

# ***Comparing (social) objectives for decision-making in housing corporations***

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## **Abstract**

Housing corporations are not after a financial gain but allocate (consciously if not unconsciously) a part of their available capital in order to achieve a range of social objectives. The real problem is that it is often very difficult to compare these objectives. Do we choose for an extra affordable house or do we spend more on livability? Answering these types of questions remains difficult as long as there is no objective way to compare the objectives.

This article describes a method to compare objectives using pairwise comparisons following Saaty's Analytic Hierarchy Process (AHP). With the help of the AHP objectives are ordered by importance and a weight-vector is determined. In order to use the AHP, we will have to choose an interval per objective with the minimum prerequisite level and the desired level. By using these intervals, it becomes possible to compare objectives measured in different units. This method can be used to support the decision making process at a corporation level, but also to elaborate on the sub-objectives at a district or regional level. Hereby, an optimal balance of allocated capital and the score of the objectives can be achieved at every decision making level.

Key words: housing corporations, social objectives, Saaty, resource allocation, weighting, transparency.

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## Introduction

Housing corporations constitute the biggest group of players in the Dutch residential market, with around 2.4 million individual housing units owned. In the Netherlands, housing corporations are non-profit organizations which are required to operate in the interest of housing. This is reflected in the Housing Act and the Social Rented Sector Management Decree (BBSH). The BBSH, which is established by the Dutch government, contains the rights and duties of Dutch housing corporations<sup>1</sup>.

In 1995, the Dutch government completely withdrew the direct financial support to the Dutch housing corporations. As a consequence, the last decade the focus of Dutch housing corporations has slowly become more outward looking, and more upon performance. They must achieve a return on their investment to finance future investment in new stock and urban renewal. Insight into this return is therefore indispensable in the evaluation of performance. The lack of information on their investment performance has hindered the extension of transparency in the market. Transparency is important not only for stakeholders, but also for the portfolio managers themselves. It enables the organizations to take better-informed decisions.

The increased demand for transparency is further illustrated by the current discussion on the supposedly excessive surplus capital in the Dutch social housing sector. The government and the public think that housing corporations are very (or even too) wealthy, and that they should spend more on, for instance, urban renewal and on increasing the housing stock. Therefore, housing corporations should be able to show how much capital they have available, what they plan to do with this capital, and whether they have excess capital.

To be able to answer these questions and to increase transparency, housing corporations have to objectify their resource allocation decisions. Just like commercial organizations, housing corporation management is responsible for allocating resources in order to achieve the organization's purpose.

“In organizations, the decision-making function is the responsibility of management. In order to execute its responsibility, an organization's management requires information about the resources available to it and their relative effectiveness for achieving the organization's purpose. Resources are acquired, allocated, motivated and manipulated under the manager's control. They include people, materials, plant and equipment, money, and information.”  
(Churchman, cited in [7, p. 235])

The organization's purpose is attained through the achievement of multiple (often numerous, and competing) objectives. For housing corporations, social objectives and financial restrictions will often be competing. An important question then is how a housing corporation rationally allocates its resources in order to achieve its goals.

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<sup>1</sup> For a more thorough description of the Dutch social housing system and the role of housing corporations herein, see for instance [8], [9], [10], [11], [19], [20] and [21].

Gruis [8] elaborates on the measurement of financial consequences of policies and how the risks involved in policies can be measured. There is no general methodology for the estimation of the social consequences. Gruis and Nieboer [10] forms an explorative study to the usage of performance indicators at housing corporations in order to measure both financial and social return on investments. Gruis [9] discusses how financial and social returns can be measured in relation to asset management in Dutch housing corporations. The author gives an overview of possible (social) performance indicators, but he does not try to compare or weigh these indicators. An explorative survey among Dutch housing corporations indicates that, although housing corporations collect a lot of data on social return, only a small minority really evaluate their performance by comparing their output against pre-set targets or benchmarks. Gruis [9] concludes that these results indicate that housing corporations are not actively striving to use their financial surpluses in the interest of housing.

Thus, traditionally housing corporations set financial targets and discuss social aspects, but they fail to set concrete targets for their social objectives which can be measured and evaluated properly (see also Gruis [9]). The problem is that objectives are often difficult to compare. How does an additional affordable house weigh against better livability? As long as these objectives cannot be compared objectively, this dilemma remains tough to resolve. This is mainly because the social objectives are often difficult to quantify. Moreover, if a quantitative measure does exist, there is often a large difference in the units of measurement between different objectives (for example, the number of affordable houses versus complaints from tenants). These differences prevent a straightforward comparison of the objectives. Perhaps this is the reason why the current decision-making process does not take into account the social objectives but only the financial objectives. Normally, an estimate of the financial consequences of a decision is available, no matter how uncertain these often are. On the other hand, people are much more reserved in estimating social consequences. Therefore, measuring social consequences usually occurs after the fact, if they are measurable at all.

The aim of this article is not to make every social objective measurable, but it does introduce a method that makes it possible to compare (social) objectives. This allows both the ability to actively involve social objectives in the decision-making process of corporations, as well as increasing the possibility of more transparent management processes. We see the financial objectives in the methodology that we want to apply as the preconditions for the corporation as a whole, but not as *the* conditions for individual investment decisions. Therefore, we leave the financial objectives as they are and focus only on the social objectives. In the remainder of this paper, we first describe the methodology based on a theoretical example. Then we present a real-life case, and we end with the conclusions.

## Methodology

To overcome the problem depicted above, we propose a methodology based on six concurrent steps:

1. Naming the objectives
2. Defining the objectives
3. Determining a score for the objectives
4. Weighing the objectives
5. Scoring the current policy
6. Optimizing the policy

We will now discuss these steps and work out an example.

### 1. Naming the objectives

In principle, housing corporations distinguish two types of objectives. The first type is derived from the performance fields of the BBSH, while the second type is formed by the corporation's own social and portfolio objectives.

The six performance fields of the BBSH are:

1. Offering affordable housing for the target group
2. Keeping up the quality of the properties
3. Involving the tenants with policy and management
4. Guaranteeing financial continuity
5. Stimulating livability in neighborhoods and districts
6. Stimulating living and care

In our eyes, performance field number 4, guaranteeing financial continuity, is a pre-condition and not necessarily an objective.

Housing corporations may have specific objectives depending on the local housing market context. These include, but are not limited to:

1. More spacious homes
2. More homes for the mid to high income groups
3. More accessible homes
4. More homes in combination with good parking possibilities
5. More homes for the elderly
6. More homes for the young

For our example, we have chosen a typical mid-sized housing corporation that owns 8,000 dwellings. Since the proposed methodology can be universally used for both BBSH and the corporations' own objectives, we will use a limited set of – in this case both BBSH and non-BBSH objectives – to demonstrate the power of our concept. The objectives that we use in our example are very common for Dutch housing corporations. The objectives given below have been used in a number of real life applications of our methodology. The objectives are:

- Offering affordable housing for the target group (affordability)
- Stimulating livability in neighborhoods and districts (livability)
- Involving the tenants with policy and management (customer satisfaction)
- More homes for the elderly (housing for the elderly)
- More homes for the young (housing for the young)

## **2. Defining the objectives**

It is important to establish a good and uniform definition of the objectives. For instance the terms ‘affordability’ and ‘livability’ are rather arbitrarily. Even within a single organization different definitions can co-exist. For adequate decision-making, it is imperative to achieve uniformity inside the corporation in terms of the definitions of the objectives.

In the previous paragraph 5 objectives were defined for our example. In order to use them later on, we will operationalize these as follows:

1. Affordability; number of dwellings where the net rent is lower than € 500 per month
2. Livability; number of dwellings where the score for livability is higher than 6 out of 10
3. Customer satisfaction; number of customers who move into in a dwelling who declare their satisfaction with a minimum of 7 out of 10
4. Housing for the elderly; number of dwellings without barriers and suitable for the elderly
5. Housing for the young; number of dwellings with rent lower than € 325 per month and suitable for the young

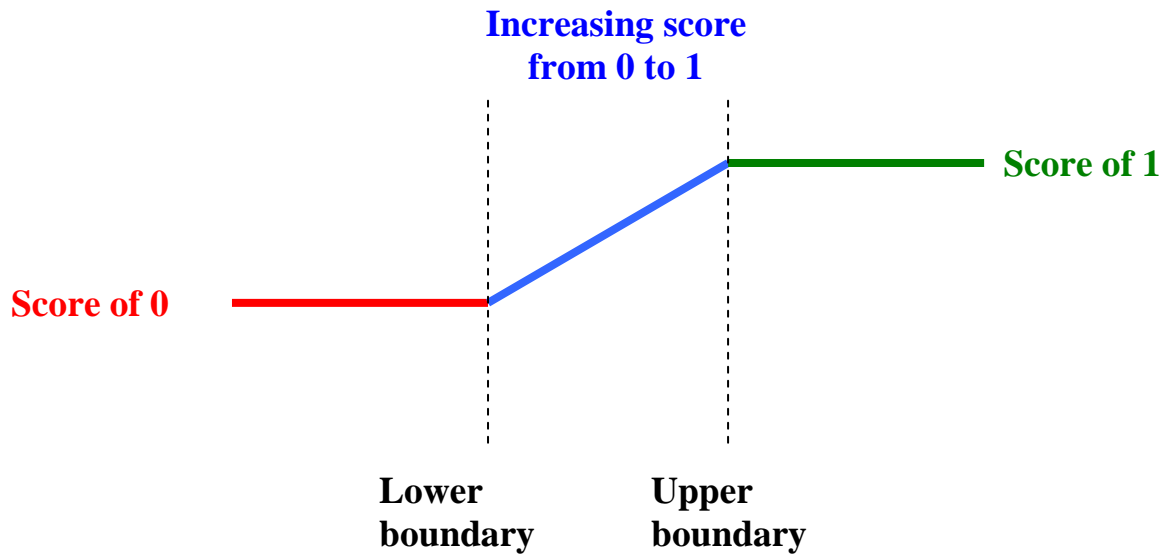
## **3. Determining a score for the objectives**

When setting the objectives it is important to name the desired level (what score indicates that the objective is achieved), and at what moment the objective has to be reached. Doing this for all the objectives allows making a comparison between the objectives.

Because the units of measurement of the objectives that we want to compare are not equal, it is difficult to directly weigh them up against each other. Perhaps one finds an average livability score of 6.5 more important than realizing 5,000 affordable dwellings, given the fact that there are already 4,500 affordable dwellings. However, this would be different if there were no affordable dwellings whatsoever. Therefore, what we need is the utility function for each objective. This utility function transforms the score for each objective to a value in the 0 – 1 range. However, it is very difficult to obtain utility functions in real life cases. Decision makers usually have difficulties in telling what their utility functions are. In our example we assume very simple utility functions. We define a unit per objective and set a desired level and a minimum level:

- Lower boundary = minimum required level, a lower score indicates that the objective has overall not been achieved (score = 0);
- Upper boundary = desired level, a higher score indicates that the objective has been reached completely (score = 1);

The score per objective is now determined as in figure 1.



**Figure 1. Utility function to determine a uniform score per objective**

This means that everything achieved above the upper boundary does not count for the score of this objective. On the other hand, there is no penalization if you are far under the lower boundary. These utility functions have proven their use in practice, see the real-life case later in this paper<sup>2</sup>. However, for some cases they are probably too simple. In that case, it is possible to allocate more boundaries, which will extend the scoring possibilities.

For our example, we want to achieve the following boundaries in a period of 10 years:

- |    |                         |         |   |                 |
|----|-------------------------|---------|---|-----------------|
| 1. | Affordable housing      | : 5,000 | – | 6,000 dwellings |
| 2. | Livability              | : 5,500 | – | 7,000 dwellings |
| 3. | Customer satisfaction   | : 3,000 | – | 4,000 customers |
| 4. | Housing for the elderly | : 200   | – | 800 dwellings   |
| 5. | Housing for the young   | : 100   | – | 500 dwellings   |

### **Analytic Hierarchy Process**

In order to get a firm understanding of the following two steps of our proposed methodology, it is wise to first pay attention to the underlying methodology of Saaty's Analytic Hierarchy Process (AHP). The AHP restructures the decision-making problem hierarchically and by using pairwise comparison the ratios between the objectives are determined. The AHP uses this input to generate a weight vector that reflects the priority of each objective. This enables to grade various policies.

The basic problem with the decision making process for for example housing corporations is that the features of the (multi criteria) objectives tend to have different

<sup>2</sup> The utility functions used in our approach are quite similar to the points scoring system applied by Hemphill *et al.* [12] to measure the performance of a number of indicators of sustainable urban regeneration. The authors use a 0-10 scale to measure the contribution to sustainability. Below the minimum level, the score is 0 and above the optimum or maximum level the score is 10 points. The main difference with our approach is that we assume a continuous function, whereas Hemphill *et al.* assume a stepwise discrete function for most indicators: 6 intervals are defined with 0, 2, 4, 6, 8 and 10 points respectively. The intermediate intervals have equal width, which implies that essentially they are assuming a linear relationship. In [13] the same authors use the weighted sum of these indicators to compare urban regeneration projects in three European cities.

dimensions; so called incommensurability [3]. The problem is that if you fail to address the differences in dimensions, you fail to use a methodological sound method, which may result in an invalid result. Various alternative methods to AHP have the same overall objective (for example multi attribute utility theory [3]) yet they tend to fail to effectively deal with this incommensurability. The approach of using hierarchical structuring and pairwise comparisons is not sensitive to this shortcoming. Examples of this approach include so-called outranking approaches and Saaty's AHP [3]. The outranking approach is a reaction on Saaty's AHP, as there are different insights on the underlying concepts of AHP [22]. However, the presented alternative is not as straightforward as AHP, nor is it clear whether the outranking approach actually performs better in the end.

The AHP is the product of Saaty's effort to create a straightforward procedure to deal with complexity. One of the strengths of the AHP is that it relies closely on a strategy that humans often use to deal with complexity: "*the hierarchical structuring of complexity into homogeneous clusters of factors*" [6]. This basis of the AHP ensures a transparent decision making process, something that – as was stated in the introduction – is increasingly important for housing corporations and other organizations. This is an advantage for both external parties as well as for the decision makers themselves.

The final phase in the AHP (after hierarchical structuring and the analysis) is formed by a synthesis function. In complex situations humans tend to have difficulty to synthesize many elements intuitively. Using the AHP methodology this shortcoming can be compensated. The AHP closes the gap between the human ratio, and a mathematical method for the synthesis of this subjective information in the form of the objectives. This gives rise to both popularity of and criticism on the AHP.

Although there is a discussion amongst scientists on the theoretical validity of the AHP, the number of successful real life applications is very large. Just [5] already returns over 1400 references regarding AHP. A general overview on cases in various branches can be found in Zahedi [28]. Ball and Srinivasan [2] use the AHP for house selection. Their model allows the buyer to consistently evaluate property attributes. A recent application of this method to the field of commercial property investment can be found in Adair, Hutchinson and Leheny [1]. At this stage we will return to our methodology and our case. Some side notes on the usage of the AHP can be found in appendix III. For a more thorough description of the theory behind the AHP Saaty [23] [25] can be consulted or [7].

## **5. Weighing the objectives**

The next step in our methodology is to rank these objectives based on their relative importance. We do this by assigning a value between 0 and 1. The sum of the weight factors adds up to 1. With five objectives, the average weight is 1/5. If a weight factor for a particular objective is higher than 0.2 it is more important than the average objective. If it is lower, the objective is less important than the average objective.

### *Comparing objectives*

We assign a value between 1 and 9 to each objective  $D_1$  that we are comparing with another objective  $D_2$ . These values represent the following value judgment:

- 1 if the two objectives have the same importance
- 3 if  $D_1$  is a little bit more important than  $D_2$
- 5 if  $D_1$  is more important than  $D_2$
- 7 if  $D_1$  is much more important than  $D_2$
- 9 if  $D_1$  is absolutely more important  $D_2$

We use the inverse of the above for judgments when the first objective is less important than the second objective. Thus:

- 1/3 if  $D_1$  is a little less important than  $D_2$
- 1/5 if  $D_1$  is less important than  $D_2$
- 1/7 if  $D_1$  much less important than  $D_2$
- 1/9 if  $D_1$  is absolutely less important than  $D_2$

*The pairwise comparison matrix*

We can process the comparisons of the objectives in a matrix. The columns and rows are the five objectives. If we compare objective  $i$  with objective  $j$  the resulting value would appear in the matrix in row  $i$ , column  $j$ . Note that the main diagonal will always be ‘1’ as you are then comparing an objective with itself. To keep it simple, we will assume that only the filling of the upper triangle matrix has occurred. The values in the bottom triangle matrix are equal to the inverse (1 divided by the value) of the values in the upper triangle matrix.

Our matrix would then be equal to:

	Affordability	Livability	Customer satisfaction	Housing the elderly	Housing the young
Affordability	1	5	7	7	9
Livability	1/5	1	3	5	5
Customer satisfaction	1/7	1/3	1	1	3
Housing the elderly	1/7	1/5	1	1	5
Housing the young	1/9	1/5	1/3	1/5	1

**Table 1. Pairwise comparison matrix**

It is possible to let different people fill in the matrix and then generate a compiled matrix with values that are the average of the individual matrices. For simplicity, we will only use one matrix in our example.

The next step is formed by determining the principal eigenvector of the matrix with the use of pairwise comparisons. When the AHP was developed, processing power of computers was limited and expensive. Because of this fact, in his book Saaty presents simple mathematical methods to determine the principal eigenvector. These approaches are still used in many papers in spite of the progress made in the availability of powerful computers. This paper uses a similar approach. Additionally, appendix II describes the calculation of the principal eigenvector with use of the computer program Matlab.

First, we will normalize the pairwise comparison matrix. This means that we take the sum of each column and then divide each element by the corresponding sum. This leads to the following normalized matrix:



	Affordability	Livability	Customer satisfaction	Housing the elderly	Housing the young
Affordability	0.63	0.74	0.57	0.49	0.39
Livability	0.13	0.15	0.24	0.35	0.22
Customer satisfaction	0.09	0.05	0.08	0.07	0.13
Housing the elderly	0.09	0.03	0.08	0.07	0.22
Housing the young	0.07	0.03	0.03	0.01	0.04
Total	1	1	1	1	1

**Table 2. Normalized pairwise comparison matrix**

To check if the matrix is consistent we can look at the normalized matrix. The fact that affordability has the highest value for all the columns shows that this matrix is quite consistent. Ideally, in a consistent pairwise comparison, each column of the normalized matrix would be the same. An in-depth check of the consistency of the matrix can be carried out. An example of this check can be found in appendix I.

Lastly, we use the average of every row as a weighting in the hierarchy of the objectives. Shown below are the weightings in order of importance.

	Weight
Affordability	0.56
Livability	0.22
Housing the elderly	0.10
Customer satisfact.	0.08
Housing the young	0.04
Total	1

**Table 3. Weight vector**

By far, the most important objective is affordability, followed by livability. The least important is housing for the young.

## 6. Scoring the current policy

The weight function gives a decent amount of information. Namely – what really is important for the organization and what is not. The question now is how do we include this weightings function in the decision making process. By using our example, we explain this further.

Named, in step 3, were the following boundaries of our objectives:

1. Affordability : 5,000 – 6,000 dwellings
2. Livability : 5,500 – 7,000 dwellings
3. Customer satisfaction : 3,000 – 4,000 customers
4. Housing for the elderly : 200 – 800 dwellings
5. Housing for the young : 100 – 500 dwellings

With the current policy of the corporation, estimations of the realization of the objectives over a period of 10 years are:

1. Affordability : 6,500 dwellings
2. Livability : 6,000 dwellings
3. Customer satisfaction : 3,500 customers
4. Housing for the elderly : 320 dwellings
5. Housing for the young : 80 dwellings

The following scores can then be determined:

1.	Affordability	: 6,500, greater than 6,000	1.00 = 100%
2.	Livability	: $(6,000-5,500)/(7,000-5,500) =$	0.33 = 33%
3.	Customer satisfaction	: $(3,500-3,000)/(4,000-3,000) =$	0.50 = 50%
4.	Housing for the elderly:	$(320-200)/(800-200) =$	0.20 = 20%
5.	Housing for the young:	80, less than 100	0.00 = 0%

The percentages above show how successful the achievement of the objectives was. However, in general people find it easier to compare results expressed in terms of grades than in percentages. We will therefore give each objective a number between 0 and 10. This would lead to the following grades for the current example:

1.	Affordability	: 10
2.	Livability	: 3.33
3.	Customer satisfaction	: 5
4.	Housing for the elderly	: 2
5.	Housing for the young	: 0

As explained in section 5, there is a difference in the importance of each of the weight factors. In order to express this difference, we multiply the scores with the weighting factors. Below are the *weighed* scores:

1.	Affordability	: 5.60
2.	Livability	: 0.73
3.	Customer satisfaction	: 0.40
4.	Housing for the elderly	: 0.20
5.	Housing for the young	: 0.00

This makes the total “grade” of this corporation 6.93. In other words, given the current policy of the corporation and the weighting that they have given to the different objectives, they achieve a score of 6.93.

## 7. Optimizing the policy

In the above example, the corporation scores a grade of 6.93. The question is how we can improve this score for the corporation by using an alternative policy. Naturally many policy options can be thought up which would achieve a higher score for the corporation. For example, they can choose for a far greater investment in livability. As the objective is not completely at the desired level and the objective has a reasonably high value assigned, the score would then be much higher. However, it is not imperative that this option is chosen, as the alternative policy would also have financial consequences to consider. Every corporation would need to make a decision between the growth in score against the growth in cost. Overall, the aim would be an efficient policy variant. This is a policy variant where given the scores of the objectives the costs are as low as possible, or where given a specific cost level the scores for the objectives are as high as possible.

The corporation’s resources are roughly equal to the value of its housing stock. There are different methods to value the housing stock. With some of these methods, the value depends upon the corporation’s policy (i.e., the strategy chosen). This is undesirable in case different policies have to be compared (see [16]). Gruis [8] discusses several concepts of value and valuation methods for housing corporations. He distinguishes two relevant values for housing corporations: the income stream

value and the market value for rented dwellings. The market value for rented dwellings is also used for the Aedex / IPD social housing property index (see [29]). The market value for rented dwellings gives the maximum earning capacity of the housing stock. However, the actual policy of the housing corporation will almost always deviate from the assumptions made to obtain the market value because of the corporation's social objectives. Therefore, the income stream value is also important for a housing corporation. The income stream value is the Net Present Value of:

- rental income according to the corporations' rental policy;
- operating costs according to the corporations' portfolio strategy;
- sales results according to corporations' portfolio strategy;
- residual value according to the market.

The income stream value, therefore, is the resultant of the corporations' portfolio strategy and not of the market. As the market value is independent of the corporations' policy and the income stream value mirrors the expected value of the current policy, the difference between the two values is the "opportunity cost"<sup>3</sup> for the corporation. In other words, the costs the corporation has to make to realize their social objectives.

Suppose that in our example the market value is equal to € 700 million and the income stream value is € 200 million. Thus, the grade for the corporation is 6.93 and its associated (opportunity) costs are € 500 million. Thus, the corporation pays in fact € 72 million per 1 point in the score. The lower the costs per point in the score the more efficient the policy is<sup>4</sup>.

The question is how to optimize the policy. Ideally an inventory is made of all the possible policy variants followed by an analysis of the costs and grades. In practice, this is not possible. There is an innumerable amount of policy variants and estimating the score and costs is labor-intensive. It would be more practical to take the current policy and systematically find better solutions.

A logical next step would be to divide the decision-making problem into subprojects (ie. on a regional level). This division can be enforced top-down, but it can also be the result of negotiations between, for example, regional teams. The described method can be applied to every division of the properties. This enables the possibility to match the division to the decision-making structure of the organization.

## **Real-life case**

As stated before, the AHP is already being used in numerous branches. To show that the presented methodology does not only work in theory, we will now demonstrate the practical use by means of a real-life case. This case is taken from [14].

In 2005 one of the Netherlands' largest housing corporations, Portaal, implemented an asset liability management strategy using the presented methodology. Leading in the process of naming and defining the objectives was the organization's general mission statement, divided into three elements:

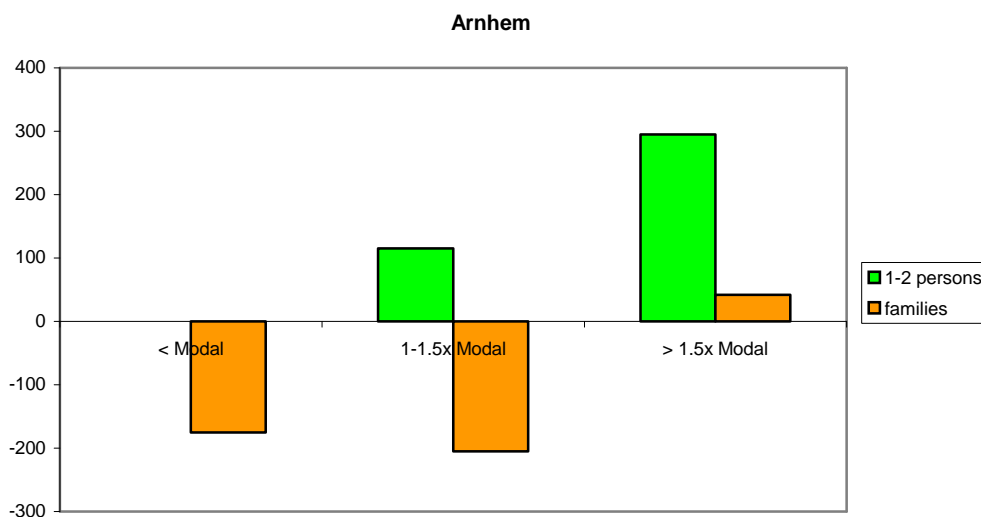
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<sup>3</sup> Gruis[8] uses the term economic loss.

<sup>4</sup> This method of dividing the opportunity costs by the score in order to be able to compare different policies is comparable to the approach used by Ball and Srinivasan [2] to compare different houses in a house selection process. They divide the listed price of a house by the score for buying to obtain a common unit of comparison (the so-called "Attribute Weighted Price").

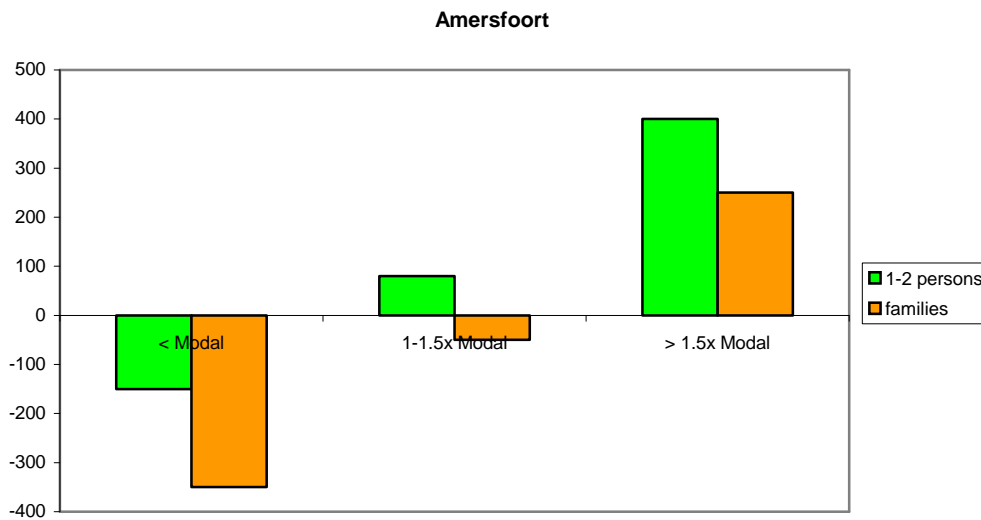
- People who cannot afford to buy a house, should be given the opportunity to rent affordable housing;
- The tenants should be able to count on well maintained housing, in a livable environment where they feel at ease;
- Portaal takes extra care for certain groups, including mentally/physically challenged and homeless people.

This mission statement was then translated into a number of objectives. The first three objectives are based on Portaal’s philosophy to ensure that a directly proportional share of the target groups should be accommodated. In figures 2 and 3 one can see the relative market shares of Portaal per income group per household type in two Dutch cities: Arnhem and Amersfoort. Three categories of income group per household type are determined; each based on a plural of the modal income<sup>5</sup> per household. It is clearly visible that in Arnhem and Amersfoort, Portaal meets, even exceeds, its goal when it comes down to housing for incomes of more than 1.5 modal per household and incomes of 1 to 1.5 modal per household of 1 to 2 persons. It is also evident that the goal is not met in Amersfoort for incomes below modal, and in Arnhem for family households in the category below 1.5 modal.



**Figure 2: relative market share of Portaal per income group per household type in the city of Arnhem**

<sup>5</sup> The term modal income, or simply referred to as ‘modal’, refers to a commonly used gross income value in the Netherlands. Although the term may suggest something else, this term does NOT refer to the statistical modal. For 2005 the modal income was set to € 29.000, in this case Portaal uses a slightly higher level of € 30.000 (roughly \$ 38.000).



**Figure 3: relative market share of Portaál per income group per household type in the city of Amersfoort**

Based on the findings in this first phase, Portaál has set six objectives for the period of 2007-2011. Please note that although only the data of Arnhem and Amersfoort have been discussed, these objectives are valid for the corporation in general.

1. Portaál strives to house at least a direct proportional share of the households with an income below modal in its operating area in 2011.
2. Portaál strives to house at least a direct proportional share of the households with an income between 1 to 1.5 times modal in its operating area in 2011.
3. Portaál strives to house at least a direct proportional share of the households with special needs in its operating area in 2011.
4. Portaál strives to achieve that 75% percent of their customers is satisfied with the quality of the housing and grades this aspect with at least a 7 out of 10 in 2011.
5. Portaál strives to achieve that 65% percent of their customers is satisfied with the quality of their neighborhood and grades this aspect with at least a 7 out of 10 in 2011.
6. Portaál strives to achieve that 70% percent of their customers is satisfied with the quality of the service and grades this aspect with at least a 7 out of 10 in 2011.

Of these six objectives, Portaál gives priority to the objectives for the lower income groups, the housing of people with special needs, and the customer satisfaction of the quality of the neighborhood. This prioritization is reflected in the table 4.

Objective	Weight vector
Housing households below modal	0.32
Housing households 1 – 1.5 x modal	0.08
Housing households with special needs	0.23
Customer satisfaction: housing	0.13
Customer satisfaction: neighborhood	0.19
Customer satisfaction: service	0.07

**Table 4: Portaal weight vector**

Portaal has also set both upper and lower limits. The current achievements are seen as the lower limits; in other words, a new policy should not lead to a lower performance. The levels set in the six objectives for 2007-2011 are seen as the upper limits. A score of 10 would therefore indicate that all these objectives are completely realized. A score of 0 would indicate that the performance in 2011 is lower on all six objectives compared to today.

Before the effects of different policies can be determined, first the current policy has to be analyzed. Based on annual customer satisfaction surveys and on external resources Portaal can determine what the effects are of their current policy. In this section we will specifically look at the situation of the performance of Portaal in the city of Leiden. With the current policy, the customer satisfaction for the neighborhood is expected to rise from 57% in 2005 to 62% in 2011 (see objective 5). In order to reach the ambition of 65% of all customers satisfied with the neighborhood, Portaal has come up with the idea of upgrading a certain housing estate near the city centre of Leiden, including an upgrade of the surrounding area. It is expected that this upgrade will increase the customer satisfaction of the neighborhood. The extra investment is likely to be returned by means of an increase in the rent per property. In table 5 two policies are depicted: the current policy in which the upgrade is not included, and the alternative policy in which it is included.

Objectives	Current policy (2007-2011)		Alternative policy (2007-2011)	
<b>Estate</b>				
Customer satisfaction neighborhood	50%		75%	
Customer satisfaction housing	65%		100%	
<b>Portaal Leiden</b>		Score		Score
Households below modal	1.500	8	1.500	8
Households 1 – 1.5 x modal	1.500	10	1.500	10
Households with special needs	250	7	250	7
Customer satisfaction: housing	73.0%	6	73.5%	7
Customer satisfaction: neighborhood	62.0%	4	62.5%	5
Customer satisfaction: service	70.0%	10	70.0%	10
	<b>Total:</b>	7.21	Total:	7.53

**Table 5: comparing the performance of the current and alternative policy**

This analysis clearly shows the difference between these policies. In the alternative policy “customer satisfaction: neighborhood” still falls short of the upper limit of 65%, but the total effect is marginally better than the current policy.

Determining a new policy is also a question of analyzing the financial aspects. In table 6 the financial consequences of both policy variants are depicted.

	<b>New policy</b>	<b>Alternative policy</b>
Market value	€ 400 million	€ 400 million
Income stream value	€ 350 million	€ 349.8 million
Opportunity costs	€ 50 million	€ 50.2 million
Objective score	7.21	7.53
Costs per unit score	€ 6.93 million	€ 6.67 million

**Table 6: Financial consequences of the current and alternative policy**

In this case, not only does the alternative policy perform better on the social objectives, but also the costs per unit score are lower. The alternative policy will therefore be implemented.

Portaal has the intention to use this method again for future investment decisions.

## **Conclusion**

In this paper we have described a methodology to determine the importance of social objectives. By using the pairwise comparison method, we have created a weighting between the different objectives. The resulting weight vector made it clear which objective of the corporation is the most important.

For the corporation as a whole it was determined to which degree the set target was met. This resulted in a score per objective, which in turn can be multiplied with the weight factor of the appropriate objective. The summed up score attaches a grade to the current policy of the corporation.

For the decision making process of the corporation, it is of importance to keep in mind how a change in the policy can effect the total score. With this, people are continually seeking for a more efficient policy. That is not only a policy that leads to a higher grade. We must also take the costs of the policy into account. A policy can be called efficient when the ratio between the score and the cost is as high as possible.

In order to achieve a more efficient policy the corporation will have to, step-by-step, find and analyze alternative policy variants. If an alternative policy offers a favorable effect on the score / costs ratio, the new policy can be implemented. To get to an efficient policy variant quickly, it is crucial to use employees with as much knowledge of the properties as possible. On a local level, employees can get to efficient solutions by splitting the objectives and the costs of the corporation as a whole (consider it a large project) into sub-projects. The explained methodology ensures that the total score of the corporation also improves.

The proposed methodology makes it easier to compare social objectives with other social objectives and with financial objectives. However, it remains tough to determine what the exact effect is on a social objective if an X amount of cash is

spent. The number of houses for the elderly is an example of a social objective in which the relation investment versus expected performance is evident. The term livability on the other hand is a bit more complex. The authors wish to stress the following two points. Firstly, it is important to operationalize (especially social) objectives in unambiguous performance indicators. Secondly, the power of the proposed methodology lies not in pure one-on-one relations between the financial investment and the social and financial results. Much more important is the power of our concept as a sensitivity analysis (i.e. what is the overall effect if more attention is paid to objective A than to objective B or C and vice versa).



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## Appendix I: Check for Consistency

In this appendix, we go deeper into testing the consistency of the pairwise comparison matrix. This is quite important for the ‘garbage in, garbage out’ principle. If the matrix were not consistent, deriving sensible conclusions would not be possible. For a more comprehensive foundation, see chapter 4 in Forman & Selly [7].

We call the amount of different objectives  $n$ . We call the pairwise comparison matrix  $A$  and the weight vector  $w$ . First, we multiply this  $n*n$  matrix  $A$  with the  $n*1$  weight vector,  $A*w$ . In our example:

	Affordability	Livability	Customer satisf.	Housing the elderly	Housing the young
Affordability	0.63	0.74	0.57	0.49	0.39
Livability	0.13	0.15	0.24	0.35	0.22
Customer satisf.	0.09	0.05	0.08	0.07	0.13
Housing the elderly	0.09	0.03	0.08	0.07	0.22
Housing the young	0.07	0.03	0.03	0.01	0.04
Totaal	1	1	1	1	1

	Affordability	Livability	Customer satisfaction	Housing the elderly	Housing the young
w:	0.56	0.22	0.08	0.10	0.04

	Affordability	Livability	Customer satisfaction	Housing the elderly	Housing the young
Aw:	3.25	1.25	0.45	0.49	0.19

Next, we calculate the eigenvalue  $\lambda$  using  $\frac{1}{n} \sum_{i=1}^n \frac{\text{element i from } A * w}{\text{element i from } w}$ .

In our example:  $\lambda = \frac{1}{5} * 27.0271 = 5.4054$

The eigenvalue in a fully consistent filled in matrix is equal to the sum of the diagonal elements of the matrix (the trace of the matrix), or  $n$ . Therefore, we can use the difference between  $\lambda$  and  $n$  as an inconsistency criterion. Furthermore,  $\lambda$  is always greater than or equal to  $n$ .

We now calculate the consistency index (CI) as  $CI = \frac{\lambda - n}{n - 1}$

In our example that would be  $CI = \frac{5.4054 - 5}{5 - 1} = \frac{0.4054}{4} = 0.1014$

Eventually we use the  $CI$  to see if  $A$  is consistent (enough). We use the following criterion:

If  $CI = 0$  then  $A$  is consistent

If  $CI / RI_n \leq 0.10$  then  $A$  is consistent enough

If  $CI / RI_n > 0.10$  then  $A$  is reasonably inconsistent

The ‘random’ index  $RI_n$  is the averaged value of  $CI$  for arbitrary chosen values of  $A$  (given that the values on the main diagonal are 1 and the below triangle matrix is the inverse of the above triangle matrix). For  $n$  objectives  $RI_n$  is given by:

n	2	3	4	5	6	7	8	9	10	...
RI n	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.51	..

In our example that would be  $CI / RI_5 = \frac{0.1014}{1.12} = 0.0905$

This is smaller than 0.10 and therefore sufficiently consistent. Therefore, we can see that the weight-function is reliable and we can use it for further analysis.

## Appendix II: Principal Eigenvector

The weight vector of the AHP as described by Saaty [23] is generated by the principal eigenvector. In the example in this paper an estimation is used. The real principal eigenvector calculated with the use of Matlab is:

	Weight
Affordability	0.58
Liveability	0.22
Housing the elderly	0.08
Customer satisfact	0.09
Housing the young	0.03
Total	1

**Table A1. Principal eigenvector**

The approach used in this paper closely matches the real principal eigenvector. Remarkably the rank has changed. The cause for this shift probably lies in the fact that 'Housing the elderly' and 'Customer satisfaction' have a very similar weight. This can cause a shift in rank when different methods are used to determine the eigenvector. One should always take the differences between the weights into consideration, and not only the ranking. A statement like one objective is more important than another while the difference in weight is very small, is not tenable.

### Appendix III: Critique on the usage of AHP

The authors do not pretend to give a complete overview of the critiques on AHP. In this appendix only the most relevant issues will be mentioned, including a reference for background information.

First of all, the theory behind the AHP is based on a set of axioms (a more extensive definition of these axioms and the theory can be found in Saaty [24]). In Warren [27] the authors question if the axioms are backed up by an adequate mathematical foundation. For instance, the axioms would be unsuitable to function as required and sufficient preconditions for a mathematical method.

Secondly, the AHP uses a system in which semantic statements for pairwise comparison of objectives are translated to numerical ranks. The ranking system in this paper/article refers to the original ranking system introduced by Saaty (the development of the original system is described in Saaty [23]). A paper from the field of psychology by Miller [18] has played an important role in the development process. It is perhaps useful to take into consideration the critique on Miller by Holder [15]. One important element of this critique is formed by the friction between the psychological aspects and the numerical interpretation. In the case of AHP, it allows a certain degree of inconsistency and transitivity – which is correct from a psychological point of view - that could lead to numerical discrepancies.

Another source of critique on the original AHP is the phenomenon of rank reversal [15]. Rank reversal refers to the shift in rank of alternative objectives each time the problem is evaluated on a different basis or when small changes occur (for instance when a very similar objective is added to the list). This phenomenon was first reported by Belton and Gear [4]. Belton and Gear noticed that whenever an alternative, yet very similar objective was added, rank reversal occurred.

The cause of this form of rank reversal should be sought in the normalization of columns in the matrix. Belton and Gear therefore propose to divide the column elements by its largest value. This version of the AHP was later accepted by Saaty and is being referred to as *ideal mode AHP*. However, Saaty [24] has shown that ideal mode AHP is also sensitive to rank reversal.

In Triantaphyllou [26] a case study is used to research more forms of rank reversal. [26] shows that rank reversal occurs when ideal mode AHP is applied. Saaty [24] also points out that rank reversal, although contra-intuitive, is not uncommon in real-life. When the problem is multidimensional, the multiplicative AHP can provide a solution in order to prevent rank reversal (Lootsma [17]).

In this paper the original AHP is used. In our current application, there will be no evaluation of sub-problems. However, if in a later stage the structure becomes multidimensional (when objectives are split up in sub-objectives), the multiplicative AHP can be used. This will prevent rank reversal from occurring. However, for our current application even when rank reversal occurs this should not be too problematic.

The final remark refers to the translation of pairwise comparisons to weight vectors. Over the years various methods have been developed for the synthesis of the matrix with scores in order to create the weight vector. According to Saaty the principal eigenvector is the appropriate weight vector for the matrix with pairwise comparisons. To this day no consensus exists regarding which method best describes the appropriate weight vector. For an overview of alternative methods for determining a weight vector Zahedi [28] can be used. This paper also deals with the different criteria that are proposed for the evaluation of these alternatives.

As stated before, this is not a complete list of all critique. A recent report that elaborates on the critique on the AHP is Warren [27]. In this report virtually all important scientific papers published on the field of AHP are reviewed. Warren concludes that one should be careful while implementing the AHP, as the AHP has a number of questionable characteristics. Especially the validity of the ratio scale assumption is questionable. To conclude, there is a discussion amongst scientists on the theoretical validity of the AHP. In spite of this, the number of successful real life applications is very large. The AHP has proven its relevance in practice.