Multi-criteria decision analysis for the assessment of non-clinical hospital services: Methodology and case study

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HIGHLIGHTS

- Non-clinical hospital services (e.g. sterilization) have non negligible impacts on patients.
- Decisions concerning non-clinical hospital services are a multi-criteria decision problem.
- A generalized methodology for assessing the sterilization service is presented.
- An international multidisciplinary panel of experts and a local panel of professionals were involved.
- The methodology supported the reorganization of the sterilization service in a real setting.

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ABSTRACT

Non-clinical hospital services to support clinical activities, such as the sterilization service and clinical engineering, are an important technology asset in healthcare, and require constant improvement aimed to reduce economic burden and increase quality. The selection of the most effective healthcare service to adopt in a healthcare facility is a multi-criteria decision problem that classical Health Technology Assessment, being mostly focused on medicines, vaccines and medical devices, cannot easily address.

Here we present a methodology based on Multi-Criteria Decision Analysis allowing a full assessment of non-clinical hospital services and supporting the selection of the most suitable solution in a certain environment.

The methodology involves two different panels of experts: the first one includes international professionals and is aimed at selecting the assessment criteria that are relevant to the target service; the second one is a local panel whose members know the needs and peculiarities of the specific healthcare facility. This approach allows the final decision makers to take into account changes and constraints of their environment, but examining criteria that are internationally recognized as of interest. The proposed methodology, tested in a real context of an Italian Local Health Authority, is versatile and can be applied in any context, even out of the healthcare domain, especially if data in the literature are not sufficient to allow comparisons with similar services in different settings.

1. Introduction

The need for containing the economic burden of the health care system without negatively affecting its quality and the services provided to citizens, has received the attention of both policy-makers and researchers in recent years. Consequently, several methodologies and approaches have been implemented in the health care domain, for helping policymakers in planning more effectively and allocating health care resources efficiently and equitably [1]. Health Technology Assessment (HTA) is one of the methodologies mostly applied to those technologies that directly involve patients and that can have potential effects on them (such as medicines, medical devices, and surgical procedures), in a patient-centered view [2]. HTA is defined by the World Health Organization (WHO) as "systematic evaluation of properties, effects, and/or impacts of health technology" [3]. Even though HTA essentially consists in a systematic review of the available

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Abbreviations: HTA, Health Technology Assessment; NCHS, Non-Clinical Hospital Services; CSSD, Central Sterile Services Department; MCDA, Multi-Criteria Decision Analysis; ASM, Local Health Authority of Matera; ROC, Rank Ordered Centroid literature/state-of-the-art of the health technology under assessment, it does not have a more precise and standard definition, and its actual contents may vary in different application contexts.

Even though not directly involving the patient, Non-Clinical Hospital Services (NCHSs) are considered among the main "health technology assets" [4] and have non-negligible indirect impacts on patients. NCHSs include all those services/facilities that support the clinical processes, such as, for example, the clinical engineering service, aimed to manage all the medical devices within a healthcare organization, the sterilization service, either internal or outsourced, the informatics infrastructure, etc. NCHSs are often subject to renewal due to different reasons, such as indirect hazardous consequences related to the service (e.g., increasing patients' infections due to incorrect surgical tool sterilization), excessive costs or the introduction of new hospital strategies (e.g., investment on innovative technologies). Provided their central role for supporting care delivery, NCHSs renewal (or establishment) should require specific evaluation, aimed not only to contain costs, but also to ensure quality of care.

An important example of a NCHS is the Central Sterile Services Department (CSSD). CSSD is defined as a technical support unit, whose purpose is to provide appropriately-processed medical-hospital articles, thus providing conditions for direct attendance and health care provision for ill and healthy individuals [5]. Indeed, CSSD plays a crucial role in hospital settings, since it provides tools and medical devices that must be properly sterilized, assuring the appropriate quality of medical care [6]. Moreover, in addition to adverse events for patients, defects in sterilization can lead to heavy economic burden [7].

CSSDs can be considered as hybrid systems, since they include not only products (e.g., medical devices, supplies), but also structures, work processes, and organizational aspects that have to be carefully assessed and monitored for assuring good quality of service. CSSD must comply with national and international standards, as well as quality and safety requirements defined at different levels and that can depend on the specific health care system. However, hospitals are usually allowed to implement different organizational configurations of the service, i.e. internal, outsourced or mixed [8], according to their strategic goals, preferences, external constraints and opportunities. Choosing the best implementation of a CSSD requires a careful multi-domain assessment including technical, economic and organizational aspects.

Applying a classical HTA approach to CSSD, as well as to other NCHSs, might be problematic due to the lack of information of state-of-the-art scientific findings, the difficulty to compare the available data, and the limited development of standard methods that are capable to consider both the best practices and the peculiarities of each context, which are the basis for HTA. Therefore, other methods to overcome the lack of state-of-the-art scientific findings and other tools for the evaluation can be exploited within HTA. Among them, the use of scientific panels of experts and of Multi-Criteria Decision Analysis (MCDA) can be a possible solution. MCDA can support the assessment when data from the technical or scientific literature are not sufficient to apply other methods. Indeed, MCDA has been increasingly used in decision-making concerning healthcare systems because of its sound methodological grounds and it has been also considered an effective support tool for HTA [9]. Moreover, MCDA offers the potential to overcome some limitations of traditional decision-support tools, as it can take into account quantitative and qualitative data simultaneously.

Even though MCDA for NCHSs has been already documented [8,10], some of the still open challenges of the MCDA application in HTA regard the identification and definition of the criteria to include in the assessment, and how to select criteria that are internationally recognized as important.

In this work, we present an assessment methodology, based on the concepts of HTA and supported by an MCDA method aimed to answer the following research question: is it possible to find a generalized method for assessing NCHSs, integrating international experts' know-how and specific needs at a local level? In order to validate the methodology proposed, a case study on the evaluation of the sterilization service in a large Italian Local Health Authority is presented.

2. Methods

2.1. Methodology

The proposed methodology includes innovative steps, aimed to involve both international and national panels of experienced professionals, together with other steps combining some of the available paths described in the literature concerning HTA and MCDA (e.g., [11–13]).

Fig. 1 shows a swim-lane activity diagram of the assessment process that comprises:

1. Identification of the decision goal
2. Identification of the alternative technology assets (alternative services)
3. Decomposition of the decision objective into evaluation dimensions
4. Definition of the criteria (such as properties, measures of performance, etc.) of interest for each dimension
5. Selection of the most important criteria for each dimension, which will be used for the assessment (international level)
6. Assessment of the alternative services on the selected criteria (local level)
7. Calculation of group judgments and overall performance of the alternatives (local level).

This methodology proposes the use of two panels of experts: the first one (international panel) was established to ensure the definition of shared criteria, at a more general level, in replacement of the criteria coming from the literature and the state-of-the-art; the second one (local panel) was established to weight the general criteria, identified by the international panel, according to the specificity of the local context in which the technology under assessment has to be exploited. The two panels answer two specific questions: "(1) which are the most important criteria for evaluating a technology at an abstract and more general level?" and "(2) which are the most important criteria when the constraints of the local context are included in the assessment?"

2.2. Case study definition

The methodology was applied to the sterilization service of the Local Health Authority of Matera ("ASM"), in the Basilicata Region, Italy. The ASM comprises five hospitals. Among these, three hospitals perform surgical activities, for a total of 392 ordinary beds, 90 Day Hospital beds, 15 operating rooms, 13,000 surgical operations in 2015. The sterilization service is mixed, since some of the activities are outsourced to external companies. However, the ASM owns proprietary systems, technologies and surgical tools.

2.3. Application of the methodology to the case study

A detailed description of the steps of the methodology is provided below. The actual application of the methodology takes the form of an assessment process that should be guided and facilitated by a Coordination Group, which is particularly responsible for the clear and transparent employment of the decision-support tools.

(Step 1) - First of all it is necessary to identify the technology to be assessed. At the ASM, the CSSD has a mixed management. As already mentioned, the ASM comprises several hospitals, which

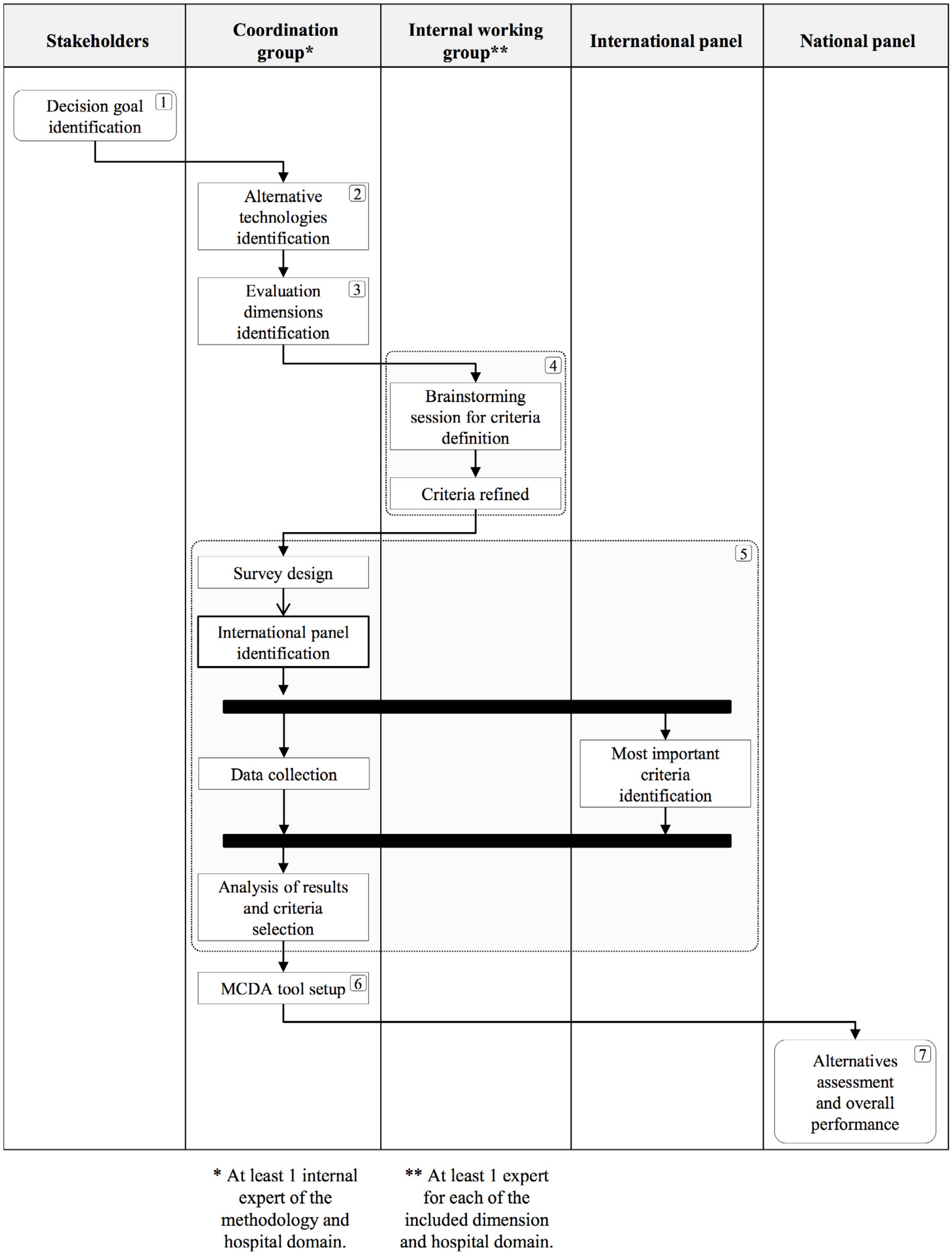

Fig. 1. Unified Modeling Language (UML) Activity diagram of the proposed methodology. The plot is organized in vertical swimlanes representing the main actors responsible for the activities.

became part of the ASM in different times and whose CSSDs were structured and managed differently (internal, mixed and outsourced services). The outsourced activities of the CSSDs are managed by a unique provider. The expiration of the contract with this provider represented the opportunity to perform a reconfiguration of the whole CSSD.

(Step 2) - For healthcare services, it is possible to identify alternative solutions by taking into consideration either the opportunities that are actually offered by the market, or by devising technically-feasible but not ready-made solutions. This latter approach can be useful to detect and satisfy the expected features and performances of the service for the specific hospital. The outputs of the application of the whole method, by choosing the latter approach, may be also used by the specific hospital to clarify the healthcare needs, and it may serve as an important driver for claiming specific requirements to outsourced companies or to stakeholders at a macro level.

The alternatives identified by the ASM were based on their previous experiences and the current bids submitted by external providers. Moreover, as reported in [8], the three alternatives are the models that are typically employed in sterilization management. All the alternatives complied with regulations and standard requirements (e.g. concerning safety). Particularly, the three alternatives were:

A1. Internal service: all the reprocessing and sterilization phases are handled "in house" (each hospital operates its own sterilization service), involving internal staff and using the (available) proprietary systems, technologies and surgical tools;
A2. External service: all the reprocessing and sterilization phases are handled through external resources. Staff, systems, technologies and surgical tools are outsourced to external companies;
A3. Mixed service: staff involved in the reprocessing and sterilization phases, including logistic, are outsourced to external companies. Systems, technologies and surgical tools are proprietary.

(Step 3) — The dimensions of interest should be now defined. As already mentioned in the Introduction, the properties to be assessed may differ according to different kinds of technologies and contexts of application. Among all the dimensions currently in use for assessing health technologies, we propose the following: effectiveness/technical properties (T), organizational properties (O), safety (S) and economic dimension (E).

Technical properties, including "performance characteristics and conformity with specifications for design, composition, manufacturing, tolerances, reliability, ease of use, maintenance, etc." [11], may be better defined as "operational effectiveness" in the specific context of hospital services, thus including effectiveness, as another property frequently used in HTA. Specifically, operational effectiveness aims at better utilizing the organization's available resources, better implementing its processes and better accomplishing its goals. Organizational properties embrace both management issues, related to the planning and organization of the healthcare service, and the personnel's soft skills. Typically, the aspects most frequently used within this dimension are education, skills and centralization/decentralization [14]. Widely used within HTA, safety can be defined as "judgment of the acceptability of risk associated with using a technology" [11]. The four dimensions are general and comprehensive, and they can be, anyhow, shaped on the specific context, including different kinds of properties according to the characteristics of the service.

(Step 4) — After defining the dimensions, it is necessary to define the criteria of interest for each dimension. The aim of this step is to identify a comprehensive list of criteria related to the healthcare service to be assessed, at the international level. In the case study, a brainstorming between professionals working at the ASM was performed. Specifically, the professionals involved ("Internal Working Group") were: one clinical engineer specialized in health technologies, one clinical engineer specialized in procurement, one engineer specialized in organizational management, and two healthcare professionals working at the CSSD. Each participant performed a brief review on the state-of-the-art quality indicators in sterilization services (e.g., [7,15,16]). During the brainstorming, the professionals discussed both the literature and their specific situation. This activity produced a first list of criteria. Then, criteria definitions were refined, in order to make them unambiguous, comprehensive, direct, operational, understandable, which are the main properties for a good attribute according to Keeney and Gregory [17].

At the end of step 4, we identified the following:

– Criteria for the effectiveness/technical dimension (T): (T.1) structure management; (T.2) operational and technological level; (T.3) characteristics of structures and installed equipment; (T.4) surgical tools updating; (T.5) process productivity; (T.6) lead time of surgical tools; (T.7) other.
– Criteria for the organizational dimension (O): (O.1) possibility to recruit other staff; (O.2) supervision and management competences; (O.3) operational competence; (O.4) organization flexibility; (O.5) management of unplanned situations; (O.6) coordination and organization synergy; (O.7) other.
– Criteria for the safety dimension (S): (S.1) responsibility of Quality Controls; (S.2) service provider lock-in; (S.3) clinical risk management; (S.4) technological adjustment; (S.5) other.

As for the economic dimension (E) we considered as criterion the total cost, consisting of costs for personnel and training, technologies and their maintenance, and insurances.

(Step 5) - The most important criteria were selected by an international panel. This step was divided into 4 tasks:

a. Design of the survey;
b. Identification of channels for involving experts in the field;
c. Collection of data;
d. Analysis of results and selection of criteria to be included in the MCDA model.

In task (a), the survey questionnaire was divided into the dimensions previously determined. For each dimension, all the identified criteria were listed, together with the editable field "other". The questionnaire was designed and administered through SurveyMonkey, a free web-based tool that allows developing customizable surveys. Respondents were asked to rank the criteria in each dimension according to their importance (from the most to the least important). A short description of each criterion was provided in order to ensure that respondents understood their meaning (See Supplementary Material). Moreover, to verify that panel members were representative of the target population of professionals, some preliminary questions, related to their professional background, were inserted.

Regarding task (b), in addition to dedicated associations and societies devoted to the field of interest, one of the easiest ways for reaching international experts may be through LinkedIn. In fact, LinkedIn Groups often gather professionals who enjoy being part of the online community and they may be interested in providing their support as "helpers", as defined by [18]. Furthermore, web-based surveys have been proven to be more reliable compared to telephone ones [19]. In the case study presented here, the web link to SurveyMonkey was posted on the following LinkedIn groups: "Decontamination Sciences & Sterile Services Personnel", "Sterilization of Pharmaceuticals, Medical Devices & Biological Materials", "SVN-Sterilisatie Vereniging Nederland", "Sterile Processing Department Professionals". No individual invitations were made, but a single call accompanied the public post. No rewards were foreseen for completing the questionnaire.

After a preliminary test, in task (c) the survey questionnaire was posted on the abovementioned LinkedIn Groups. Data collection lasted 1 month. However, since not all respondents might be suitable for being included, some inclusion criteria were defined. The international panel had to be an international multidisciplinary group of professionals working in the field of hospital sterilization. They should have had either at least 3 years of experience and a certification in the field (e.g., Certified Sterile Processing and Distribution Technician — CSPDT, Certified Registered Central Service

Table 1
Criteria selected for the study with corresponding performance levels.

ID	Dimension	Criterion	Level	Value
C1	Organizational	Supervision and management competences	L1 L2 L3	Poor Medium High
C2	Organizational	Operational competence	L1 L2 L3	Poor Medium High
C3	Effectiveness/technical	Structure management	L1 L2 L3	Mean time to repair >8 working hours Mean time to repair between 1 and 8 working hour (s) Mean time to repair $\leq$ 1working hour
C4	Effectiveness/technical	Operational and technological level	L1 L2 L3	Up-Time <95% Up-Time between 95% and 99% Up-Time $\geq$ 99%
C5	Safety	Responsibility of quality controls	L1 L2 L3	Poor Medium High
C6	Safety	Clinical risk management	L1 L2 L3	Poor Medium High
C7	Economic	Total cost	L1 L2 L3	More than 2,200,000 € Between 1,800,000 € and 2,200,000 € Less than 1,800,000 €

Technician — CRCST, Certified Instrument Specialist — CIS), or, since a certification system is not offered in all Countries, at least 10 years of experience in the field.

In task (d), in order to aggregate the respondents' judgments and obtain the overall level of importance of each criterion, it was necessary to convert the rankings into cardinal values. To this end, the rank ordered centroid (ROC) was employed, as it provides a reliable transformation when compared to other methods and it has been demonstrated to weight more accurately than the other rank-based formulae [19]. ROC produced the ranking of the criteria within each dimension, taking into account the average of respondents' judgments. In this way we obtained three ranked lists of criteria, one for the Organization, one for the Technical/Effectiveness, and one for the Safety dimension. Then, we selected the first two criteria, in each list, in order to ensure a balanced contribution of all the dimensions of interest, and to reduce the burden on respondents (see Results section). The selected six criteria were used as input to step 6.

(Step 6) — The MCDA tool to be used is to be set-up. A key advantage of MCDA in HTA is its "ease of use", one of the most important characteristics for a tool to be actually used in practice. In this respect, among the available MCDA methods (e.g., AHP [20] or ELECTRE [21]), PAPRIKA [22] is very intuitive and easy-to-use, even by decision-makers or assessors with limited knowledge of MCDA, and therefore could be the right choice in the case study. The set-up was made directly through "1000minds", an on-line tool made available by the authors of the method (www.1000minds.com). The criteria selected in the previous step were validated by a clinical engineer, who also defined the performance levels. Particularly, for each of the six selected criteria (two for each dimension) and the criterion representing the economic perspective, three different qualitative or quantitative levels were defined (Table 1). The levels vary from L1 (worst performance) to L3 (best performance). In order to ensure repeatability, for each level, a detailed description of the meaning of the level was provided and the alternatives were assessed accordingly.

(Step 7) - In the last step, decision makers of the local health authority ("National Panel") were required to perform pairwise comparisons through the PAPRIKA tool. More specifically, the 1000minds software, using the set-up performed in Step (6), generated a questionnaire in which pairs of hypothetic scenarios/technologies/features were proposed to respondents. Eventually, pairwise comparisons allowed to determine the weighted contribution of a specific level of performance to the overall priority of an alternative. In the case study, the local panel was composed by six decision makers, working at the ASM, with the following positions: director of clinical engineering service, chief medical officer, hospital risk manager, procurement officer, operating theater director, chief business officer. These were the people entitled to take the final decision. The panelists were provided with a full explanation of the qualitative values so as to avoid ambiguity. The final weights (levels of importance) of the criteria, were produced by "1000minds" by aggregating the results of the answers provided during the pairwise comparisons by each panelist. Using these final weights, 1000minds provided the ranking of the three available alternatives (A1, A2, and A3).

3. Results

From April 2016 to May 2016, 53 filled questionnaires were collected: 27 respondents (50.9%) fully or partially (at least one dimension was fully completed) completed the questionnaire. Only 19 fully completed questionnaires (35.8%) were selected to be included in the international panel as the respondents met the defined pre-requisites (see the description of step 5 in Section 2.3). The average number of years of the respondents' experience was 16.68, and 11 professionals included in the international panel held certifications.

Of the 19 professionals within the international panel, 1 was from Indonesia, 1 from Canada, 4 from the USA, 2 from Australia, 1 from New Zealand, 3 from the UK, 1 from France, 5 from Italy, and 1 from the Netherlands. Moreover, of the 19 professionals working within sterilization services, 2 were engineers, 7 technicians/nurses, 1 biologist, 7 managers, 1 product specialist, and 1 pharmacist. The average time for completing the survey was 11′41″ (min 4′31″, max 26′50″). The results of the ROC analysis are reported in Table 2 for each dimension.

As described in the previous section, the first two criteria of each dimension (highlighted in bold in Table 2) and the criterion representing the economic perspective, were used for setting-up PAPRIKA involving the local panel of professionals.

The MCDA assessment model is made up of seven criteria (C1–C7) with three preference levels each (L1–L3). It is worth mentioning that the PAPRIKA method builds a set of "potential" alternatives

Table 2
Weighted sum and mean of cardinal values obtained through the application of the Rank Order Centroid (ROC) method, within dimensions ("O": organizational properties; "T": effectiveness/technical properties; "S": safety properties). The highest values of importance in each dimension are displayed in bold and new IDs (C1–C6) were assigned to the corresponding criteria.

ID	New ID	Criteria	Sum	Mean
O.1		Other staff recruitment	2.37	0.12
O.2	**C1**	**Supervision and management competence**	**4.68**	**0.25**
O.3	**C2**	**Operational competence**	**3.93**	**0.21**
O.4		Organization flexibility	2.39	0.13
O.5		Management of unplanned situations	2.47	0.13
O.6		Coordination synergy	1.79	0.09
O.7		Other	0.27	0.01
T.1	**C3**	**Structures management**	**4.23**	**0.22**
T.2	**C4**	**Operational and technological level**	**4.00**	**0.21**
T.3		Characteristics structure/installed equipment	2.87	0.15
T.4		Surgical tools updating	2.20	0.12
T.5		Process productivity	2.47	0.13
T.6		Lead time of surgical kit	2.63	0.14
T.7		Other	0.45	0.02
S.1	**C5**	**Responsibility of quality controls**	**5.71**	**0.30**
S.2		Service provider lock-in	2.61	0.14
S.3	**C6**	**Clinical risk management**	**5.78**	**0.30**
S.4		Technological adjustment	4.14	0.22
S.5		Other	0.48	0.03

Table 3
Median, mean and standard deviation of priorities.

Criterion	Median	Mean	Standard deviation
C1	18.0%	18.2%	3.1%
C2	18.4%	17.9%	2.5%
C3	12.2%	11.3%	4.5%
C4	11.0%	9.8%	4.5%
C5	17.9%	16.1%	6.8%
C6	15.9%	16.6%	6.3%
C7	10.6%	10.1%	6.2%

whose performance profiles are obtained from the combination of the aforementioned levels. The alternatives are then pairwise compared by the decision-makers in order to obtain the overall priorities that will be assigned to the actual investigated alternatives [22]. In the specific case $3^7 = 2187$ combinations of the levels and an equal number of potential alternatives are possible. However, "1000minds" software is able to reduce this number by eliminating the potential alternatives that are dominated by others during the interactive assessment process. In the case study, the average number of pairwise comparisons that were made by the six respondents of the local panel was 29.5 (min 23, max 40) and the average time needed for completing the assessment process was 7′ (min 6′, max 9′).

The median, mean and standard deviation of the obtained priorities, representing the relative importance (weights) of the criteria to the participants, are reported in Table 3 and in the radar chart in Fig. 2. In particular, the weight of a criterion corresponds to the average priority obtained by the best level of that criterion (L1). For example (see Table 3), since the average priority (mean) of L1 in C4 and C1 are 9.8% and 18.2% respectively, C1 is almost twice as important as criterion C4. Moreover, the Marginal Rate of Substitution (i.e., the rate at which the decision makers are ready to exchange an alternative for another one while maintaining the same level of utility) of the column criteria for the row criteria, is shown in Table 4.

Table 5 shows in the last column the normalized attribute weights (W_i) and, in the fourth column, the single attribute scores (S_i): their product corresponds to the weighted contribution of a level in a criterion to the overall priority. In other words, the overall priority of an alternative (P) is calculated as:

$P = \sum_{i=1}^{n} W_i \cdot S_i$ where n is the number of criteria

According to these weights and scores, the system suggested the following ranking:

1. Internal service (A1): P = 100; Ranked 1st
2. Mixed service (A3): P = 42.45; Ranked 2nd
3. External service (A2): P = 21.45; Ranked 3rd

Thus suggesting the adoption of alternative A1. Moreover, the concordance between each panelist was very high: the internal service for CSSD was the alternative preferred by all the local panelists, followed by the mixed service. The outsourced service was at the third and last position for all of the six stakeholders.

4. Discussion and conclusions

In this study, we have presented and applied a novel methodology for supporting decision making processes for NCHSs based on MCDA, and involving two panels of experts for the definition of the evaluation criteria, which is one of the most problematic steps in applying MCDA within HTA.

The results of the preliminary stage of the study, focused on the scouting and identification of an international multidisciplinary panel of experts, allowed to identify the main aspects to be considered for the assessment of a CSSD. Even though 19 professionals are a considerable number for the scope of the work, the low percentage of respondents who completed the survey, compared to the total amount of collected questionnaires (35.8%), may suggest that the definition of the criteria should be further simplified. On the other hand, LinkedIn represented a good channel for easily reaching experts in the field of interest at the international level. Indeed, LinkedIn will be also used for sharing the results of the work, in order to facilitate the dissemination process as it is one important aspect of HTA.

At a local level, the application of the MCDA method using the previously selected attributes, allowed to identify the best solution according to the decision makers' preferences, through an easy-to-use and not time-consuming tool (7' per person on average). All the decision makers expressed their preference for the internal service, followed by the mixed service and the outsourced one. This result is in line with the characteristic of the area: the ASM comprises five hospitals, and it covers a wide area (3.479 km^2), with a population density of 58 inhabitants/km^2; the presence of mountains and the existing transport network do not favor the

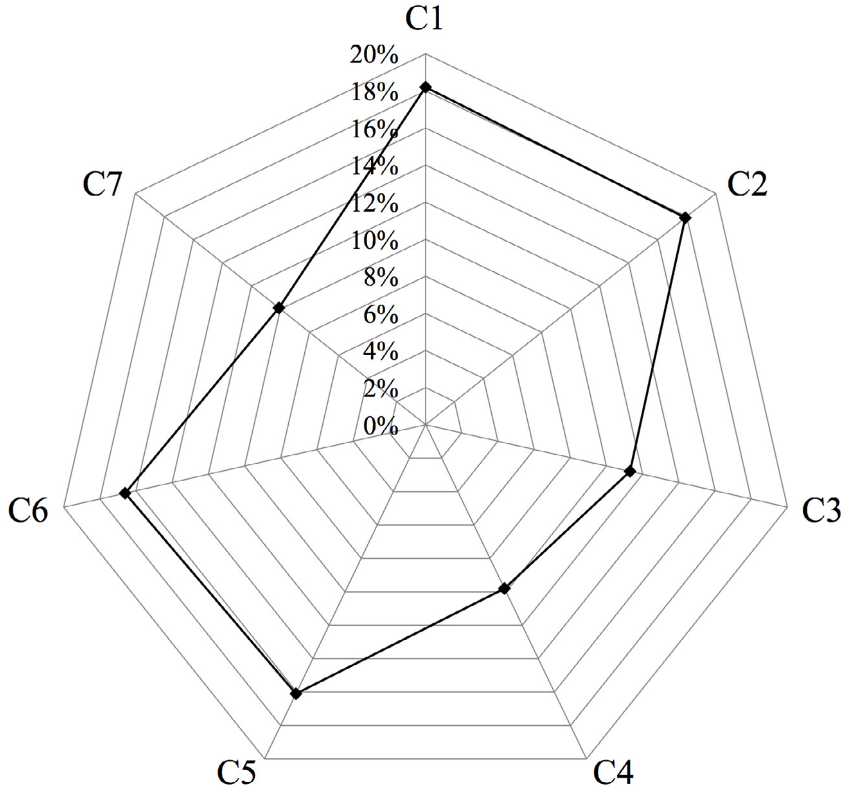

Fig. 2. Radar chart of the priorities identified by the participants. The black squares represent the normalized weights of criteria.

Table 4
Relative importance of criteria (ratio between the weights of the row criteria to the column criteria).

Marginal rate of substitution		C1	C2	C6	C5	C3	C7	C4
Supervision and management competence	C1		1	1.1	1.1	1.6	1.8	1.9
Operational competence	C2	1		1.1	1.1	1.6	1.8	1.8
Clinical risk management	C6	0.9	0.9		1	1.5	1.6	1.7
Responsibility of quality controls	C5	0.9	0.9	1		1.4	1.6	1.7
Structures management	C3	0.6	0.6	0.7	0.7		1.1	1.2
Overall cost	C7	0.6	0.6	0.6	0.6	0.9		1
Operational and technological level	C4	0.5	0.5	0.6	0.6	0.9	1	

Table 5
Normalized criterion weights and single criterion scores (means).

ID	Attribute	Level	Single attribute score (0–100)	Attribute weight (sum to 1)
C1	Supervision and management competence	Poor Medium High	0 70.4 100	0.182
C2	Operational competence	Poor Medium High	0 83.5 100	0.179
C3	Structure management	Mean time to repair >8 working hours Mean time to repair 1–8 working hour(s) Mean time to repair ≤ 1working hour	0 55.9 100	0.113
C4	Operational and technological level	Up-Time <95% Up-Time between 95% and 99% Up-Time ≥ 99%	0 67.9 100	0.098
C5	Responsibility of quality controls	Poor Medium High	0 69.9 100	0.161
C6	Clinical risk management	Poor Medium High	0 68.2 100	0.166
C7	Total cost	More than 2,200,000 € Between 1,800,000 € and 2,200,000 € Less than 1,800,000 €	0 69 100	0.101

centralized management of patients and services (e.g. a centralized sterilization service). Moreover, an interesting result is related to the low weight given to the economic dimension. Indeed, since the current policy of different Italian Regions encourages hospitals to outsource non-core services, including the CSSD, this might work as leverage for the hospital to claim an in-house CSSD.

Nevertheless, the results might change if the methodology is employed in a different context. This will be investigated in future research. Moreover, the proposed methodology is sufficiently versatile to be applied to any hospital service, thanks to the consistency given by the international perspective which is then adapted to local needs.

In conclusion, the proposed methodology for assessing a non-clinical hospital service, by integrating the international experts' know-how and the specific needs at the local level, proved to be successful: the local panelists, who were entitled to take the final decision on the reorganization of the sterilization department, were very satisfied with the method, as it was easy-to-use, and well representing their decision criteria, thus facilitating the overall decision process. Furthermore, even though it is on its preliminary stage, the present study can lay the basis for investigating and exploiting the HTA approach even though sufficient scientific findings are not available in the literature. However, some minor issues (e.g., better definition of criteria) must still be resolved, and the approach might be worthwhile being extended and validated in different contexts.

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Declaration of Conflicting Interests

The Authors declare that there is no conflict of interest.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.orhc.2018.08.002.

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