five parts:

- Energy sources (hospital facility)
- Energy sources (transportation)
- Monitoring
- Programs and opportunities
- Energy consumption trends

4.10.1 Energy sources for the hospital

1.1 Energy contract procurement

This indicator has the purpose to evaluate if the energy procurement contract with the energy supplier foresees providing of “clean energy” through a percentage of energy that comes from renewable resources like the six listed below.

The evaluation is:

1.1.1 Photovoltaic	Yes (1 point) No (0 points)
1.1.2 Eolic	Yes (1 point) No (0 points)
1.1.3 Cogeneration or trigeneration	Yes (1 point) No (0 points)
1.1.4 Geothermic	Yes (1 point) No (0 points)
1.1.5 Biomass	Yes (1 point) No (0 points)
1.1.6 Solar thermal	Yes (1 point) No (0 points)

1.2 Energy generation at the hospital facility

These indicators has the purpose to evaluate the presence of a energy production plant, like the three listed below, **in** the hospital facility.

1.2.1 Cogeneration or trigeneration

Cogeneration, also known as Combined Heat and Power (CHP), is a very efficient, clean, and reliable approach to generating power and thermal energy from a single fuel source such as natural gas or bio methane. Cogeneration plants recover the "waste heat" that is otherwise discarded from conventional power generation to produce thermal energy.

This energy is used to provide cooling or heating for industrial facilities, district energy systems, and commercial buildings. Through "waste heat recovery," cogeneration power plants achieve typical effective electric efficiencies of 70% to 90%, a dramatic improvement over the average 33% efficiency of conventional fossil-fueled power plants.

Cogeneration power plants' superior energy efficiencies significantly reduces air emissions including; carbon emissions and greenhouse gas emissions, as well as emissions ofnitrous oxides, sulfur dioxide, mercury, particulate matter. Carbon dioxide emissions from the burning of fossil fuels is recognized as the leading greenhouse gas associated with climate change.

[cogeneration.net]

A plant producing electricity, heat and cold is sometimes called trigeneration or, more generally, polygeneration plant.

Trigeneration, also called CCHP (Combined Cooling, Heat and Power), refers to the simultaneous generation of electricity, useful heating and useful cooling from the same original heat source such as fuel or solar energy. Waste heat insufficient in energy to produce electricity through mechanical means, such as through a steam turbine, contains usable energy that is harnessed for thermal regulation purposes as described in cogeneration. Trigeneration differs from cogeneration in that some of the waste heat is used for cooling. CCHP systems can attain higher efficiencies per unit fuel than cogeneration or traditional power plants.

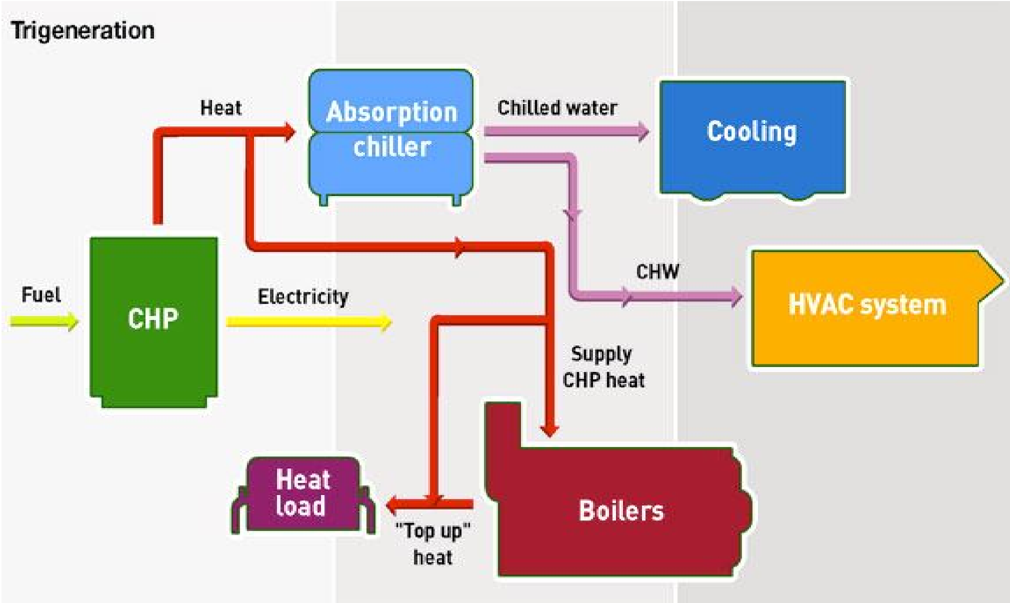

Figure 4.38 : Trigeneration cycle

A hospital presents dimensions and consumption rates which are generally compatible with the use of a cogeneration or trigeneration system. The installation of this kind of plant is a good energy saving practice for the hospital energy management.

1.2.2 Photovoltaic

Photovoltaic is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. Photovoltaic power generation employs solar panels composed of a number of cells containing a photovoltaic material. A photovoltaic system typically includes an array of solar panels, an inverter, may contain a battery and interconnection wiring. Many solutions of photovoltaic systems are available and we report only two simple example of a grid-connected photovoltaic system for a medium dimension facility.

Figure 4.39: Photovoltaic system by Dallas Medical Center, Dallas SYSTEM SIZE: 337kW [www.sunwize.com]

Figure 4.40: Photovoltaic system in a Grocery in Monrovia, California - SYSTEM SIZE: 230kW [www.sunwize.com]

1.2.3 Solar thermal

Solar Thermal Energy (STE) is a technology for harnessing solar energy for thermal energy. Solar thermal collectors are classified by the USA Energy Information Administration as low, medium. or high temperature collectors.

- Low temperature collectors are flat plates generally used to heat swimming pools.
- Medium-temperature collectors are also usually flat plates but are used for heating water or air for residential and commercial use.
- High temperature collectors concentrate sunlight using mirrors or lenses and are generally used for electric power production.

STE is different from photovoltaic, which converts solar energy directly into electricity.

Medium temperature collectors are the best solution for a healthcare facility.

Figure 4.41 : Solar thermal plant in the University of Wisconsin [www.hhgroupholdings.com]

The evaluation for these indicators concerns the presence of a energy production system in the hospital:

Yes (1 point)

No (0 points)

4.10.2 Energy sources for the transportation

<u>2.1 More than a half of the vehicles equipped with petrol or diesel engines</u>

The healthcare facility is equipped with different means of transport. The main are the ambulances, but other trucks and delivery van operate with the hospital.

The use of petrol or diesel engine must be substituted with modern non-polluting engines like natural gas, electric or hybrid propulsion.

This indicator asks if more than a half of the hospital vehicles are equipped with traditional petrol or diesel engines:

Yes (0 points)

No (1 point)

2.2 GPL, CNG or GN vehicles

A Natural Gas vehicle (GN) is an alternative fuel vehicle that uses Compressed Natural Gas (CNG) or, less commonly, Liquefied Natural Gas (GPL) as a clean alternative to other automobile fuels.

Figure 4.42 : A methan-fueled bus in Italy

The indicator asks if there is at least one vehicle with gas propulsion:

Yes (1 point)

No (0 points)

2.3 Electric vehicles

Battery Electric Vehicles (BEVs), also known as All-Electric Vehicles (AEVs), are electric vehicles whose main energy storage is in the chemical energy of batteries. They are considered zero emission vehicle because they produce no emissions.

The indicator asks if there is at least one vehicle with electric propulsion:

Yes (1 point)

No (0 points)

2.4 Hybrid vehicles

Hybrid vehicles are bi-fuel means of transport. The most common type of hybrid vehicle is the gasoline-electric hybrid vehicles, which use gasoline (petrol) and electric batteries for the energy used to power internal-combustion engines (ICEs) and electric motors.

The indicator asks if there is at least one vehicle with hybrid propulsion:

Yes (1 point)

No (0 points)

4.10.3 Monitoring

3.1 Energy management program ISO 50001 certified

ISO 50001 is the new standard for energy management. It parallels and complements ISO 9001 for quality management, and ISO 14001 for environmental management. This standard is due to be published at the end of 2011, and will establish a framework for industrial plants, commercial facilities or entire organizations to manage energy. The document is based on the common elements found in all of ISO’s management system standards and will provide the following benefits:

- A framework for integrating energy efficiency into management practices
- Making better use of existing energy-consuming assets
- Benchmarking, measuring, documenting, and reporting energy intensity improvements and their projected impact on reductions in greenhouse gas (GHG) emissions
- Transparency and communication on the management of energy resources
- Energy management best practices and good energy management behaviours
- Evaluating and prioritizing the implementation of new energy-efficient technologies
- A framework for promoting energy efficiency throughout the supply chain
- Energy management improvements in the context of GHG emission reduction projects.

3.2 Measuring, reporting and documentation of the energy improvement (ISO 50001 basic guidelines)

The main pillars of the ISO 50001 are the activity of benchmarking, measuring, documenting, and reporting energy improvements. These activities represent an intermediate step between the global application of the standard and a general unawareness of the energy matter.

3.3 Energy Manager

Before introducing energy-saving measures, an energy management programme should be set up, and an energy manager appointed. The Certified Energy Manager is a professional certification issued by the Association of Energy Engineers. Professionals become eligible for this certification after demonstrating expertise in several areas ranging from standards, air quality, energy audits, lighting, procurement and even financing. The Energy Manager is responsible for the Energy policy choices, and covers the following tasks:

- specification of actions, intervention and procedures useful to promote a reasonable use of the energy
- organisation of energy budget in function of economical parameters and final utilizations
- support to the decisional process concerning energy choices and policies

In order to guarantee the fulfilment of this tasks, the Energy Manager should be officially designated and all the community should be informed of his position.

The evaluation is:
Yes (1 point)
No (0 points)

4.10.4 Programs and opportunities

4.1 Car sharing program

A car sharing program can be very useful for a healthcare facility.
An article appeared on 7th May, 2009 on the New York Times provides an example of a company's car sharing program: "Google employees can choose from among two dozen Toyota Prius and Ford Escape hybrids, provided by an auto sharing company. Employees who don't drive their own cars to work (the company offers a shuttle service) can use car sharing at will, for both business and personal purposes. That way, they have a car available for errands, medical appointments or picking up a sick child from school." [www.nytimes.com]
An healthcare facility can enact similar programs, enabling employees that work on shifts to make an optimal use of the car.

4.2 Benefits for the public transport use

The use of public transport is helpful in order to reduce the use of personal vehicles for the employees, patients and visitors transport.
The healthcare facility could implement a public-transport-promoting policy using benefits and rebates for the use of them.

4.3 Incentives for bicycle use

The use of the bicycle is an optimal solution for low distance movements of people. For example if the hospital presents different buildings and the movement of personnel is required between them. The availability of bicycles in the hospital or other policies able to promote the use of them represent a good behaviour of the hospital towards a more sustainable transportation management.

The evaluation for these indicators is:
Yes (1 point)
No (0 points)

4.10.5 Energy consumption trends

5.1 [Electricity consumption-current year]/ [Electricity consumption 1 or 2 or 3 years ago]

A comparison of the electrical consumption between the current year and the past years must be taken into account in order to define a trend of the facility towards electricity saving. The hypothesis is that the hospital hasn't planned substantial changes in the wards management like removal or adding of important structures. In this case a correction of the indicator should be performed.

5.2 [Thermal energy consumption-current year]/ [Thermal energy consumption 1 or 2 or 3 years ago]

As for electrical consumption, thermal consumption is useful to define a energy saving trend. The consumption of gas is mainly connected with the thermal energy. The hypothesis is the same of the indicator 5.1.

For these indicators the evaluation is:

> 1 (0 points)

0,95 – 1 (0,5 points)

0,90 – 0 95 (1 point)

4.11 Office processes

This module presents the indicators related to the administrative offices of healthcare facilities. Even though the size of these environments, dedicated to administrative tasks, can be relatively small compared to the other operative areas, the consumption of resources can be very high: the maintenance of a constant temperature of around 20°C in both winter and summer, the presence of workstations with computers and printers, the use of large quantities of paper material impact significantly on the environmental sustainability.
Moreover, the nature of the activities requires the design of workstations based on factors considering the ergonomics and the available space, to ensure the best possible working conditions for the employees. Another issue to consider when carrying out administrative activities is the use of paper.
The following are the indicators identified to assess the sustainability performance of the administrative department of a healthcare facility.

1. PCs quality

Two factors concerning the functioning of PCs are taken into account: the monitors and the systems for connecting them to the electric network. We exclude servers from our assessment, which are not considered also by the European legislation on energy.
For computer monitors the presence of one of the following environmental certifications must be assessed, which ensure the compliance of certain parameters for energy efficiency:

- ISO 14001;
- EMAS;
- EPEAT;
- ENERGY STAR.

It is very important to remember that even in standby conditions there is still a power consumption of some hardware elements, which affects the energy consumption. Therefore it is necessary to evaluate how PCs are connected to the electric network, choosing solutions that can interrupt the power transmission when it is not necessary to use computers, for example using a power strip with an on/off switch.
The assessment will determine whether the two elements mentioned above are present within the company:

- monitor with environmental certifications;
- solutions to stop the electricity flow to the equipment.

Indicator evaluation:

- 2 elements verified (1 point)
- 1 element verified (0.5 points)
- None (0 points)

2. Stationery material

The environmental commitment of a company involves also the selection of suppliers. In administrative offices stationery items such as pens, highlighters, folders, binders and staplers are massively used. Many items of "green" stationery are available on the market, such as ballpoints in recycled plastic or recycled cardboard folders.

The company will receive a positive evaluation if there is a continuous supply of "green" stationery material.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

3. Use of containers for exhausted toner or outsourcing of its disposal

The toner, used in laser printers and photocopiers, is a fine powder that contains carbon, iron oxides and resin. During printing or copying processes, volatile organic compounds, ozone and formaldehyde are released [apat.gov], so that the machines using it have to be placed in rooms separated from the rooms where employees work, and having a good air circulation: in Italy, for example, this subjects are regulated by the "Testo Unico Sicurezza Lavoro". Due to the presence of pollutants and toxic substances to humans, it is necessary to regulate the collection of waste toner, providing a closed container for its collection and subsequent disposal to ecological platforms, or let specialized companies take care of its collection and disposal.

The evaluation is positive if one of the above exposed procedures is respected.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

4. Containers for exhausted batteries or use of rechargeable batteries

Batteries contain heavy metals, including nickel, lead, mercury and cadmium, which are harmful to the environment and the human health and which are not consumed and do not become harmless when the battery is exhausted. Due to the small size of the batteries, they are often disposed of with general waste, causing substantial environmental damages.

The indicator takes into account the existence of containers dedicated to the separated disposal of exhausted batteries or the use of rechargeable batteries. Rechargeable batteries imply the reuse of the single elements, which contain heavy metals, for several times, avoiding the necessity of purchasing new units containing harmful elements. The latest generation of rechargeable batteries can be recharged up to one thousand times, with a gradual decrease in thier capacity after about five hundred charge cycles [dw-europe.com].

The evaluation will be positive if the company adopts one of the two above analyzed warinesses in the management of batteries.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

5. Modalities for the reduction of paper use

The use of integrated information systems for information management is becoming increasingly important. An information system can not be separated from a good physical infrastructure, composed of elements to support the process of data digitalization. Inside offices, the paper is commonly used to carry out basic activities: a recent analysis about the information flows and processes in administrative offices highlights the abuse of paper, estimating that about 70% of the prints is useless and directly eliminated after its use [wikipedia.en].

The introduction of software for the work management is often accompanied by resistance to change and difficulty of separation from a culture which is linked to paper documents. A company has the responsibility to train employees and support them in approaching the software introduced. The following is a list of some useful functionalities to satisfy the need to reduce the use of paper. The present assessment takes into account how many elements of the list shown below are applied:

- digitalized archiving of documents (archive allows information research and consultation);
- scanner for the document digitalization;
- automatic archiving of all imported documents (via mail or scanner or local PCs);
- archive accessibility from any location;
- internal messaging for the sending of files;
- philosophy of improving the web management of supplier orders;
- client PCs accessible with personal accounts;
- fax and software integration.

The indicator rewards the highest possible presence of the above listed functionalities.

Indicator evaluation:

- More than 6 functionalities (1 point)
- Between 4 and 6 functionalities (0.5 points)
- Between 0 and 3 functionalities (0 points)

6. Exclusive use of "green" paper

The evaluation will be positive if the reams of paper used for printing documents have characteristics that demonstrate a particular consideration for the environment, i.e. if the reams used are built of recycled paper or paper derived from controlled cultivations. Recycled paper must meet a specific criterion: it must be recycled at least for 75%. The paper produced through controlled cultivations, instead, must be PEFC or FSC certified.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

7. Waste separation

The predisposition of an area and separate containers for waste separation has the double objective of making employees aware of the environmental respect and improving the waste disposal performances of the healthcare facility. These areas must be clearly signaled and show explanatory signs to promote the proper use of containers.

The assessment will reward the healthcare facilities which ensure the presence of the above mentioned areas.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

8. Document management system

A document management system (DMS) is a computer system, or set of computer programs, used to track and store electronic documents and/or images of paper documents. It is usually also capable of keeping track of the different versions created by different users (history tracking) [wikipedia.en].

8.1 Availability of a document management system

The present sub-indicator rewards the presence of a document management system in a healthcare facility

8.2 Use of a web based document management system

Document management systems have been recently developed and use web based architectures [mdsynergy.com]. The most important functionality is the following:

- Medical information:

  Physicians and their staff often deal with a lot of paperwork. Web based document management systems allow to seamlessly manage medical records and diagnostic results of patients, including medical bills. Feature-rich electronic medical records software provide comprehensive document management solutions by accumulating, regulating, storing and promulgating patient information in a secure environment. Electronic prescribing systems are also available to prescribe an accurate and legible prescription from the point of view of care. The purpose of the system is to prepare paperless prescriptions and improve medicine data management [mdsynergy.com].

In addition, the following functions can benefit of such a system:

- Inventory: Documents generated include goods received notes, material requisitions from consuming departments, materials issue acknowledgments, accounting records, bin cards, inventory verification reports, list of reorder points and goods replenishment requests. A centralized computer-based system can eliminate the need for many paper documents and speeds up transactions. Such a system also enables concerned persons to verify current availability of needed materials.
- Purchasing: Documents include suppliers lists, purchase requests, invitations to quote or bid, quotes and bids received, comparison reports, correspondence and negotiation records, supplier assessment reports, purchase order copies and inspection reports. A web-based system can make locating and communicating with prospective suppliers, even if they are located at the other end of the world, far easier. All communications can be put on record without difficulty. This system can be integrated with the internal inventory system for error-free synchronization.
- Transport: It is essential to have web access to track all shipments. When integrated with purchasing systems, the status of each purchase order can be tracked from commencement to completion.

- Warehousing: Similar to inventory, a centralized system not only speeds up transactions, but also enables availability verifications. Times and costs are strongly reduced.

[articlegarden.com]

The present sub-indicator rewards the availability and the use of a web based document management system.

For the sub-indicators listed above, the evaluation is the following:

- Yes (1 point)
- No (0 points)

9. Workstation ergonomics

Ergonomics is the science that studies the work in relation to the environmental, instrumental and organizational conditions in which it takes place. The goal of ergonomics is to adapt these conditions to the needs of the worker, considering its characteristics and its activities. Ergonomics is a necessary condition to ensure the welfare, to promote productivity and to reduce the lack of workers [tesina warehousing].

In the case of an office, there are many important elements to be considered:

- equipment: screen, keyboard, work seat;
- environment: space, lighting, noise, heat, humidity;
- computer/employee interface: software used, available information.

The main risks for the health of staff members are tendinitis, disorders to joints and neck, back pain and computer vision syndrome; the latter is so called because it is linked to eye and visual function disorders which were found in workers using computer stations equipped with monitors [tesina warehousing].

Generally, many of these problems can be avoided if they are known; a training about ergonomics of the workplaces is very important, and free courses for employees should be organized within the healthcare facility.

The evaluation will be positive if the company is committed to managing and organizing training courses for employees about ergonomics of the workplaces.

Indicator evaluation:

- Yes (1 point)
- No (0 points)

CHAPTER 5 – Evaluation model implementation

The evaluation model proposed in this work has the purpose to cover the widest range of aspects in a hospital facility management. The aspects of a healthcare facility can be characterized by using a subdivision of the activities. The core activities and subdivision of this kind of structures are often thought with a medical concept, that is a subdivision based on the different healthcare disciplines like cardiology, neurology, surgery and others. However, our research has started with an industrial idea of the hospital, this means with the idea of a subdivision of the hospital in functional and operative areas. We think that this idea is useful to analyze in detail all the structures of a healthcare facility without compromising the medical model of the activities.

This model, developed under an industrial concept of an hospital, needs to be tested and analyzed in his features, advantages and disadvantages.

As a *test case* for our model we had the opportunity to find a new healthcare facility, located at 25 km north-east from Milan.

5.1 The application of the model

The evaluation model presented in this work is a set of indicators that were found out and organized after a deep investigation of the sustainable practices that an hospital can enact. This research was conducted operating a subdivision of the hospital in eleven areas of interest. However, in order to be certified as valid and efficient, this model needs to be tested.

The testing activity allows the authors of the model to:

- apply the model to a real facility
- discuss over problems encountered during application of the model in the facility
- compare the indicators with the opinion of the interlocutors that operate into the facility
- check the feasibility and applicability of the indicators

These features are fundamental in order to analyze the applicability of the model.

5.2 The Healthcare facility of Vimercate

The hospital of Vimercate was inaugurated in December 2009 and began to operate in November 2010 after a transfer procedure from the former healthcare facility, located in the center of Vimercate. The project of the hospital was signed by Mario Botta, a notorious architect operating in Milan.

The facility is developed with a horizontal conception, in order to respect the urban morphology of Vimercate which does not present high buildings.

The building is structured with three main blocks:

- The first one (at left on the picture) is the welcome area and presents the commercial structures and the reception
- The second one covers a central position and houses the diagnosis and care wards.
- The third one is composed of four petals housing the hospital confinement wards.

Furthermore a great amount of green area is present around the whole hospital.

[www.infobuild.it]

Figure 5.1: Vimercate healthcare facility

5.3 The interview

The interview took place in May 2011.

As a first step we explained to the hospital general management the object of our research and the possibility to enact a survey in the hospital structure. The hospital management was really interested. Our interlocutor became the responsible for the communication, whom we asked the possibility to address our questions to a series of persons that we defined as the main responsible for the areas of interest that out evaluation model takes in consideration.

The persons identified by us as first were:

- Responsible for the Materials Management
- Responsible for the Hospital Pharmacy
- Responsible for the Sterilization Center
- Responsible for the Surgical Block
- Responsible for the Food Service
- Responsible for the Laundry
- Responsible for the Waste Management
- Responsible for the Technical Office
- Responsible for the Safety

Because of the high number of technical figures needed, the responsible for the communication offered himself to answer the majority of the questions, under his general and wide knowledge of the hospital structures.

However, not all the questions were given an answer, because of the high specification level of information needed.

5.4 The answers

In the evaluation phase we posed all the questions reported in the evaluation model. However, the need of specific knowledge of the issues considered in the model demonstrated that in order to answer all the questions a number of expert as interlocutors is needed.

In our case the responsible for the communication was able to answer almost all the questions about:

1. Patient-related aspects – 24 indicators/27 indicators (28 were autonomously evaluated)

2. Materials Management – 12 indicators/12 indicators
3. Hospital Pharmacy – 15 indicators/19 indicators
8. Logistics – 14 indicators/20 indicators
10. Energy-related aspects – 19 indicators/21 indicators
11. Office processes – 9 indicators/10 indicators

In the following modules only for a few indicators an answer was found:
5. Food Service – 12 indicators/24 indicators
6. Laundry management – 13 indicators/31 indicators

The following modules received very few answers:
4. CSSD, Surgical instruments management, Surgical block – 4 indicators/ 48 indicators
7. Waste management – 7 indicators/35 indicators
9. Building-related aspects – 8 indicators/26 indicators

In the patient module a number of indicators were evaluated autonomously for example on the website or with an inspection.

In the first six modules we can accept a lack of knowledge of some indicators. These information could be found with a second investigation of the responsible called for the interview.
The Food service and Laundry management modules received about half of the answers because the Food supply society was external to the hospital. The food service is outsourced. The same problem was for the Laundry management, which is outsourced.
In this case, a responsible for the specific service could be individuated and asked for the corresponding module.
The last three modules presented a strong lack of information because of their technical and specific implications.
For example, for the building module, the responsible for the communication addressed us to the technical office. The CCSD is outsourced and the Sterilization instruments management, the Surgical block, as the Waste management module, present technical issues that should be analyzed in detail.
Because of the large amount of work in the hospital, it was hard for other managers or technical directors to find the time useful for us to complete the test. At the same time it was difficult for the responsible of the communication to find answer for the remaining questions.

5.5 The results

The result of the test is a sum of the points obtained in every single module divided by the maximum points reachable for every module or section.

5.5.1 Module Score

The Module Score (MS) referred to a single module is:

$$MS_k = \sum_{i=1}^{m} P_i$$

The subscript *k* represents the number of the module, for example MS_1 represents the module score of the patient-related aspects module. The subscript *m* represents the total number of indicators that were evaluated in the module. For every indicator a number P_i has been established in function of the points achieved during the assessment.

The module score represents a sustainability indicator for the considered module.

The maximum score reachable by every module is represented by:

$$MS_{k,\max} = \sum_{i=1}^{m} P_{i,\max} = m$$

The Module Evaluation (ME) of the module is a relative score represented by this expression:

$$ME_k = \frac{MS_k * 100}{MS_{k,\max}}$$

For example, the module evaluation of a module which presents 30 indicators, of which 25 have been evaluated (*m*=25), with a module score (MS_k) of 20 points, presents;

$$MS_{k,\max} = 25$$

$$MS_k = 20$$

$$ME_k = \frac{20 * 100}{25} = 80$$

Because the maximum value of ME_k is 100, we will display 80/100.

5.5.2 Section Score

This partial evaluation is made also for the module sub-sections, (Section Score, SS) with the following notation:

$$SS_{k,h} = \sum_{i=1}^{n} P_i$$

$$SS_{k,h\max} = \sum_{i=1}^{n} P_{i,\max} = n$$

$$SE_{k,h} = \frac{SS_{k,h} * 100}{SS_{k,h,\max}}$$

Where h is the number referred to the sub-module, k the module, n the number of indicators for every section.

5.5.3 Total Score

The Total Score of the evaluation model is:

$$TS = \sum_{j=1}^{k} MS_j$$

And the total maximum score is

$$TS_{\max} = \sum_{j=1}^{k} MS_{j,\max}$$

Where $MS_{j,max}$ is the maximum score of each module j.
As for the modules partial score, a relative evaluation of the whole model is provided:

$$TE_k = \frac{TS * 100}{TS_{\max}}$$

5.5.4 Completeness index

In order to evaluate how the evaluation is complete a comparison between the total number of indicators in the model and the number of indicators evaluated can be performed.
The completeness index is:

$$CI_{k,h} = \frac{Number\_of\_indicator\_evaluated}{Total\_number\_of\_indicators}$$

This indicator can be evaluated for the sub-section, for the module, for the entire model.

5.5.5 Result statistics

The following two tables (Tables 5.1 and 5.2) are a general resume of the results of the test. We can see the points achieved in every single indicator. The indicators are presented with the belonging module and the number reported in the table (Attachment 1) and in the Chapter 4.
When the indicator presents no score it means that we found no answer in the interview.

Module 1	Score	Module 2	Score	Module 3	Score	Module 4	Score	Module 5	Score
1.1	1,00	1.1	1,00	1.1	1,00	1.1		1.1	
1.2.1	1,00	1.2	1,00	1.2	1,00	1.2.1		2.1	
1.2.2	1,00	2.1	1,00	2.1	1,00	1.2.2		2.2	
1.3.1	0,00	3.1	1,00	2.2	1,00	1.2.3		2.3	
1.3.2	1,00	3.2	1,00	2.3	1,00	1.3		2.4	1,00
1.3.3	0,00	3.3	1,00	2.4	1,00	1.4.1		2.5	1,00
1.3.4	0,00	4.1	0,00	2.5	1,00	1.4.2		3.1	1,00
1.3.5	0,00	4.2	1,00	2.6	1,00	1.4.3		3.2	1,00
1.4	1,00	5.1	1,00	3.1	1,00	1.5.1		3.3	1,00
1.5.1	1,00	5.2	1,00	3.2	1,00	1.5.2		4.1	1,00
1.5.2	1,00	5.3	1,00	3.3	1,00	1.5.3		4.2	
1.5.3	0,00	5.4	1,00	3.4	1,00	1.6	1,00	4.3	
1.5.4	0,00			3.5	1,00	1.7.1		4.4	
1.6.1	0,00			4.1		1.7.2		5.1	1,00
1.6.2	0,00			4.2		1.7.3		5.2	1,00
1.6.3	0,00			4.3		1.7.4		5.3	
2.1.1	1,00			4.4	1,00	1.7.5		5.4	1,00
2.1.2	1,00			5.1	1,00	1.8		5.5	1,00
2.1.3	1,00			5.2		1.9		5.6	1,00
2.1.4	1,00					1.10		5.7	1,00
2.2	1,00					1.11		6.1	
3.1	0.5					1.12		6.2	
3.2.1						2.1		7.1	
3.2.2						2.2		7.2	
3.2.3						2.3.1			
3.3	1,00					2.3.2			
3.4	1,00					2.3.3			
3.5.1	1,00					2.4.1			
3.5.2	1,00					2.4.2			
3.5.3	1,00					2.5			
3.5.4	1,00					2.6			
3.6.1	1,00					2.7			
3.6.2	1,00					2.8			
3.6.3	1,00					2.9			
3.7.1	1,00					2.10			
3.7.2	1,00					3.1			
4.1	0,00					3.2			
4.2	1,00					3.3.1			
4.3	0,00					3.3.2			
4.4	1,00					3.3.3	1,00		
4.5.1	1,00					3.3.4	1,00		
4.5.2	1,00					3.3.5	1,00		
4.6	0,00					3.4			
4.7	0,00					3.5			
5.1.1	1,00					3.6			
5.1.2	1,00					3.7			
5.1.3	0.5					3.8			
5.1.4	0,00					3.9			
5.2.1	0,00								
5.2.2	1,00								
5.2.3	1,00								
5.3.1	1,00								
5.3.2	1,00								
5.3.3	0,00								
5.3.4	1,00								

Table 5.1: Indicator scores, Modules 1-5

Module 6	Score	Module 7	Score	Module 8	Score	Module 9	Score	Module 10	Score	Module 11	Score
1.1	1,00	1.1.1		1.1	0,00	1.1		1.1.1	0,00	1	1,00
1.2	1,00	1.1.2		1.2	1,00	1.2.1		1.1.2	0,00	2	1,00
1.3	1,00	1.2.1		1.3	0,00	1.2.2		1.1.3	0,00	3	
2.1	1,00	1.2.2		1.4	0,00	1.2.3		1.1.4	0,00	4	1,00
2.2	1,00	1.2.3		1.5		1.2.4		1.1.5	0,00	5	1,00
3.1		1.3.1		1.6	0,00	1.3		1.1.6	0,00	6	1,00
3.2		1.3.2		2.1	1,00	1.4		1.2.1	1,00	7	1,00
3.3	1,00	1.3.3		2.2	1,00	2.1		1.2.2	0,00	8.1	1,00
4.1		1.3.4		2.3	0.5	2.2		1.2.3	0,00	8.2	1,00
5.1		1.4.1		2.4	1,00	2.3		2.1	1,00	9	1,00
5.2		1.4.2		2.5	1,00	3.1		2.2	1,00		
6.1		2.1.1		2.6		3.2		2.3	1,00		
6.2		2.1.2		2.7		3.3	1,00	2.4	1,00		
6.3		2.1.3		3.1	0.5	4.1		3.1	1,00		
7.1	1,00	2.1.4		3.2		4.2		3.2	0,00		
7.2	1,00	2.1.5		3.3		4.3		3.3	1,00		
7.3	1,00	2.2.1		3.4	0.5	5.1		4.1	0,00		
7.4	1,00	2.2.2		4.1	1,00	5.2		4.2	0,00		
7.5	1,00	2.2.3		4.2	1,00	5.3		4.3	0,00		
7.6	1,00	2.2.4		4.3		6.1	1,00	5.1			
7.7	1,00	2.2.5				6.2	1,00	5.2			
8.1		2.3				6.3	1,00				
8.2		2.4	0,00			6.4	0,50				
8.3		3.1				6.5	1,00				
9.1		3.2	1,00			7.1	1,00				
9.2		3.3.1				7.2	1,00				
9.3		3.3.2									
9.4		3.3.3									
9.5		3.4									
9.6		3.5.1	1,00								
9.7		3.5.2	1,00								
		3.5.3	1,00								
		3.6.1									
		3.6.2	1,00								
		3.6.3	0.5								

Table 5.2: Indicator scores, Modules 6-11

In table 5.3 we reported the calculation of the statistics explained in the precedent paragraphs. The indices referred to the sub-section of the modules are highlighted in blue. In orange we can see the indicators referred to the modules and in green the global evaluation referred to the whole model.

First of all we must notice the Completeness Index (CI) that for some modules is very low. CCSD with Sterilization and Surgery Block and Waste management are the lowest (0,08 and 0,2), but also Laundry, Food Service and Building are under 0,5.

For this modules the evaluation needs other investigation.

Patient-related aspects, Materials management, Energy-related aspects and Office processes present the higher CI value (between 0,9 and 1) and the evaluation con be considered complete.

An intermediate value (between 0,7 and 0,8) belongs to the Hospital pharmacy and the Logistic processes, which would present a more complete evaluation with an other in-depth investigation.

The modules that present a relatively high CI can be analyzed. We will analyze the module 1, 2, 10, 11 and, even if borderline, 3 ,5 and 8.

SECTION	***NUMBER OF INDICATORS***	SS	SSmax	SE	MS	MSmax	ME	CI(sub se	CI(module
1.Patient-related aspects									
List of services	16	7	16	43,75				1,00	
Central booking center	5	5	5	100,00				1,00	
Customer satisfaction	15	12	12	95,83				0,80	
Website	8	4	8	50,00				1,00	
Accessibility	11	8	11	68,18				1,00	
	55				35	52	67,31		0,95
2.Materials Management									
Packaging and cases	2	2	2	100,00				1,00	
Reuse and recycling	1	1	1	100,00				1,00	
Management software	3	3	3	100,00				1,00	
Purchasing	2	1	2	50,00				1,00	
General	4	4	4	100,00				1,00	
	12				11	12	91,67		1,00
3.Hospital Pharmacy									
Machine and equipment	2	2	2	100,00				1,00	
Preparation and delivery of medication	6	6	6	100,00				1,00	
Medication safety	5	5	5	100,00				1,00	
Purchasing	4	1	1	100,00				0,25	
Education	2	1	1	100,00				0,50	
	19				15	15	100,00		0,79
4.CSSD, Steriliz., Surg.									
Central sterile supply department	22	1	1	100,00				0,05	
Surgical instruments management	13	0	0	#DIV/0!				0,00	
Surgical block	13	3	3	100,00				0,23	
	48				4	4	100,00		0,08
5. Food service									
Machine and equipment	1	0	0	#DIV/0!				0,00	
Purchasing of foods	5	2	2	100,00				0,40	
Menus	3	3	3	100,00				1,00	
Waste management	4	1	1	100,00				0,25	
Food delivery	7	6	6	100,00				0,86	
Management software	2	0	0	#DIV/0!				0,00	
Personnel	2	0	0	#DIV/0!				0,00	
	24				12	12	100,00		0,50
6.Laundry									
Machine and equipment	3	3	3	100,00				1,00	
Purchasing of materials	2	2	2	100,00				1,00	
Consumption	3	1	1	100,00				0,33	
Layout	1	0	0	#DIV/0!				0,00	
Quality control	2	0	0	#DIV/0!				0,00	
Process control	3	0	0	#DIV/0!				0,00	
Transport	7	7	7	100,00				1,00	
Management software	3	0	0	#DIV/0!				0,00	
General	7	0	0	#DIV/0!				0,00	
	31				13	13	100,00		0,42
7.Waste management									
Healthcare waste typologies	11	0	0	#DIV/0!				0,00	
Waste treatment companies	12	0	1	0,00				0,08	
General	12	5	6	75,00				0,50	
	35				5	7	64,29		0,20
8.Logistic processes									
Internal and external transport systems	6	1	5	20,00				0,83	
Material storage	7	5	5	90,00				0,71	
Patient management	4	1	2	50,00				0,50	
Safety	3	2	2	100,00				0,67	
	20				9	14	60,71		0,70
9.Building-related aspects									
Construction materials and general certifications	7	0	0	#DIV/0!				0,00	
Water and hygenic services	3	0	0	#DIV/0!				0,00	
Rooms	3	1	1	100,00				0,33	
Indoor air quality	3	0	0	#DIV/0!				0,00	
Energy efficiency	3	0	0	#DIV/0!				0,00	
Parking areas	5	5	5	90,00				1,00	
Safety	2	2	2	100,00				1,00	
	26				8	8	93,75		0,31
10.Energy-related aspects									
Energy sources for the hospital	9	1	9	11,11				1,00	
Energy sources fot the transportation	4	4	4	100,00				1,00	
Monitoring	3	2	3	66,67				1,00	
Programs and opportunities	3	0	3	0,00				1,00	
Energy consumption trends	2	0	0	#DIV/0!				0,00	
	21				7	19	36,84		0,90
11.Office processes									
	10	9	9	100,00				0,90	
	10				9	9	100,00		0,90
Total number of indicators	301	127	165						
Total number of points	126,5						CI(total)	TE	
Total number of indicators evaluated	165						0,55	0,77	

Table 5.3: Statistics of the whole model

5.5.5.1 Patient-related aspects analysis

The patient module presents a high CI (0,95) and even for the sub-sections the CI is high.
The Central booking center and the Customer satisfaction sections present high values of Section Evaluation (SE). Lower values are for the List of services, the Website, the Accessibility.
As a feed back for this area we advice the hospital to:

- List of services
    - provide a more detailed facility plan
    - give more information about how to reach the facility and the internal means of transport
- Website
    - Provide a sustainability balance
    - Use a more intuitive website
    - Provide an organization chart and personnel professional profiles
- Accessibility
    - Add a shuttle service
    - Add tactile maps for unsighted persons

5.5.5.2 Materials management analysis

The Materials management module presents a CI=1 and a MS=91,6. The only indicator which received zero point is the one who refers to the distance of suppliers and evaluates if the distance of the suppliers is considered in the choice of them. The responsible for the communication answered us that the choice of the suppliers depends only on the bid that the supplier proposes because the national law imposes this decisional process. In this case we can give no advice to the hospital.
However, in our work we reported two examples of hospital which were able to select local suppliers. (paragraph 4.5.2)
Furthermore, referring to the section General, the responsible for the communication said that the warehouse management is made with Just In Time policies.

5.5.5.3 Energy-related aspects analysis

The Energy-related aspects modules received a CI=0,90 and a MS=36,8. The MS seems low, but the structure of this module doesn't give the possibility to reach high values. The comparison between different evaluation will demonstrate this trend.

In the first section, Energy sources for the hospital, the low score is due to the fact that the hospital presents a cogeneration plant and for this reason doesn't need an energy contract or other power plants.
In the fourth section, Programs and opportunities, the hospital gained no point. We advice the hospital to promote the use of public means and to incentivize car sharing and bicycle mobility solutions.

5.5.5.4 Office processes analysis

In the Office processes module all the answers received a positive and maximum evaluation. CI=0,9 and MS=100. Only one indicator received no answer, concerning the actuation of solutions able to minimize the environmental impact of toner.
The hospital seems to present an optimal management of the office and we advice the hospital to propose his management model as an example. The comparison with other structures is useful for the continuous improvement of the activity.

5.5.5.5 Hospital pharmacy, Food service and Logistic processes short analysis

The Hospital pharmacy module presents a CI=0,78 and MS=100. The hospital presents an avant-garde pharmacy management. However, a further investigation should be performed in order to identify possible weak points and give advices to the hospital.

The Food service presents CI=0,5 and MS=100. In this case the evaluation cannot be considered valid because of the strong lack of information. The food service is outsourced and an interview with a technical director of the division is necessary.

The Logistic processes module presents a low score and a relatively low CI. CI=0,7 and MS=60,7. The lowest score belong to the first and the third section, Internal and external transport systems and Patient management.
We advice the hospital to:

- Internal and external transports systems
  - Consider the use of electric vehicles and automatic robots for the transportation of materials
- Patient management
  - Use RFID tracking of the patient and electronic chart bed-patient correspondences

In every case a deeper investigation should be performed to detect other possible weak points.

5.5.5.6 Global evaluation

In general we consider that the evaluation is incomplete (the CI of the whole model is 0,54). A more affordable evaluation requires interviews with other technical director.

CHAPTER 6 – Conclusions and future developments

6.1 Introduction

In this conclusive chapter we provide some conclusions derived from the application of the model in a healthcare facility, highlighting the main critical issues and achievements. This work is first step in the healthcare sustainability evaluation, for this reason we provide some ideas of future developments that the model can put into action.

6.2 Evaluation model critical issues

The evaluation model presents several critical issues. This work presents the features of the model and the application in a hospital is useful to analyze the main problems that can be encountered during the evaluation of an healthcare facility.
In particular two issues should be underlined:

6.2.1 Data collection and elaboration

The possibility to enact a complete evaluation of the facility depends on the availability of the personnel to take part to interviews. In the former chapter we noticed that a complete evaluation requires different interviews at different levels.
As a first step it is fundamental to individuate a general manger, for example a communication manager or a general director of the hospital. This figure can answer to the majority of questions, avoiding a long list of appointments that can be uneasy for the activity management of the hospital.
In a second step, the most technical and particular aspects of the hospital taken in consideration by the modules could be analyzed in a second turn by other specific managers or technical director.
Our research gave us the opportunity to individuate as “technical modules” the following:

4. Sterilization and surgical block
5. Food service
6. Laundry management
7. Waste management
9. Building-related aspects

For these modules the interview with a technical director is the best choice.

6.2.2 Indicators applicability

The large amount of indicators used in the evaluation model covers a wide range of aspects of the hospital management. Some aspects could be difficult to detect or could seem nonsense to the managers. However, our model is based on a state of the art of the sustainability in healthcare sector and is aware that some practices could be not yet diffused or consolidated in a hospital.
For example, the indicator present in many modules, referring to the distance of the suppliers (Evaluates if the distance of the suppliers is considered in the choice of them), found a particular answer in the hospital of Vimercate: the purchasing division has the compulsion to take in consideration all the suppliers that make an offer and the decision for the final supplier must be based on the most competitive bid. The law forbids to favour some suppliers on the basis of special features (for example the distance). Nevertheless, our evaluation model classifies as “more sustainable” a purchasing division that favours local suppliers, minimizing materials transportation.

Some indicators need to be found autonomously consulting the website or with a general inspection of the facility.

In case that an indicator cannot be evaluated, because of a lack of information or troubles in finding the right interlocutor, the evaluation can be performed and doesn’t loose its validity.
However, the lack of information must be reported in percentage and taken into account. For example if 80 on a total of 100 indicators were evaluated, we will say that 80% of the information were recorded in the analysis.

6.3 Evaluation model achievement and advantages

The evaluation model presents several advantages and strong points.

6.3.1 Global and complete

First of all the model is global and covers all the aspects of a healthcare facility management. The most important plants of the hospital are considered: laundry machines, laboratories of the pharmacy, machines of the food service division, machines for the sterilization and the operating room, plants of energy generation. All the aspects of management are considered: materials management, purchasing, logistics, office processes, external and internal transportation, waste management. A special attention to the patient is covered by the patient-related aspects module which considered all the features of the hospital which are directly connected with the patients. The structure of the building is analyzed in the ninth module.

The interview which took place in the hospital of Vimercate gave us the opportunity to compare the approach of our model with the opinion of a facility manager.

Our model was judged as detailed and exhaustive.

The features of completeness of the model present an issue about the modality of evaluation.

The evaluation of the healthcare facility with this model must be voluntary and not imposed by a third party. However, the evaluation shall not be executed by internal personnel, but by a third party equipe. This practice guarantees that each indicators is evaluated with the competence required, avoiding problems of false positive evaluation. The third party organization is posed as guarantee that the indicators are correctly and truly evaluated. The ideal situation is that a commitment is formed in the healthcare facility with the pledge of evaluating the hospital performance, with the aid of this model.

6.3.2 Specific feedbacks for every area

The model exhaustiveness is joined by an other important feature. The structure of the indicators, grouped in eleven different modules, is useful to provide a specific evaluation for every area of interest of the facility. The score reached in every module represents an important indicator of the sustainability that the hospital demonstrates in that sector. The evaluation provides, beyond the scores, a feedback and some indications about how it is possible to improve the sustainability and the efficiency of the sector.

6.4 Future developments

The evaluation model must not be considered a final product, able to provide a perfect assessment of the sustainability in a healthcare facility. The evaluation model can be expanded and improved with a continuous update that comes from the review and comparison with the application in healthcare facilities and the developments of normative, state of the art, assessment tools, areas of interest.

Specifically, we identified four areas of improvement:

6.4.1 Continuous monitoring of the indicators

The use of the evaluation model is designed for the execution of single evaluation which provide a response and some indications for the hospital to improve its sustainability. This application can be joined by a continuous monitoring of the indicators. This means that a facility which has already done the evaluation, and has identified areas with low sustainability in his organization, can take the pledge of monitoring the critical areas and periodically checking the indicators in order to verify improvements that increase the sustainability of the hospital.

6.4.2 Extension and elaboration of the modules

The modules are subdivided in different areas. This subdivision is useful because every single aspect can be considered and thoroughly analyzed, favouring the addition of other single indicators or the adjustment of the single parameters on the basis of new tests and applications.

6.4.3 Addition of other modules

The modules reported in this model represent the main areas of interest of an healthcare facility. However, the development of the sustainability matters and issues favours the elaboration of other modules that can be added to the model without compromising his efficiency and validity.

6.4.4 Integration with assessment tools which have a medical view of the facility

As we have already explained in the beginning of chapter five, the model is based on an industrial view of the healthcare facility. This view is useful to detect the main activities and provide a deep analysis of the organization. Nevertheless, an assessment tool with a medical view, that is, for example, a subdivision in medical departments, can join the evaluation model proposed in this work giving a certain increase of efficiency and exhaustiveness in the sustainability analysis.

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1.Patient-related aspects

	INDICATOR	DESCRIPTION	EVALUATION
1	**LIST OF SERVICES**		
1.1	**Number of hospital beds (*)**	Evaluates the detail of information available with regard to hospital beds	Number of beds specified for each ward = 1
			Number of beds as an aggregate value for the whole facility = 0.5
			Number of beds omitted = 0
1.2	**Information about the medical performances**	Evaluates the availability of ambulatory and inpatient performances	
1.2.1	Ambulatory performances **(*)**		Yes = 1
			No = 0
1.2.2	Inpatient performances **(*)**		Yes = 1
			No = 0
1.3	**General facility plan**	Evaluates the availability of information regarding the location of the most important hospital environments	
1.3.1	Location of the main access ways **(*)**		Yes = 1
			No = 0
1.3.2	Location of the main hospital blocks, the single wards and ambulatories **(*)**		Yes = 1
			No = 0
1.3.3	Location of the reception desks **(*)**		Yes = 1
			No = 0
1.3.4	Location of the rest areas **(*)**		Yes = 1
			No = 0
1.3.5	Location of the toilets **(*)**		Yes = 1
			No = 0
1.4	**Indication of the visiting times for every single ward (*)**	Visiting times may be different for each ward	Yes = 1
			No = 0

1.5	**Information about how to reach the facility**	Evaluates the detail of description regarding the different modalities available to reach the facility	
1.5.1	By car **(*)**		Yes = 1
			No = 0
1.5.2	By railway **(*)**		Yes = 1
			No = 0
1.5.3	By airplane **(*)**		Yes = 1
			No = 0
1.5.4	By means of public transport **(*)**		Yes = 1
			No = 0
1.6	**Information about the presence of internal means of transport**	Internal means of transport simplify the internal mobility and are very helpful especially in wide extended facilities	
1.6.1	Internal shuttle service **(*)**		Yes = 1
			No = 0
1.6.2	Escalators **(*)**		Yes = 1
			No = 0
1.6.3	Elevators **(*)**		Yes = 1
			No = 0
2	**CENTRAL BOOKING CENTER (CBC)**		
2.1	**Booking modalities offered**	Evaluates the range of possibilities available to book medical performances	
2.1.1	Call center booking		Yes = 1
			No = 0
2.1.2	E-mail booking		Yes = 1
			No = 0
2.1.3	Online booking, through pre-filled forms		Yes = 1
			No = 0
2.1.4	Totem counters booking		Yes = 1
			No = 0
2.2	**Central Booking Center opening on Saturdays**	Evaluates the opening of the CBC	Yes = 1

		during non-working days	No = 0
3	**CUSTOMER SATISFACTION**		
3.1	**Presence of dedicated elevators depending on the type of users**	Dedicated elevators avoid the possibility of reciprocal interference between the different categories of users, like patients, healthcare personnel, material transport service, cleaning service	Dedicated elevators for all categories = 1
			Dedicated elevators for 2 or 3 of the listed categories = 0.5
			General purpose elevators = 0
3.2	**Humanization of healthcare environments**	Evaluates the choice of painting the different hospital environments with colors able to minimize the patients' psychological discomfort	
3.2.1	Painting of the patient rooms with colours able to arouse feelings of good mood and well-being		Yes = 1
			No = 0
3.2.2	Painting of the surgical block environments and of the operating rooms whit colours which minimize the negative afterimage of blood		Yes = 1
			No = 0
3.2.3	Painting of the dressing rooms with colours which minimize the patients' sense of discomfort and estraneity		Yes = 1
			No = 0
3.3	**Presence of green elements with a height of at least 40 cm (*)**	Green elements can lower the patients' psychological discomfort	Yes = 1
			No = 0
3.4	**Possibility for the patients of filling a questionnaire of customer satisfaction**	Evaluates the possibility for patients to express their feedback	Yes = 1
			No = 0
3.5	**Customer satisfaction questionnaire considered aspects**	Evaluates the presence in the questionnaire of the most relevant customer satisfaction indicators	
3.5.1	Facility accessibility		Yes = 1
			No = 0
3.5.2	Waiting times for the supply of the various services		Yes = 1
			No = 0
3.5.3	Perceived comfort of the patients' permanence in the		Yes = 1

	facility		No = 0
3.5.4	Quality of the human relationships between the patient and the medical, nursing and technical personnel		Yes = 1 No = 0
3.6	**Patient entertainment**	Evaluates the presence of 3 different typologies of patients' entertainment solutions	
3.6.1	Collective entertainment initiatives (like theatre, movies, small group activities)		Yes = 1 No = 0
3.6.2	Presence of monitors or multimedia systems for a one-to-one interaction with the patient		Yes = 1 No = 0
3.6.3	Possibility of an internet access		Yes = 1 No = 0
3.7	**Availability for the patient of informative material about his pathology**	Evaluates the possibility for the patients to receive written and oral information about their pathology	
3.7.1	Distribution of material in paper or in electronic format		Yes = 1 No = 0
3.7.2	Presence of totem counters		Yes = 1 No = 0
4	**WEBSITE**		
4.1	**Presence of a sustainability balance (*)**	Description of the efforts undertaken to improve the social, economic and environmental sustainability	Yes = 1 No = 0
4.2	**Online version of the list of services (*)**	Lists of services contain a complete description of the provided services	Yes = 1 No = 0
4.3	**Number of necessary clicks to enter the list of services starting from the homepage (*)**	Evaluates the intuitiveness of the website	1 click = 1 2 clicks = 0,5 3 clicks = 0

4.4	**Availability of a sitemap (*)**	Sitemaps improve the website navigability	Yes = 1
			No = 0
4.5	**Presence of contact information**	Evaluates the possibility of directly contacting the healthcare personnel	
4.5.1	Availability of a switchboard **(*)**		Yes = 1
			No = 0
4.5.2	Availability of the phone numbers of the different wards **(*)**		Yes = 1
			No = 0
4.6	**Availability of the organization chart (*)**	Indicates the pursuit of a transparency policy	Yes = 1
			No = 0
4.7	**Availability of the personnel professional profile (*)**	Indicates the pursuit of a transparency policy	Yes = 1
			No = 0
5	**ACCESSIBILITY**		
5.1	**External accessibility**	Evaluates the possibility of reaching the facility from highways, by railways and other means of transport	
5.1.1	Accessibility from highways **(*)**		Less than 3 km = 1
			Between 3 and 10 km = 0.5
			More than 10 km = 0
5.1.2	Accessibility by railway services **(*)**		Less than 10 km = 1
			Between 10 and 60 km = 0.5
			More than 60 km = 0
5.1.3	Accessibility by means of public transport (underground, tram, bus) **(*)**		Three means of transport = 1
			One or two means of transport = 0.5
			None = 0
5.1.4	Accessibility by a dedicated shuttle service **(*)**		Yes = 1
			No = 0
5.2	**Presence of internal means of transport**	Evaluates the presence of means to	

5.2.1	Shuttle service	transport people and material between the different hospital blocks and floors	Yes = 1
			No = 0
5.2.2	Escalators		Yes = 1
			No = 0
5.2.3	Elevators		Yes = 1
			No = 0
5.3	**Internal signage**	Evaluates the presence of different signage typologies, with special regard to unsighted persons	
5.3.1	Floor-, wall-mounted- and suspended signage		Three types of signage = 1
			Two types of signage = 0.5
			One type of signage = 0
5.3.2	Application of specific chromatic patterns to identify each floor		Yes = 1
			No = 0
5.3.3	Tactile maps for partially-sighted and unsighted persons		Yes = 1
			No = 0
5.3.4	Acoustic signallers in elevators for partially-sighted and unsighted persons		Yes = 1
			No = 0

(*) Autonomously evaluated

2.Materials management service

	INDICATOR	DESCRIPTION	EVALUATION
1	**PACKAGING AND CASES**		
1.1	**Use of "green" packages**	Evaluates if the purchasing of materials with green packages is considered	Yes=1
			No=0
1.2	**Specific containers for the disposal of green packages**	Evaluates if the disposal of green packages is made using specific containers	Yes=1
			No=0
2	**REUSE AND RECYCLING**		
2.1	**Reuse and recycling policy**	Evaluates if a reuse and recycling policy is enacted	Yes=1
			No=0
3	**MANAGEMENT SOFTWARE**		
3.1	**Management software for orders and procurement**	Evaluates if the purchasing and ordering of materials is performed with the aid of a management systems	Yes=1
			No=0
3.2	**Management software for materials management ware house**	Evaluates if the management of the warehouse is performed with the aid of a management software	Yes=1
			No=0
3.3	**Traceability of consumer goods with RFID or BARCODE systems**	Evaluates if a RFID or BARCODE system for the traceability of goods is present	Yes=1
			No=0
4	**PURCHASING**		
4.1	**Distance of supplier facilities**	Evaluates if the distance of the suppliers is considered in the choice of them	Yes=1
			No=0
4.2	**Green Procurement**	Evaluates if the purchasing are performed applying a green procurement policy	Yes=1
			No=0

5	**GENERAL**		
5.1	**Short term materials rotation rate**	Evaluates if the short term materials rotation rate is kept under control	Yes=1
			No=0
5.2	**High value materials rotation rate**	Evaluates if the high value materials rotation rate is kept under control	Yes=1
			No=0
5.3	**Annual inventory**	Evaluates if an annual inventory is performed	Yes=1
			No=0
5.4	**Stock materials level monitoring**	Evaluates if the stock materials level is kept under control	Yes=1
			No=0

3.Hospital Pharmacy

	INDICATOR	**DESCRIPTION**	**EVALUATION**
1	**MACHINE AND EQUIPMENT**		
1.1	**Certified Machines**	Evaluates if the purchasing of machines used by the pharmacy is towards Energy Star or Tco or similar certified machines	Yes=1
			No=0
1.2	**Pharmacy equipment in compliance with ISO 11418:2005**	Evaluates if the pharmacy equipment is ISO 11418:2005 certified	Yes=1
			No=0
2	**PREPARATION AND DELIVERY OF MEDICATIONS**		
2.1	**Unit-dose distribution system**	Evaluates if a the unit-dose methos is used	Yes=1
			No=0
2.2	**Use of the RFID or BARCODE system for the identification of medications and packages**	Evaluates if a RFID or BARCODE system for the identification is in use	Yes=1
			No=0
2.3	**Medication returns managed by pharmacy**	Evaluates if the returns of medications are managed by the pharmacy staff	Yes=1
			No=0

2.4	**Centralized warehouse**	Evaluates the presence of a centralized warehouse	Yes=1 No=0
2.5	**Automatic warehouse**	Evaluates the presence of aa automatic warehouse	Yes=1 No=0
2.6	**Regular control of stock areas**	Evaluates if regular control of stock areas are performed by the staff	Yes=1 No=0
3	**MEDICATION SAFETY**		
3.1	**One therapy sheet**	Evaluates if the one therapy sheet method is used	Yes=1 No=0
3.2	**Management software of the medication warehouse**	Evaluates the presence of a management software in the medication warehouse	Yes=1 No=0
3.3	**Computerized prescribed order entry (CPOE)**	Evaluates if the CPOE system is implemented in the management software	Yes=1 No=0
3.4	**The entire process is computerized**	Evaluates if the entire management process in wards, pharmacy and warehouse is computerized	Yes=1 No=0
3.5	**Percentage of wrong medications**	Evaluates if the percentge of wrong medication is kept under control	Yes=1 No=0
4	**PURCHASING**		
4.1	**Distance of suppliers**	Evaluates if the distance of the suppliers is considered in the choice of them	Yes=1 No=0
4.2	**Average replenishment time**	Evaluates the time between replenishments of the pharmacy warehouse	1 week=1 2 week= 0.5 more than 2 weeks =0
4.3	**Existence of replenishment minimum**	Evaluates the presence of a replenishment minimum	Yes=0 No=1
4.4	**Medications delivery frequency**	Evaluates the time between replenishments of the pharmacy	Daily=1

		warehouse	Every two days=0.5
			More than every two days=0
5	**EDUCATION**		
5.1	**Education about themes of medication safety**	Evaluates if training program about medication safety are present	Yes=1
			No=0
5.2	**Regular meeting between manager, pharmacists and technicians**	Evaluates if regular meetings are performed	Once a month=1
			Once every three months =0.5
			Less than once every three months =0

4.CSSD, Surgical instruments management, Surgical block

	INDICATOR	DESCRIPTION	EVALUATION
1	**CENTRAL STERILE SUPPLY DEPARTMENT (CSSD)**		
1.1	**CO_2 emissions associated with the transport service for one sterilization order**	Evaluates the environmental sustainability of the means of transport used by the CSSD	Less than X = 1
			Between X and Y = 0.5
			More than Y = 0
1.2	**Quality control and monitoring**		
1.2.1	Record of the number and nature of the encountered problems	The registration of the problems allows to develop organized and effective intervention plans to solve them	Yes = 1
			No = 0
1.2.2	Check of the surgical instruments before delivering the	Sterilized surgical kits must be adequately and	Yes = 1

	sterilized kits	carefully checked before their delivery	No = 0
1.2.3	Meetings with the personnel and reports on a regular basis	Evaluates if the personnel is periodically informed and updated about the quality control and monitoring procedures and their results	Yes = 1
			No = 0
1.3	**Information about autoclaves**	Rewards the presence of all needed information elencated	All elements present = 1
			One or more elements missing = 0
1.4	**Packaging of surgical instruments with medical-grade or polypropylene/kraft paper**		
1.4.1	Packaging with a double orthogonal layer	Allows the opening of the package without compromising the sterility of the contained items	Yes = 1
			No = 0
1.4.2	Application of adhesive labels containing the information on the outside of the envelopes	The use of markers, pens or stamps on the paper alters its permeability	Yes = 1
			No = 0
1.4.3	Protection of sharp or cutting material through appropriate supports	The protection allows to avoid damages to envelopes and operators	Yes = 1
			No = 0
1.5	**Packaging of surgical instruments in sterilization containers with filters**		
1.5.1	Substitution of the paper filters after each sterilization cycle	Paper filters can optimally sustain only one single sterilization cycle	Yes = 1
			No = 0
1.5.2	Updating of the number of effectuated sterilization cycles	Every filter is designed to sustain only a precise number of sterilization cycles	Yes = 1
			No = 0
1.5.3	Presence of a chemical indicator in every single container	Chemical indicators detect the reaching of sterilization conditions	Yes = 1
			No = 0
1.6	**Tracking information on each sterilized package**	Evaluates the presence of the elencated information for every unit to be sterilized, Sterilization and/or expiration date, description of the article if not visible, name of the operator who packaged the unit, number of the autoclave's	All elements present = 1
			One or more elements missing = 0

		progressive cycle, autoclave cycle type	
1.7	**Sterilized material storage**		
1.7.1	Cabinets exposure to direct light sources	Localized heat risks to damage the packages' surfaces	No = 1
			Yes = 0
1.7.2	Use of rubber bands for the assembly of more packages	Rubber bands can damage the packages' surfaces	No = 1
			Yes = 0
1.7.3	Use of coating materials which allow an easy cleaning of floors and walls	The choice of coating materials simplifies cleaning procedures	Yes = 1
			No = 0
1.7.4	Limited access to the warehouse	Every access to the warehouse must be recorded and authorized singularly	Yes = 1
			No = 0
1.7.5	Storage of the material optimized according to the sterilization date	Material must be used sequentially with the dates of sterilization	Yes = 1
			No = 0
1.8	**Sterilization processes management software**	Evaluates the use of a software for the monitoring and management of all sterilization processes	Yes = 1
			No = 0
1.9	**Water consumption per processed sterile unit**	Provides an indication about the water efficiency of the sterilization department	Less than X = 1
			Between X and Y = 0.5
			More than Y = 0
1.10	**Annual energy consumption / annual number of processed sterile units**	Estimates the energy efficiency of the sterilization department	Less than X = 1
			Between X and Y = 0.5
			More than Y = 0
1.11	**Saturation of the sterilization machines**	Evaluates the efficiency in the use of the sterilization machines	More than 70% = 1
			Between 30% and 70% = 0.5
			Less than 30% = 0
1.12	**Regular training and education about the new**	Evaluates the presence of updated training courses	Yes = 1

	sterilization procedures	for the personnel about state of the art sterilization technologies and techniques	No = 0
2	**SURGICAL INSTRUMENT MANAGEMENT**		
2.1	**Tracking system adopted**	Evaluates the possibility of tracking surgical instruments through one of the elencated modalities	RFID = 1
			Barcode = 0.5
			Manual tracking = 0
2.2	**Traceability detail level**	The tracking of the single surgical instruments allows a higher accuracy in their management	Single instruments tracked = 1
			Single surgical kits tracked = 0
2.3	**Redesign of surgical kits**		
2.3.1	Existence of an updating plan of the surgical kits	Evaluates if surgical kits are periodically examined and updated	Yes = 1
			No = 0
2.3.2	Considered aspects in the updating plan	Evaluates the execution of the elencated removal activities of inadequate surgical instruments. Removal of redundant, incoherent, technically obsolete and excessively worn instruments	All aspects considered = 1
			One or more aspects not considered = 0
2.3.3	Participation to periodical redesigns of surgical kits	Evaluates if the contribution of different internal professional figures is taken into account during the redesign of surgical kits	3 professional figures = 1
			2 professional figures = 0.5
			1 professional figure or none = 0
2.4	**Packed and single-use instruments**		
2.4.1	Possibility of using packed and single-use instruments	The necessity of their use indicates a lack in the composition of surgical kits	Yes = 1
			No = 0
2.4.2	(Annual budget spent for packed or single-use instruments) / (Number of surgical kits available)	The better surgical kits are designed, the less packed or single-use instruments are needed	Less than X = 1
			Between X and Y = 0.5
			More than Y = 0
2.5	**Location of the warehouses containing packed and**	The warehouse location influences the rapidity of	Inside of the operating room

	single-use instruments	picking an instrument in case of necessity	= 1 Outside of the operating room = 0
2.6	**Presence of multiple exemplars of the most frequently maintained instruments**	Evaluates the presence of redundancy of the instruments which are often sent to maintenance	Yes = 1 No = 0
2.7	**Presence of additional surgical instruments in the kits, to face predictable clinical complications**	Avoids the necessity of opening other kits to face clinical complications	Yes = 1 No = 0
2.8	**Tracking of the instruments sent to maintenance**	This expedient eliminates the risk of uncertainties during the recomposition of the kits in the CSSD	Yes = 1 No = 0
2.9	**Periodical lubrication of the joints subject to friction**	The lubrication minimizes the instruments' wear	Yes = 1 No = 0
2.10	**Surgical instrument management software**	Evaluates the presence of a software to help scheduling the use of surgical kits for the different interventions	Yes = 1 No = 0
3	**SURGICAL BLOCK**		
3.1	**Use of specific modular self-supporting wall and covering systems**	Evaluates the use of systems to guarantee an optimal and flexible use of critical hospital areas	Yes = 1 No = 0
3.2	**Single- or general-purpose operating rooms**	Evaluates whether operating rooms are dedicated to specific types of interventions or not	General-purpose = 1 Single-purpose = 0
3.3	**Airborne contamination**		
3.3.1	Presence of laminar air flow conditioning systems	Evaluates the presence of a system to isolate the air above the operating table from the surrounding	Yes = 1 No = 0

		air	
3.3.2	Presence of surface-sliding doors	This type of doors eliminates the air turbulences typically caused by swinging doors	Yes = 1
			No = 0
3.3.3	Existence of separate paths for non-sterilizable equipment and clean material	Improves the asepsis level of the surgical block	Yes = 1
			No = 0
3.3.4	Use of lamps with low aerodynamic profile	Evaluates the presence of lamps able to contribute maintaining laminar air flow conditions	Yes = 1
			No = 0
3.3.5	Application of the UNI E02058560 norm	The norm deals with ventilation and air-conditioning systems	Yes = 1
			No = 0
3.4	**Colours of the internal walls and furnishings**	Evaluates the choice of colours able to stimulate a positive psychological effect on patients	Psychological effects considered = 1
			Psychological effects not considered = 0
3.5	**Application of minimally invasive surgery technologies**	Evaluates the choice of technical solutions to improve the surgical performances offered	Practice of robotic surgery = 1
			Practice of minimally invasive surgery = 0.5
			Minimally invasive surgery not practiced = 0
3.6	**Domotic technology**	Evaluates the presence of state of the art audio-video technologies	Yes = 1
			No = 0
3.7	**Application of the IEC 60601-1-9 norm**	Evaluates the application of the Norm for the Environmentally Conscious Design of Medical Electrical Equipment	Yes = 1
			No = 0
3.8	**Operating room management software**	Evaluates the use of software tools to help managing the most important operating room processes	Yes = 1
			No = 0

3.9	**Annual electric power consumption / annual number of surgical interventions performed**	Evaluation of the effectiveness of the electric power consumption in the surgical block	Less than X = 1
			Between X and Y = 0.5
			More than Y = 0

5.Food Service

	INDICATOR	**DESCRIPTION**	**EVALUATION**
1	**MACHINE AND EQUIPMENT**		
1.1	**Certified Machines**	Evaluates if the purchasing of machines used by the food service is towards Energy Star or Tco or similar certified machines	Yes=1
			No=0
2	**PURCHASING OF FOODS**		
2.1	**Use of local foods**	Evaluates if the purchasing of local foods is considered and enacted	Yes=1
			No=0
2.2	**Cooked foods prepared into the kitchen**	Evaluates if the preparation of the cooked foods takes place into the kitchen	Yes=1
			No=0
2.3	**Km of food transportation by external societies**	Evaluates the medium distance of the food supplier	< 5 km=1
			5 ÷ 10 km=0.6
			10 ÷ 15 km=0.3
			>15 km =0
2.4	**Nutritional analysis made by an expert or by a team in collaboration with the hospital**	Evaluates if the nutritional analysis are made, and in case if by and expert orby a team	Yes, by a team = 1
			Yes, by an expert = 0.5
			No=0
2.5	**Suppliers apply the HACCP principles**	Evaluates if suppliers apply the HACCP principles	Yes=1
			No=0
3	**MENUS**		

3.1	**Menus customized by ward**	Evaluates the possibility of a separate management of the menus by ward	Yes=1 No=0
3.2	**Menus customized by patients**	Evaluates the possibility of a separate management of the menus by patient	Yes=1 No=0
3.3	**Consideration of feedback from staff**	Evaluates if evaluations are made to check diseases of errors for the staff	Yes=1 No=0
4	**WASTE MANAGEMENT**		
4.1	**Reusable dishes and flatware**	Evaluates if dishes and flatware are not single-use but are supposed to be used more times	Yes=1 No=0
4.2	**Composting of food waste**	Evaluates if the organic waste of foods are used to make the composting	Yes=1 No=0
4.3	**Recycling of paper and plastic**	Evaluates if paper and plastics used in the food delivery are recycled	Yes=1 No=0
4.4	**Monitoring of not served meals**	Evaluates if the non served percentage is kept under control	Yes=1 No=0
5	**FOOD DELIVERY**		
5.1	**Cultural problems considered (international patient)**	Evaluates if specific menus can be prepared for international patients	Yes=1 No=0
5.2	**Use of cold chain system**	Evaluates if the cold chain is used for the conservation of foods	Yes=1 No=0
5.3	**Bacteriological monitoring of the served meals**	Evaluates if and how often a bacteriological analysis of served meals is performed	Twice a year = 1 Once a year = 0.5 Never = 0
5.4	**Hospital food service is ISO 22000 certified**	Evaluates if food service is ISO 22000 certified	Yes=1 No=0
5.5	**Assessment of the staff efficiency in the delivery process**	Evaluates if the delivery staff efficiency is kept under control	Yes=1 No=0

5.6	**Transportation trolley with heating system**	Evaluates the presence of heating systems for the food transportation	Yes=1
			No=0
5.7	**Transportation trolley with complete solutions of meal preservation**	Evaluates the presence of complete systems for the conservation of foods during the food transportation	Yes=1
			No=0
6	**MANAGEMENT SOFTWARE**		
6.1	**Availability of a management software**	Evaluates if a management software is present	Yes=1
			No=0
6.2	**Management software can consider desires of patients, nutritional requirements, diets and intolerances**	Evaluates if the software can consider various aspects of customization	Yes=1
			No=0
7	**PERSONNEL**		
7.1	**Personnel training in good manipulation practices (food safety)**	Evaluates the presence of manipulation practices in the training courses	Yes=1
			No=0
7.2	**HACCP or similar update courses**	Evaluates the participation of the staff to HACCP or similar update courses	Yes=1
			No=0

6.Laundry Management

	INDICATOR	DESCRIPTION	EVALUATION
1	**MACHINE AND EQUIPMENT**		
1.1	**Certified Machines**	Evaluates if the purchasing of machines used by the laundry is towards Energy Star or Tco or similar certified machines	Yes=1
			No=0
1.2	**Washing machines are in compliance with ISO 8230:2008 (safety requirements)**	Evaluates if the compliance of the ISO safety requirements are considered	Yes=1
			No=0
1.3	**Washing machines are in compliance with ISO 9398:2003 (technical requirements)**	Evaluates if the compliance of the ISO technical requirements are considered	Yes=1
			No=0

2	**PURCHASING OF MATERIALS**		
2.1	**Purchasing choices of chemical products follow sustainability principles**	Evaluates if the purchasing choices are in favour of low environmental impact products with low risk disposal procedures	Yes=1
			No=0
2.2	**Suppliers are ISO 9001 – ISO 14001 – OHSAS 18001 certified**	Evaluates if the choice of the suppliers considers the that they are certified	Yes=1
			No=0
3	**CONSUMPTION**		
3.1	**Consumption monitoring (water, gas, electricity, water softening, compressed air)**	Evaluates if a consumption control monitoring is present	Water Yes=1 No=0
			Gas Yes=1 No=0
			Electricity Yes=1 No=0
			Compressed air Yes=1 No=0
			Water Softening Yes=1 No=0
3.2	**Program of consumption efficiency continuous improvement**	Evaluates if the consumption is monitored and a continuous improvement policy is applied	Yes=1
			No=0
3.3	**Water properties are regularly checked**	Evaluates if the water properties are regularly checked	Yes=1
			No=0
4	**LAYOUT**		
4.1	**Separation between clean and soiled linen with physical barrier or air flux**	Evaluates the type of separation between soiled and clean linen	Physical barrier = 1
			Air flux = 0.5
			No=0
5	**QUALITY CONTROL**		
5.1	**Record of problems and malfunctions encountered**	Evaluates the presence of a problem and malfunctions record	Yes=1
			No=0
5.2	**Regular reporting of personnel activities**	Evaluates the presence of activities record	Yes=1

			No=0
6	**PROCESS CONTROL**		
6.1	**Maintenance plan for the laundry**	Evaluates the presence of a maintenance plan	Yes=1
			No=0
6.2	**Maintenance of the laundry equipment with supplier contract**	Evaluates if the maintenance plan is with supplier contract	Yes=1
			No=0
6.3	**How is the maintenance made?**	Evaluates how the maintenance is done	Predictive = 1
			Preventive = 0.5
			Corrective =0
7	**TRANSPORT**		
7.1	**Soiled linen enclosed in specific bags**	Evaluates if the soiled linen are enclosed in specific bags	Yes=1
			No=0
7.2	**Waterproof bags for infected linen**	Evaluates if the infected linen is enclosed in water proof bags	Yes=1
			No=0
7.3	**Separation between soiled linen and infected linen**	Evaluates if the soiled linen and the infected linen are separated	Yes=1
			No=0
7.4	**Water soluble membrane laundry bags for infected linen**	Evaluates is the laundry uses water soluble membrane bags for the infected linen	Yes=1
			No=0
7.5	**Chromatic differentiation of linen containers**	Evaluates if the laundry uses containers with different colors in function of the type of linen that the container contains	Yes=1
			No=0
7.6	**Infected linen is clearly distinguished from the other**	Evaluates if the infected linen is distinguished from the other type	Yes=1
			No=0
7.7	**RFID or BARCODE identification of uniforms**	Evaluates the presence of RFID or BARCODE system for the identification of uniforms	Yes=1
			No=0
8	**MANAGEMENT SOFTWARE**		
8.1	**Management software with productivity analysis**	Evaluates the presence a management software	Yes=1

		with productivity analysis	No=0
8.2	**Management software with consumption analysis**	Evaluates the presence a management software with consumption analysis	Yes=1
			No=0
8.3	**Software with linen identification RFID or BARCODE**	Evaluates the presence of RFID or BARCODE system in the management software	Yes=1
			No=0
9	**GENERAL**		
9.1	**Training and educational program for exposure to infections**	Evaluates if the courses foresee infectivity matters	Yes=1
			No=0
9.2	**Monitoring of linen repurchasing rate**	Evaluates is the hospital keeps under control the linen repurchasing rate	Yes=1
			No=0
9.3	**Laundry is internal**	Evaluates if the laundry operates in the hospital	Yes=0
			No=1
9.4	**Number of uniform for every doctor**	Evaluates the number of uniform for every doctor	
9.5	**Uniform repurchasing rate**	Evaluates the uniform repurchasing rate	
9.6	**Automatic delivery of the uniforms**	Evaliates if the laundry has got an automatic delivery system of the uniforms	Yes=1
			No=0
9.7	**Trend of [washed kg per year]/[global consumption per year] between different years**	Evaluates the efficiency trend of the laundry	

7. Waste Management

	INDICATORS	DESCRIPTION	EVALUATION
1	**HEALTHCARE WASTE TYPOLOGIES**		
1.1	**Hazardous infectious waste**		
1.1.1	Percentage on the total annual amount of waste	Not hazardous waste is often disposed of	(Value$_{current\ year}$ / Average

		as if it were hazardous infectious waste, with increased costs	$value_{previous\ 3\ years}) < 1 = 1$
			$(Value_{current\ year}$ / Average $value_{previous\ 3\ years}) > 1 = 0$
1.1.2	Mass-specific disposal costs	Rewards the commitment to obtain disposal costs reductions	$(Value_{current\ year}$ / Average $value_{previous\ 3\ years}) < 1 = 1$
			$(Value_{current\ year}$ / Average $value_{previous\ 3\ years}) > 1 = 0$
1.2	**Hazardous not infectious waste**		
1.2.1	Percentage of waste sent to recovery	Rewards the increase of waste recovery over the years	$(Value_{current\ year}$ / Average $value_{previous\ 3\ years}) > 1 = 1$
			$(Value_{current\ year}$ / Average $value_{previous\ 3\ years}) < 1 = 0$
1.2.2	Mass-specific disposal costs	Rewards the commitment to obtain disposal cost reductions	$(Value_{current\ year}$ / Average $value_{previous\ 3\ years}) < 1 = 1$
			$(Value_{current\ year}$ / Average $value_{previous\ 3\ years}) > 1 = 0$
1.2.3	Mass-specific recovery costs	Rewards the commitment to obtain recovery cost reductions	$(Value_{current\ year}$ / Average $value_{previous\ 3\ years}) < 1 = 1$
			$(Value_{current\ year}$ / Average $value_{previous\ 3\ years}) > 1 = 0$
1.3	**Not hazardous waste**		
1.3.1	Percentage of waste sent to recovery	Rewards the increase of waste recovery over the years	$(Value_{current\ year}$ / Average $value_{previous\ 3\ years}) > 1 = 1$
			$(Value_{current\ year}$ / Average $value_{previous\ 3\ years}) < 1 = 0$
1.3.2	Percentage of disposal costs spent for the public disposal service	We consider an increase in the use of public services positive in terms of sustainability	$(Value_{current\ year}$ / Average $value_{previous\ 3\ years}) > 1 = 1$
			$(Value_{current\ year}$ / Average $value_{previous\ 3\ years}) < 1 = 0$
1.3.3	Mass-specific disposal costs	Rewards the commitment to obtain disposal cost reductions	$(Value_{current\ year}$ / Average $value_{previous\ 3\ years}) < 1 = 1$

			$(Value_{current\ year} / Average\ value_{previous\ 3\ years}) > 1 = 0$
1.3.4	Mass-specific recovery costs	Rewards the commitment to obtain recovery cost reductions	$(Value_{current\ year} / Average\ value_{previous\ 3\ years}) < 1 = 1$
			$(Value_{current\ year} / Average\ value_{previous\ 3\ years}) > 1 = 0$
1.4	**Waste that can be disposed of together with conventional residential refuse**		
1.4.1	Percentage of waste sent to recovery	Rewards the increase of waste recovery over the years	$(Value_{current\ year} / Average\ value_{previous\ 3\ years}) > 1 = 1$
			$(Value_{current\ year} / Average\ value_{previous\ 3\ years}) < 1 = 0$
1.4.2	Percentage of disposal costs spent for the public disposal service	We consider an increase in the use of public services positive in terms of sustainability	$(Value_{current\ year} / Average\ value_{previous\ 3\ years}) > 1 = 1$
			$(Value_{current\ year} / Average\ value_{previous\ 3\ years}) < 1 = 0$
2	**WASTE TREATMENT COMPANIES**		
2.1	**Certifications**		
2.1.1	UNI EN ISO 9001	The ISO 9000 family of standards relates to quality management systems	Yes = 1
			No = 0
2.1.2	UNI EN ISO 14001	The standard helps reducing a negative environmental impact	Yes = 1
			No = 0
2.1.3	OHSAS 18001	The norm represents a reference point for social sustainability-related themes	Yes = 1
			No = 0
2.1.4	EMAS	It introduces some key performance indicators (KPIs) regarding environmental themes	Yes = 1
			No = 0
2.1.5	UNI EN ISO 16001	The norm represents the European standard for Energy Management Systems	Yes = 1
			No = 0

2.2	**Services included in the subscribed treatment contracts**		
2.2.1	Provision of waste containers	There exists a wide range of waste containers types	Yes = 1
			No = 0
2.2.2	Waste collection and packaging	Waste collection processes can be optimized if outsourced to specialized companies	Yes = 1
			No = 0
2.2.3	Waste transportation	There exist internationally agreed rules for different transport modes	Yes = 1
			No = 0
2.2.4	Storage and handling of healthcare waste on site	Consists of waste sub-collection stations or areas located throughout the hospital	Yes = 1
			No = 0
2.2.5	Recovery	Some companies are specialized in both waste disposal and recovery	Yes = 1
			No = 0
2.3	**Waste weighting modalities**	Weighting modalities influence the waste disposal costs	Exact weighting = 1
			Presumed weighting = 0.5
			Weighting outsourced = 0
2.4	**Sale of waste X-ray plates**	For the recovery of the silver contained in them	Yes = 1
			No = 0
3	**GENERAL**		
3.1	**Total waste production in kg/bed/day**	The indicator rewards the actuation of strategies for the reduction of the bed-specific waste production	$(\text{Value}_{\text{current year}} / \text{Average value}_{\text{previous 3 years}}) < 1 = 1$
			$(\text{Value}_{\text{current year}} / \text{Average value}_{\text{previous 3 years}}) > 1 = 0$
3.2	**Training courses for the healthcare personnel about healthcare waste-related topics**	Training courses are very important to make the personnel aware of sensitive waste-related considerations	Yes = 1
			No = 0
3.3	**Sustainability interventions**		

3.3.1	Introduction of new waste separate collection modalities in the current year	Evaluates positively any new waste separation modality introduced	Yes = 1
			No = 0
3.3.2	Lyfe Cycle Assessment (LCA) considerations about materials and equipment supplies	LCA allows to compare the full range of environmental and social damages assignable to products and services	Yes = 1
			No = 0
3.3.3	Preferential use of chlorinated plastics-free materials and equipment	Chlorinated plastics release hazardous substances during recycling and disposal processes	Yes = 1
			No = 0
3.4	**Presence of dedicated paths for the waste evacuation from the wards**	Dedicated paths avoid the risk of contaminating other clean material	Yes = 1
			No = 0
3.5	**Solvents, reagents, expired pharmaceuticals and other chemical risk liquids**		
3.5.1	Use of trolleys equipped with containment vessels	Containment vessels are capable of receiving any spillage of liquid materials	Yes = 1
			No = 0
3.5.2	Presence of impermeable bags on the internal side of the waste containers	Impermeable bags represent an additional barrier to the spillage of liquid waste material	Yes = 1
			No = 0
3.5.3	Application of labels to waste containers and drums also in case of intermediate storage	Well readable labels and warnings allow to univocally recognize waste containers and their danger level	Yes = 1
			No = 0
3.6	**Waste-related data**		
3.6.1	Waste management software	Can help for the monitoring and an optimized management of the internal waste flows	Yes = 1
			No = 0
3.6.2	Detail of internal waste-related data at single ward level	The knowledge of waste sub-streams at a high detail level can increase the effectiveness of the waste management	Yes = 1
			No = 0
3.6.3	Tracking modalities of the waste containers	The tracking can be done manually or through barcode or RFID solutions	RFID = 1
			Barcode = 0.5
			Manual tracking = 0

8. Logistic processes

	INDICATORS	DESCRIPTION	EVALUATION
1	**Internal and external transport systems**		
1.1	**Presence of a pneumatic tube system**	Evaluates the presence of a system for the transport of light loads	Yes = 1
			No = 0
1.2	**Presence of automated guided vehicles**	Evaluates the presence of a system for the automated internal logistics of heavy loads	Yes = 1
			No = 0
1.3	**Presence of electric track vehicles**	These systems currently allow to transport loads up to 14 kg throughout the whole facility	Yes = 1
			No = 0
1.4	**Presence of autonomous mobile robots**	These robots represent a simplified version of AGVs but are able to transport lighter loads	Yes = 1
			No = 0
1.5	**Planning and optimization of internal transport systems**	Rewards the intervention of a consulting company in the previous 5 years for the planning of new internal transport solutions or the optimization of existing ones	Yes = 1
			No = 0
1.6	**Use of electric ambulances for internal transports**	Rewards the preferential use of ambulances with no emissions	Yes = 1
			No = 0
2	**Material storage**		
2.1	**Use of automated storage/retrieval systems**	The use of state of the art systems for the automated storage and retrieval is positively evaluated	Yes = 1
			No = 0
2.2	**Warehouse Management System (WMS)**	A WMS aims to control the movements and storage of materials within a warehouse and process the associated transactions	Presence of a WMS integrated with the general platform = 1

Presence of a WMS not

			integrated with the general platform = 0.5
			WMS not used = 0
2.3	**Traceability technology adopted for the hospital assets**	Evaluates the choice between different tracking modalities	RFID = 1
			Barcode = 0.5
			Manual tracking = 0
2.4	**Identification codes readable by human operators**	Evaluates the presence of additional, clearly readable codes on the stored items, to univocally identify them in case of malfunctioning of the electronic readers	Yes = 1
			No = 0
2.5	**Use of the Voice Picking technology**	Evaluates the use of an effective technology able to help the operators during logistic tasks	Yes = 1
			No = 0
2.6	**Restricted access to storage area**	Evaluates if the access to the storage area is limited to authorized personnel	Yes = 1
			No = 0
2.7	**Planning of the storage logic**	Rewards the intervention of external consultants for the optimization of the storage logic	Yes = 1
			No = 0
3	**Patient management**		
3.1	**Patient management software and tracking**	Rewards the use of a solution to manage patient logistics	Use of a patient management software associated with RFID tracking = 1
			Use of a patient management software associated with barcode tracking = 0.5
			Patient management software not in use = 0
3.2	**Bed management software and tracking**	Rewards the use of a solution to manage bed logistics	Use of a bed management software associated with RFID tracking = 1

Use of a bed management software associated with

			barcode tracking = 0.5
			Bed management software not in use = 0
3.3	**Use of electronic patient charts**	Rewards the use of electronic patient charts	Yes = 1
			No = 0
3.4	**Monitored correspondences**	Evaluates the complexity level of the tracking performed	Bed-patient-electronic chart correspondences = 1
			Bed-patient correspondences = 0.5
			Simple patient tracking = 0
4	**Safety**		
4.1	**Safety Management System (SMS)**	Rewards the use of an organizational system pursuing the objectives of corporate health and safety	Yes = 1
			No = 0
4.2	**Safety courses**	Safety courses are organized to minimize the risk of accidents which can occur during logistic activities	Yes = 1
			No = 0
4.3	**Injury Frequency Rate**	Evaluates the level of reduction of the Injury Frequency Rate obtained	IFR lower than 40% of average IFR3 previous years = 1
			IFR between 40% and 80% of average IFR3 previous years = 0.5
			IFR higher than 80% of average IFR3 previous years = 0

9.Building-related aspects

	INDICATORS	DESCRIPTION	EVALUATION

1	**CONSTRUCTION MATERIALS AND GENERAL CERTIFICATIONS**		
1.1	**Energy class of the building**	Evaluates the energy class of the building	A=3
			B=2
			C=1
			D=0
1.2	**Certifications of the building**	Evaluates the presence of building certifications	
1.2.1	**A generic certification of sustainability is present**		Yes = 1
			No = 0
1.2.2	**LEED certification**		Yes = 1
			No = 0
1.2.3	**BREEAM certification**		Yes = 1
			No = 0
1.2.4	**SB100 certification**		Yes = 1
			No = 0
1.3	**Insulated roof**	Evaluates the presence of insulated roof like green roof or cold roof	Yes = 1
			No = 0
1.4	**Insulated walls**	Evaluates the presence of insulated walls	Yes = 1
			No = 0
2	**WATER AND HYGIENIC SERVICES**		
2.1	**Water saver in shower and sinks**	Evaluates if water saving systems are present in shower and sinks	Yes=1
			No=0
2.2	**Collection of rainwater from roofs**	Evaluates if a rainwater collection system is present in the hospital	Yes=1
			No=0
2.3	**Rainwater used for irrigation, sanitary, cleaning**	Evaluates if the rainwater is used ofr irrigation, sanitary, cleaning	Yes=1
			No=0
3	**ROOMS**		

3.1	**Natural light optimized in order to decrease artificial light consumption**	Evaluates if the rooms present an optimized structure for the lighting energy saving	Yes=1
			No=0
3.2	**Kind of room lamps**	Evaluates the kind of lamps used in the rooms	Incandescent light bulb =0
			Halogen=0.25
			Fluorescent compact=0.5
			Fluorescent tube=0.75
			Led=1
3.3	**Cleaning companies are ISO 14001 certified**	Evaluates if the cleaning companies are ISO certified	Yes=1
			No=0
4	**INDOOR AIR QUALITY**		
4.1	**Air quality requisites**	Evaluates if the hospital takes into account the respect of air normative	Yes=1
			No=0
4.2	**Soundproof materials**	Evaluates if the hospital considerably presents soundproof materials and the environment isn't noisy	Yes=1
			No=0
4.3	**Low VOC materials**	Evaluates if the hospital presents low voc materials and the diffusion of organic compound is limited	Yes=1
			No=0
5	**ENERGY EFFICIENCY**		
5.1	**High efficiency lighting systems**	Evaluates if the hospital presents advanced lighting systems like dimmers or sensors	Yes=1
			No=0
5.2	**Passive solar heating on south exposures**	Evaluates if the hospital presents passive solar heating systems	Yes=1
			No=0
5.3	**Internal painting useful to increase natural light and decrease artificial light consumption**	Evaluates if the colors of the paintings are studied for the optimization of light diffusion (clear colors)	Yes=1
			No=0
6	**PARKING AREAS**		

6.1	**Parking areas for handicapped**	Evaluates if parking areas for disabled are present	Yes=1
			No=0
6.2	**Parking for bicycles**	Evaluates if parking areas for bicycles are present	Yes=1
			No=0
6.3	**Dedicated parking areas for personnel, visitors and patients**	Evaluates if parking areas for personnel, visitors and patients are present	Yes=1
			No=0
6.4	**High number of services near the hospital**	Evaluates the number of services near the hospital	More than 9 services = 1
			Between 3 and 9 services = 0.5
			Less than 3 services = 0
6.5	**Extension of the green area around the hospital**	Evaluates the amount of green area around the hospital	[Green area]/[Total area] > 0.3 (1 point)
			0.3 > [Green area]/[Total area] > 0.1 (0.5 points)
			[Green area]/[Total area] < 0.1 (0 points)
7	**SAFETY**		
7.1	**Evacuation plan ISO 23601-2009 certified**	Evaluates the presence of a certified evacuation plan	Yes=1
			No=0
7.2	**ICS 11.140 Hospital equipment**	Evaluates the consideration of this normative for the hospital equipment (in general)	Yes=1
			No=0

10. Energy-related aspects

	INDICATORS	DESCRIPTION	EVALUATION
1	**ENERGY SOURCES FOR THE HOSPITAL**		

1.1	**Energy contract procurement**	Evaluates if the hospital present a energy contract with a percentage coming from renewable resources	
1.1.1	**Photovoltaic**		Yes = 1 No = 0
1.1.2	**Eolic**		Yes = 1 No = 0
1.1.3	**Cogeneration or trigeneration**		Yes = 1 No = 0
1.1.4	**Geothermic**		Yes = 1 No = 0
1.1.5	**Biomass**		Yes = 1 No = 0
1.1.6	**Solar thermal**		Yes = 1 No = 0
1.2	**Energy generation at the hospital facility**	Evaluates if the hospital presents a energy generation plant	
1.2.1	**Cogeneration or trigeneration**		Yes = 1 No = 0
1.2.2	**Photovoltaic**		Yes = 1 No = 0
1.2.3	**Solar thermal**		Yes = 1 No = 0
2	**ENERGY SOURCES FOR THE TRANSPORTATION**		
2.1	**More than a half of the vehicles equipped with petrol or diesel engines**	Evaluates if the hospital presents more than a half of the vehicles with petrol or diesel engine	Yes=0 No=1
2.2	**GPL, CNG or GN vehicles**	Evaluates if the hospital is equipped with GPL or similar vehicles	Yes=1 No=0
2.3	**Electric vehicles**	Evaluates if the hospital is equipped with	Yes=1

		electric vehicles	No=0
2.4	**Hybrid vehicles**	Evaluates if the hospital is equipped with hybrid vehicles	Yes=1
			No=0
3	**MONITORING**		
3.1	**Energy management program ISO 50001 certified**	Evaluates if the hospital has a Energy management program in compliance with ISO 50001 (end of 2011)	Yes=1
			No=0
3.2	**Measuring, reporting and documentation of the energy improvement (ISO 50001 basic guidelines)**	Evaluates if the hospital which is not ISO 50001 certified presents the basic guidelines of the normative	Yes=1
			No=0
3.3	**Energy Manager**	Evaluates if the hospital has got an Energy manager	Yes=1
			No=0
4	**PROGRAMS AND OPPORTUNITIES**		
4.1	**Car sharing program**	Evaluates the presence of car sharing program	Yes=1
			No=0
4.2	**Benefits for the public transport use**	Evaluates the presence of public transport incentives	Yes=1
			No=0
4.3	**Incentives for bicycle use**	Evaluates the presence of bicycles use incentives	Yes=1
			No=0
5	**ENERGY CONSUMPTION TREND**		
5.1	**[Electricity consumption-current year]/ [Electricity consumption 1 or 2 or 3 years ago]**	Evaluates the electricity consumption trends	>1 = 0
			0.95 - 1 = 0.5
			0.90 - 0.95 =1
5.2	**[Thermal energy consumption-current year]/ [Thermal energy consumption 1 or 2 or 3 years ago]**	Evaluates the thermal (gas) consumption trends	>1 = 0
			0.95 - 1 = 0.5
			0.90 - 0.95 =1

11.Office processes

	INDICATORS	DESCRIPTION	EVALUATION
1	**PCs quality**	Evaluates the presence of the elencated elements able to improve the environmental and economic sustainability of PCs. Monitor with environmental certifications; solutions to stop the electricity flow to the equipment in specific conditions	2 elements verified = 1
			1 element verified = 0.5
			None = 0
2	**Stationery material**	Rewards the continuous supply of green stationery material	Yes = 1
			No = 0
3	**Use of containers for exhausted toner or outsourcing of its disposal**	Evaluates the actuation of solutions to minimize the environmental impact of toner	Yes = 1
			No = 0
4	**Containers for exhausted batteries or use of rechargeable batteries**	Rewards the actuation of solutions to minimize the environmental impact of batteries	Yes = 1
			No = 0
5	**Modalities for the reduction of paper use**	Rewards the highest possible number of modalities actuated for the reduction of paper use, between those elencated	More than 6 = 1
			Between 4 and 6 functionalities = 0.5
			Between 0 and 3 functionalities = 0
6	**Exclusive use of "green" paper**	Evaluates if the paper used is PEFC or FSC certified or is recycled for at least 75%	Yes = 1
			No = 0

7	**Waste separation**	Evaluates the presence of areas for the waste separation provided with the right containers	Yes = 1
			No = 0
8	**Document management system**		
8.1	Availability of a document management system	Evaluates the presence of a computer system to track and store electronic documents	Yes = 1
			No = 0
8.2	Use of a web based document management system	Rewards the use of a state of the art document management system	Yes = 1
			No = 0
9	**Workstation ergonomics**	Evaluates if training courses about ergonomics are organized	Yes = 1
			No = 0

Modulo 1.PAZIENTE

CUP

1) E' possibile usufruire del servizio CUP per prenotare prestazioni mediche da postazioni remote?
SI NO

2) Gli sportelli per le prenotazioni sono aperti anche al sabato?
SI NO

CUSTOMER SATISFACTION

1) Sono presenti ascensori dedicati per le seguenti categorie?
a) pazienti
b) personale sanitario
c) servizi di trasporto materiali
d) servizi di pulizia
SI NO

2) I colori con cui sono tinteggiate le pareti delle camere dei degenti, le pareti degli ambienti del blocco chirurgico e le pareti degli spogliatoi sono stati scelti considerando l'effetto psicologico che i colori sono in grado di generare sui pazienti?
SI NO

3) E' possibile per i pazienti compilare un questionario di valutazione della customer satisfaction?
SI NO

4) Nel questionario di customer satisfaction, è possibile esprimere un parere riguardo a:

Accessibilità della struttura?
SI NO

Tempi di attesa per l'erogazione dei vari servizi?
SI NO

Confort percepito durante la propria permanenza?
SI NO

Qualità delle relazioni con il personale medico, infermieristico e tecnico?
SI NO

5) Intrattenimento dei pazienti

Sono organizzate attività di intrattenimento collettivo (spettacoli teatrali, proiezioni di video, attività di gruppo)?

SI NO

Sono presenti sistemi multimediali per l'intrattenimento dei pazienti?
SI NO

E' possibile un accesso a internet?
SI NO

6) Disponibilità per i pazienti di informazioni relative alla loro patologia

Viene distribuito ai pazienti materiale informativo in formato cartaceo oppure elettronico?
SI NO

Sono presenti consultori all'interno della struttura, dove i pazienti possano parlare con personale competente a proposito della propria situazione?
SI NO

ACCESSIBILITA'

1) Presenza di mezzi di trasporto interni

E' presente un servizio bus navetta (interno; con i principali collegamenti esterni)?
SI NO

Sono presenti scale mobili?
SI NO

Sono presenti ascensori?
SI NO

2) Segnaletica interna

E' presente segnaletica a pavimento? Segnaletica a parete? Segnaletica sospesa?
1 tipologia 2 tipologie 3 tipologie

Sono applicati pattern cromatici per identificare ciascun piano dell'edificio/degli edifici?
SI NO

Sono presenti mappe tattili per persone ipovedenti e non vedenti?
SI NO

Sono presenti segnalatori acustici negli ascensori per persone ipovedenti e non vedenti?
SI NO

ASPETTI BUILDING ED ENERGIA LATO PAZIENTE

1) **Sono applicati negli ambienti interni materiali autoigienizzanti, antiodore ed antibatterici?** (Sul mercato sono disponibili numerose aziende specializzate nell'applicazione di rivestimenti fotocatalitici con nano materiali a base di titanio per ottenere superfici autopulenti, antibatteriche, antiodore)
SI NO

2) **Le aziende di pulizie utilizzate dispongono di certificazione ISO 14001 (sistemi di gestione ambientale)?**
SI NO

3) **I reparti di degenza sono ubicati in modo tale da garantire una esposizione alla luce naturale possibilmente elevata?**
SI NO

4) **Sono distribuite negli ambienti interni piante di altezza superiore ai 40 cm?**
SI NO

Modulo 2: Materials Management – Economato

Destinatario: Responsabile per l'economato e la gestione materiali

Il settore economato si occupa della gestione, acquisto e smaltimento dei generi di largo consumo utili per le diverse funzioni dell'ospedale. Nel seguente modulo valuteremo la sostenibilità del settore suddiviso in 5 aree tematiche:

- Confezionamento e imballaggi
- Riutilizzo e riciclaggio
- Software di gestione
- Contratti di acquisto
- Generale

1. Confezionamento e imballaggi

1.1 Viene considerato e privilegiato l'acquisto di materiali con imballaggi "green"?	SI=1 NO=0
Per imballaggi green si intendono imballaggi fatti con carta riciclata, biodegradabili, riciclabili, riutilizzabili, privi di sostanze tossiche	
1.2 Sono presenti specifici contenitori per la gestione di imballaggi "green"?	SI=1 NO=0
Gli imballaggi green vengono smistati in maniera differente dagli altri rifiuti	

2. Riutilizzo e riciclaggio

2.1 E' presente una politica di riutilizzo e /o riciclaggio dei materiali?	SI=1 NO=0
Esiste uno specifico programma certificato e documentato per il riciclaggio e riutilizzo di prodotti.	

3. Software di gestione

3.1 Viene utilizzato un software di gestione per gli approvvigionamenti e gli ordini?	SI=1 NO=0
3.2 Viene utilizzato un software per la gestione dedicata del magazzino economale?	SI=1 NO=0
3.2 E' prevista la tracciabilità dei beni economali con soluzioni come BARCODE e RFID?	SI=1 NO=0

4. Contratti di acquisto

4.1 Viene tenuta in considerazione la distanza dei fornitori, cercando di privilegiare fornitori a distanze minori?	SI=1 NO=0
4.2 E' prevista l'applicazioni di logiche di "Green procurement"?	SI=1 NO=0

5. Generale

5.1 E' effettuato il calcolo dell'indice di rotazione di materiali a breve scadenza?	SI=1 NO=0
5.2 E' effettuato il calcolo dell'indice di rotazione su prodotti di elevato valore unitario?	SI=1 NO=0
5.3 E' previsto lo svolgimento di un inventario annuale dei prodotti a magazzino?	SI=1 NO=0
5.4 Vengono monitorati i livelli delle giacenze?	SI=1 NO=0

Modulo 3: Hospital Pharmacy – Farmacia d'ospedale

Destinatario: Responsabile o direttore della farmacia

Il settore farmacia si occupa dell'acquisto, la preparazione, la consegna e lo smaltimento dei medicinali in tutto l'ospedale. All'interno della farmacia, oltre allo stoccaggio di tutti i medicinali è presente un laboratorio per la preparazione in sede di specifiche soluzioni. Nel seguente modulo valuteremo la sostenibilità del settore dopo averlo suddiviso in 5 aree tematiche:

- Macchinari
- Preparazione e consegna dei medicinali
- Sicurezza dei medicinali
- Acquisti
- Formazione

1. Macchinari

1.1 Sono presenti macchinari con certificazione Energy Star o TCO o similari?	SI=1 NO=0
1.2 La strumentazione della farmacia è in rispetto della norma ISO 11418:2005?	SI=1 NO=0

2. Preparazione e consegna dei medicinali

2.1 E' implementata la logica di somministrazione monodose dei farmaci?	SI=1 NO=0
Distribuzione automatizzata dei farmaci caratterizzata dalla verifica di ogni singola prescrizione e dalla preparazione in farmacia della terapia giornaliera per ogni paziente	
2.2 Esiste un sistema RFID o BARCODE per l'identificazione di farmaci e/o relativi involucri?	SI=1 NO=0
Utilizzo del sistema RFID o BARCODE per identificare il farmaco o il suo contenitore	
2.3 E' previsto che i ritorni di medicinali siano gestiti dalla farmacia?	SI=1 NO=0
Nel caso in cui un medicinale risulti sbagliato o inutile è la farmacia stessa ad occuparsene	
2.4 I medicinali vengono stoccati in un magazzino centralizzato?	SI=1 NO=0
2.5 Per lo stoccaggio dei medicinali sono utilizzati degli magazzini automatizzati?	SI=1 NO=0
2.6 Sono previsti controlli regolari delle aree di stoccaggio medicinali?	SI=1 NO=0

3. Sicurezza dei medicinali

3.1 Viene utilizzato il metodo della scheda unica di terapia?	SI=1 NO=0
3.2 E' presente un sistema informatico per la gestione dei medicinali a magazzino?	SI=1 NO=0
3.3 Il sistema informatico è equipaggiato con Computerized Physician Order Entry (CPOE)?	SI=1 NO=0
Presenza sul sistema informatico di software con gestione CPOE, o PIR Prescrizione Informatizzata in Reparto	
3.4 L'intero processo (reparto-farmacia-magazzino di reparto) è completamente informatizzato?	SI=1 NO=0
3.5 Viene registrata la percentuale di medicinali non consegnati o consegnati in modo errato per incompletezza di informazioni sul paziente o per errori di consegna?	SI=1 NO=0

4. Acquisti

4.1 Nella gestione degli acquisti viene tenuta in considerazione la distanza dei fornitori?	SI=1 NO=0
4.2 Qual è il tempo medio di riapprovvigiona mento garantito dai fornitori?	1 settimana=1 2 settimane=0.5 3 settimane=0
4.3 Esistono minimi di riordino verso i fornitori?	SI=0 NO=1
4.4 Ogni quanto tempo vengono effettuate le consegne di medicinali ai reparti?	Quotidianamente=1 Ogni due giorni=0.5 Più che ogni due giorni=0

5. Formazione

5.1 Viene pianificata la formazione su problemi di sicurezza nella gestione di medicinali?	SI=1 NO=0
Presenza, nei programmi di formazione, di tematiche di sicurezza di medicinali	
5.2 Vengono effettuati meeting regolari e verbalizzati tra manager, farmacisti e tecnici?	Una volta al mese = 1 Una volta ogni tre mesi = 0,5 Meno di una volta ogni tre mesi = 0

Modulo 4.CENTRALE DI STERILIZZAZIONE, GESTIONE DELLO STRUMENTARIO CHIRURGICO, BLOCCO OPERATORIO

CENTRALE DI STERILIZZAZIONE

1) Qual è il tempo richiesto per l'evasione di un ordine medio (tempo che intercorre dalla consegna del materiale alla centrale alla ricezione del materiale sterilizzato)?

2) La centrale di sterilizzazione è interna all'ospedale oppure esterna? Se è esterna, a che distanza si trova dall'ospedale?

3) Sono organizzati presso la centrale di sterilizzazione periodici corsi di formazione e aggiornamento relativi alle nuove procedure di sterilizzazione?
SI NO

4) Controllo e monitoraggio della qualità

Esiste un sistema di registrazione contenente il numero e la natura dei problemi verificatisi presso la centrale?
SI NO

Sono organizzate riunioni regolari con il personale relative ai problemi riscontrati e a tematiche sulla qualità?
SI NO

5) Informazioni riguardo alle autoclavi

Sono presenti per ciascuna macchina i seguenti elementi:
Manuale d'istruzioni?
SI NO

Copia del manuale contenente la descrizione delle corrette procedure di sterilizzazione?
SI NO

Schede giornaliere relative ai cicli di sterilizzazione effettuati?
SI NO

Schede riportanti i controlli settimanali delle macchine?
SI NO

Schede riportanti approfonditi controlli trimestrali delle macchine?
SI NO

Schede contenenti dati relativi ai processi di ispezione e manutenzione svolti?
SI NO

6) Packaging delle unità da sterilizzare con carta tipo medical grade o polipropilene/kraft

Si utilizza la tecnica di confezionamento mediante doppio strato ortogonale? Questa tecnica permette un'effettiva protezione, agevole apertura ed estrazione asettica del contenuto.
SI NO

Sono applicate etichette adesive recanti le informazioni relative a ciascuna unità da sterilizzare?
SI NO

Parti affilate o taglienti degli strumenti da sterilizzare vengono sempre opportunamente protette?
SI NO

7) Packaging delle unità da sterilizzare in container per sterilizzazione con filtri

I filtri in carta sono sostituiti dopo ciascun ciclo di sterilizzazione (i filtri in carta sostengono in modo ottimale un solo ciclo di sterilizzazione)?
SI NO

Nel caso si utilizzino filtri in tessuto, si tiene conto del numero di cicli di sterilizzazione effettuati, in modo da capire quando sia il momento di sostituire i filtri?
SI NO

Si utilizza un indicatore chimico di processo per ciascun container, in modo da verificare l'effettivo raggiungimento delle condizioni di sterilizzazione?
SI NO

8) Informazioni per la tracciatura di ogni singola unità sterilizzata

Sono presenti le seguenti informazioni:
Data di sterilizzazione?
SI NO

Descrizione degli articoli contenuti, se non visibili?
SI NO

Nome dell'operatore che si è occupato del trattamento della particolare unità da sterilizzare?
SI NO

Numero del ciclo di sterilizzazione associato a quella determinata unità chirirgica?
SI NO

Tipo di ciclo dell'autoclave?

SI NO

9) Deposito del materiale sterilizzato

Gli armadi contenenti le unità sterilizzate sono esposti a fonti di luce diretta?
SI NO

Qual è la temperatura media dell'aria nell'area di deposito?
Fra 18°C e 24°C Altri valori

Qual è l'umidità relativa dell'aria nell'area di deposito?
Fra il 40% e il 50% Altri valori

Sono utilizzati elastici di gomma per tenere insieme più unità sterili?
SI NO

Pavimenti e pareti sono rivestiti con materiali che ne permettano un'agevole pulizia?
SI NO

L'accesso al magazzino è limitato al solo personale autorizzato?
SI NO

Il deposito delle unità sterili avviene secondo la data di sterilizzazione?
SI NO

10) E' utilizzato un software di gestione dei processi di sterilizzazione?
SI NO

11) Qual è la quantità totale annua di acqua utilizzata?
Qual è la quantità totale annua di unità sterili processate?

12) Qual è la quantità totale annua di energia elettrica consumata?
Qual è la quantità totale annua di unità sterili processate?

13) Qual è il numero di unità sterili processate durante l'anno?
Qual è il numero di cicli di sterilizzazione annui effettuati?
Qual è la capienza delle sterilizzatrici in termini di unità sterili?
Qual è il numero di sterilizzatrici utilizzato?
(Ne ricavo la saturazione delle macchine)

GESTIONE DELLO STRUMENTARIO CHIRURGICO

1) A quale livello di dettaglio è effettuata la tracciatura dello strumentario chirurgico?
Singolo strumento chirurgico Kit chirurgico

2) Qual è la tipologia di sistema di tracciabilità utilizzata?
RFID Barcode Tracciatura manuale

3) Riprogettazione dei kit chirurgici

E' prevista una procedura di aggiornamento periodico dei kit chirurgici (Se sì, perchè? Chiedi se sono tenuti in considerazione strumenti ridondanti, incoerenti, tecnicamente obsoleti, eccessivamente usurati)?
SI NO

Gli infermieri ferristi partecipano alle attività di aggiornamento / riprogettazione dei kit chirurgici?
SI NO

4) Qual è il numero totale annuo di strumenti imbustati o monouso utilizzati? Qual è il numero di kit chirurgici presenti?

5) Dove sono ubicati gli armadi contenenti gli strumenti imbustati e monouso?
All'interno delle sale operatorie All'esterno delle sale operatorie

6) All'interno dei kit sono presenti esemplari multipli degli strumenti maggiormente soggetti a manutenzione?
SI NO

7) I kit chirurgici sono facilmente integrabili con ferri imbustati, in modo da poter far fronte all'insorgenza di eventuali complicazioni chirurgiche senza ricorrere all'apertura di ulteriori kit?
SI NO

8) E' eseguita la tracciatura degli strumenti inviati in manutenzione?
SI NO

9) Sono condotte periodiche lubrificazioni dei giunti mobili degli strumenti, sottoposti a fenomeni di attrito?
SI NO

10) E' utilizzato un software per la gestione dello strumentario chirurgico?
SI NO

BLOCCO OPERATORIO

1) Sono utilizzati sistemi modulari per la realizzazione degli ambienti del blocco operatorio, in modo da garantire un certo grado di riconfigurabilità degli ambienti stessi?
SI NO

2) Contaminazione aerea

Sono presenti sistemi di condizionamento dell'aria a flusso laminare?
SI NO

Sono utilizzate porte scorrevoli?
SI NO

Esiste un percorso dedicato allo sporco ed uno dedicato al pulito?
SI NO

Sono utilizzate lampade a basso profilo aerodinamico?
SI NO

E' applicata la norma UNI E02058560 (progettazione, installazione, messa in marcia, controllo delle prestazioni, accettazione, gestione degli impianti e dei componenti che concorrono al controllo della contaminazione ambientale e al mantenimento di prefissate condizioni termoigrometriche nei blocchi operatori)?
SI NO

3) **I colori per le tinteggiature degli ambienti del blocco operatorio sono stati scelti tenendo in considerazione il loro potenziale effetto psicologico positivo sui pazienti?**
SI NO

4) **Sono utilizzati sistemi per la chirurgia mininvasiva (per esempio colonne laparoscopiche oppure robot chirurgici come DaVinci)?**
SI NO

5) **Sono utilizzate tecnologie domotiche in sala operatoria, che permettano per esempio la possibilità di monitorare in modo centralizzato lo stato delle diverse apparecchiature in uso?**
SI NO

6) **E' applicata la norma IEC 60601-1-9 (acquisto di apparecchiature medicali realizzati con una progettazione che permetta di minimizzare il loro impatto ambientale nell'intero ciclo di vita)?**
SI NO

7) **E' utilizzato un software che consideri uno o più fra i seguenti aspetti (pianificazione delle sale, gestione dello staff, programmazione degli interventi chirurgici, gestione dello strumentario chirurgico)?**
SI NO

8) **E' utilizzato un software di supporto, per assistere i medici nella formulazione delle diagnosi e delle decisioni operative in sede chirurgica (per esempio: gestione della cartella clinica elettronica)?**
SI NO

9) **Qual è il consumo totale annuo di energia elettrica? Qual è il numero totale annuo di interventi chirurgici effettuati**

Modulo 5: Food Service – Servizio Pasti

Destinatario: Responsabile della mensa e dell'approvvigionamento alimentare

Il settore del servizio pasti si occupa di soddisfare tutte le necessità della struttura ospedaliera riguardanti le mense, sia dei dipendenti che dei pazienti. Nel servizio pasti è dunque contemplata la distribuzione del cibo nelle camere, l'acquisto, la preparazione e il mantenimento dei cibi. Nel seguente modulo valuteremo la sostenibilità del settore dopo averlo suddiviso in 7 aree tematiche:

- Macchinari
- Approvvigionamento cibi
- Menù
- Gestione dei rifiuti
- Distribuzione dei pasti
- Software di gestione
- Personale

1. Macchinari

1.1 Sono presenti macchinari con certificazione Energy Star o TCO o similari?	SI=1 NO=0

2. Approvvigionamento cibi

2.1 Viene privilegiato e massimizzato l'acquisto di cibi locali?	SI=1 NO=0
2.2 Viene privilegiata e massimizzata la preparazione dei cibi cotti autonomamente all'interno della cucina?	SI=1 NO=0
2.3 Qual è la distanza media che percorrono le società esterne per il trasporto del cibo?:	< 5 km=1 5 ÷ 10 km=0.6 10 ÷ 15 km=0.3 >15 km =0
2.4 Le analisi nutrizionali dei menù sono condotte da un esperto o da un team in collaborazione con lo staff dell'ospedale?	Si, da un team = 1 Si, da un esperto=0,5 NO=0
E' presente un esperto che effettua analisi sui menù e li redige	
2.5 Si privilegiano fornitori che applicano i principi dell'HACCP?	SI=1 NO=0
Certificazione HACCP presente presso i fornitori	

3. Menù

3.1 I menù sono personalizzati o personalizzabili in funzione dei reparti?	SI=1 NO=0
Possibilità di gestione separata dei menù presso diversi reparti	
3.2 I menù sono personalizzati o	SI=1 NO=0

personalizzabili in funzione dei pazienti?	
Possibilità di gestione separata dei menù per ogni singolo paziente	
3.3 Viene effettuato un rilevamento e considerazione del feedback dello staff riguardante le operazioni di servizio pasti e gestione degli stessi?	SI=1 NO=0
Presenza di questionari per la rilevazione di disagi ed errori per lo staff	

4. Gestione dei rifiuti

4.1 Si utilizzano piatti e posate riutilizzabili?	SI=1 NO=0
Piatti e posate non sono di tipo usa e getta ma vengono riutilizzati più volte	
4.2 Si effettua il compostaggio degli avanzi di cibo?	SI=1 NO=0
Sugli avanzi organici viene effettuato un compostaggio gestito autonomamente e secondo normative	
4.3 Si effettua il riciclaggio di carta e plastica?	SI=1 NO=0
La carta e la plastica di rifiuto vengono gestite per il riciclaggio	
4.4 Viene tenuta sotto controllo la percentuale giornaliera di pasti non serviti?	SI=1 NO=0

5. Distribuzione dei pasti

5.1 Vengono considerate le problematiche culturali (pazienti internazionali)?	SI=1 NO=0
Menù appositi per pazienti con particolari condizioni culturali	
5.2 Viene utilizzata la catena del freddo come metodo di mantenimento del cibo?	SI=1 NO=0
5.3 Si effettua un monitoraggio batteriologico dei cibi serviti?	Due volte l'anno=1 Una volta l'anno=0,5 Mai=0
Vengono effettuati rilevamenti su campioni casuali per verificare la presenza di batteri	
5.4 E' presente la Certificazione ISO 22000?	SI=1 NO=0
Il servizio pasti è conforme a ISO 22000	
5.5 Vengono effettuati test per valutare il livello di efficacia ed efficienza del personale nella distribuzione dei pasti?	SI=1 NO=0
5.6 I carrelli di trasporto dei cibi sono equipaggiati con sistemi di riscaldamento dei pasti?	SI=1 NO=0
5.7 I carrelli di trasporto dei cibi sono equipaggiati con sistemi completi di mantenimento del cibo che garantiscono la conservazione e distribuzione mantenendo inalterata la qualità dei cibi?	SI=1 NO=0

6. Software di gestione

6.1 E' utilizzato un software di gestione dei pasti?	SI=1 NO=0
Presenza di un software di gestione dei menù e della consegna dei pasti	
6.2 Se tale software è utilizzato considera ed elabora desideri o esigenze dei pazienti, specifici requisiti nutrizionali e eventuali diete o intolleranze?	SI=1 NO=0
Presenza, sul software di gestione, di sistemi che considerano preferenze dei pazienti e requisiti nutrizionali richiesti	

7. Personale

7.1 E' prevista la formazione del personale riguardo a pratiche di corretta manipolazione dei cibi?	SI=1 NO=0
Presenza, nei programmi di formazione, di tematiche di manipolazione dei cibi	
7.2 Sono previsti corsi di aggiornamento riguardanti HACCP o altre normative per il personale addetto alla distribuzione dei pasti e delle cucine?	SI=1 NO=0

Modulo 6: Laundry – Lavanderia

Destinatario: Responsabile o direttore della lavanderia

Il settore lavanderia si occupa del lavaggio di tutti i materiali come lenzuola e coperte delle stanze dei pazienti. Ma anche camici e vestiti, sia dei medici che dei pazienti. Tale reparto è importante perché garantisce l'eliminazione di batteri e contaminazioni. Nel seguente modulo valuteremo la sostenibilità del settore dopo averlo suddiviso in 10 aree tematiche:
- Macchinari
- Approvvigionamento di materiali per il lavaggio
- Consumo utenze
- Layout
- Controllo qualità
- Controllo del processo
- Trasporto
- Software di gestione
- Generale

1. Macchinari

1.1 Sono presenti macchinari con certificazione Energy Star o TCO o similari?	SI=1 NO=0
1.2 Le macchine di lavaggio rispettano la norma ISO 8230:2008 (requisiti di sicurezza)?	SI=1 NO=0
1.2 Le macchine di lavaggio rispettano la norma ISO 9398:2003 (requisiti tecnici)?	SI=1 NO=0

2. Approvvigionamento materiali per il lavaggio

2.1 Le scelte di acquisto dei prodotti chimici di lavanderia seguono principi di sostenibilità ambientale?	SI=1 NO=0
Vengono privilegiati prodotti a basso impatto ambientale e con procedure di smaltimento meno pericolose	
2.2 Si controlla che i fornitori abbiano la certificazione ISO 9001 o ISO 14001 o OHSAS 18001?	SI=1 NO=0

3. Consumo utenze

3.1 E' previsto il controllo e il monitoraggio dei consumi idrici, di metano, di elettricità, di aria compressa e di depurazione delle acque?	Acqua SI=1 NO=0 Metano SI=1 NO=0 Elettricità SI=1 NO=0 Aria compressa SI=1 NO=0 Depurazione delle acque SI=1 NO=0
Presenza di un programma di controllo dei consumi	
3.2 E' previsto un programma di miglioramento continuo dei costi delle	SI=1 NO=0

utenze?	
I consumi vengono monitorati per soddisfare degli obiettivi di miglioramento	
3.2 Le proprietà dell'acqua sono controllate regolarmente?	SI=1 NO=0
Controllo regolare delle proprietà dell'acqua	

4. Layout

5.1 La separazione tra capi puliti e sporchi è ottenuta con una barriera fisica o con un flusso d'aria direzionato dai capi puliti verso i capi sporchi?	Barriera fisica=1 Flusso d'aria=0.5 NO=0

5. Controllo qualità

6.1 Viene tenuto un record di problemi e malfunzionamenti incontrati?	SI=1 NO=0
6.2 Vengono effettuati report regolari dell'attività del personale? (meeting, problemi, assenze)	SI=1 NO=0

6. Controllo del processo

7.1 Esiste di un piano di manutenzione della lavanderia?	SI=1 NO=0
Piano di manutenzione certificato della lavanderia	
7.2 La manutenzione dell'equipaggiamento di lavanderia è effettuata a contratto da fornitore?	SI=1 NO=0
7.3 Come viene svolta la manutenzione?	A guasto=0 Preventiva=0,5 Predittiva=1
La manutenzione viene effettuata con la modalità indicata	

7. Trasporto

7.1 La biancheria sporca viene trasportata in lavanderia dopo essere stata chiusa in appositi sacchetti? (utile per trasporto su scivoli)	SI=1 NO=0
7.2 Sono previsti appositi sacchetti impermeabili per il trasporto della biancheria infetta?	SI=1 NO=0
Per biancheria infetta di intende quella sporca di liquidi organici	
7.3 E' prevista la separazione della biancheria sporca da quella infetta?	SI=1 NO=0
7.4 Sono in uso presso la lavanderia sacchetti con cuciture o a membrana idrosolubile per biancheria molto sporca?	SI=1 NO=0
7.5 E' prevista una metodologia di codificazione cromatica per i contenitori della	SI=1 NO=0

biancheria?	
7.6 La biancheria infetta è chiaramente identificata e distinta dalle altre?	SI=1 NO=0
7.7 E' presente l'identificazione delle divise attraverso un sistema RFID o BARCODE?	SI=1 NO=0

8. Software di gestione

8.1 Viene utilizzato un software di analisi gestionale della produttività?	SI=1 NO=0
Presenza, sui sistemi informatici, di un software che analizzi la produttività del reparto	
8.2 Il software effettua un'analisi dei consumi?	SI=1 NO=0
Presenza, sui sistemi informatici, di un software che analizzi consumi delle diverse utenze	
8.3 Il software prevede la gestione e identificazione dei capi con sistema RFID o BARCODE?	SI=1 NO=0
Sistema RFID o BARCODE sui capi di vestiario (divise) e lenzuola	

9. Generale

9.1 E' presente per gli addetti della lavanderia un programma di formazione riguardante l'esposizione a infezioni e aggiornamento sulle tecniche di lavanderia?	SI=1 NO=0
Presenza, nel programma di formazione, di tematiche di infettività e aggiornamenti	
9.2 Viene tenuto il monitoraggio dei riacquisti di divise e altri capi?	SI=1 NO=0
9.3 La lavanderia è interna all'ospedale?	SI=0 NO=1
9.4 Qual è il numero di divise presenti per ogni dipendente?	
9.5 Qual è il tasso di riacquisto delle divise?	0-10%=1 10%-20%=0.5 20%-30%=0
[N° divise riacquistate all'anno] / [n.totale divise]	
9.6 E' presente un sistema di distribuzione automatica delle divise?	SI=1 NO=0
9.7 Qual è il trend del rapporto [Kg lavati anno] / [Consumi delle utenze] nei diversi anni?	
E' necessario calcolare il rapporto [Kg lavati anno] / [Consumi delle utenze] nei diversi anni e verificare sia in diminuzione	

Modulo 7.GESTIONE RIFIUTI

TIPOLOGIE DI RIFIUTI SANITARI

1) Rifiuti pericolosi a rischio infettivo

Qual è la quantità totale annua di rifiuti in generale prodotta?
Qual è la quantità totale annua di rifiuti pericolosi a rischio infettivo prodotta?
(Chiedere valori per l'anno corrente e per i precedenti tre anni)

Quali sono i costi di smaltimento al chilo per questa tipologia di rifiuti?
(Chiedere valori per l'anno corrente e per i precedenti tre anni)

2) Rifiuti pericolosi non a rischio infettivo

Qual è la quantità totale annua di rifiuti pericolosi non a rischio infettivo prodotta?
Qual è la quantità totale annua di rifiuti pericolosi non a rischio infettivo inviata a recupero?
(Chiedere valori per l'anno corrente e per i precedenti tre anni)

Quali sono i costi di smaltimento al chilo per questa tipologia di rifiuti?
(Chiedere valori per l'anno corrente e per i precedenti tre anni)

Quali sono i costi di recupero al chilo per questa tipologia di rifiuti?
(Chiedere valori per l'anno corrente e per i precedenti tre anni)

3) Rifiuti non pericolosi

Qual è la quantità totale annua di rifiuti non pericolosi prodotta?
Qual è la quantità totale annua di rifiuti non pericolosi inviata a recupero?
(Chiedere valori per l'anno corrente e per i precedenti tre anni)

Costi di smaltimento totali annui?
Costi di smaltimento annui sostenuti per usufruire del servizio pubblico di smaltimento?
(Chiedere valori per l'anno corrente e per i precedenti tre anni)

Quali sono i costi di smaltimento annui sostenuti per questa tipologia di rifiuti?
(Chiedere valori per l'anno corrente e per i precedenti tre anni)

Quali sono i costi di recupero annui sostenuti per questa tipologia di rifiuti?
(Chiedere valori per l'anno corrente e per i precedenti tre anni)

4) Rifiuti assimilabili agli urbani

Qual è la quantità totale annua di rifiuti assimilabili agli urbani prodotta?
Qual è la quantità totale annua di rifiuti assimilabili agli urbani inviata a recupero?
(Chiedere valori per l'anno corrente e per i precedenti tre anni)

Costi di smaltimento totali annui?

Costi di smaltimento annui sostenuti per usufruire del servizio pubblico di smaltimento?
(Chiedere valori per l'anno corrente e per i precedenti tre anni)

AZIENDE APPALTATRICI DEL SERVIZIO DI TRATTAMENTO RIFIUTI

1) Certificazioni

Le aziende incaricate del servizio di smaltimento rifiuti sono certificate:

UNI EN ISO 9001? (sistemi di gestione della qualità)
SI NO

UNI EN ISO 14001? (sistemi di gestione ambientale)
SI NO

OHSAS 18001? (sistemi di gestione della sicurezza)
SI NO

EMAS? (tematiche ambientali)
SI NO

UNI EN ISO 16001? (politiche energetiche)
SI NO

2) Servizi inclusi nei contratti di trattamento rifiuti

Sono forniti i differenti contenitori per le varie tipologie di rifiuti?
SI NO

E' attivo un servizio di raccolta interna e confezionamento dei rifiuti?
SI NO

E' attivo un servizio di trasporto dei rifiuti verso la loro destinazione finale?
SI NO

E' attivo un servizio di immagazzinamento dei rifiuti in stazioni intermedie all'interno dell'ospedale?
SI NO

Nei contratti di trattamento rifiuti è incluso anche un servizio di recupero rifiuti?
SI NO

3) Modalità di pesatura rifiuti
Pesatura esatta all'interno della struttura
Pesatura presunta all'interno della struttura
Pesatura effettuata presso la destinazione finale dei rifiuti

4) E' effettuata la vendita delle lastre radiografiche di scarto?
SI NO

5) Sono previsti percorsi dedicati per l'evacuazione dei rifiuti dai reparti, di modo che i carrelli contenenti i rifiuti non usufruiscano dei medesimi percorsi nè montacarichi dedicati al pulito?
SI NO

GENERALE

1) Sono organizzati corsi di formazione interni per personale ospedaliero relativi ad argomenti riguardanti i rifiuti sanitari?
SI NO

2) Sono state introdotte nuove modalità di raccolta differenziata nell'anno corrente?
SI NO

3) Solventi, reagenti, farmaci scaduti e altri liquidi a rischio chimico

Durante il trasporto di tali rifiuti, sono utilizzati carrelli dotati di vassoi di contenimento, atti a contenere eventuali spandimenti di liquidi?
SI NO

Sono adattati sacchi impermeabili all'interno dei contenitori di rifiuti, in modo da garantire un'ulteriore barriera di sicurezza rispetto ad eventuali versamenti?
SI NO

Sono applicate etichette identificative ai contenitori di rifiuti anche presso le aree di stoccaggio intermedio?
SI NO

4) Dati relativi ai rifiuti

E' presente un software di gestione dei rifiuti?
SI NO

I flussi di rifiuti sono noti per ogni singolo reparto?
SI NO

Quali sono le modalità di tracciabilità dei contenitori dei rifiuti?
RFID Barcode

Modulo 8.PROCESSI LOGISTICI

1) Sistemi di trasporto interni

Sono presenti sistemi di trasporto interni automatizzati (posta pneumatica, AGVs, veicoli automatici su rotaia)?
SI NO

Negli ultimi 5 anni sono stati effettuati studi da parte di società di consulenza esterne per la progettazione di nuove tipologie di sistemi di trasporto interni oppure per un'ottimizzazione dell'uso dei sistemi esistenti?
SI NO

Sono utilizzate ambulanze elettriche per gli spostamenti interni?
SI NO

2) Magazzini

Sono utilizzati magazzini automatizzati?
SI NO

E' utilizzato un sistema WMS (sistema di gestione del magazzino)?
Il sistema è integrato con la piattaforma generale aziendale?
SI NO

Come viene garantita la tracciabilità dei beni a magazzino?
RFID Barcode Tracciatura manuale

I beni a magazzino sono provvisti anche di codici leggibili a vista da parte degli operatori, in modo tale da poter supplire ad eventuali malfunzionamenti dei sistemi di lettura automatici?
SI NO

E' utilizzata la tecnologia Voice Picking per gestire i prodotti a magazzino?
SI NO

L'accesso alle aree di magazzino è consentito solamente a personale autorizzato?
SI NO

Negli ultimi 5 anni sono stati condotti studi da parte di società di consulenza esterne per ottimizzare le procedure di magazzino?
SI NO

3) Tracciamento e gestione dei pazienti

E' utilizzato un software per la gestione dei pazienti?
SI NO

Qual è la tipologia di tracciabilità utilizzata per la gestione dei pazienti?
RFID Barcode

E' utilizzato un sistema per il tracciamento automatico dei letti ospedalieri?
SI NO

Che cosa viene tracciato?
Paziente (braccialetto RFID/barcode)
Associazione paziente/letto
Associazione paziente/letto/cartella clinica elettronica

4) Gestione automatizzata dei farmaci / farmacia automatizzata

Sono presenti dei magazzini automatizzati?
SI NO

E' utilizzato un software per la gestione delle dosi di farmaci da somministrare ai pazienti?
SI NO

E' implementata la logica di somministrazione monodose dei farmaci (distribuzione automatizzata dei farmaci caratterizzata dalla verifica di ogni singola prescrizione e dalla preparazione in farmacia della terapia giornaliera per ogni paziente)?
SI NO

Il magazzino farmaci è centralizzato?
SI NO

5) Sicurezza

E' presente un sistema per la gestione della sicurezza (un sistema organizzativo finalizzato al raggiungimento degli obiettivi di salute e sicurezza aziendale, progettato con il più idoneo rapporto tra costi e benefici)? Per esempio, è applicato lo standard OHSAS 18001?
SI NO

Sono organizzati corsi di formazione relativi a tematiche legate alla sicurezza?
SI NO

Indice di frequenza infortuni:
Qual è il numero totale di dipendenti? Qual è il numero totale annuo di infortuni sul lavoro occorsi?
Chiedere i valori per l'anno corrente e per i precedenti 3 anni

Modulo 9: Building – Edificio

Destinatario: Responsabile della gestione dell'edificio

L'edificio è una struttura fisica e preesistente la quale condiziona fortemente la gestione sostenibile dell'ospedale. Esso è valutato secondo la sua rispondenza a criteri di basso impatto ambientale con riferimento ai materiali, gli impianti e la disposizione e organizzazione di aperture e altre componenti. Nel seguente modulo valuteremo la sostenibilità del settore dopo averlo suddiviso in 7 aree tematiche:

- Materiali da costruzione e costruzione dell'edificio
- Acqua e servizi igienici
- Camere
- Qualità dell'aria interna
- Efficienza energetica
- Aree di parcheggio e limitrofe
- Sicurezza

Operazioni autonome:
- Osservazione e ispezione dell'edificio (preliminare, se non soddisfacente si rende necessaria l'intervista)
- Rilevazione dell'ubicazione di mezzi di trasporto e servizi da google maps

1. Materiali da costruzione e costruzione dell'edificio

1.1 Quale è la classe media degli edifici? (eventualmente pesata sui metri quadri)	A=3 B=2 C=1 D=0
1.2 La costruzione dell'edificio:	
1.2.1 Ha ottenuto una certificazione di sostenibilità?	SI=1 NO=0
1.2.2 Ha ottenuto la certificazione LEED?	SI=1 NO=0
1.2.3 Ha ottenuto la certificazione BREEAM?	SI=1 NO=0
1.2.4 Ha ottenuto la certificazione SB100?	SI=1 NO=0
1.3 E' presente un tetto con colorazione chiara o materiale isolante per ridurre i costi di raffrescamento?	SI=1 NO=0
E' necessario rilevare la tipologia del tetto per valutare la pertinenza con criteri ambientali	
1.4 Vi sono muri con strato di isolamento per ridurre costi di raffrescamento e riscaldamento?	SI=1 NO=0
E' necessario rilevare la tipologia dei muri per valutare la pertinenza con criteri ambientali	

2. Acqua e servizi igienici

2.1 E' prevista l'installazione di doccioni e filtri per lavandini a basso flusso d'acqua?	SI=1 NO=0
2.2 E' prevista la raccolta dell'acqua piovana dai tetti?	SI=1 NO=0
E' presente un sistema di raccolta dell'acqua piovana	
2.3 L'acqua raccolta dai tetti viene utilizzata per irrigazione, sanitari, pulizia?	SI=1 NO=0
La raccolta dell'acqua piovana è finalizzata alla distribuzione di acqua agli impianti sanitari, all'irrigazione, dove non sono richieste proprietà particolari dell'acqua	

3. Camere

3.1 E' ottimizzato l'utilizzo della luce naturale per diminuire l'utilizzo della luce artificiale?	SI=1 NO=0
Nelle camere è massimizzato l'uso di luce naturale che riesce ad illuminare soddisfacentemente ogni punto della stanza (è necessario un sopralluogo)	
3.2 L'illuminazione delle stanze è ottenuta con lampade a:	INCANDESCENZA=0 ALOGENE=0.25 FLUORESCENTI COMPATTE=0.5 FLUORESCENTI TUBOLARI=0.75 LED=1
3.3 Le società di pulizia sono certificate ISO 14001?	SI=1 NO=0

4. Qualità dell'aria interna

4.1 E' tenuto in considerazione il rispetto delle normative per la qualità dell'aria?	SI=1 NO=0
4.2 Si può constatare una presenza cospicua di materiali fonoassorbenti al fine di ridurre la rumorosità degli ambienti?	SI=1 NO=0
4.3 I materiali presenti all'interno della struttura sono stati selezionati per diminuire la diffusione di polveri e sostanze organiche? (Materiali battericidi, antiodore, autopulenti)	SI=1 NO=0

5. Efficienza energetica

5.1 Sono presenti sistemi di illuminazione ad alta efficienza con controlli avanzati dell'illuminazione?	SI=1 NO=0
Presenza di sensori di passaggio e variatori di luminosità in funzione della luce presente	
5.2 Sono presenti sistemi di riscaldamento solare passivo? (diretti o indiretti)	SI=1 NO=0
5.3 Sono presenti sistemi fotovoltaici sulle superfici esposte a sud?	SI=1 NO=0

5.4 Si può constatare che i colori dei locali interni esaltano la luce naturale diminuendo i consumi di elettricità?	SI=1 NO=0
Colori chiari	
5.6 Si può constatare la massimizzazione della luce naturale nelle aree interne lontane dalle pareti?	SI=1 NO=0
Nelle aree interne, lontane da pareti esterne, sono visibili accorgimenti come finestrelle o vetrocemento per rendere le zone più luminose	

6. Aree di parcheggio e limitrofe

6.1 Sono presenti aree di parcheggio poste in particolare vicinanza alla struttura per utenti con disabilità?	SI=1 NO=0
Verificare autonomamente tale proprietà	
6.2 Sono presenti aree di parcheggio per biciclette?	SI=1 NO=0
Verificare autonomamente tale proprietà	
6.3 Sono presenti aree di parcheggio specificatamente dedicate a personale, pazienti e visitatori?	SI=1 NO=0
Verificare autonomamente tale proprietà	
6.4 E' possibile constatare la presenza di un elevato numero di servizi nelle vicinanze dell'ospedale?	Più di nove servizi=1 Tra 3 e 9 servizi=0.5 Meno di tre servizi=0
Verificare autonomamente tale proprietà	
6.5 Quanto è estesa l'area verde limitrofa all'ospedale?	Area verde/area totale>0.3=1 0.3>area verde/area totale>0.1=0.5 Area verde/area totale<0.1=0
Verificare autonomamente tale proprietà	

7. Sicurezza

7.1 Sono presenti sistemi antincendio privi di CFC?	SI=1 NO=0
7.2 E' previsto un programma di evacuazione certificato secondo ISO 23601:2009	SI=1 NO=0
7.3 Nella scelta degli equipaggiamenti dell'ospedale vengono considerate e privilegiate soluzioni certificate secondo la norma ISO 11400?	SI=1 NO=0

Modulo 10: Energy – Energia

Destinatario: Responsabile della gestione dell'energia

L'aspetto energetico dell'ospedale analizza le modalità in cui tutti i servizi ricevono l'energia necessaria a farla funzionare. In particolare si parla di impianti di riscaldamento e raffrescamento, energia elettrica, combustibile per i trasporti. Inoltre sarà considerata la possibilità di incentivare forme di trasporto "verdi". Nel seguente modulo valuteremo la sostenibilità del settore dopo averlo suddiviso in 5 aree tematiche:

- Sorgenti energetiche per l'ospedale
- Sorgenti energetiche per i trasporti
- Monitoraggio
- Programmi e opportunità
- Trend di consumo energetico

Operazioni autonome:
- Nessuna

1. Sorgenti energetiche per l'ospedale

Tipo di contratto, quantità di energia proveniente da fonti rinnovabili

1.1 Esiste un approvvigionamento energetico (da contratto) proveniente da fotovoltaico?	SI=1 NO=0
E' necessario verificare la percentuale di energia che è fornita da tale sistema, se presente	
1.2 Eolico	SI=1 NO=0
E' necessario verificare la percentuale di energia che è fornita da tale sistema, se presente	
1.3 Cogenerazione o trigenerazione	SI=1 NO=0
E' necessario verificare la percentuale di energia che è fornita da tale sistema, se presente	
1.4 Geotermico	SI=1 NO=0
E' necessario verificare la percentuale di energia che è fornita da tale sistema, se presente	
1.5 Biomassa	SI=1 NO=0
E' necessario verificare la percentuale di energia che è fornita da tale sistema, se presente	
1.6 Solare termico	SI=1 NO=0
E' necessario verificare la percentuale di energia che è fornita da tale sistema, se presente	

1.7 E' presente, presso l'ospedale, un impianto di cogenerazione?	SI=1 NO=0
1.8 E' presente, presso l'ospedale, un impianto fotovoltaico?	SI=1 NO=0
1.9 E' presente, presso l'ospedale, un impianto solare termico?	SI=1 NO=0

2. Sorgenti energetiche per i trasporti

2.1 Il parco automezzi è equipaggiato per più della metà con mezzi a benzina o gasolio?	SI=0 NO=1
2.2 Sono presenti veicoli a GPL?	SI=1 NO=0
2.3 Sono presenti veicoli elettrica?	SI=1 NO=0
2.4 Sono presenti veicoli Ibrido?	SI=1 NO=0

3. Monitoraggio

3.1 E' presente un programma di Energy Management certificato secondo ISO 50001?	SI=1 NO=0
3.2 Se non è presente la cert. ISO 50001 è prevista la misurazione, il report e la documentazione del miglioramento energetico?	SI=1 NO=0
E' presente un sistema di misurazione, report e documentazione del miglioramento energetico	
3.3 E' presente la figura dell'Energy Manager ?	SI=1 NO=0

4. Programmi e opportunità

4.1 E' previsto un programma di car sharing per i dipendenti dell'ospedale?	SI=1 NO=0
Esiste una struttura adatta a svolgere servizio di car sharing per i dipendenti	
4.2 Sono presenti benefits sull'uso di trasporto pubblico per i dipendenti o per i pazienti?	SI=1 NO=0
Presenza di biglietti scontati o particolari convenzioni per l'utilizzo di trasporti pubblici da parte dei dipendenti o dei pazienti	
4.3 Sono previsti incentivi dell'utilizzo della bicicletta per spostamenti ridotti?	SI=1 NO=0
Esiste un parco biciclette utilizzabili gratuitamente o a tariffe convenienti da dipendenti o pazienti	

5. Trend di consumo energetico

5.1 [Consumo di elettricità nell'anno corrente] / [consumo di elettricità 1 o 2 o 3 anni prima]	>1=0 0.95 – 1 = 0,5 0,90 ÷ 0,95 = 1
5.2 [Consumo di energia termica nell'anno corrente] / [consumo di energia termica 1 o 2 o 3 anni prima]	>1=0 0.95 – 1 = 0,5 0,90 ÷ 0,95 = 1

Modulo 11.PROCESSI OFFICE

1) **I monitors impiegati sono dotati di una o più fra le seguenti certificazioni?**
- ISO 14001
- EMAS
- EPEAT
- ENERGY STAR

SI NO

2) **Sono implementate soluzioni per interrompere il flusso di energia elettrica ai computers quando essi non sono utilizzati (per esempio multiprese dotate di interruttore ON/OFF)?**
SI NO

3) **Sono organizzati corsi di formazione sull'ergonomia degli ambienti di lavoro e delle postazioni di lavoro?**
SI NO

4) **Si ricorre all'utilizzo di materiale di cancelleria "verde", prodotto per esempio con plastiche riciclate oppure carte riciclate?**
SI NO

5) **Sono utilizzati contenitori specifici e chiusi per la raccolta delle cartucce di toner esauste, oppure in alternativa esiste un servizio esterno che si occupa della raccolta e smaltimento di tali cartucce?**
SI NO

6) **Sono utilizzati contenitori specifici per lo smaltimento differenziato di batterie scariche, oppure in alternativa si ricorre all'uso di batterie ricaricabili?**
SI NO

7) **Modalità per la riduzione nell'uso di carta**

L'archiviazione dei documenti è digitalizzata (archivio gestito per la ricerca e consultazione)?
SI NO

Sono presenti scanners per l'acquisizione di documenti?
SI NO

Tutti i documenti importati (tramite mail o scanner o dai PC locali) sono archiviati automaticamente?
SI NO

L'archivio è accessibile da ogni postazione?
SI NO

Esiste una rete di messaggistica interna per l'invio di files?
SI NO

Qual è una percentuale verosimile di ordini di fornitura eseguiti tramite web, anzichè via fax o materiale cartaceo in generale?
(Valuta fasce percentuali)

I PCs client sono accessibili con account personale?
SI NO

Il servizio fax è integrato con il software?
SI NO

9) **Si ricorre all'utilizzo di carta riciclata almeno al 75%, oppure all'utilizzo di carta dotata delle certificazioni FSC o PEFC?**
SI NO

10) **E' prevista un'area, accuratamente segnalata, provvista di contenitori adibiti alla raccolta differenziata?**
SI NO

11) **E' presente un sistema di gestione documentale (tracciamento e archiviazione di documenti elettronici)?**
SI NO