A.H.P. as a normative frame for purchasing decisions in health care services.

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Two are the main phases of the decision process:
- definition and issuing of tender specifications;
- evalutation of the bidders proposals and selection of the "best" one.
In the first one A.H.P. contribution is related to structuring and weighing evaluation criteria.
In the second one the decision panel will assign merit evaluations to each bidders proposal under each terminal criterion; then evaluations and prices will be sinthetized in order to select the "best" proposal.
A.H.P. approach as well as other methodologies currently used are tested. Problems still open are highlighted and discussed.

1. Frame of domestic and european laws.

The supply of high technology equipments to public organitazions (as they are in Italy most of the health care services) must satisfy a lot of formal conditions. In particular, the italian law about awarding procedure textually says:
The supplies (....) are awarded on the basis of (....) the economically most favourable proposal, evaluated according to different elements (....) as price, realization and delivery terms, utilization cost, performance, quality, look, functional characteristics, technical merit, after-sale service, technical assistance. (....) The criteria that will be used in awarding phase must be reported in tender specifications and sorted in decreasing order of importance.

2. The issue of tender specifications.

In the following we refer to supply tenders in health care services. In particular, the case is about the supply of high tech equipments to medical laboratories. In this environment, the Public Administration usually refers to only two criteria: Price and Quality. Many other criteria are inclusively considered in quality issue.

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A decision tree is designed, where the main criteria (often the only criteria written in tender specifications) are Price and Quality. A weight is assigned to each criterion. Usually, no specification is made about Price, while Quality criterion is divided among sub-criteria of second level (and also of third level in a few cases). Figure 1 shows a two levels tree. All the sub-criteria have their relative weights, of course.

3. General considerations.

The price weight has to be so lower (and quality weight so higher) as more relevant is technological complexity of the supplies. On the contrary, Public Administration Offices often propose high weights of price criterion also in tenders of very high technology supplies. In this way all the other criteria could become insignificant versus minimum price criterion. Moreover, if the minimum price approach is chosen, all the aspects of a complex equipment have to be listed in constraint form within technical specifications of tender: in this case no evaluation is made about the real matching between offers and requirements, but only a check about written versus offered technical parameters. Subsequently, when the price envelopes are open, the Technical Committee has non evaluation and no decision to make in awarding phase.

Many objections are made about this approach. First, it is impossible to consider a priori all the aspects of the supply, because some opportunities become known only after, concerning particular conditions and/or solutions set up by the suppliers actually attending the tender. On the other hand, technical specifications over-detailed can involve the identification of a given supplier (against the general principle of open competition) or of no supplier, too (note that in the phase of tender design the Technical Committee leaves aside the consideration of actually existing products: only a list of needs is reported in technical specifications).

Moreover, if the minimum price approach is chosen, the price has the rank of objective, all the other aspects (technical merit, organization, security, personnel, and so on) can only be in constraint form. This approach can involve relevant errors in searching the optimal decision, because it is not able to compare an economical premium (however little) with a quality premium (however great, beyond the constraints).

If public authority is absolutely free regarding the weights evaluation, it can happen that two departments of the same health care service have different behaviours about the same tender; and also the same department can have different behaviours at different times. This fact can take shape of protectionism. Public Administration must show a stable, unambiguous rule in all situations and towards all competitors.

In health care services the final decision is taken by the Administration Offices, because the medical staff can only give support and consultancy in purchasing decision process. The goal of offices is cost minimization, of course, and this involves two alternative kinds of effects:

- high-quality products, presenting a greater price, are sistematically overtaken by low-quality products: so the market is shifting to low quality supplies;
- Technical Committee, to force the Administration Offices, writes technical specifications so detailed, that the final choice becomes just before given: so the competition is not really open.

4. Mathematical models and decision processes.

Many mathematical models are used to define a transparent, efficient and controllable process of purchasing decisions. A.H.P. [2] approach has been also tested in this framework. The aim is an *a priori* definition of decision process in normative form.

Two are the main phases of decision process:

- definition and issuing of tender specifications;
- evalutation of the bidders proposals and selection of the "best" one.

In the first one A.H.P. contribution is related to structuring and weighing evaluation criteria; the bidders proposals (and prices, of course) are still unknown. The macro-criteria are Quality and Price, which represent conflicting objectives within the decision panel (the technical staffs prefer high qualities, the administrative officers prefer low prices). The procedure of rating the bidders proposals has also to be described in tender specifications.

In the second phase the decision panel will assign merit evaluations to each bidders proposal under each terminal criterion; then evaluations and prices will be mixed up in order to select the "best" proposal.

4.1. Bidders proposals evaluation.

In the following sections the decision structure used as reference is the one represented in fig. 1.

In the evaluation procedure currently used three steps can be higlighted.

In the first one the decision board examines the alternatives from the point of view of Quality, in order to get a sinthetized evaluation for this 1° level criterion.

In the second one the alternatives are evaluated under Price point of view.

In the third step, once ratings of Alternatives under Quality and Price are available, a composition of both evaluations is performed in order to get the final result.

These three steps are now described with more detail.

4.1.1. Alternatives evaluations from Quality point of view.

Within decision board alternatives are scrutinied from the point of view of each "leave" criterion of figure 1.

By first the alternative, which is evaluated the best under Qi criterion, is selected and it gets the value 1.

The other ones are rated accordingly to their relative performances with respect to the best one.

The alternatives ratings are then sinthetized accordingly to the following formula:

$$X = X_{ij} * W_{qi}$$

where:

X_{ij} = rating of alternative j under criterion i;

W_{qi} = weight of criterion i;

X_{qj} = sinthetized rating of alternative j under Quality point of view.

The procedure has points of similarity with the one named as "Ideal mode" in Expert Choice software implementation of A.H.P. [3]
In fact the total weight of a "leave" criterion is assigned to the best alternative. The other alternatives get a fraction of the criterion's weight accordingly to their relative performance with respect to the best one.
It is worth noting that A.H.P. is much more richer and can better support a group decision making process.
By using A.H.P. frame:

- the best alternative is not selected by first but it is the outcome of a process in which each alternative is compared with the other ones;
- decision makers are more comfortable in using the full scale of judgement (from 1 to 9) while in the above described procedure it has been proved that very low rating values are avoided;
- the attention of the members of the group decision is focused always only on two items to be compared and this can help discussion and expression of different views; moreover each member can give his own judgement, then the group pairwise comparison value can be obtained by taking the geometrical mean of the expressed judgements.

4.1.2. Alternatives evaluation from Price point of view.

Although there are examples of hierarchies composed of a set of subcriteria belonging to Total Cost, in the present discussion it is assumed that the alternative are rated (X_{pj}) accordingly only to their price.

4.1.3. Sinthetized alternatives evaluation from Price and Quality point of view.

Various approaches are used to obtain the final evaluation of the alternatives using the resulting ratings under Quality and Price criteria and they are below described.

a) *Scaling functions for Price and Quality criteria* (see figure 2. case #1).
About Quality, the alternatives with a rating value equal to X_{qmax} get the maximum result. Alternatives with a rating value lower than X_{qmax}-X_{qmed} get the minimum result.
This kind of scaling function is aimed to disregard "false echo" alternatives presented by the bidders in order to protect their own technical proposals. This function is of truncated type and does not preserve the ratio scale meaning of the ratings obtained from Quality point of view.
The same considerations made for Quality's scaling function can be applied also in the case of Price.
Scaled values under Quality (X^s_{qj}) and Price (X^s_{pj}) are respectively multiplied for the related weights (W_q, W_p) in order to obtain final evaluations of bidders.
Note that the scaling functions slope just in relation to bidder's proposal characteristics.

b) *Iperbolic function for Price* (see figure 2. case #2).
About Quality function, the alternatives with a rating value equal to X_{qmax} get the maximum result, the other ones get a result equal to X_{qj}/X_{qmax}.
This scaling function preserves a ratio-scale meaning of the ratings obtained under Quality point of view.
With respect to Price the proposal with the lowest one gets the maximum result.
Alternatives with a price greater than the lowest one gets a result equal to X_{pmin}/X_{pj}.
This procedure is just the same as the one named "Ideal mode", already above mentioned, but it has to be noticed that here it is applied as if Price and Quality were the only two evaluation criteria.
This procedure fails when there are more than two alternatives with the same Q/P ratio.
In fact in the following example:

	A	B	C
Quality	30	60	90
Price	10	20	30

with equal weight for Quality and Price, alternatives A and C are the best ones.
If only two alternatives were present they obtain equal final rating.

c) *Range interval linear function for Price and Quality* (see figure 2. case #3) .
About Quality functions, the alternatives with a rating value equal to X_{qmax} get the maximum result.
Alternatives with a rating value equal to X_{qmin} get the minimum result.
A similar scaling function is used for Price.
This procedure resembles the additive utility theory [1]. But within additive utility theory the weights of the criteria are assessed after defining upper and lower bounds of the scales under which the alternatives are rated.
Moreover the scales used to measure the alternatives performances are not necessarily linear.
Note that in order to achieve a coherence in the overall methodology the additive utility theory should have coherently applied to the whole set of criteria and subcriteria of figure 1.

d) *Remark.*
Some considerations are worth doing about the three phases procedure until now examined. More precisely attention has to be given to the effect created by the rescaling function under Quality criteria.
Let the following example be considered:

	X_{qj}		X^s_{qj}	
	A	B	A	B
Quality	0.2	0.5	0.4	1.0
Price	100	150	1.0	0.67

The alternatives are scaled accordingly to the procedure described above in paragraph 4.1.1.
Assuming equal weight for Quality and Price, alternative B is the best.
If non scaled values for Quality criteria were used, as a coherent use of "Ideal mode" implies, alternative A would obtain the best score.
The effect produced by the scaling function is to give a sort of extra-premium to the alternative which has the best result under Quality point of view.

5. A.H.P. Approach.

In this section three possible approaches of A.H.P. methodology are investigated.
In the first one the complete hierarchy of figure 1. is evaluated. The second one is characterized by two distinct evaluations, respectively under Quality and Price.
Then the ratio of both evaluations for each alternative is taken as final result.
The third one is a variant of the second one, in fact the ratio Q/P is modified in the following one Q^{α}/P^{β}.

a) *Complete Hierarchy.*
Under this approach the complete hierarchy of figure 1. is evaluated.
This means that a relative importance to Price and Quality is assigned.
Under Price criterion alternative performances are equal to the inverse of price.
The major concern due to this approach is related to rank reversal.
Let use as reference table 1.
If only A and B are the alternatives to be evaluated, they obtain equal final scores.
When alternative C, which is an exact copy of A, is also present, alternatives rank reversal occurs and B gets the maximum result.
The advise to drop alternatives which are exact copy of other ones is difficult to follow in this case where legal problems are present.
The case in which alternatives A, B, D are present is interesting. B and D have the same Price and the same evaluation from Quality point of view, but have different performances under the criteria belonging to Quality.
In this case alternative D can not be dropped, but still it is very difficult to accept this type of result within the decision board, in which the only trade-off between Price and Quality can be discussed by all the members.

	PRICE $W_p = 0.5$	QUALITY $W_q = 0.5$		Synthesis with respect to QUALITY			Synthesis with respect to PRICE and QUALITY		
		W_{q1} = 0,5	W_{q2} = 0,5	A & B	A & B &C	A & B &D	A & B	A & B &C	A & B &D
A	1	1	1	0,25	0,2	0,2	0,5	0,31	0,31
B	1/3	3	3	0,75	0,6	0,6	0,5	0,37	0,37
C	1	1	1		0,2			0,31	
D	1	2	2/7			0,2			0,31

Table 1.

b) *Q/P ratio.*
The final evaluation of each alternative j is the ratio X_{qj}/X_{pj}.
This approach avoids the problem arising when there are alternatives which are exact copy of other ones (at least from Price and Quality criteria point of view).
In fact in this case alternatives A,B,C and D of table 1 obtain the same evaluation.
But this methodology is not flexible, in fact it is not able to accept any relative importance assigned to Price and Quality within the decision board.

c) Q^{α}/P^{β} ratio.
The final evaluation of each alternative j is the ratio $X_{qj}{}^{\alpha}/X_{pj}{}^{\beta}$.
This approach still presents the same benefits of the previous one with the advantages connected to the exponential factors α e β.
An intuitive meaning of α e β is given below.
There are two alternatives j_1 and j_2 to be evaluated by a decision board composed of N_A representatives of the medical staff and N_B members of the administration staff. All the members of the medical staff express the same pairwise comparison judgement which is equal to X_{qj1}/X_{qj2}. Also the members of the administration department express the same pairwise comparison judgement which is equal to X_{pj1}/X_{pj2} (this ratio is proportional to P_{j2}/P_{j1}, where P_{j1} is the price of alternative j_1).

If geometric mean is used in order to sinthetize judgements of the members of the decision board the final comparison of the two alternatives (X_{j1}/X_{j2}) turns to be:

$$(X_{qj1}/X_{qj2})^{N_A/(N_A+N_B)} * (X_{pj1}/X_{pj2})^{N_B/(N_A+N_B)} \propto$$

$$\propto \quad (X_{qj1}/X_{qj2})^{N_A/(N_A+N_B)} \; / \; (P_{j1}/P_{j2})^{N_A/(N_A+N_B)}$$

So the meaning of α and β is connected to the relative power within the decision board of members who care about Quality and those ones interested in Price.

6. Application to real case.

The six different approaches discussed in the paragraphes 4.1.3. and 5 are examined in relation to the case of figure 1.

Final alternatives evaluations are also shown in figure 1

It is interesting to note the similarity in results produced by the five approaches which assign a relative importance to Price and Quality.

In the related final orderings alternatives A,B,C,D obtain a better result than E,F,G.

When the Q/P ratio approach is used, the result is just the opposite.

This kind of result highlights the relevance of declaring the relative importance of Price and Quality in order to comunicate to the potential bidders the decision board preferences.

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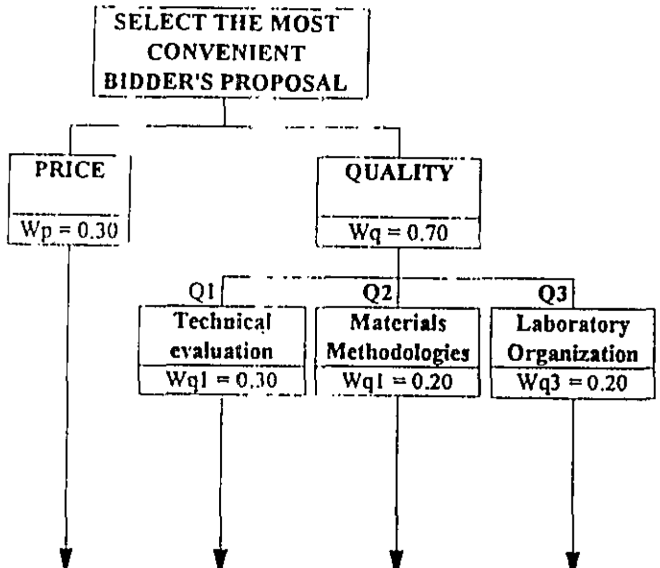
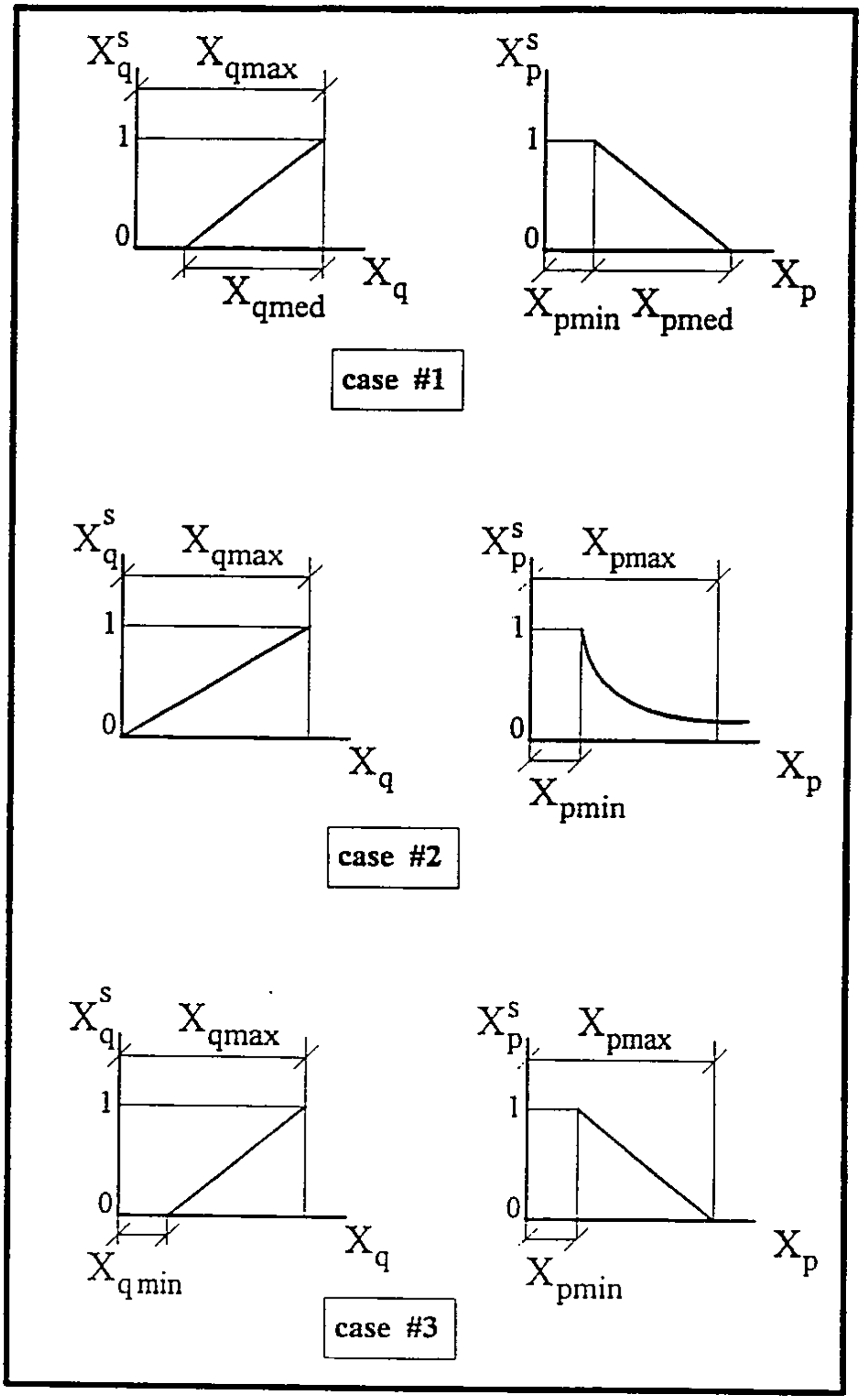


alternatives	PRICE	Q1	Q2	Q3	figure 2. case #1	figure 2. case #2	figure 2. case #3	complete hierarchy	Q/P ratio	Q''/P^5 ratio
A	140	60	60	100	74,30	77,67	69,87	14,69	1,00	6,31
B	190	100	100	20	70,00	79,47	70,00	14,73	0,79	6,07
C	170	90	90	40	71,85	79,29	71,69	14,79	0,87	6,20
D	130	50	70	100	75,12	77,36	69,26	14,71	1,05	6,36
E	100	80	60	20	68,00	69,85	49,93	13,72	1,12	5,97
F	80	30	40	70	58,46	62,68	28,30	12,82	1,08	5,34
G	60	20	20	80	61,69	68,88	30,00	14,51	1,40	5,69

methodologies — alternatives evaluations

Figure 1.



X_q^s
X_{qmax}
1
0
X_q
X_{qmed}
X_p^s
1
0
X_p
X_{pmin} X_{pmed}
case #1
X_q^s
X_{qmax}
1
0
X_q
X_p^s
X_{pmax}
1
0
X_p
X_{pmin}
case #2
X_q^s
X_{qmax}
1
0
X_q
$X_{q\,min}$
X_p^s
X_{pmax}
1
0
X_p
X_{pmin}
case #3

Figure 2.