Chapter 7

Suggested Method for Stigma Assessment[1]

7. 1 Introduction

Mundy (1992a) suggests the use of market evidence where market data is available and contingency method where market data is unavailable (see Chapter 6). In the real world, unfortunately, it is very rare to have a sufficient amount of transaction data of contaminated land. Therefore it is difficult to implement Mundy's suggestion. Regarding the use of the contingency method where market data is unavailable, Mclean and Mundy (1998) have subsequently concluded that it should be used as a supplementary method only. Apart from Mundy's market data and survey approaches, there is an alternative approach to deal with stigma. Researchers and practitioners consider that stigma may also be expressed as a percentage of the unimpaired value (Patchin 1994, Sanders 1996). Patchin (1994) finds that the stigma value reduction percentage rate may be as high as 69% of the unimpaired value. This alternative treatment of stigma is also practised in Australia.

It should be noted that the term 'stigma impact' referred to earlier in the thesis is the impact on the overall value of the property. The stigma value reduction percentage rate (to be referred to as stigma factor) is a percentage rate based on which the overall stigma impact is calculated. It is a factor to be used in the impaired value approach to assess the overall value of the contaminated property. The stigma factor is based on "the subjective judgement of the property profession and comprise[s] a significant risk factor contingency allowance applied as a deduction from the valuation assessment." (Spencer 1993, p.587). My 1998 survey results show that the majority of respondents use a percentage reduction of the unimpaired value to reflect the stigma impact (see Chapter 6). However, the percentage rate is generally obtained by arbitrary determination or 'gut-feeling'. Although the respondents claim that the estimation is made with regard to a number of factors, they do not allege to have used any defensible methods to assess the relevant figure.

Since the stigma factor is based the "subjective judgement" of a valuer, it is difficult to claim if the chosen stigma factor has been accurately assessed. At most a valuer may claim that the stigma estimated is the most probable one having regard to all relevant evidence. Whilst well-experienced valuers may estimate the most probable stigma factors with 'gut-feeling', however, the skill is difficult to master and defend. For valuers who do not have the skill, they need a method that is easy to learn and apply to help them assess stigma factor. Even for the well-experienced valuers, they also need a method to verify if their 'guesstimation' is acceptable. In view of the need, this Chapter introduces a new stigma assessment method for the consideration of the industry. The objective is that the method should produce results at least equal to, if not better than, the best estimate made by the experienced and competent valuers.

7.2 The suggested method

My 1998 survey shows that 58% of the less experienced group and 72% of the more experienced group allow for a stigma factor in their valuation (Table 6 – 1 in Chapter 6). However, the current stigma factor assessment methods used by Australian valuers are unsatisfactory. Equation 5 – 4 in Chapter 5 shows the model of the impaired value approach. When this approach is used to assess the value of a contaminated property, the valuer may use any valuation method he or she thinks fit to assess the unimpaired value of the property. He or she then needs to assess stigma if there is evidence about its existence. Since the stigma factor

[1] This chapter is based on my paper: Chan N. 2000, *Assessment of Contaminated Land Stigma Impact*, presented at the 5th Asian Real Estate Society Annual Conference, Beijing, China, 26 – 30 July.

is a key element in the impaired value approach, there needs to be a reliable and defensible method to assess the stigma factor.

As mentioned in Chapter 6, Patchin (1991) and Mundy (1992a) have together identified 13 criteria to assess stigma. Clearly stigma is a function of an array of criteria. The determination of stigma thus involves making decisions with regard to this array of criteria or multiple criteria. It is therefore logical to develop the proposed stigma factor assessment method on the basis of a multi-criteria decision making (MCDM) method.

The proposed method will be developed on the following assumptions:

1. Valuers are regarded as a proxy for their clients (owners, purchasers, occupiers, developers, financiers and insurers, etc.). Their views are unconstrained and are a realistic representation of their clients.
2. The stigma factor is a function of the unimpaired value.
3. The stigma factor can be expressed as a percentage reduction of the unimpaired value.
4. Valuers are able to roughly estimate, from their experience and evidence before them, a range of value reduction percentages for stigma using the best/worst case approach.
5. The range of value reduction percentages forms the alternatives in the multi-criteria decision making process.

The first assumption is important. It reiterates the fact that valuations are independently carried out by valuers, whereas stakeholders, such as owners, occupiers, financiers, developers, and insurers, etc., often rely on the recommendations from valuers to make a decision. Under this assumption, valuers may, in the course of carrying out the impartial and independent valuation, make decisions based on their experience and the evidence before them. It reinforces the professional position of valuers to assess market value of the property. One may argue that under this assumption, if the valuers have a risk perception higher than the public, including the clients, they may amplify the public's level of fear in formulating the advice. Nevertheless Gallimore and Jayne (1999 p. 253) find that "there is no empirical evidence to show that this happens". One may also argue that there may be clients who do not want to touch contaminated properties in any circumstances and the valuer's view does not represent the clients. If there were such a client, the valuer would not have been instructed to value the property any way. Even if a valuation is required, this assumption still holds because the valuer may select a stigma factor that returns a negative or zero impaired value for the property.

The second and third assumptions are based on research results from overseas (Patchin 1994 & Sanders 1996) and my 1998 survey in Australia that stigma can be expressed as a percentage of the unimpaired value. The fourth assumption is to assume that a competent valuer, given his/her experience and the available evidence, is able to estimate a range of stigma value reduction percentage rates for the property. Since the aim is to estimate a reasonable stigma value reduction percentage rate (the stigma factor), the last assumption highlights that the target stigma factor figure is a result of applying the proposed MCDM method to analyse the range of percentage rates estimated under the fourth assumption. In this regard, it is thus necessary to find out what are the necessary criteria and alternatives for the MCDM model.

7.3 Methodology

The following process was adopted to develop the target method:

1. Finding out the criteria considered by valuers in stigma impact assessment
   This is an essential step, as the proposed MCDM method will be built on the criteria. The necessary information was obtained from a mail survey and personal interviews of valuers in 1998.

2. Finding out valuers' perception of environmental risks
   It is necessary to find out valuers' perception of environmental risks of different land uses and industries and hence the associated stigma factor of the relevant land uses and industries. The necessary information was obtained from a mail survey and personal interviews with valuers in 1998. There are many land uses and industries that are likely to cause land contamination. In view of that the list of land uses and industries contained in the Contaminated Land Valuation Practice Standard (AIVLE 1994 Appendix II, now the API Professional Practice 2000 Appendix II) is reasonably comprehensive and that valuers should be familiar with it, the whole list was used in the survey. As the survey results are a collective view of the respondents, they can be assumed to be representative, and may be used as a benchmark to check the reasonableness of the probable stigma factors suggested by the valuers.

3. Selection of a suitable MCDM model to quantify stigma
   Relevant literatures on MCDM were consulted in order to select an appropriate model for this purpose.

4. Test run the chosen model
   Valuers are invited to supply data for the test from a stigma affected contaminated property that they valued before. The resulting figure is then compared with the figure in the original valuation.

7.4 Stigma assessment criteria

Patchin and Mundy have identified 13 criteria for stigma assessment. Since Patchin's trouble factor has common ground with Mundy's disruption factor, (both are time related), the two criteria can be deemed as one and it can be assumed that they together have effectively identified 12 criteria. Although these 12 criteria have already been identified, it is unwise simply to incorporate them into the proposed model because of the difference in conditions between the United States and Australia, and also different opinions between valuers in the two countries. In order to find out what criteria are considered by Australian valuers when assessing stigma impact, a mail survey and follow-up interview of valuers in New South Wales, Victoria and Queensland were conducted in 1998 (in the same survey as outlined in Chapter 5). The survey results show that Australian valuers generally look at the 16 criteria below when estimating the stigma impact. No preference or priority for criteria was given by respondents because of they were at liberty to list the criteria of their concern. The purpose of the freedom to the respondents was to uncover all possible criteria. Following is a list of criteria with a description based on the responses. In other words the list contains the criteria and the definition of them as given by and presumably adopted by the respondents.

1. Land uses – previous uses, current use and proposed use (highest and best use);
2. Health risks – continuous problems, known problems, potential problems;
3. Contamination – type, degree, toxicity, ground water affected, residual contaminants;
4. Remediation – costs, quality, cleaned up by whom, any sign-off environmental audit report;
5. Legal liabilities – under sale/lease contract, any previous claim, potential claim;
6. Publicity/reputation of site – media exposure, odour, visibility of contamination;
7. Market conditions – supply, demand, property value, economic factors, demography;
8. Physical features of site – location, dimensions, contour, facilities, proximity of adjoining properties;
9. Time factor – time lapse since cessation of contaminated uses, time required (inherent hassles) for clean up, length of previous contaminated uses;
10. Government regulation – council restrictions and attitude;
11. Listing/ranking on contaminated land register;
12. Guarantee from vendor;
13. Ownership – who was the previous and current owner;

14. Community feeling / perceived risks;
15. Mortgageability; and
16. Purpose of valuation.

The criteria identified by Australian valuers are more extensive than those suggested by Patchin (1991) and Mundy (1992a). Table 7-1 below summarises and contrasts the criteria from this survey and those identified by Patchin and Mundy.

Table 7 – 1 Comparison of stigma criteria

Australian valuers	**Patchin (1991)**	**Mundy (1992a)**
Land uses	Property type	
Health risks		Prognosis
Contamination	How clean?	Degree of peril
Remediation	Hidden clean up cost	
Legal liabilities	Public liability	
Publicity / reputation of site		Concealability
Market conditions		
Physical characteristics of site		Aesthetic effect
Time factor	Trouble factor	Disruption
Government regulation		
Listing/ranking on register		
Guarantee from vendor		Responsibility
Ownership		Responsibility
Community feeling / perceived risk		Level of fear
Mortgageability	Mortgageability	
Purpose of valuation		

Source: Chan 2000a

The Table shows that, there are 4 criteria explicitly considered by Australian valuers in addition to those criteria that are also commonly identified by Patchin and Mundy. The extra criteria include the purpose of valuation, market conditions, government regulation, and listing on contaminated land register. These are actually normal considerations in ordinary valuations. The omission of these criteria in Patchin and Mundy's work may simply be because these two prominent researchers might have thought that valuers would take them into consideration anyway and therefore did not explicitly include them into the list of consideration. However, the analysis in section 7.9 below shows that the extra criteria should be explicitly considered.

Patchin and Mundy are two prominent property researchers and practitioners in the Unites States. Their works on stigma are frequently referred to by other property researchers (e.g. Guntermann 1995, Dotzour 1997, Syms 1997b). In this study, it was found that twelve (12) of the 16 criteria identified by Australian valuers coincided with those identified by Patchin and Mundy. It shows that the criteria suggested by these two researchers are reasonable and reflect real life situations not only in the United States but also in Australia. Despite that the 4 extra criteria are normal valuation considerations, the analysis in section 7.9 below shows that these extra criteria are significant factors in the assessment of stigma. Accordingly it is reasonable to include all 16 criteria in the proposed stigma assessment model.

All the 16 criteria are explained in the list on page 7 – 3. Regarding the remediation criterion, the respondents to survey claim that they generally agree to the environmental consultant's recommendation but will judge the effectiveness of the remediation method with their own opinion.

7.5 Environmental Risks perceived by Valuers

Regarding the perceived risks and percentage adjustment for different land uses and industries, the survey result is summarised in Table 7 – 2 on the next page. The figures are the perceived stigma factors for alternative land uses (residential, commercial and industrial) on contaminated sites. The analysis is carried out statistically with 95% confidence interval[2]. The first column of the table shows the previous/existing land uses or industries. For the purpose of this survey, there is no difference between a former and current contaminated industries/land uses. The other columns show the perceived stigma factor if the land is alternatively used for residential, commercial or industrial purposes. It can be seen that the figures match the concept that the higher the perceived environmental risks associated with the previous/existing land uses or industries, the higher is the stigma value reduction percentage. Since the figures represent a collective view of the respondents' risk perception of contaminated land, they are assumed to be the market's view and are used as a benchmark to check the reasonableness of probable stigma factors supplied by valuers for testing the validity of the proposed model.

It is interesting to note that none of the figures in Table 7 – 2 is near 69% reported by Patchin (1994). One reason may be that contaminated land in Australia is not as notorious as that in the US. It may also be due to that Australian investors and developers perceive the potential risks differently and are not as suspicious as their American counterparts because land contamination laws in Australia are not as stringent as those in the US. In particular, there is no several liability in Australia. Nevertheless the figures in Table 7 – 2 have a higher variance than 25 – 30% in England as reported by Richards (1996, p. 10).

Table 7 – 2 Stigma value reduction percentages perceived by Australian valuers (with 95% confidence)

Land uses / Industries	**Residential (%)**		**Commercial (%)**		**Industrial (%)**	
1. Abattoirs and Animal Processing Works	18	27	7	13	5	11
2. Acid/alkali plant and formulation	20	28	10	15	7	12
3. Agricultural Activities (Vineyards, Tobacco, Sheep Dips, market Gardens)	10	20	4	8	2	6
4. Airports	8	18	3	7	1	6
5. Alumina Refinery Residue Disposal Areas	19	28	8	14	4	10
6. Asbestos production, and disposal	29	42	16	26	12	24
7. By-Product Animal Rendering	19	28	8	15	5	10
8. Bottling Works	7	13	2	7	1	7
9. Breweries	8	15	2	6	1	5
10. Brickworks	9	19	2	10	1	9
11. Car Wreckers	12	19	4	8	2	5

[2] A zone of values within which one is confident that the true population mean lies. Increasing the confidence interval to 99% will increase the assurance that the zone contains the population mean, but it makes the estimate less precise (Lucey 1988).

Land uses / Industries	Residential (%)		Commercial (%)		Industrial (%)	
12. Cement Works	12	19	4	9	1	7
13. Cemeteries	15	27	5	13	3	7
14. Ceramic Works	9	17	2	6	1	4
15. Chemicals manufacture and Formulation	22	34	10	15	6	13
16. Coal Mines and Preparation Plants	20	33	10	18	6	15
17. Defence Works	17	27	7	12	4	9
18. Docks	7	14	2	7	1	4
19. Drum Reconditioning Works	15	23	6	11	2	11
20. Dry Cleaning Establishments	11	19	4	9	2	6
21. Electricity Distribution	11	19	4	11	3	8
22. Electroplating and Heat Treatment Premises	16	25	7	12	3	11
23. Ethanol Production Plants	18	28	8	14	3	12
24. Engine works	10	18	4	8	1	8
25. Explosives industries	17	26	7	13	3	13
26. Fertiliser Manufacturing Plants	17	26	7	14	4	15
27. Gas works	18	31	7	14	4	12
28. Glass Manufacturing Works	11	20	5	9	2	7
29. Horticulture/Orchards	6	15	2	8	1	4
30. Industrial Tailings Ponds	22	33	11	18	7	16
31. Iron and Steel Works	17	27	7	18	4	11
32. Landfill Sites	21	32	11	23	9	19
33. Lime Works	17	26	9	15	6	14
34. Marinas and Associated Boat Yards	5	11	1	6	1	3
35. Metal treatment	14	24	7	13	2	11
36. Mineral Sand Dumps	15	24	7	13	4	9

Land uses / Industries	Residential (%)		Commercial (%)		Industrial (%)	
37. Mining and Extractive Industries	18	27	8	14	5	11
38. Munitions Testing and Production Sites	21	31	10	17	6	16
39. Oil Production, Treatment and Storage	24	35	10	18	7	14
40. Paint Formulation and Manufacture	21	32	9	15	6	13
41. Pesticide Manufacture and Formulation	26	37	12	20	9	20
42. Pharmaceutical Manufacture and Formulation	15	25	7	16	4	12
43. Photographic Developers	13	21	5	10	3	7
44. Piggeries	13	21	5	10	2	10
45. Plant Nurseries	6	11	2	5	0	7
46. Plastic or Fibreglass	11	18	4	8	1	9
47. Power Stations	15	24	6	13	3	10
48. Prescribed Waste Treatment and Storage Facilities	24	35	11	19	7	18
49. Printed Circuit Board Manufacturers	10	18	4	8	1	10
50. Properties Containing Underground Storage Tanks	16	25	6	15	4	13
51. Radioactive Materials, Use or Disposal	35	51	19	33	15	29
52. Railway Yards	12	21	4	13	2	11
53. Research Laboratories	9	18	3	13	1	10
54. Sawmills and Joinery Works	10	16	3	8	2	8
55. Scrap Yards	12	21	4	8	2	6
56. Service Stations	13	22	5	10	2	6
57. Sewerage Works	21	32	10	19	5	16
58. Smelting and Refining	19	30	8	16	5	15
59. Sugarmill or Refinery	11	20	5	10	1	9
60. Tanning and Associated Trades (eg Fellmongery)	18	28	9	15	4	13
61. Timber Treatment Works	18	28	8	15	5	14

Land uses / Industries	Residential (%)		Commercial (%)		Industrial (%)	
62. Transport/Storage Depots	10	15	4	7	1	7
63. Tyre Manufacturing and Retreading Works	11	17	4	8	1	9
64. Waste Treatment Plants in which Solid, Liquid Chemical, Oil, Petroleum or Hospital Wastes are Incinerated, Crushed, Stored, Processed, Recovered or Disposed of.	24	38	12	22	8	19
65. Wood Storage Treatment	13	21	5	10	2	10
66. Wood Treatment Facility	16	26	7	15	3	14
67. Wood Preservation	15	25	7	15	3	14

Source of industries and land uses: AIVLE 1994 Appendix II

Figures 7 – 1 below, Figures 7 – 2 and 7 – 3 on the next page show graphically the variation of the mean value of the perceived stigma factors shown in Table 7 – 2. The charts show that despite the stigma value reduction percentage varies with the alternative uses, the patterns of variation in the three alternative land uses are highly similar.

Figure 7 – 1 Variation of Stigma Factors – Residential

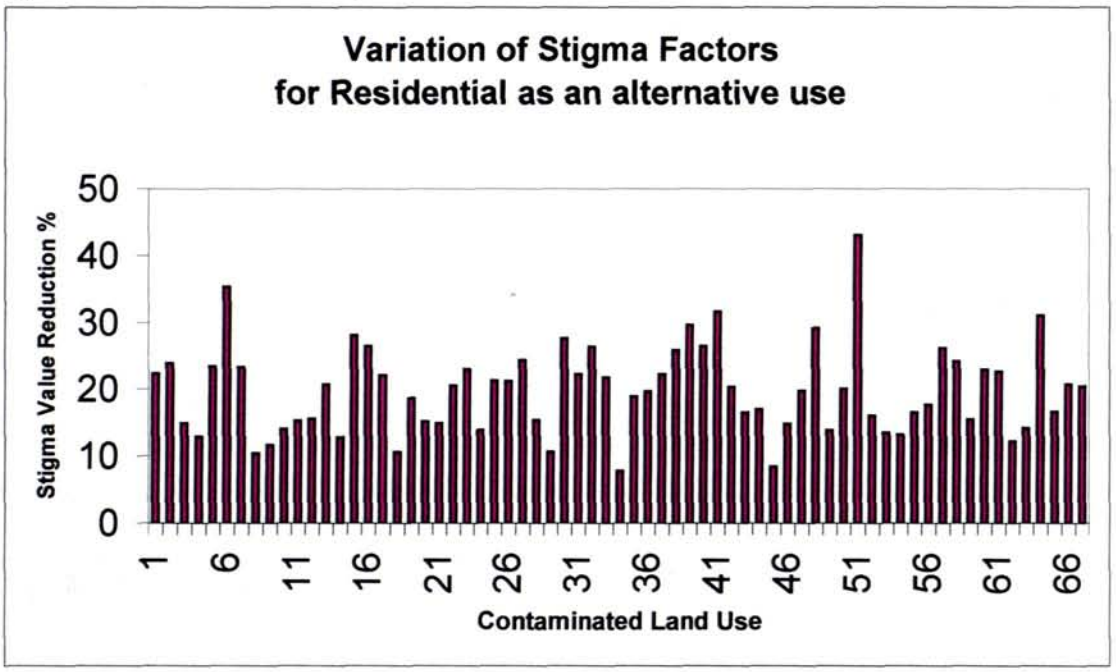


Figure 7 – 2 Variation of Stigma Factors – Commercial

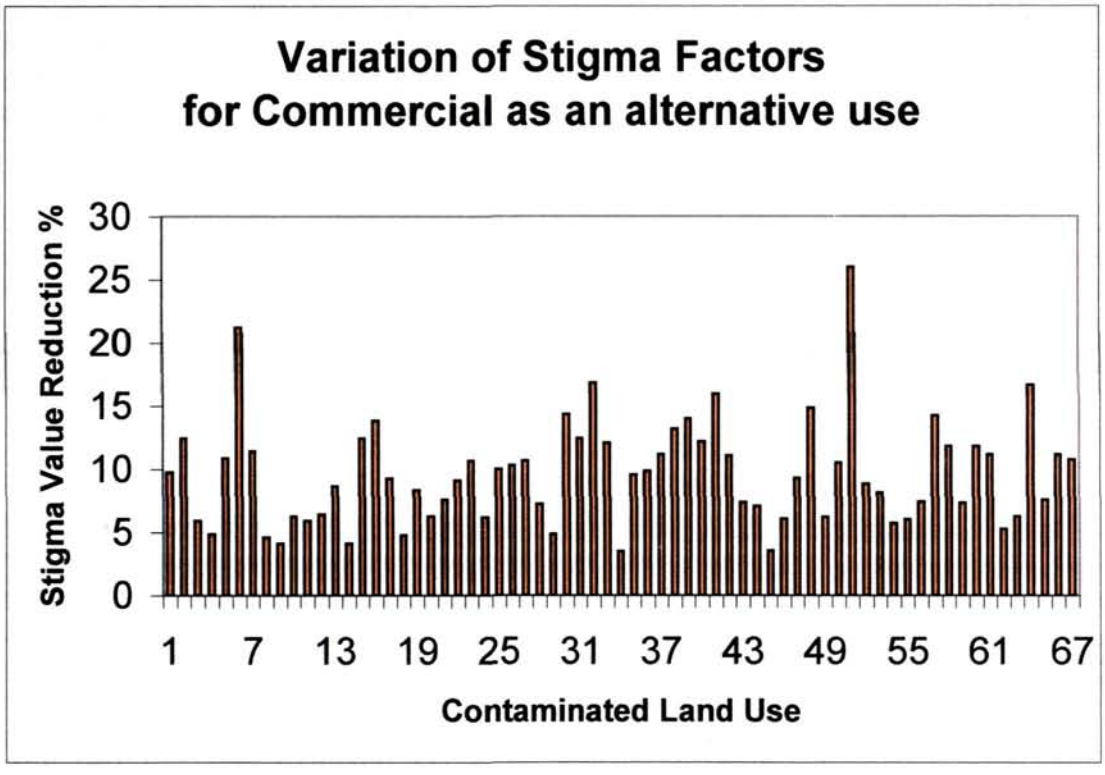
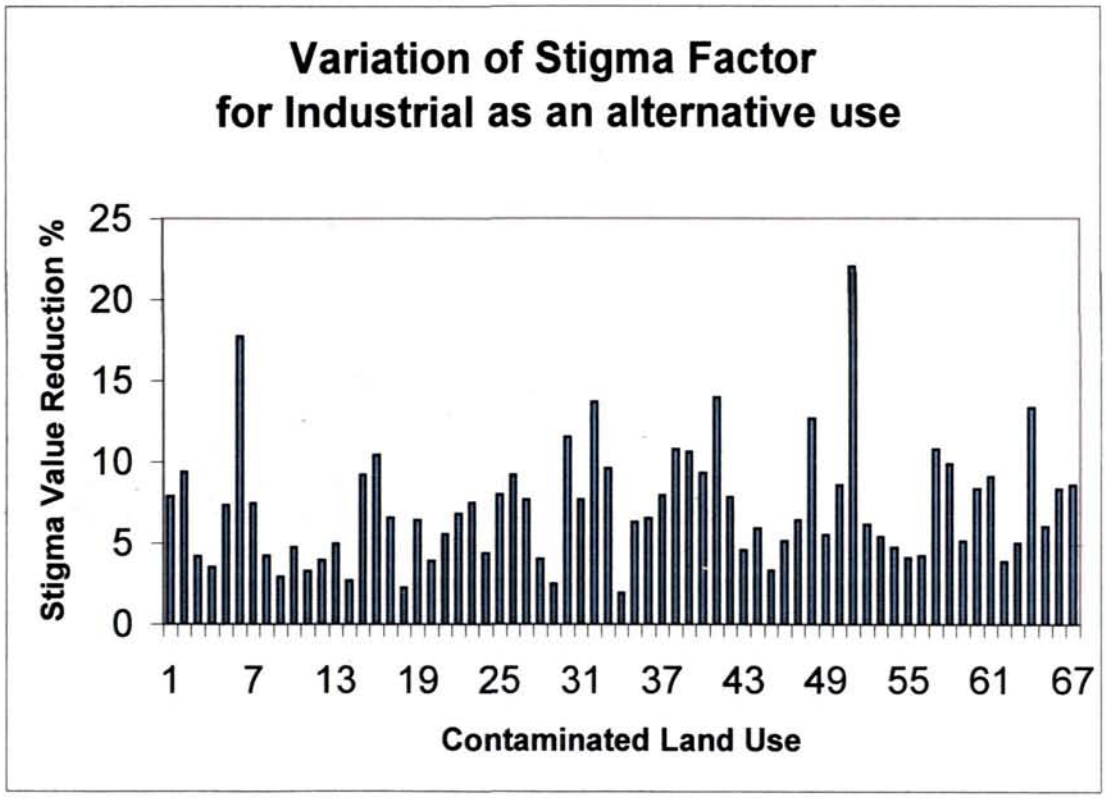


Figure 7 – 3 Variation of Stigma Factors – Industrial



As can be seen from the charts, the respondents perceived that land use No. 51 (i.e. radioactive materials, use or disposal) has the highest environmental health risks. They believe that even after clean up, the average value reduction due to stigma can be as high as 43% for residential, 26% for commercial and 22% for industrial uses. It is interesting to note that despite that more information is known about the danger of asbestos today and the general public's concern is easing, the respondents still regard asbestos (i.e. land use No. 6) as very dangerous and give it the second highest scores – 35% for residential, 21% for commercial and 18% for industrial uses. This is in sharp contrast to the situation in the United States as mentioned on page 6 – 2.

At the other end, land uses No. 34 (Marinas) and No. 45 (plant nurseries) are considered to have the lowest stigma impact. The scores for No. 34 are 8% for residential, 3% for commercial, 2% for industrial uses whereas the scores for No. 45 are 8% for residential, 4% for commercial and 3% for industrial uses. It shows that the respondents considered the risks involved are relatively minor such that the impact on the impaired value of the property is small.

7.6 Which MCDM method?

It is well accepted that valuation is not an exact science. This idea has been accepted by the property industry and in a number of court decisions including the latest Australian case *Boland v Yates Property Corporation [1999] HCA* 64 at 277. In this case, Callinan J rules that valuation "requires the exercise of judgements and the forming of opinions, often on matters in respect of which certitude is impossible and uncertainty highly likely". In the course of assessing the stigma factor, the valuer, having regard to all relevant criteria, needs to form an opinion and make a decision on the appropriate discount rate for the stigma value impact. Accordingly, there should be a reliable method with which the stigma factor chosen will adequately reflect the true value of the subject property.

The objective of the stigma assessment process is to estimate a reasonable value reduction percentage rate having regard to the sixteen criteria identified above (Section 7.4). Accordingly, the valuer has to make a decision/judgement as to what value reduction percentage rate (stigma factor) is reasonable for the subject property. "Reasonable" means the percentage rate chosen should not lead to over or under valuation of the property. It is obvious that this decision has to be a good decision. Although critics may argue that a good decision does not necessarily guarantee a good outcome, a good decision nevertheless has a high correlation with the achievement of a good outcome. The problem is how do we know that it is a good decision.

Henig and Buchanan (1996 p.1) point out that " a good decision based solely on what the decision-maker desires is not scientific, because no one except the decision-maker who can objectively judge his desires. While the decision-maker is the only one who can select the 'best' alternative and who has the final word, it is the process by which the decision is made that science can judge. This is the scientific approach, by which a good decision comes from a good decision making process". Thus a good decision needs to have scientific contents and is brought about by a good decision making process. The decision process ultimately determines the methods to be used.

In the conclusion of Chapter 6, it was mentioned that if a valuation method is "to be accepted by the profession, it must be easily understood and easy to use. Its theoretical soundness must be matched by a practical application". Accordingly, the proposed MCDM method for this study needs to satisfy the following criteria:

- it must enable the decision maker to make a decision
- it must be based on existing knowledge.
- it must be practical.
- it must be conveniently carried out/applied.

There are a variety of methods for making decision with multiple criteria. They range from goal programming to methods based on rates and weights. Goal programming is an operations research decision analysis technique whereas the rates and weights types of decision-making method are developed upon the work originated by Kepner & Tregoe (1981). Hoffman, Schniederjans and Sirmans (1990) have used this method to develop a multi-criteria model for corporate property evaluation.

Strictly speaking, goal programming is not a MCDM method although it is a decision analysis technique. This method requires the decision-maker to specify the goals to be achieved. If the goals are achieved, he is assumed to be satisfied. If not, the method will attempt to approach the goals as close as possible. It does not help the decision-maker choose the best alternative with regard to the relevant criteria because there is no alternative in the model. This method assumes a well-defined single objective function (a mathematical model) to adequately represent the decision problem (Buchanan & Henig 1997).

Goal programming focuses on an objective (scientific) mathematical model and downplays the role of the decision-maker. It should be noted that models do not make decisions – people do (Ragsdale 1995) and that the decision-maker stands in the centre of the decision making process (Buchanan & Henig, ibid). Given the inherent characteristics, goal programming and its sibling operations research techniques are not suitable to be a candidate for the proposed stigma assessment method. Since decision-making and valuation are subjective in nature, it is necessary to consider other more subjective multi-criteria based decision-making methods to take care of the decision-maker's subjective preferences.

MCDM is a generic term. It has a number of alternative names such as Multi-criteria Decision Analysis, Multi-attribute Utility Theory, Multiple Attribute Decision Making, and Multi-objective Decision Making, etc. A MCDM method, apart from the consideration of a number of criteria, has to consider the decision-maker's preferences implicitly and the alternatives explicitly. The decision-maker looks at a value function and uses it to select the "best" alternative (Henig & Buchanan 1996).

MCDM methods are developed on the basis of Von Neumann and Morgenstern's utility theory from 1944 and the work of Keeney and Raiffa in multi-criteria decision-making from 1976 (Wenstop, 2000). Since then, there are a number of derivatives from the original methods. Among the derivatives, the weighted sum model (WSM) and the analytical hierarchy process (AHP) are two widely used methods (Triantaphyllou & Sanchez 1997). They are based on easily understood principles although they differ in the depth of mathematics involved. Other derivatives are based on unusual ideas such as fuzzy logic, multi-attribute utility theory and displaced ideal, and conformal metric aggregation techniques, etc. (Messimer et al c. 1997)

The four criteria for a suitable MCDM method outlined above have limited the scope of MCDM methods to be considered. They do not allow the consideration of methods that are too sophisticated, unproven or impractical. It should be noted that there is no evidence to show that a sophisticated method must be better. Bouyssour et al (1993) comment that "there is no possibility of deciding if one method makes more sense than another toward a specific problem situation" (cited in Buchannan & Henig 1997 p.2). Unless the method is unacceptably cumbersome, as long as it works, it is a good method. Accordingly, this study will focus on the more familiar WSM and AHP methods.

7.6.1 Weighted Sum Model (WSM)

WSM, also known as the multi-criteria scoring model, is a very simple and widely used MCDM method. It allows the decision-maker to determine subjectively the criterion scores and weights needed in the assessment. It is based on an additive utility assumption (Triantaphyllou & Sanchez 1997) such that the decision-maker rates each alternative in the decision problem based

on each criterion. Weights are then assigned to each criterion indicating its relative importance to the decision-maker. A weighted average score is finally calculated for each alternative using the following formula (Ragsdale 1995):

$$\text{Weighted average score for alternative j} = \sum w_i s_{ij}$$

Where w_i = weight for criterion i

s_{ij} = score for alternative j on criterion i

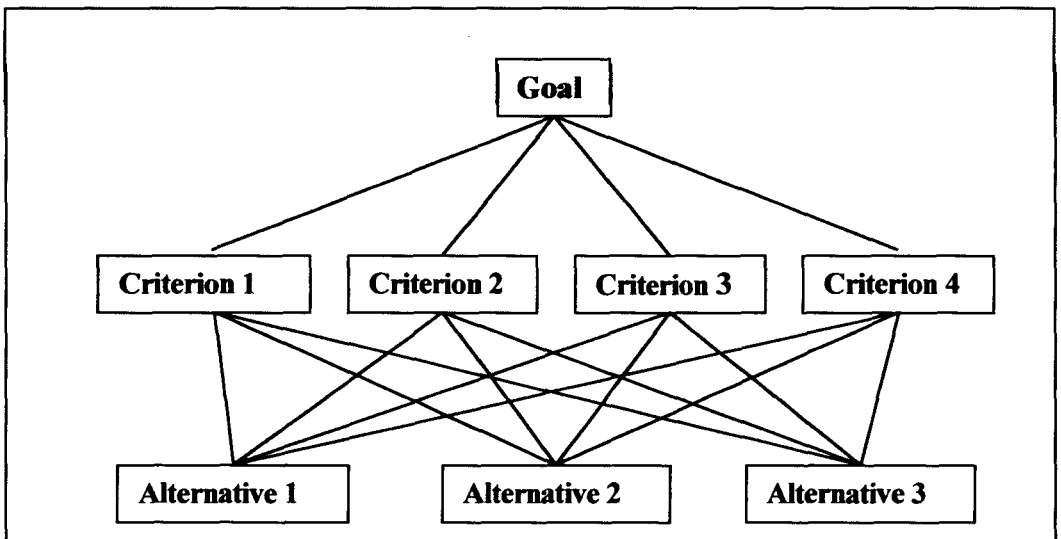
The decision-maker then chooses the best alternative that corresponds to the largest weighted average score in the maximisation case.

The advantage of WSM is that it is simple and straightforward. The concept can be easily grasped by participants and the mathematics involved is manageable by most people. The necessary calculations may be performed manually or be easily done with an ordinary spreadsheet program. The application of the method does not require any expensive dedicated software package. Despite its simplicity, there are chances that a decision-maker may find it difficult to determine the criterion score and weights needed. In this case, it is difficult to apply this method. Another problem with WSM is that it is less suitable for more complex decision making problems. Bender et al (1997 p. 505) point out that "[w]hen there are more than a few different criteria, it is not feasible to perform a direct weighting". There are 16 criteria in the subject study, it is clearly a complex decision making problem that is beyond the scope of WSM.

7.6.2 Analytic Hierarchy Process (AHP)

AHP was invented by Saaty (1980). It is a more comprehensive and structural framework for decision making than WSM. It breaks down the problem into its component parts (the goal, criteria and alternatives) and arranges them into a hierarchical structure. A typical hierarchical decision making structure is shown in Figure 7 – 4 below. The figure shows a simple AHP decision-making model that has one layer of criteria. It should be noted that there may be more than one layer of criteria. For more detailed analysis, each criterion in the first layer may give rise to several sub-criteria such that it is possible to have two, three or more layers in the model.

Figure 7 – 4 A typical AHP hierarchical structure



Source: Based on ISNAR 1998 p.1

AHP was developed to improve decision making for specific problems that "involve prioritisation of potential alternate solutions through evaluation of a set of criteria elements" (Asahi, Turo and Shneiderman 1995, p.2). AHP recognises and incorporates the knowledge and expertise of the participant/decision maker in the priority setting process (ISNAR 1998). The participant has to establish priorities among the elements of the hierarchy, synthesise judgements based on personal knowledge and experience to get a set of overall priorities, check the consistency of the judgements and draw a conclusion based on the results of the process (Saaty 1995).

In an AHP analysis, the priorities of the elements of the hierarchy are to be made by pairwise comparisons, i.e. to compare the elements in pairs against a particular criterion. Saaty (1995) suggests that a matrix is the preferred form for pairwise comparisons because this approach reflects the dual aspects of priorities: dominating and dominated. To illustrate this idea, Saaty (1995) uses the example in Figure 7 – 5 below to show a pairwise comparison matrix for the comparison of the degree of comfort between three cars:

Figure 7 – 5 Sample matrix for comparing three cars for comfort

Comfort	C	T	L
Chevrolet (C)	1	1/2	1/4
Thunderbird (T)	2	1	1/2
Lincoln (L)	4	2	1

Source: Saaty 1995 p.75

In any AHP model, the most important step is to calculate a preference score to each alternative. The best alternative is the one with the highest preference score. The mathematics of the AHP method is rather involved. "Mathematically, the objective is to determine the non negative weights w_i of criterion c_i for $i = 1$ to n, where n is the number of criteria. If the weights $w = (w_1, \ldots, w_n)$ were known, then the relative importance of the criterion c_i compared to c_j would be the ratio of w_i/w_j The basic idea of AHP is precisely to proceed from a pairwise comparison of the criteria and to evaluate the weights through a special procedure [for instance, using the eigen-vector method]" (Bender et al 1999 p.283).

For a fully consistent comparison of n different criteria, the comparison matrix is represented by:

$$A = \begin{bmatrix} a11 & a12 & a13 & .... & a1n \\ a21 & a22 & a23 & .... & a2n \\ a31 & a32 & a33 & .... & a3n \\ .... & .... & .... & .... & .... \\ an1 & an2 & an3 & .... & ann \end{bmatrix} \approx \begin{bmatrix} w1/w1 & w1/w2 & w1/w3 & .... & w1/wn \\ w2/w1 & w2/w2 & w2/w3 & .... & w2/wn \\ w3/w1 & w3/w2 & w3/w3 & .... & w3/wn \\ .... & .... & .... & .... & .... \\ wn/w1 & wn/w2 & wn/w3 & .... & wn/wn \end{bmatrix}$$

Equation 7 - 1

Where a_{ij} = quantified judgements on pairs of criteria c_i and c_j
wi/wj = weight ratio corresponding to judgement a_{ij}

If $wi/wj = a_{ij}$, then $a_{ij} = 1/a_{ij}$ for all i and j.

It can be seen that the diagonal elements of the weight ratio matrix are unity and the upper right and low left triangular block of elements are reciprocal. The reciprocal property of matrix A means that there is no need to take the whole matrix into account, it is sufficient to take only the lower triangular portion of the matrix in an empirical study. And a total of n * (n-1)/2 comparative judgements are required (Bender et al 1997).

Since the weights are represented by the relative weight vector $W = (w_1, w_2, w_3, ..., w_n)$, it is natural to normalise this eigen-vector such that the sum of vector components equals to one, i.e.

$$\sum_i w_i = 1 \qquad \text{Equation 7 – 2}$$

If the matrix A is multiplied by the transpose of the relative weight vector, w, then the following equation holds:

$$AW = nW \qquad \text{Equation 7 - 3}$$

W is to be found by solving a matrix algebra eigen-value equation with n as the eigen-value and W as the right eigen-vector of the matrix A (Zahedi 1986 as cited in Bender et al 1997). The above equations are based on the assumption that the weights, w_i, are known. In practice, they are not known and the matrix A is found through an empirical study. Accordingly Equation 6 – 3 will not necessarily be satisfied. Saaty (1996) suggests finding the relative weight vector, w, as an eigen-vector solution of the equation:

$$AW = \lambda_{max} W$$

where λ_{max} is the maximal eigen-value of A_i.

Due to different personal perceptions of individual participants to the AHP process, there is bound to be inconsistency in the pairwise comparison. On the other hand, when the number of criteria increases, the number of inconsistence will also grow. Saaty (1980) introduces the concept of a consistency ratio (CR) to measure the reliability of the relative weights. CR is defined as:

$$CR = CI/ACI*100\%$$

where CI = consistency index = $(\lambda_{max} - n)/(n - 1)$
ACI = average index of randomly generated weights

In general, the pairwise comparison matrix is considered to be consistent if the CR does not exceed 10%. The above is only a brief outline of the mathematical background of AHP. Further details of the method and applications can be found in Saaty's "The Analytical Hierarchy Process Series" (Saaty 1985, 1991, 1992, 1994a, 1994b, 1995, 1996).

7.6.3 General comments on AHP

AHP has been around for sufficient time to make itself known to researchers and practitioners. A study conducted by Golden, Wasil and Levy (1989) shows that there have been over 150 research papers that apply this method in diverse areas. This method has been successfully applied in a number of property researches, for example, Ball and Srinivasan (1994) apply this method in house selection in Boston, Pan (1996) uses this method to select real estate projects, Bender et al (1997) apply this method to analyse perceptions concerning the environmental quality of housing in Geneva, Ho (1999) applies this method to determine preferences on office

quality attributes in Sydney, Bender et al (1999) use this method to assess environmental quality perceptions of urban commercial property in Geneva.
The popularity of the method is due to "its ability to rank both qualitative and quantitative parameters at the same time." (Bender et al 1997 p.506). AHP can be used where a decision-maker may find it difficult to determine the criterion score and weights needed in WSM (Ragsdale 1995). The idea of pairwise comparison is logical and easily understood. The hierarchical structure makes it suitable for solving both simple and complex decision making problems. Its ability to enable systematic structuring of any complex multi-layer and multi-dimensional problem makes AHP different from other multi-attribute decision models (Ball & Srinivasan 1994).

As can be seen from the above section, the mathematics of AHP is rather complicated. The proposed stigma factor assessment model requires the consideration of 16 criteria. If AHP is applied in this regard, it will require a large number of pairwise comparisons and associated calculations. Fortunately dedicated AHP software products, such as 'Decision Science Plus', 'Ergo', 'DecideRight', 'Expert Choice' and 'Criterium DecisionPlus', etc are available. Coupled with computers that are now widely available in a valuer's office today, decision scores can be readily calculated and the results can be easily checked for reasonableness.

7.6.4 The preferred MCDM method and the proposed model

Having regard to the above analysis, it appears that both methods have their relative strengths and weaknesses. AHP, however, can be used in situation where a decision-maker may find it difficult to determine the criterion score and weights needed in WSM. It is more versatile that it can be used to solve both simple and complex decision making problems. Wenstop (2000) points out that in a multi-criteria decision making model the size of criteria should be as small as possible, 10 criteria are many. There are 16 criteria in the subject study. It is clearly a complex decision making problem that cannot be easily dealt by WSM. Given that the AHP model has the ability to handle complex decision making problems and there is proven records of being used by a number of property researchers, it is more suitable to build the proposed stigma assessment model with the AHP approach.

In this study, AHP is the chosen MCDM method for assessing the stigma factor as it has satisfied the criteria in Section 7.6 above. The relevant AHP analysis is carried out with the software package 'Criterium DecisionPlus 3.0 Student Version' (a free copy can be down loaded from http://www.infoharvest.com). Using the 16 criteria identified above, the suggested AHP hierarchy model is constructed as shown in Figure 7 – 6 on the next page.

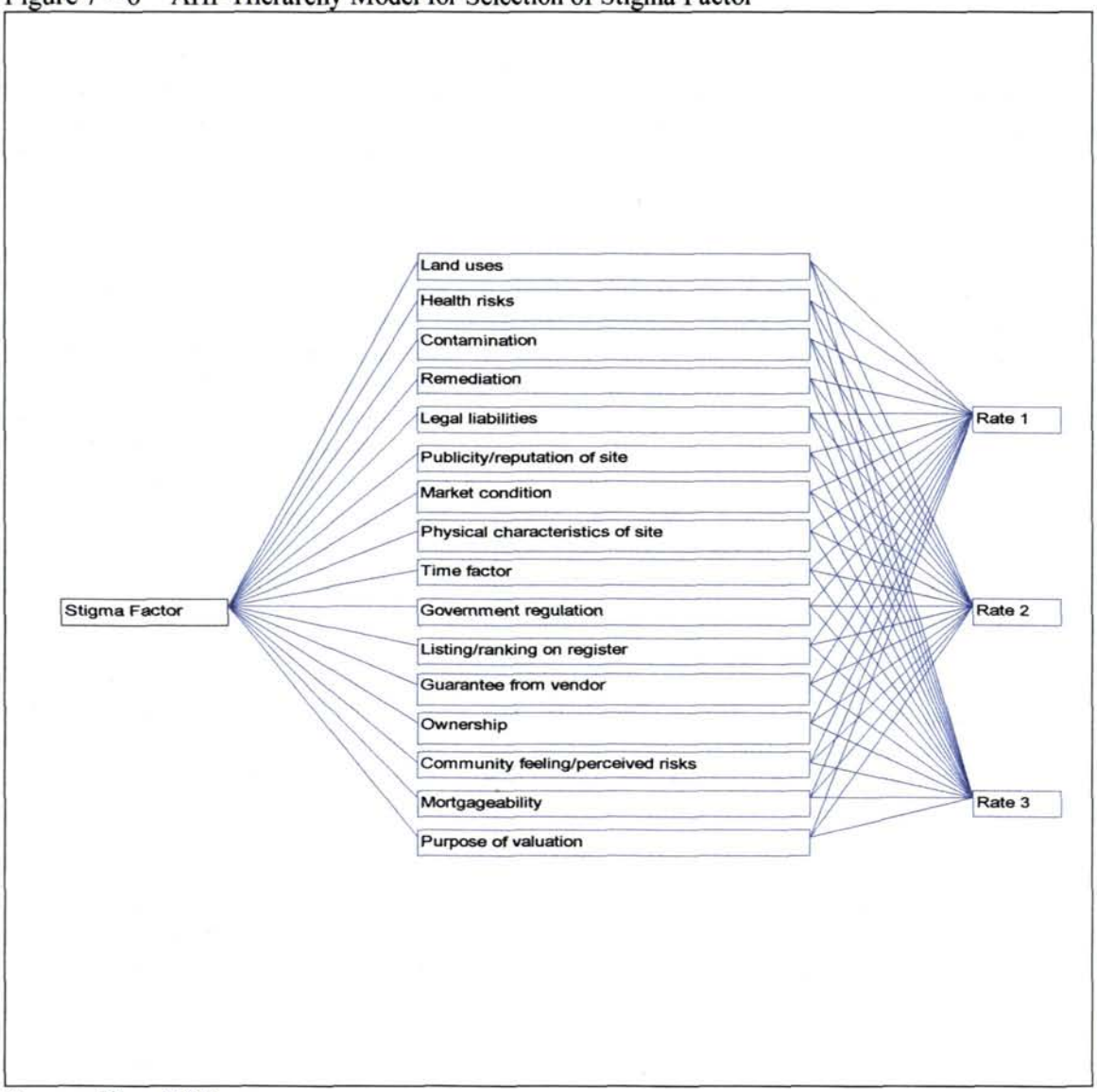
In order to apply this model, it is necessary to build the model first. The valuer (participant) needs to run the software and build the model as shown in Figure 7 – 6. The stigma factor on the left is the goal of the decision making model. It is followed by the 16 criteria in the middle. The blocks on the right are the alternatives (probable stigma factors) to be considered. Once the model is built, it can be saved as a template for future use.

When valuing a contaminated property with the impaired value approach, the valuer needs to value the unimpaired value of the property having regard to, among other considerations, its highest and best use. He or she also needs to assess any financial loss due to the contamination with information from the client and obtain the remediation and related costs from an environmental consultant. The AHP model is then used to find the relevant stigma factor. The impaired value of the property is finally obtained by carrying out a calculation according to Equation 5 – 4 in Chapter 5.

To use this model, the valuer needs firstly to objectively consider and analyse all evidence before him and then to rate the relative importance of the criteria with respect to the goal (i.e. the target stigma factor). The sum of the individual weights should add up to 100. Next the

valuer needs to estimate using the best/worst case approach three probable stigma factors Rate 1, Rate 2 and Rate 3 for the subject property having regard to the evidence before him/her. These three rates are the alternatives of the AHP model. In respect of each of the probable stigma factors, the criteria are considered again and are rated according to their relative importance under a '0 – 10' scale. A zero rating means the criterion has no relevance. A rating of '10' means the criterion has extreme importance. For example, when rating the criterion 'land Use' for an alternative, say 5%, the valuer may consider that this criterion is worth 7 out of 10. Accordingly a value of 7 is entered into the cell corresponding to Rate 1 and criterion 'land use'.

Figure 7 – 6 AHP Hierarchy Model for Selection of Stigma Factor



Source: Chan 2000a

In rating the criteria, the valuers need to exercise considerable judgement based on personal experience and the available evidence. After all necessary ratings have been carried out; the reasonable (target) stigma factor is obtained by processing the relevant weighted criteria and alternatives with the software package.

It should be noted that the number of probable stigma factors (alternatives) and layer of criteria in the model are not fixed. In this research, only three probable stigma factors and one criteria layer are used for simplicity and demonstration purposes. In practice, the number can be

changed as the participant (valuer) thinks fit. Likewise, the criteria may be subdivided into sub-criteria. For example, the criterion 'land use' may be subdivided into 'previous use', 'current use', and 'highest and best use'.

7.7 Testing the proposed model

The applicability and validity of the model are tested with data supplied by practicing valuers. In order to collect the relevant data, written requests were sent to 40 respondents in October 1999. They were the practising valuers that I interviewed in my 1998 survey. They were chosen because they had experience in contaminated land valuation and were willing to participate in the 1998 follow up interview. There is a better chance that they will participate in the current round of data collection.

The valuers concerned were requested to supply the information required for the suggested AHP model assuming the underlying conditions of the original valuation remain unchanged. There is no need to disclose details of the property or the client. Having regard to the characteristics and other relevant evidence of the site, they had to estimate three probable stigma factors using the best/worst case approach and rate the 16 criteria accordingly.

In order to keep the impact of possible "anchoring effect" to a minimum, i.e. to reduce the impact of possible bias due to the previous experience of the valuers (Diaz 1997, Gallimore & Wolverton 1998), the valuers were not told which computer software would be used for the analysis and hence they should have no access to the relevant software. Since the mathematics behind is very complex and the result is not known until all ratings are completed and calculations by the software are finished, it is not possible for the valuer to fiddle the ratings in the middle of the process to accommodate a pre-selected stigma factor figure. Hence the ratings given could be regarded as the valuer's best judgment. In addition, they have no access to the information in Table 7 – 2.

The stigma factor obtained from the model was then compared with the one they used in the original valuation. A revaluation of the property was subsequently prepared using the stigma factor from the AHP model. The new result was then compared with the original valuation. The original valuations are concluded cases. They are assumed to be correct and are used as benchmark to check the accuracy[3] of the figures returned by the AHP model. The figures in Table 7 – 2 were used to check if the probable stigma factors supplied are reasonable. In order to make sure the figures supplied by the valuers were their genuine estimates, they had no access to Table 7 – 2 so that they did not copy figures from it.

A questionnaire as shown in Appendix IV was sent the valuers concerned. After two written reminders and several follow-up phone calls, 22 valuers responded to the request. Five of them said that they did not want to participate, seven nominated a contaminated site they had valued but there was no stigma involved. Out of the remaining 10 returns, only six had meaningful data that could be used to test the model. Accordingly all of these six returns are used as case studies to test the applicability and validity of the suggested AHP model. In each of the case studies, it is assumed that the underlying conditions of the original valuation remain unchanged, and that the unimpaired value, financial loss due to contamination and remediation cost in the original valuation are correct and are not reassessed.

Ideally the proposed AHP model should return a stigma factor that is the same or very close to the one estimated mentally by an experienced valuer in the original valuation. As far the 'better than' objective is concerned, it is difficult to prove it because there is no way to tell if the figure from the revaluation is more accurate than the original valuation. Accordingly this thesis will focus on proving that the suggested AHP method is as good as the 'guesstimation' approach.

[3] Discussion of accuracy is given in section 7.8 below

Since valuation is an art rather than a science, the same property may have two different results if it is valued twice even by the same valuer. Accordingly, although the same valuers were requested to supply data for the tests, it is not expected that the stigma factors returned by the AHP model will be the same as the figures adopted by the valuers in their original valuation. As long as the difference is within the acceptable range of margins of error (see Section 7.8 below), the AHP model is considered acceptable.

In theory, it is best to further test the model, using the same case studies, with independent valuers who have not previously valued the property in each case study. The results can then be compared to verify the accuracy. However, in Australia there are constraints on carrying out a test in this manner. Valuers are required by law to keep the valuation and related information confidential. For example, the Valuers Registration Act 1975 (NSW) makes it an offence for a valuer to disclose to a third party the information of a valuation that he or she has prepared. The code of ethics of the API's Professional Practice 2000 also has similar confidentiality requirement. Given the confidentiality requirements, the original valuers of the case studies are unlikely to reveal the full details of the property to other valuers to test the model. On the other hand, it is also difficult to get all owners of the properties concerned to agree to the disclosure of the necessary information of the properties because of the confidentiality of their business assets. It is thus difficult to obtain and provide full details of the property in each case study for the test.

Consequently the approach taken has been to use the same valuer for the same property. This has the advantage of using the experienced estimate as the benchmark for the model. The anchoring problem is avoided by the complexity of the technique. The questions asked of the value as inputs in the model do not give away the mathematics of the model. Consequently the valuer cannot fudge his answers to match his prior estimate. In effect he or she is articulating the factors that semi-consciously influenced his/her judgement and been forced to consider factors that may not have been considered previously.

This approach is preferred to a hypothetical property for the test. However, it is meaningless to compare the results of a hypothetical property with the results from the case studies. Accordingly, such a test has not been carried out in this study. Perhaps a test with a hypothetical case may be carried out in a sperate study.

7.7.1 Case Study No.1
Ex Oil Company Depot in Armidale, NSW

The subject property was an ex-oil company depot with a site area of 3,350m^2. There were 160m^2 of offices and 90m2 of raised platform for drums. The land was zoned General Industrial 4(a). An asset valuation of the property was conducted in December 1996. At the time of valuation, the property was used for offices and as a light distribution depot of petroleum products. The property could be redeveloped for industrial, warehouse and office uses. The property had suffered from petroleum product contamination for the past 50/60 years. The adjoining properties comprise an oil depot to the west and residential properties to the north. The valuer was instructed to value the property on an uncontaminated basis. The unimpaired value was assessed to be $90,000. If remediation is taken into consideration, the property has a negative value. The remediation requires the removal of underground storage tanks and replacement of 1m thick of

Ex-Oil Company Depot in Armidale
Courtesy of Mr. Morris Wheeler,
Morris Wheeler Pty. Ltd.

clean soil, and the cost was estimated to be $100,000. In the original valuation, no stigma allowance was allowed because the valuer was instructed to carry out the assessment on a clean site basis. The assessed impaired value was negative (-) $10,000 plus contingency. The valuer reported that subsequent to the valuation, there was an offer of $100,000 for the site subject to remediation of the site and a guarantee from the owner.

For the purpose of this research, the valuer provided three probable stigma factors, 5%, 10% and 25% for the AHP model. He also provided weighting for the criteria and alternatives as shown in Table 7 – 3.

Table 7 – 3 Criteria and Alternatives Weighting of Case Study No. 1

				(Rating Scale 0 – 10)		
Goal Level	***Weights***	***Rating Set***	***Lowest Criteria***	***5%***	***10%***	***25%***
Stigma Factor	10	Land uses	Land uses	7	5	2
	10	Health risks	Health risks	0	2	5
	15	Contamination	Contamination	2	5	8
	15	Remediation	Remediation	2	5	8
	5	Legal liabilities	Legal liabilities	0	2	6
	5	Publicity/reputation of site	Publicity/reputation of site	10	8	5
	3	Market condition	Market condition	7	3	0
	5	Physical characteristics of site	Physical characteristics of site	10	0	1
	2	Time factor	Time factor	8	7	3
	5	Government regulation	Government regulation	8	7	3
	0	Listing/ranking on register	Listing/ranking on register	0	0	0
	15	Guarantee from vendor	Guarantee from vendor	10	8	0
	5	Ownership	Ownership	10	7	1
	3	Community feeling/perceived risks	Community feeling/perceived risks	10	8	3
	1	Mortgageability	Mortgageability	7	5	1
	1	Purpose of valuation	Purpose of valuation	10	5	1
Total	100					

The valuer considered that all criteria, except 'listing/ranking register', were relevant to this property. This might be due to that the property was not recorded on the register. In contrast, the valuer gave maximum rating to 'publicity', 'physical characteristics of site', 'guarantee from vendor', 'community feeling/perceived risks' and 'purpose of valuation' under the alternative 5%. Using the ratings in the table, the AHP model ranks the alternatives as shown in Figure 7 – 7. The longest bar shows a preferred stigma factor of 5%:

Since valuation is an art rather than a science, the same property may have two different results if it is valued twice even by the same valuer. Accordingly, although the same valuers were requested to supply data for the tests, it is not expected that the stigma factors returned by the AHP model will be the same as the figures adopted by the valuers in their original valuation. As long as the difference is within the acceptable range of margins of error (see Section 7.8 below), the AHP model is considered acceptable.

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Courtesy of Mr. Morris Wheeler,
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clean soil, and the cost was estimated to be $100,000. In the original valuation, no stigma allowance was allowed because the valuer was instructed to carry out the assessment on a clean site basis. The assessed impaired value was negative (-) $10,000 plus contingency. The valuer reported that subsequent to the valuation, there was an offer of $100,000 for the site subject to remediation of the site and a guarantee from the owner.

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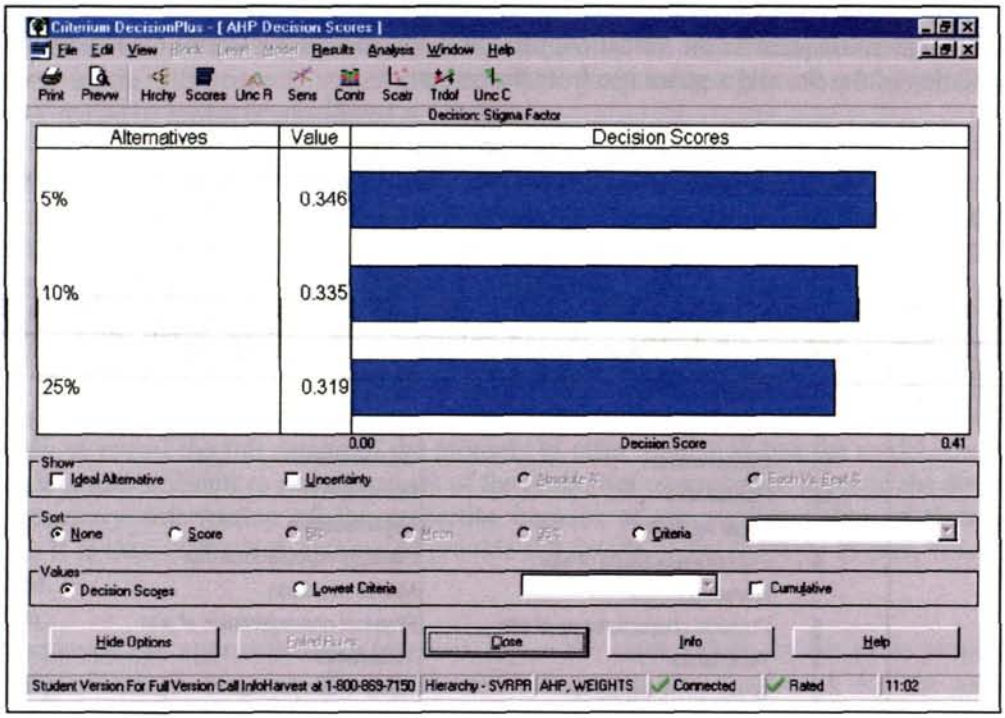
	15	Contamination	Contamination	2	5	8
	15	Remediation	Remediation	2	5	8
	5	Legal liabilities	Legal liabilities	0	2	6
	5	Publicity/reputation of site	Publicity/reputation of site	10	8	5
	3	Market condition	Market condition	7	3	0
	5	Physical characteristics of site	Physical characteristics of site	10	0	1
	2	Time factor	Time factor	8	7	3
	5	Government regulation	Government regulation	8	7	3
	0	Listing/ranking on register	Listing/ranking on register	0	0	0
	15	Guarantee from vendor	Guarantee from vendor	10	8	0
	5	Ownership	Ownership	10	7	1
	3	Community feeling/perceived risks	Community feeling/perceived risks	10	8	3
	1	Mortgageability	Mortgageability	7	5	1
	1	Purpose of valuation	Purpose of valuation	10	5	1
Total	100					

The valuer considered that all criteria, except 'listing/ranking register', were relevant to this property. This might be due to that the property was not recorded on the register. In contrast, the valuer gave maximum rating to 'publicity', 'physical characteristics of site', 'guarantee from vendor', 'community feeling/perceived risks' and 'purpose of valuation' under the alternative 5%. Using the ratings in the table, the AHP model ranks the alternatives as shown in Figure 7 – 7. The longest bar shows a preferred stigma factor of 5%:

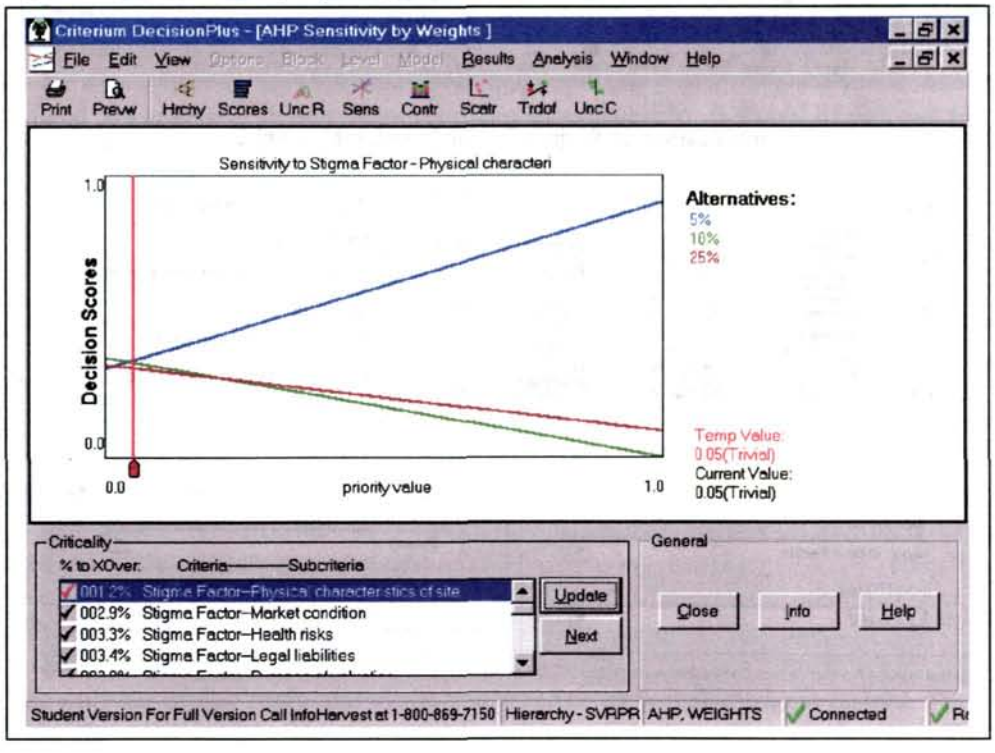
Figure 7 – 7 Stigma Factor Ranking of Case Study No. 1



Before applying the preferred stigma factor returned by the model, it is necessary to review the result to verify the robustness and reasonableness of the model. This is done by the carrying out of 'sensitivity by weights' and 'contribution by criteria' analysis with the software.

The sensitivity by weights analysis is a test for robustness of the model. It allows the participant (the valuer) to see how sensitive the scores of the alternatives are to changes in criteria weights. If a change of 5% or less to a particular criteria weight causes a change of the preferred alternative, (ie. a crossover to make another alternative the preferred one), the model is sensitive and it is risky to rely on the current inputs (InfoHarvest Inc. 1996). For the purpose of this thesis, this '5%' is referred to as 'critical value'. Figure 7 – 8 shows the sensitivity by weights analysis of this case study.

Figure 7 – 8 Sensitivity by Weights analysis of Case Study No. 1

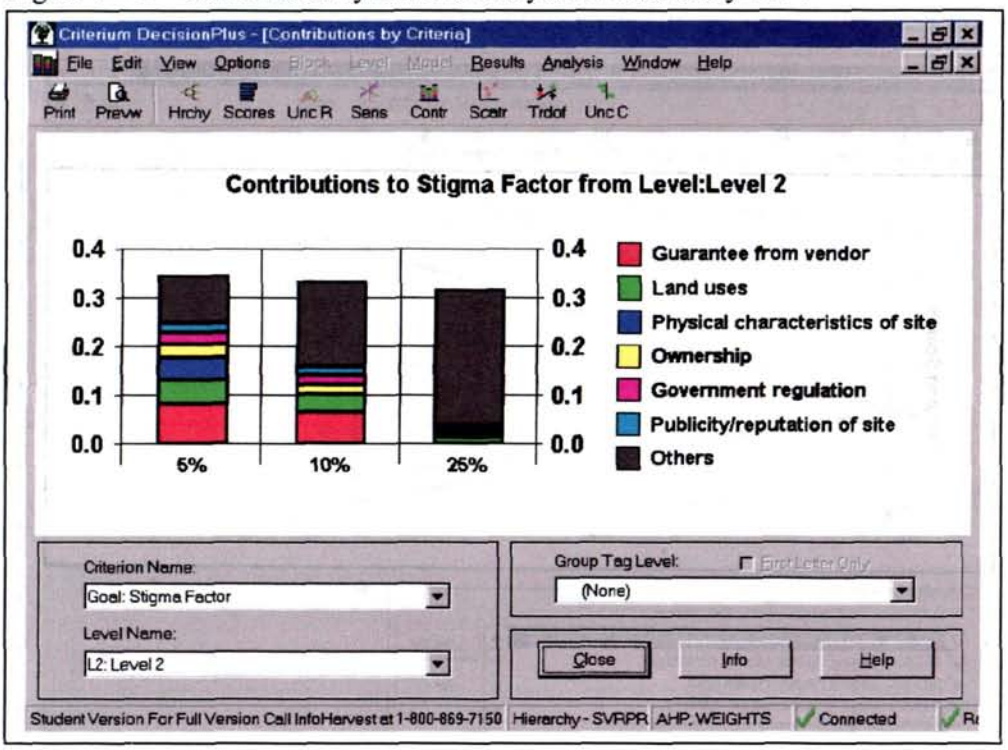


In the Figure, the sloping lines on the graph represent scores of the alternatives. The preferred alternative is the sloping line with the highest decision score. The blue line represents the preferred stigma factor of 5%. The X-axis shows the range of priority values over which the most critical weight (in this case, the weight of physical characteristics) is varied, and the Y-axis shows the decision score. The red vertical cursor line shows the current priority value of the critical weight. The point where the red cursor line intersects with the alternative line shows the decision score of the current set of weights

Below the graph, the 'Criticality' list box lists all criteria weights in the order of decreasing criticality of their priorities. The first one listed, 'physical characteristics of site' in this case, is most critical. The crossover percentage is a figure that shows the nearness of the crossover point, i.e., the new point that the red cursor line intersects with the next best alternative line. The 'Criticality'box shows that the crossover percentage of the most critical weight 'physical characteristics of site' is 1.2%. As can been seen on the graph, if the red cursor line is moved slightly to the left, it intersects with the green line (the next best alternative) making 10% to be the new preferred choice of stigma factor. Since the crossover percentage of 'physical characteristics of site' is less than the critical value (5%), the model is very sensitive.

The contribution by criteria analysis shows which criteria made the most contribution in the participant's decision and which made the least. The finding helps indicate whether the decision is a reasonable one. Figure 7 – 9 shows the results of the contribution by criteria analysis.

Figure 7 – 9 Contribution by Criteria Analysis of Case Study No. 1



The criteria which have the highest contribution to the decision score of the alternatives are displayed as coloured boxes on the right hand side. The stacked histogram on the left hand side shows the contribution of the criteria to the three probable stigma factors. The height of the stacked bars shows the respective decision score of the alternatives. From the stacked histogram, it can be seen that 'Guarantee from vendor', 'Land uses', 'Physical characteristics of site' and 'Ownership' have more contribution to the alternative 5% making it the preferred stigma factor.

In general, the various land uses and physical site characteristics are the concerns of purchasers. It is reasonable that they are also key criteria of the preferred stigma factor. In this case, the valuer reported that subsequent to the original valuation, there was an offer of $100,000 for the site subject to clean up of the site and guarantee by the vendor. This evidence reinforces that without remediation and guarantee from the owner, it is difficult to attract any purchaser. The guarantee requirement actually reflects the concerns of the purchaser. It shows that the purchaser feels safer having a guarantee from the owner than having the price adjusted by any stigma factor.

Despite the high sensitivity of the model, the contribution by criteria analysis shows that the model is still a reasonable one. Using the preferred stigma factor of 5%, the impaired value is assessed as follows:

$$\begin{aligned}\text{Impaired value} &= \text{Unimpaired value} - \text{financial loss due to contamination} - \\ &\quad \text{remediation cost} - \text{stigma impacts} \\ &= \$90{,}000 - \$0 - \$100{,}000 - (\$90{,}000 \times 5\%) \\ &= -\$14{,}500\end{aligned}$$

The result shows that if stigma factor is considered, the property has a higher negative value. The new valuation of -$14,500 is 45% more than the original valuation of -$10,000. Nevertheless, the 45% difference is still considered acceptable. The big difference arises because the original valuation was done on a clean site basis and no stigma factor was applied.

Since the original valuation is not an open market valuation, it does not reflect the true value of the property. In the revaluation, the valuer adopted a 5% stigma factor. This is a reasonable estimate having regard to the fact that the property was contaminated in the past 50/60 years, the bad image justifies the moderate stigma factor even though the owner undertakes to clean up and issue a guarantee to the purchaser. The high sensitivity of the model is due to that the valuer considered 5% and 10% stigma factors had similar probability. It would be difficult to make the selection manually. However, with the help of the AHP model, 5% is readily chosen as the preferred stigma factor.

7.7.2 Case Study No.2

A Truck Transport Depot in Seven Hills, Sydney, NSW

The subject property is a truck transport depot. The land area is about 2.6ha. On site there are 2 warehouses, office and workshops. The site is zoned General Industrial. The surrounding properties are also for industrial uses. The site was contaminated by the previous heavy industrial uses. The contaminants include significant hydrocarbons and contaminated fill with bitumen and metal contents. The current use also causes some contamination due to leakage from fuel tanks. A valuation was carried out in March 1998 for finance purpose. The unimpaired value was assessed to be $5.9 million. The estimated cost for the remedial work (to remove the topsoil in the affected area and have the area concreted afterwards) was $200,000. The impaired value was assessed to be $5.0 million reflecting a stigma factor of about 12%.

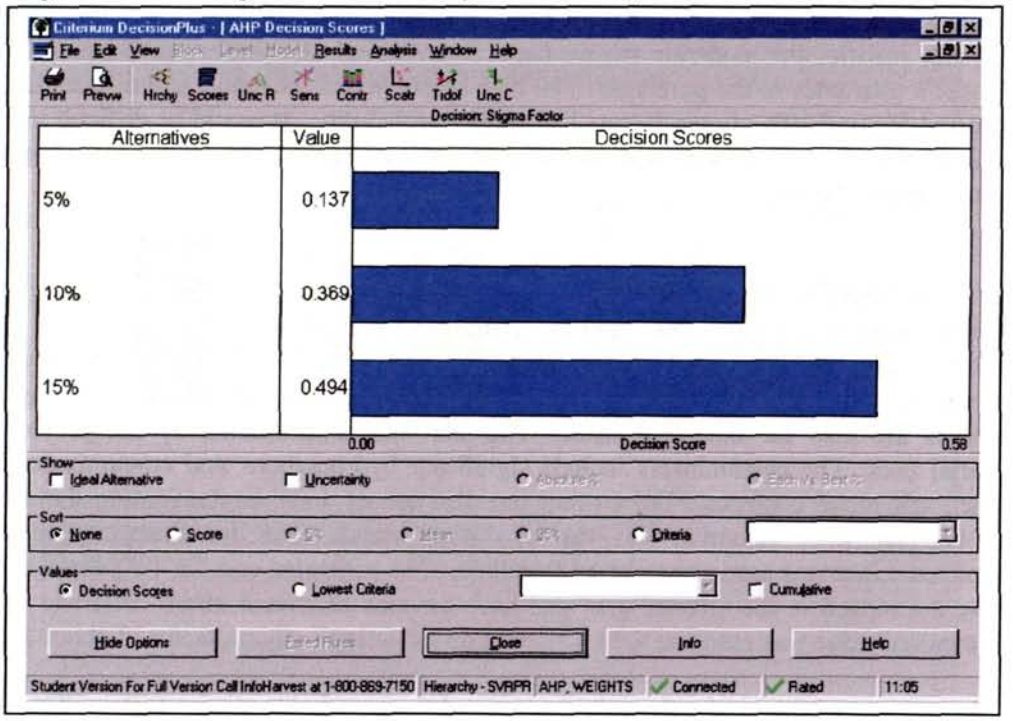
For the purpose of this study, the valuer suggested three probable stigma factors, 5%, 10% and 15% for the AHP model. He also rated the criteria and alternatives as shown in Table 7 – 4 below.

Table 7 – 4 Criteria and Alternatives Weighting of Case Study No. 2

				(Rating scale 0 – 10)		
Goal Level	***Weights***	***Rating Set***	***Lowest Criteria***	***5%***	***10%***	***15%***
Stigma Factor	15	Land uses	Land uses	2.5	7.5	10
	3	Health risks	Health risks	0	1	3
	20	Contamination	Contamination	2.5	10	10
	10	Remediation	Remediation	5	7	10
	2	Legal liabilities	Legal liabilities	0	0	2
	3	Publicity/reputation of site	Publicity/reputation of site	0	0	3
	10	Market condition	Market condition	10	5	10
	7	Physical characteristics of site	Physical characteristics of site	2.5	8	0
	2	Time factor	Time factor	0	0	2
	3	Government regulation	Government regulation	0	0	3
	5	Listing/ranking on register	Listing/ranking on register	0	0	0
	0	Guarantee from vendor	Guarantee from vendor	0	0	0
	0	Ownership	Ownership	0	0	0
	0	Community feeling/perceived risks	Community feeling/perceived risks	0	0	0
	10	Mortgageability	Mortgageability	0	10	10
	10	Purpose of valuation	Purpose of valuation	0	8	10
Total	100					

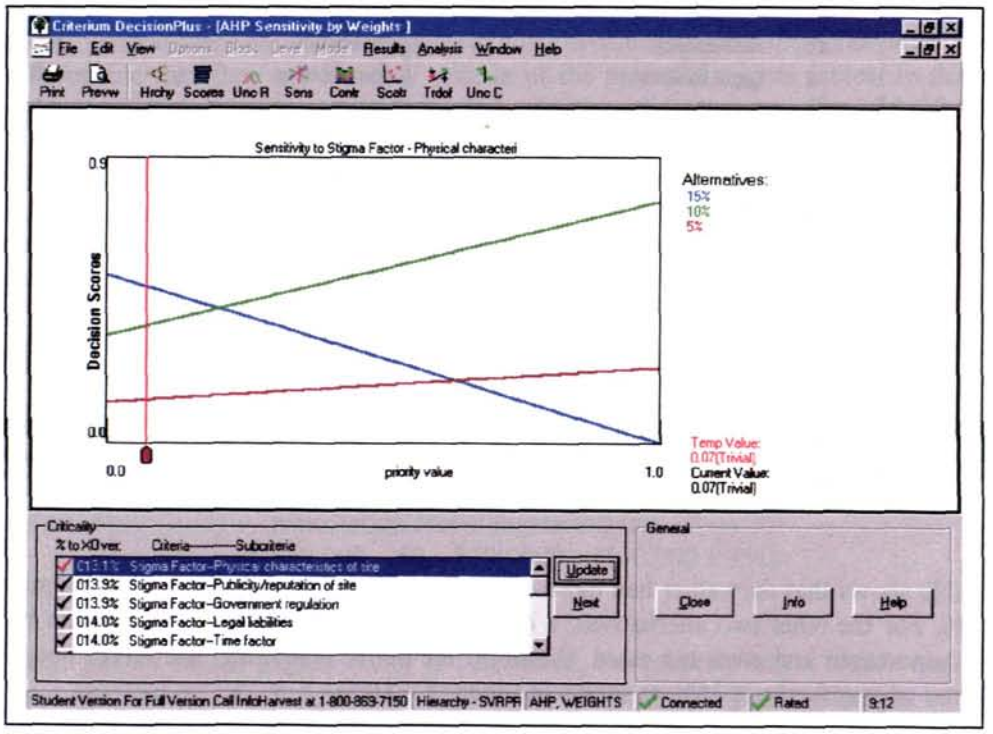
The table shows that the valuer had more emphasis on the criteria for the probable stigma factor of 15%. For the other two alternatives, a number of the criteria were considered as having little or no importance and were not rated. Based on the above weighting, the AHP model returns a preferred stigma factor of 15% as shown in Figure 7 – 10.

Figure 7 – 10 Stigma Factor Ranking of Case Study No. 2



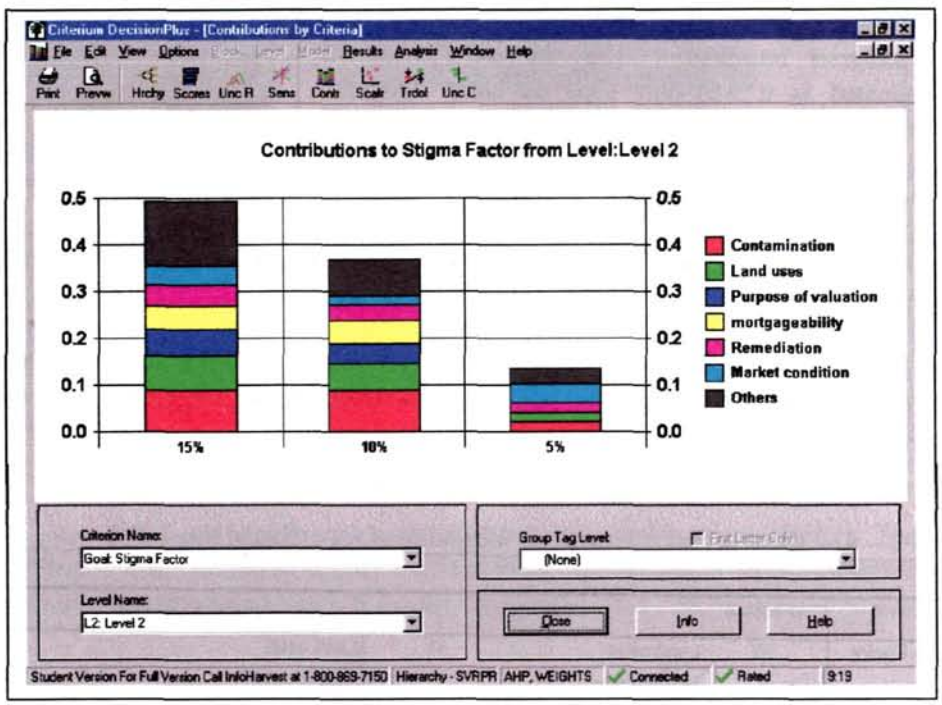
In order to verify if the result is acceptable, sensitivity by weights and contribution by criteria analysis have been carried out. The results of the sensitivity by weights analysis are shown in Figure 7 – 11 below.

Figure 7 – 11 Sensitivity by Weights Analysis of Case Study No. 2



In Figure 7 – 11, the 'Criticality' list box shows that the weight of 'physical characteristics of site' is most critical. The corresponding crossover percentage is 13.1%. Since it is much higher than the critical value (5%), the model is not sensitive and is acceptable. The results of the contribution by criteria analysis are shown in Figure 7 – 12 below.

Figure 7 – 12 Contribution by Criteria Analysis of Case Study No. 2



In Figure 7 – 12, contamination, land uses, purpose of valuation, mortgageability, remediation and market condition are the key criteria affecting the decision score of the alternatives. It can be seen that although the same number of criteria influence alternatives 15% and 10%, the criteria have more contribution to the decision score of 15% than the other alternatives. A crosscheck with the weights in Table 7 – 4 reveals that the contribution of the criteria to the three alternatives are appropriate. The distribution of the criteria in the stacked bars is reasonable. Since the alternative 15% has the highest decision score, it is reasonable that this is the preferred stigma factor. Using this stigma factor, the impaired value of the property is assessed as follows:

$$\begin{aligned}\text{Impaired value} &= \text{Unimpaired value} - \text{financial loss due to contamination} - \\ &\quad \text{remediation cost} - \text{stigma impacts} \\ &= \$5{,}900{,}000 - \$0 - \$200{,}000 - (\$5{,}900{,}000 \times 15\%) \\ &= \$4{,}815{,}000\end{aligned}$$

The result is about 4% below the original valuation of $5,000,000. As can be seen in Section 7.8 below, this difference is considered acceptable.

7.7.3 Case Study No. 3
Part of a Former Tip Site

The subject property was at Wetherill Park, an industrial area in Sydney. It has an area of 43,670m^2. It was part of a former tip site although it had not been filled. The zoning of the subject site is General Industrial 4(a). At the time of valuation, the property remained to be a vacant site. The adjoining land uses were vacant land and industrial buildings. The site itself was not contaminated as it was only used for shale stockpile. The stigma was only because it was part of a former tip site. The owner wanted to sell the site and the unimpaired value was assessed in August 1999 to be $4,150,000. The cost of removing the shale stockpile was $440,000. And the impaired value was found to be $3,100,000. This reflects a stigma factor of around 15%.

Subject site at Wetherill Park
Courtesy of Mr. Ron Bransdon, LandMark White

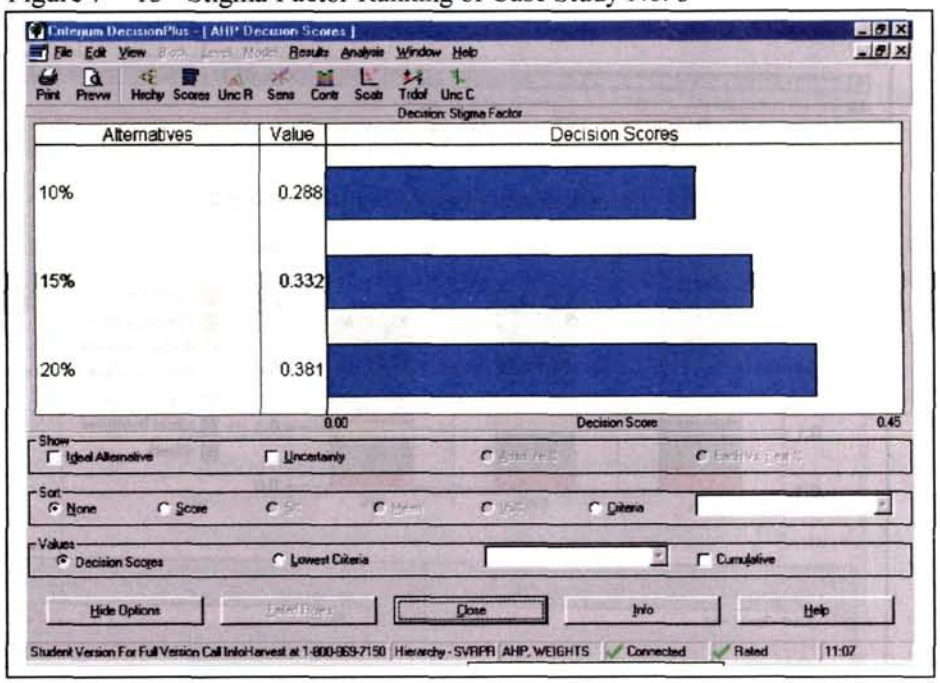
For the purpose of this research, the valuer suggested three probable stigma factors, 10%, 15% and 20% for the AHP model. He also provided weighting for the criteria and alternatives as shown in Table 7 – 5.

Table 7 – 5 Criteria and Alternatives Weighting of Case Study No. 3

				(Rating Scale 0 – 10)		
Goal Level	***Weights***	***Rating Set***	***Lowest Criteria***	***10%***	***15%***	***20%***
Stigma Factor	10	Land uses	Land uses	5	6	8
	4	Health risks	Health risks	3	4	5
	10	Contamination	Contamination	5	6	7
	8	Remediation	Remediation	3	4	5
	6	Legal liabilities	Legal liabilities	3	4	5
	10	Publicity/reputation of site	Publicity/reputation of site	7	8	9
	10	Market condition	Market condition	6	7	8
	5	Physical characteristics of site	Physical characteristics of site	3	3	3
	3	Time factor	Time factor	1	1	1
	5	Government regulation	Government regulation	1	1	1
	6	Listing/ranking on register	Listing/ranking on register	1	1	1
	5	Guarantee from vendor	Guarantee from vendor	8	8	8
	3	Ownership	Ownership	1	1	1
	3	Community feeling/perceived risks	Community feeling/perceived risks	1	2	3
	6	Mortgageability	Mortgageability	4	5	6
	6	Purpose of valuation	Purpose of valuation	3	3	3
Total	100					

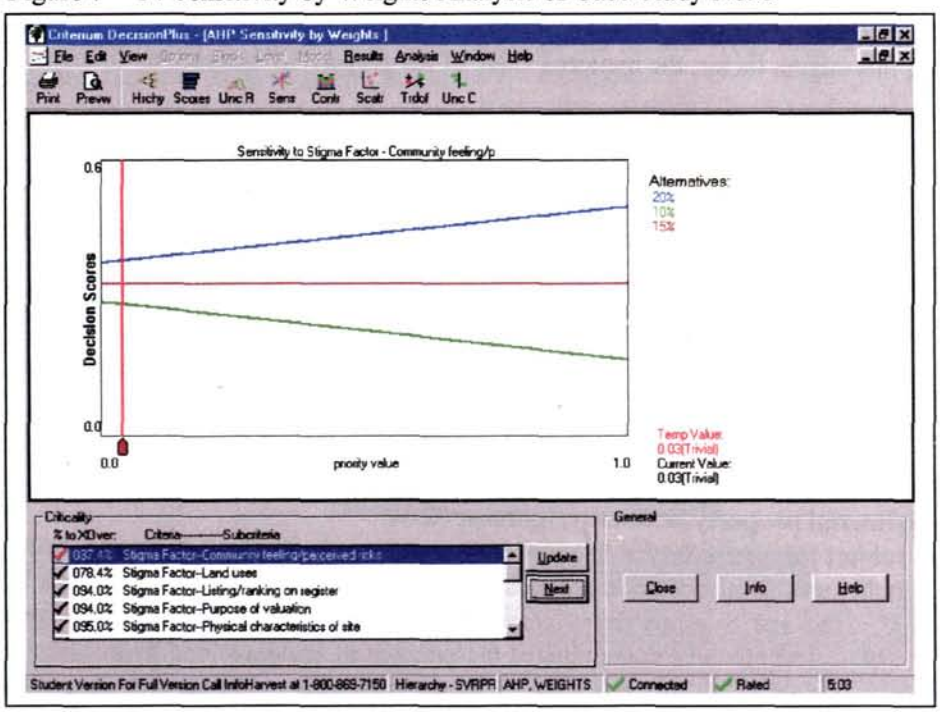
The valuer considered that all criteria were relevant to the three alternatives. Among the criteria, land uses, contamination, publicity and market condition were the major concerns of the valuer. Based on the ratings, the AHP model returns the results as shown in Figure 7 – 13.

Figure 7 – 13 Stigma Factor Ranking of Case Study No. 3



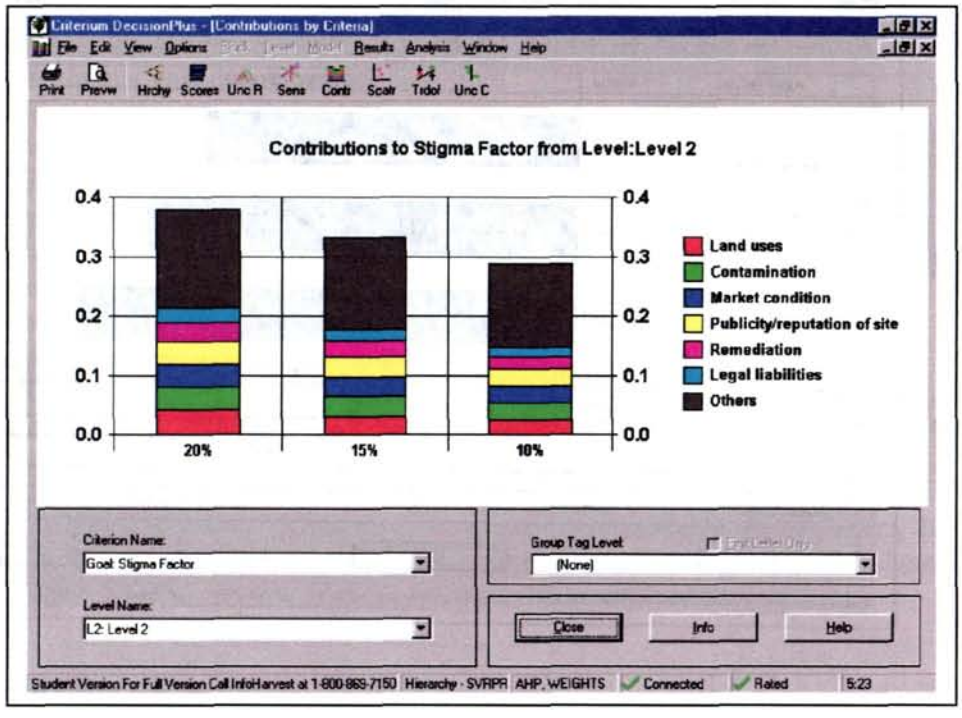
There is a clear difference between the score of the three probable stigma factors. The length of the bars shows that the preferred stigma factor is 20%. The results of the sensitivity by weights and contribution by criteria analysis are shown in Figures 7 – 14 and 7 – 15.

Figure 7 – 14 Sensitivity by Weights Analysis of Case Study No. 3



On the graph, the three alternative lines do not touch each other. The 'Criticality' list box shows that the weight of 'community feeling/perceived risks' is most critical. The crossover percentage is 37.4%, which is much higher than the critical value (5%). It indicates that the model is not sensitive to changes in the value of the critical weights.

Figure 7 – 15 Contribution by Criteria Analysis of Case Study No. 3



The results of the contribution by criteria analysis show that the three alternatives are affected by the same number of key. A crosscheck with Table 7 – 5 shows that the key criteria in Figure 7 – 15 match the weighting. In comparison, the key criteria have more contribution to 20%, making it the preferred stigma factor. Based on the analysis, the model is a reasonable one. Using this stigma factor, the impaired value of the property is assessed as follows:

Impaired value = Unimpaired value – financial loss due to contamination – remediation cost – stigma impacts

= \$4,150,000 – \$0 – \$440,000 – (\$4,150,000 x 0.20)
= \$2,880,000

This figure is about 8% lower than the original valuation of \$3,100,000. The difference is within the acceptable range (±10%) in a normal market as outlined in Section 7.8 below.

7.7.4 Case Study No. 4

An industrial property in Botany, Sydney, NSW

The subject property is an industrial property used for manufacturing and packaging of household aerosol and cosmetic products. It has a site area of about 1.5ha and a building area of 5764m^2. The site is zoned part General Business 3a and part Industrial 4a under the Botany LEP 1993. The site was contaminated by asbestos in buildings and hydrocarbon and xylene in the soil. The adjoining properties are industrial properties. The subject property was valued in May 1996 for mortgage purposes. The unimpaired value was assessed to be \$2,700,000. The environmental consultant estimated that it would cost \$105,000 to clean up the site. The impaired value was assessed to be \$2,350,000. There were no other financial losses due to the contamination on site. The valuation reflected a stigma factor of 9%. The valuer reported that

the property was subsequently sold for $1,250,000 in a desperate sale by the vendor probably for financial reasons.

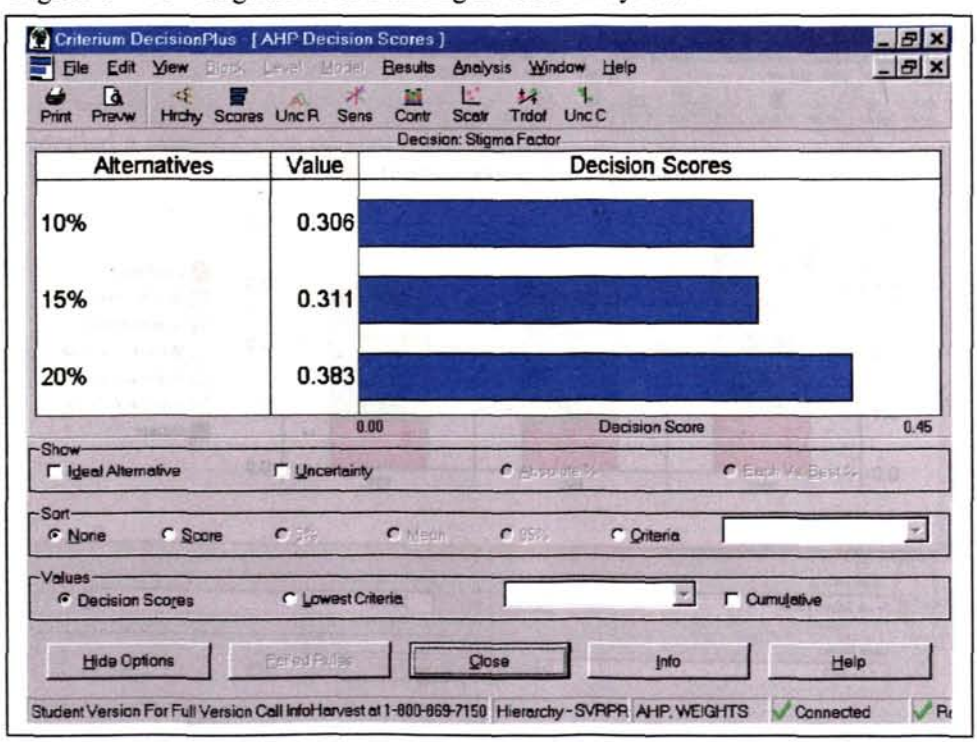
For the purpose of this study, the valuer suggested three probable stigma factors, 10%, 15, 20% for the AHP model. He also weighted the criteria and alternatives as show in Table 7 – 6 below.

Table 7 – 6 Criteria and Alternatives Weighting of Case Study No. 4

				(Rating scale 0 – 10)		
Goal Level	***Weights***	***Rating Set***	***Lowest Criteria***	***10%***	***15%***	***20%***
Stigma Factor	25	Land uses	Land uses	5	5	6
	15	Health risks	Health risks	3	3	6
	20	Contamination	Contamination	6	6	6
	12	Remediation	Remediation	7	7	6
	5	Legal liabilities	Legal liabilities	3	3	4
	0	Publicity/reputation of site	Publicity/reputation of site	0	0	0
	10	Market condition	Market condition	7	8	9
	0	Physical characteristics of site	Physical characteristics of site	0	0	0
	0	Time factor	Time factor	0	0	0
	6	Government regulation	Government regulation	5	5	6
	0	Listing/ranking on register	Listing/ranking on register	0	0	0
	0	Guarantee from vendor	Guarantee from vendor	0	0	0
	0	Ownership	Ownership	0	0	0
	0	Community feeling/perceived risks	Community feeling/perceived risks	0	0	0
	5	Mortgageability	Mortgageability	4	4	8
	2	Purpose of valuation	Purpose of valuation	7	7	7
Total	100					

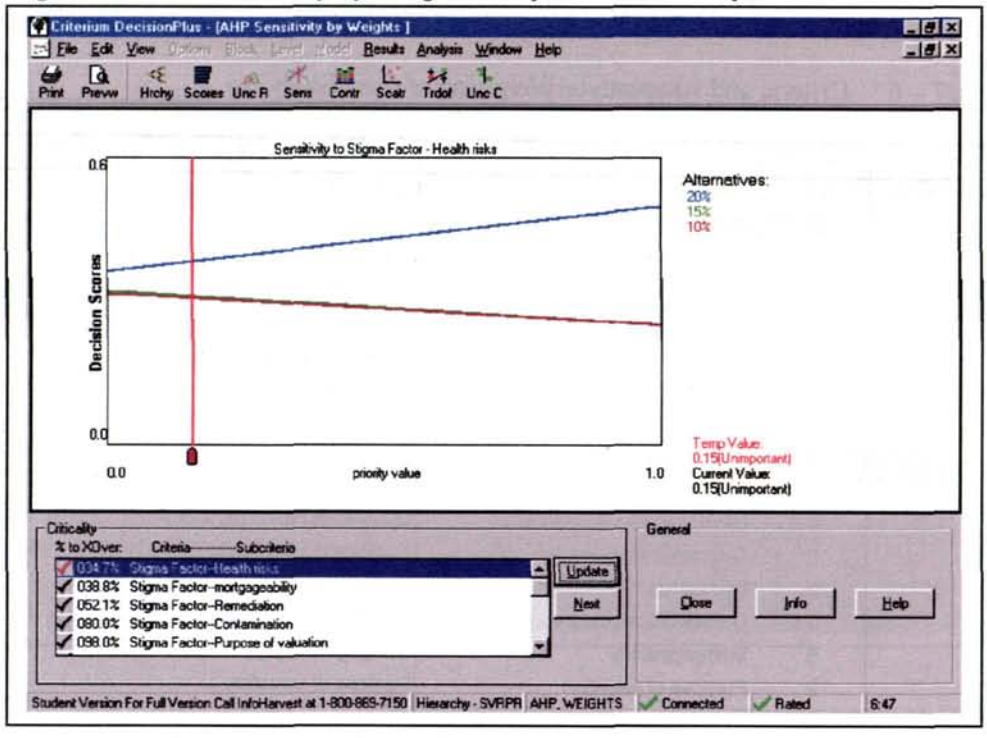
The valuer did not consider that all criteria were relevant to the subject case. Accordingly weighting was not given to certain criteria. Based on the above weighting, the AHP model returns a stigma factor of 20% as shown in Figure 7 – 16 below.

Figure 7 – 16 Stigma Factor Ranking of Case Study No. 4



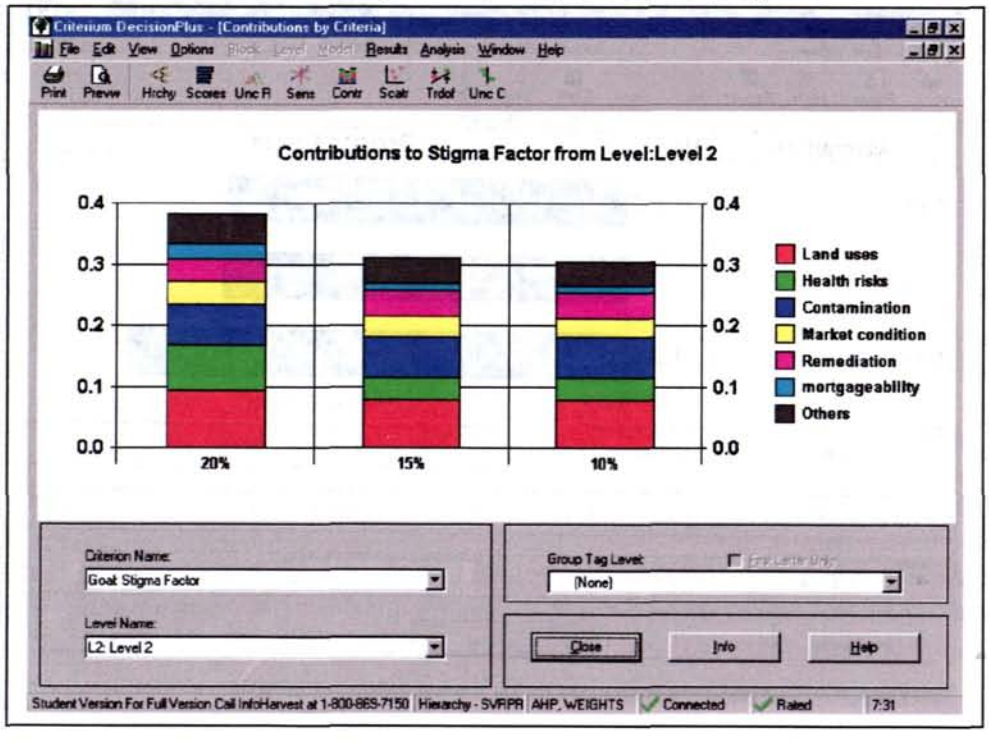
The results of the sensitivity by weights and contribution by criteria analysis are shown in Figures 7 – 17 and 7 – 18.

Figure 7 – 17 Sensitivity by Weights Analysis of Case Study No. 4



The graph in Figure 7 – 17 shows that the sloping lines of alternatives 15% and 10% are virtually the overlapping. The sloping line for the alternative 20% is distinctively above the other two lines making 20% the clear preferred stigma factor. From the 'Criticality' list box, it can be seen that the weight of 'health risks' is most critical. The crossover percentage of this critical weight is 34.7%. Since it is much higher than the critical value (5%), the model is not sensitive to changes in the value of the weights.

Figure 7 – 18 Contribution by Criteria Analysis of Case Study 4



The contribution by criteria analysis shows that while the key criteria affect all three alternatives with land uses, health risks and contamination contribute more to the decision score of the alternative 20%. While mediation has slightly higher contribution to the ranking of the other two alternatives, it does not affect 20% being the preferred alternative. These contributions are reasonable given the weighting assigned to the criteria in Table 7 – 6 and the characteristics of the site. Accordingly, the preferred alternative is reasonable one. Using the preferred stigma factor, the impaired value of the property is assessed as follows:

Impaired value = Unimpaired value – financial loss due to contamination – remediation cost – stigma impacts

= \$2,700,000 – \$0 – \$105,000 – (\$2,700,000 x 0.20)
= \$2,055,000

This figure is about 12.5% lower than the original valuation of \$2,350,000. The difference is outside the acceptable range (±10%) in a normal market as outlined in Section 7.8 below. However, the difference is within the acceptable range ((±15%) in an abnormal market. The fact that the property was eventually sold for only \$1,250,000 shows that the property was not sold under normal market conditions. Accordingly the higher than normal difference is still acceptable.

7.7.5 Case Study No. 5

A Motor Service Station in Wyong, NSW

The subject property is a service station/car repair workshop. The land and building areas are about 1,400m^2 and 250m^2 respectively. The town planning zoning permits the property to be used for commercial use. The surrounding properties are commercial and residential. The highest and best use of the property is a service station plus ancillary commercial use. Given the previous and current service station use, the property is contaminated with petrol and oil. A valuation of the property was conducted in February 2000. The unimpaired value was assessed to be \$290,000. There was a financial loss of \$20,000 due to the land contamination. The estimated remediation cost was \$40,000. The valuer adopted a stigma factor of about 3% and the impaired value was assessed to be \$225,000.

Service Station in Wyong
Courtesy of Mr. Michael McClifty, LandMark White

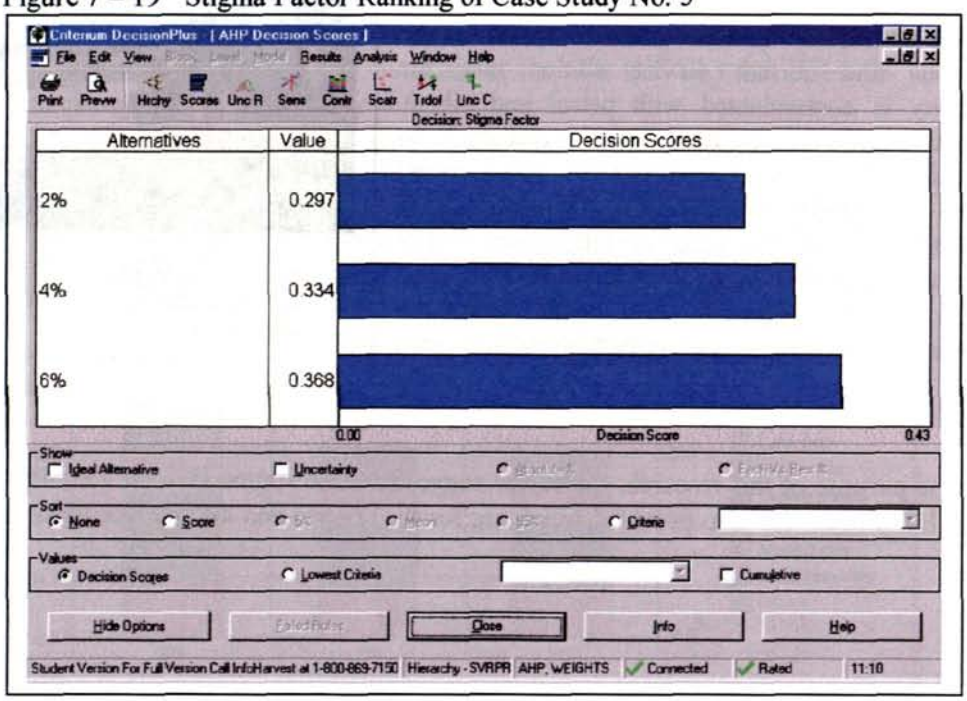
For the purpose of this research, the valuer suggested three stigma factors, 2%, 4% and 6% for the AHP model. He also provided weighting for the criteria and alternatives as shown in Table 7 – 7.

Table 7 – 7 Criteria and Alternatives Weighting for Case Study No. 5

				(Rating scale 0 - 10)		
Goal Level	***Weights***	***Rating Set***	***Lowest Criteria***	***2%***	***4%***	***6%***
Stigma Factor	6	Land uses	Land uses	6	7	7
	7	Health risks	Health risks	7	8	9
	10	Contamination	Contamination	7	8	9
	10	Remediation	Remediation	7	8	9
	3	Legal liabilities	Legal liabilities	4	4	4
	3	Publicity/reputation of site	Publicity/reputation of site	6	7	8
	5	Market condition	Market condition	5	5	5
	10	Physical characteristics of site	Physical characteristics of site	5	6	7
	4	Time factor	Time factor	3	3	3
	4	Government regulation	Government regulation	5	5	5
	4	Listing/ranking on register	Listing/ranking on register	4	5	6
	2	Guarantee from vendor	Guarantee from vendor	2	2	2
	6	Ownership	Ownership	5	5	5
	8	Community feeling/perceived risks	Community feeling/perceived risks	5	6	7
	10	Mortgageability	Mortgageability	7	8	9
	8	Purpose of valuation	Purpose of valuation	5	6	7
Total	100					

The valuer considered that all criteria were relevant for the subject property. His major concerns were the nature of contamination, the remediation required, the physical characteristics of the site and mortgageability. With the ratings in the table, the AHP model returns a stigma factor of 6% as shown in Figure 7 – 19.

Figure 7 – 19 Stigma Factor Ranking of Case Study No. 5



Before accepting 6% as the preferred alternative, sensitivity by weights and contribution by criteria analysis have been carried out to test the robustness and reasonableness of the model. Figure 7 – 20 below shows results of the sensitivity by weights analysis.

Figure 7 – 20 Sensitivity by Weights Analysis of Case Study No. 5

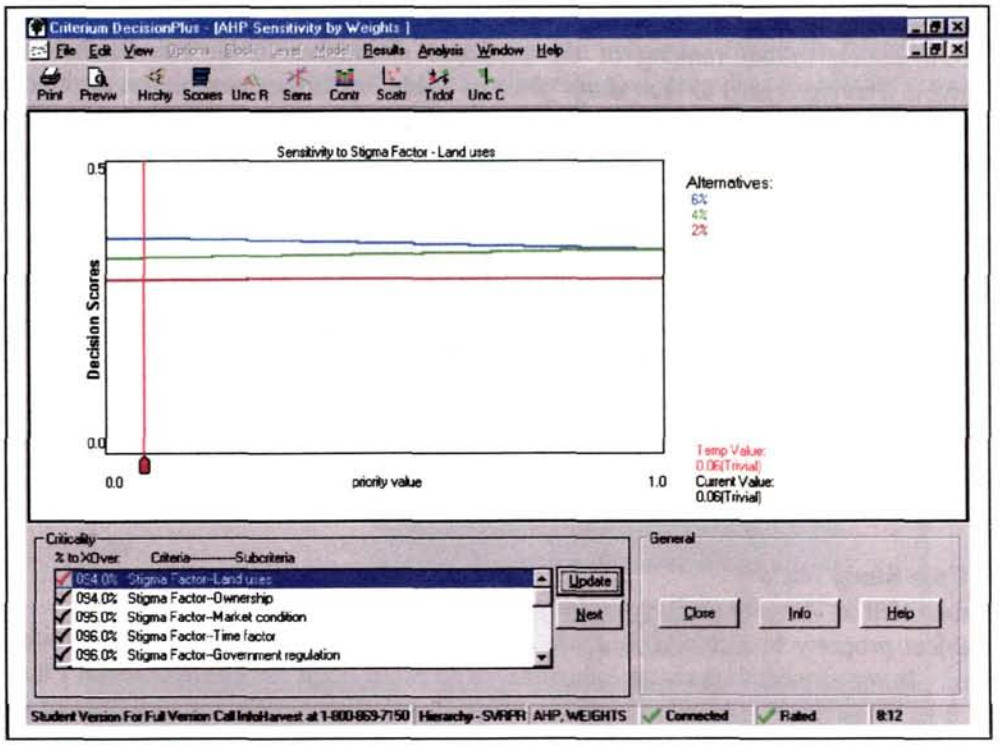
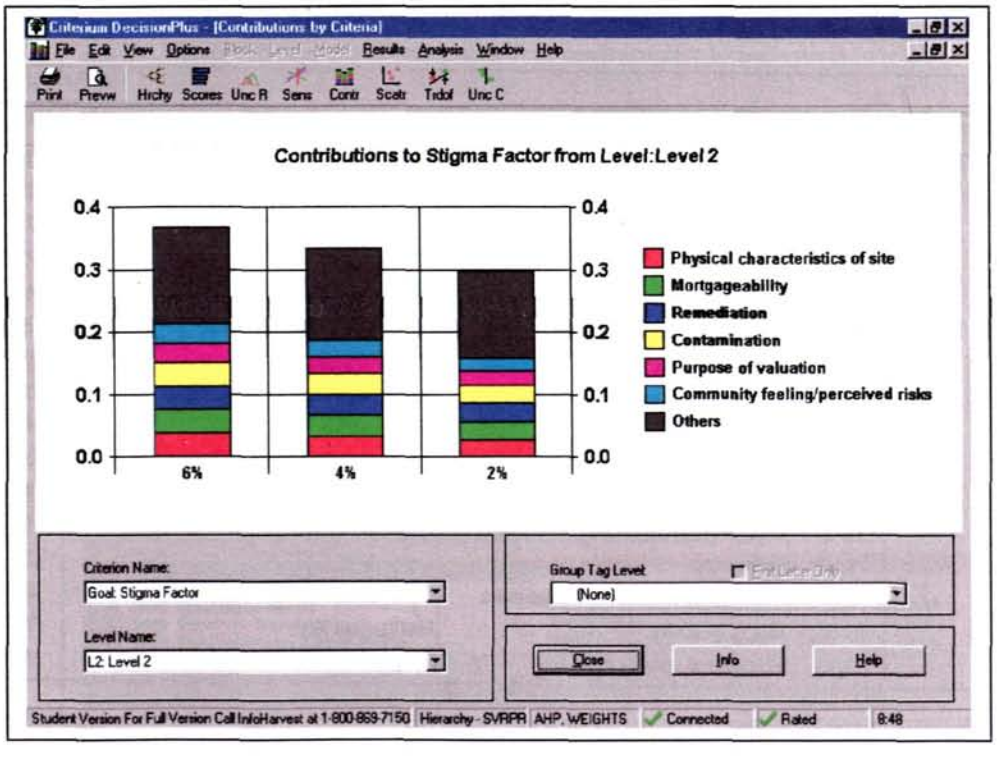


Figure 7 – 20 shows that the three sloping lines are distinctively apart. The weight of 'land uses' is most critical. It has a crossover percentage of 94% and is very much high than the 5% critical value. As can be seen from the graph, the preferred alternative 6% is highly insensitive to changes in the value of the critical weight. Accordingly the model is not sensitive and is acceptable. The reasonableness of the model is verified by the contribution by criteria analysis as shown in Figure 7 – 21 below.

Figure 7 – 21 Contribution by Criteria Analysis of Case Study No. 5



In Figure 7 – 21, all key criteria are affecting the alternatives. In comparison, the criteria have more contribution to the ranking of the preferred alternative (6%) than to the other two alternatives. Having regard to the ratings given in Table 7 – 7, the contribution of the criteria is reasonable and the model is an acceptable one. Using the preferred stigma factor of 6%, the impaired value of the property is assessed as follows:

Impaired value = Unimpaired value – financial loss due to contamination – remediation cost – stigma impacts

= $290,000 – $20,000 – $40,000 – ($290,000 x 6%)
= $212,600

This figure is around 6% below the original valuation of $225,000. This difference is within the acceptable range (±10%) in a normal market as outlined in Section 7.8 below.

7.7.6 Case Study No. 6

A Timber Mill at Homebush Bay, Sydney, NSW

The subject property is a timber mill. It has a land area of 25,000m^2. The building area is 4,000m^2. It was zoned Waterfront Industrial. The State Regional Environmental Plan No. 24 allows it to be used for residential purposes. The adjoining properties are a mixture of industrial and residential properties. The subject land has a potential to be redeveloped into residential apartments. However, the site is contaminated by heavy metals and filled materials including petroleum based products. A valuation of the property was carried out in July 1996 for market value review. The unimpaired value was assessed to be $7,500,000. The estimated clean up cost was about $1,000,000. Using a stigma factor of 13.3%, the impaired value was assessed to be $5,500,000.

For the purpose of this research, the valuer estimated three probable stigma factors, 5%, 15% and 30%. He was the only valuer who supplied such a broad range of probable stigma factors. A possible reason for the broad range of figures is that he might have difficulty in narrowing the range of probable stigma factors. He rated the criteria and alternatives as per Table 7 – 8 below.

Table 7 – 8 Criteria and Alternatives Weighting for Case Study No. 6

				(Rating scale 0 - 10)		
Goal Level	***Weights***	***Rating Set***	***Lowest Criteria***	***5%***	***15%***	***30%***
Stigma Factor	10.00	Land uses	Land uses	8	10	10
	6.67	Health risks	Health risks	7	5	9
	10.00	Contamination	Contamination	7	10	8
	10.00	Remediation	Remediation	7	10	8
	4.33	Legal liabilities	Legal liabilities	4	5	7
	3.67	Publicity/reputation of site	Publicity/reputation of site	2	4	4
	10.00	Market condition	Market condition	5	10	7
	5.00	Physical characteristics of site	Physical characteristics of site	3	2	3
	9.00	Time factor	Time factor	4	10	5
	3.00	Government regulation	Government regulation	3	3	4
	2.00	Listing/ranking on register	Listing/ranking on register	1	2	2
	10.00	Guarantee from vendor	Guarantee from vendor	1	10	2
	2.33	Ownership	Ownership	2	2	3
	2.67	Community feeling/perceived risks	Community feeling/perceived risks	3	2	5
	10.00	Mortgageability	Mortgageability	7	10	8
	1.33	Purpose of valuation	Purpose of valuation	3	2	3
Total	100.00					

The valuer considered that all criteria were relevant to the subject property. His major concerns were land uses, nature of contamination, remediation work required, and mortgageability. Land uses under alternatives 15% and 30% were given the maximum rating. It is interesting to note that the valuer also gave maximum rating to contamination, remediation, market condition, time factor, guarantee from vendor and mortgageability under the alternative 15%. It shows that the value had more inclination on the probable stigma factor. With the ratings in the table, the AHP model returns a stigma factor of 15% as shown in Figure 7 – 22.

Figure 7 – 22 Stigma Factor Ranking of Case Study No. 6

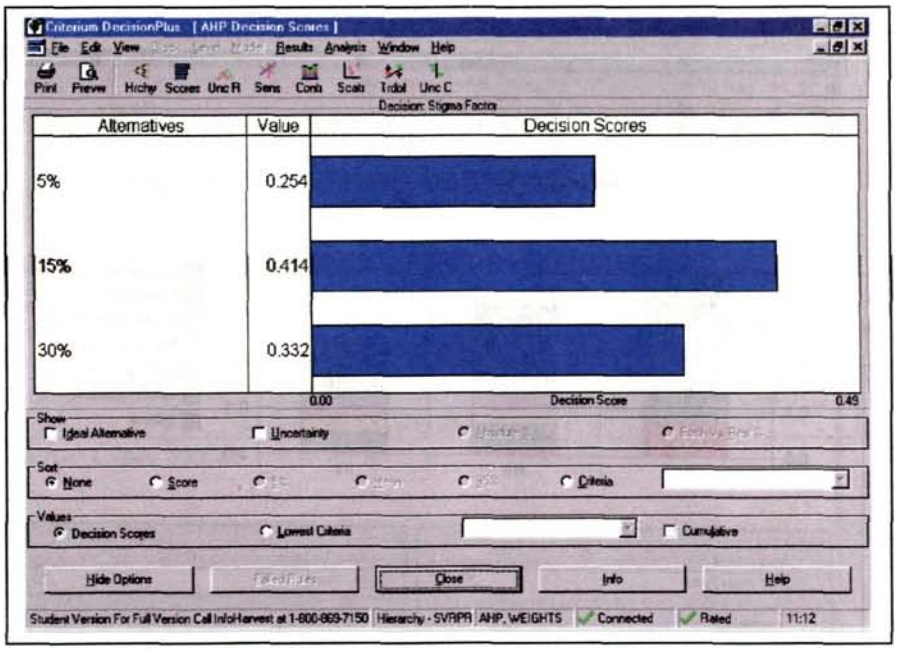
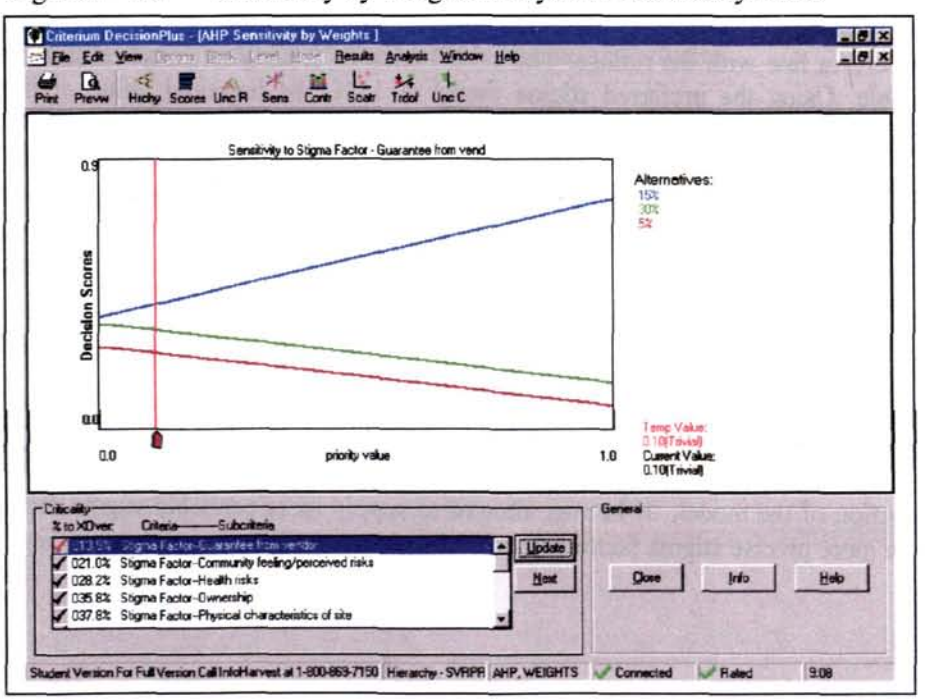


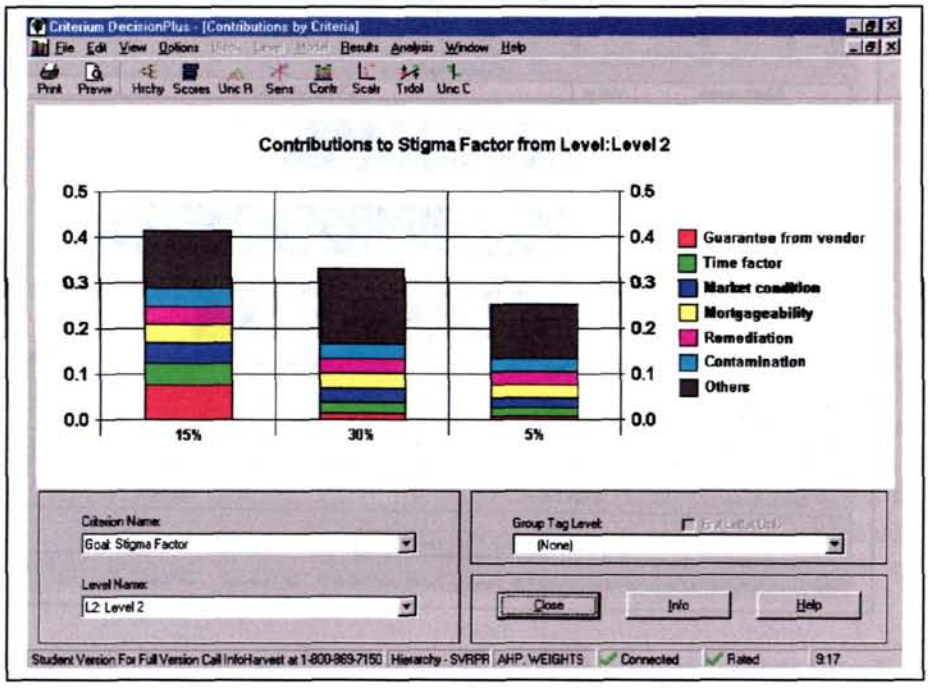
Figure 7 – 22 shows that the 15% probable stigma factor has the highest decision score and is clearly the preferred alternative. The results of the sensitivity by weights and contribution by criteria analysis are shown in Figures 7 – 23 below and 7 – 24.

Figure 7 – 23 Sensitivity by Weights Analysis of Case Study No. 6



In Figure 7 – 23, the three sloping lines do not touch on each other with 15% being the preferred alternative. The 'Criticality' list box shows that the weight of 'Guarantee from vendor' is most critical. The crossover percentage of this critical weight is 13.9%, which is substantially higher than the critical value (5%). Accordingly the model is not sensitive and is acceptable. The reasonableness of the model is verified by the contribution by criteria analysis as shown in Figure 7 – 24.

Figure 7 – 24 Contribution by Criteria Analysis of Case Study No. 6



In Figure 7 – 24, the five key criteria – guarantee from vendor, time factor, market condition, mortgageability, remediation, and contamination – have more contribution to the decision score of 15% than the other two alternatives. A crosscheck with Table 7 – 8 reveals that the key criteria are in line with the ratings. The contribution of criteria to the alternatives is considered reasonable. Using the preferred stigma factor of 15%, the impaired value of the property is assessed as follows:

$$\begin{aligned}\text{Impaired value} &= \text{Unimpaired value} - \text{financial loss due to contamination} - \\ &\quad \text{remediation cost} - \text{stigma impacts} \\ &= \$7{,}500{,}000 - \$0 - \$1{,}000{,}000 - (\$7{,}500{,}000 \times 15\%) \\ &= \$5{,}375{,}000\end{aligned}$$

The result is about 2% below the original valuation $5,500,000. The small difference is well within the acceptable range (±10%) in a normal market as outlined in Section 7.8 below. In this case study, the valuer was asked to supply only three probable stigma factors because of the construction of the model. If he was allowed to supply more probable stigma factors within the range, a more precise stigma factor can be returned and the difference in answer may be smaller.

7.8 Accuracy of Case Study Results

In the case studies, the valuers rated the criteria and alternatives differently in different cases. They had exercised considerable judgement in the reassessment of the properties. Some of them took all criteria into consideration while others considered only part of the criteria that were appropriate for the subject property. It highlights the fundamental principle that every property is unique and has to be valued according to its characteristics. Regarding the reasonableness of the range of probable stigma factors suggested in each of the case studies, a comparison is made with the stigma factors in Table 7 – 2, which are assumed to be representative and reliable for being used for a benchmark. The outcomes are shown in Table 7 – 9 below.

Table 7 – 9 Comparison of Suggested Stigma Factors and Benchmark Figures

Case Study No.	Table 7 – 2 Land Use No.	Alternative Uses					
		Residential		Commercial		Industrial	
		Case Study	Table 7 – 2	Case Study	Table 7 – 2	Case Study	Table 7 – 2
1	39					5 - 25	7 - 14
2	15					10 - 20	6 - 13
3	32					10 - 20	9 - 19
4	41					10 - 20	9 - 20
5	56			2 - 6	5 - 10		
6	65	5 - 30	13 - 21				

Source: Chan 2000a

It can be seen that with the exception Case Study No. 6, the supplied probable stigma factors are very close to the benchmark figures. They are on the whole in line with the market expectation. For Case Study No. 6, the range of probable stigma factors (5% – 30%) is excessive. It could be that the valuer was unconfident to put down a narrower range. Nevertheless, the preferred alternative 15% is within the market range of 13% - 21%.

It should be noted that the benchmark figures are not site specific but only reflect the average estimation of valuers for that particular class of land uses and industries. When it comes to the case studies, the valuers had to look at all relevant factors concerning the subject property. It is thus very rare that there is a perfect match with the benchmark figures. Having regard to the reasons given above and the fact that the valuers had no access to benchmark figures, the supplied probable stigma factors are considered reasonable and reliable.

In this study, the original valuation of the case studies has been acceptable by the clients for the respective proposes. The valuations are therefore assumed to be correct and are used as benchmark to check the accuracy of the figures returned by the AHP model. A comparison of the reassessed impaired value using the AHP model has been made with the original valuation. The results are summarised in Table 7 – 10.

Table 7 – 10 Summary of Case Study results

Case Study No.	Original stigma factor (%)	AHP Stigma factor (%)	Original valuation ($)	AHP valuation ($)	Percentage difference (%)
1	0.0	5	-10,000	-14,500	-45.0
2	12.0	15	5,000,000	4,815,000	-4.0
3	15.0	20	3,100,000	2,880,000	-8.0
4	9.0	20	2,350,000	2,055,000	-12.5
5	3.0	6	225,000	212,600	-6.0
6	13.3	15	5,500,000	5,375,000	-2.0

Source: Chan 2000a

It can be seen that the value of stigma factors returned by the AHP model (third column) is consistently higher than the original valuation (second column). Also all of the percentage differences in the last column are negative. The reason for the phenomenon may be that the revaluations were carried out with hindsight knowledge. Although the valuers were requested to reassess the properties as if the original underlying conditions remain unchanged, it was difficult to ensure that the revaluations were not influenced by new conditions that affected the properties. In this research, it happens in all case studies that the valuers became more conservative when carrying out the revaluation. If more case studies are available, a different pattern may appear.

As mentioned earlier, property valuation is also not an exact science, and it is difficult to verify the accuracy of a valuation. In the United States, there have been a number of researches in this area. Kealy et al (1988) find that "accuracy in valuation is a matter of degree" (p. 168). Cole, Guilkey and Miles (1986 p. 423) find that, in commercial appraisal, "the absolute difference in sale prices and most recent independent appraisal was almost 9%". In a study of commercial real estate return, Miles, Cole and Guilkey (1990 p. 425) find evidence to show that "the appraisal process smooths real estate returns so as to understate the true underlying variability and bias measure of correlation with other asset returns". In a study of appraisal error in commercial property, Geltner, Groff and Young (1995 p. 405) comment that "...appraisal error should not be the difference between the appraisal value and the subsequent transaction price of a subject property, but rather the difference between the appraised value and the market value of that property".

In Table 7 – 10, apart from Case Studies No. 1 and No. 4, the reassessed impaired value of all cases is within -10% to 0% range of the original valuations. In recognition of the difficulty in determining the accuracy of property valuation, the law courts have accepted the principle of 'margins of error' as a substitute for accuracy. The issue of 'margins of error' was first considered in the English court case *Singer & Friedlander Ltd v John D Wood & Co [1977] 2 EGLR 84*. In this case, Watkins J ruled that "The permissible margin of error is ... generally 10 per cent either side of a figure which can be said to be the right figure ... In exceptional circumstances the permissible margin, ..., could be extended to about 15 per cent, or a little more, either way." Since then there had been a number of researches of valuation accuracy in the United Kingdom (Crosby et al 1994, Brown et al 1996, Hutchison 1996). In a recent research in the United Kingdom, Crosby, Lavers and Murdoch (1998, p. 25), find that "there is no recorded instance of anyone [experts and judges] favouring a figure in excess of 20%. It appears therefore that, to date, 20% has been universally regarded as the absolute limit."

In Australia, there is no benchmark for assessing valuation accuracy. The 'margins of error' principle from the John D Wood case is followed. A valuer is likely to be held liable for negligence if the valuation deviates from the acceptable bracket. In *Trade Credits Limited v*

Baillieu Knight Frank (NSW) Pty Ltd (1985) Aust Tort Reports 80 – 757, the defendant was held liable and negligent because its valuation exceeded the probable value by about $2000,000 (approximately 30%). In *Challenge Bank Ltd v VL Cooper and Associates Pty Ltd [1996]* 1 VR 200, the court accepted that the true value of the subject property was between $170,000 and $240,000. The defendant's of $310,000 was outside this bracket and was held liable for negligence.

At present, there is no court ruling about the accuracy of stigma assessment. Given that stigma assessment is part of the contaminated property valuation process, it is reasonable to extend the 'margins of error' principle to cover stigma assessment. Accuracy of stigma assessment is therefore limited to assessing the most probable discount rate for the stigma factor. Using the court ruling as a benchmark, the case study results are well within the legally recognised "margins of error" and are thus reasonable and acceptable figures. Regarding Case Studies No. 1 and No. 4, the higher than normal margin of error was discussed and explained in the respective sections. Given their specific nature, their results are also considered reasonable and acceptable.

7.9 Critical Analysis of the model

This model is based on 16 criteria identified by participating valuers in the 1998 survey. Twelve (12) of them coincide with those identified by Patch and Mundy (see Table 7 – 1 above). Since they are criteria identified by both Australian valuers and researchers in the United States, it is reasonable to incorporate them in the model. Nevertheless, it is necessary to verify the validity of incorporating the 4 extra criteria into the model. The analysis is provided in Table 7 – 11 below:

Table 7 – 11 Analysis of extra criteria

Extra Criteria	Case Study						Total	Average value	Expected average value
	1	2	3	4	5	6			
Valuation purpose	1	10	6	2	8	1	28	5	6
Market Condition	3	10	10	10	5	10	48	8	6
Government Regulations	5	3	5	6	4	3	26	4	6
Listing on CL register	0	5	6	0	4	2	17	3	6
Total score	9	28	27	18	21	16	119	20	
Expected average score assuming equal value	25	25	25	25	25	25	150	25	

Note: all figures rounded up to the nearest whole number

The table summarises the scores of the 4 extra criteria in the 6 case studies. In the suggested AHP stigma assessment model, the participants (valuers) were required to rate the relative importance of the 16 criteria. There was no limit to the weighting of each criterion, but the total of all weightings should add up to 100. If each of the 16 criteria has the same importance then each of them should have a score of 6.25 (i.e. 100 ÷ 16) and the sum of the average score of the 4 extra criteria should be 25 (i.e. 6.25 x 4).

In the case studies, the valuers considered that the 4 extra criteria had different relative importance and assigned different weightings to them. The total score of Case Study No. 1, 4

and 6 is 9, 18 and 16, which is far below the average score of 25. The total score of Case Study No. 2, 3 and 5 is 28, 27 and 21 respectively. They are higher than or close to the average score. Since the total score of one half of the case studies is either higher than or close to the average, it suggests that the 4 extra criteria are significant.

Regarding the individual criterion, the average score of valuation purpose, market condition and government regulation is 5, 8 and 4, which is either close to or higher than the average score of 6. It shows that these three criteria are more important than listing on contaminated land register. It also confirms that the value of contaminated land, like other properties, is very much influenced by the valuation purpose, the market condition and government regulation. The inclusion of government regulation as a criterion reflects the importance of environmental laws as outlined in Chapters 2 and 3. The analysis shows that listing on contaminated land register is the least important among the 4 extra criteria. It may be because if the land is found to be contaminated, the market resistance will be there whether or not the land is listed on the register. This analysis supports Australian valuers' claim that in contamination land valuation, normal valuation considerations also have an important role to play. It is therefore reasonable to include all 16 criteria in the AHP stigma assessment model.

From the case study results, the performance of the AHP model is encouraging. However, the results are based on data from six case studies only. The robustness of the model is still questionable. Ideally the model should be tested with more data. Unfortunately, there is a difficulty in getting more testing data. The tests carried out were the best that I could do.

The model used in this study consists of only one layer of criteria and three alternatives. This structure is used in order to keep the model simple so that the participating valuers would not be scared off or overwhelmed by the amount of data required. If there is no problem with the supply of data, the model can be expanded by including one or more sub-criteria layers and more alternatives. The strength as well as the weakness of the model is that it can only return one of the alternatives as the preferred stigma factor. If there are more probable stigma factors in the range, the model has more alternatives to analyse and the selection of stigma factor can be carried out in a more precise manner. For example, assuming that a valuer considers 5%, 10% and 15% as three alternatives for the model. If the valuer can provide more alternatives within the range with, say, 0.5% increment, the model has more choice of alternatives and is able to make a much more precise selection than having to choose from only 3 alternatives. Likewise, if there are one or more sub-criteria layers, the result will be more refined.

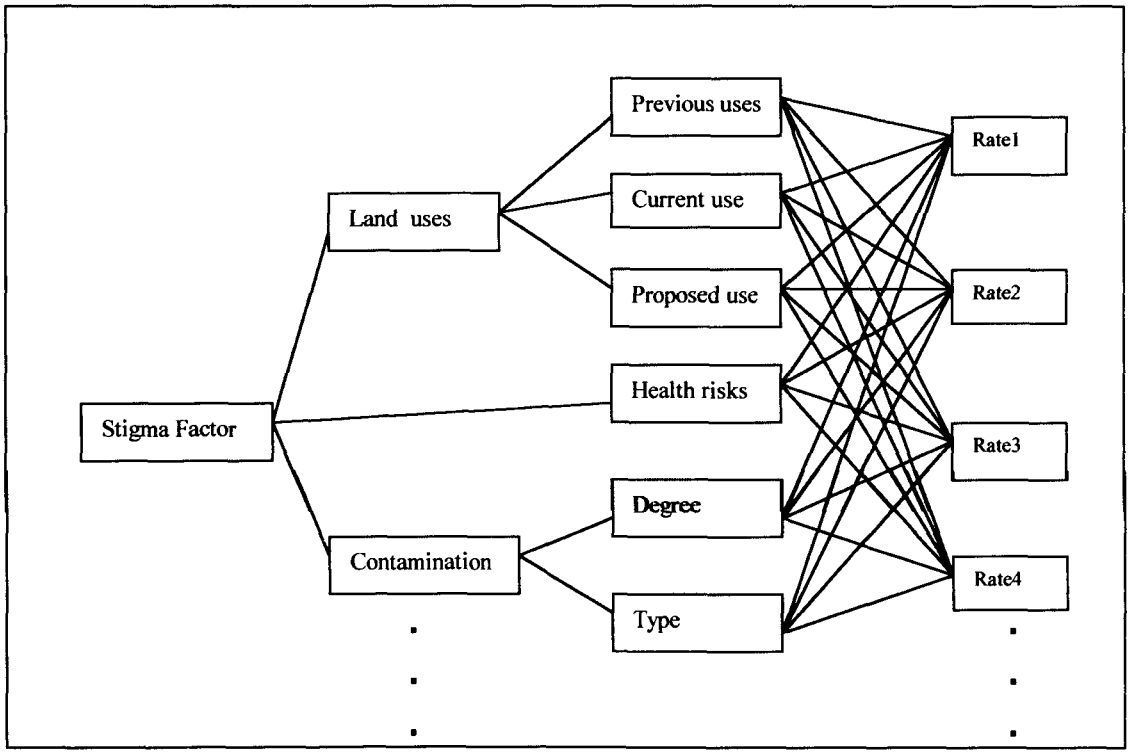
The model cannot turn a valuer without experience in contaminated land valuation into an experienced valuer in contaminated land valuation. At present, contaminated land valuation is not part of the property valuation curriculum in Australia. Students generally have a rather weak understanding in the issues. As far as practitioners are concerned, the survey results in Chapter 5 show that about one half of the respondents do not have experience in contaminated land valuation. Although valuers may attend continuous professional development (CPD) programs and related seminars to get more knowledge in this matter, they cannot get the necessary practical experience as a learning outcome. The situation in the United Kingdom is also similar. Gronow (2000 p. 332) comments that under the current system of education and training in the United Kingdom, valuer of contaminated land is faced with "a clearly impossible task". Unless and until there are suitable changes to current education and training system, valuers without experience still to need to work under experienced valuers to gain the necessary experience in contaminated land valuation.

The model is a tool to help valuers choose the reasonable stigma factor for the valuation. It only provides a more scientific and structural means for the valuers to select the appropriate stigma factor. It does not replace the valuers. In this regard, it requires the valuer (user) to estimate a range of probable stigma factors. The estimation is to be done by having regarding to all

relevant factors affecting the property including any market evidence and exercising the valuer's judgement. For this reason, if the range of probable stigma factors is incorrectly estimated, the model cannot provide the appropriate answer. The golden rule 'garbage in, garbage out' still applies to this model. The model can only work within the given range of probable stigma factors. This limitation is similar to multiple regression analysis in which the prediction of the Y-value can only be effectively made within the given range of X-values.

Although for demonstration purposes only one layer of criteria and three alternatives are included, the model is actually flexible. One or more sub-criteria and more alternatives can be added to the model to meet the operational needs of a valuer. For example, the criterion 'land uses' may be subdivided into 'previous uses', 'current use' and 'proposed use'. The criterion 'contamination' may be subdivided into 'type of contaminant' and 'degree of contamination'. Figure 7 – 25 shows a part print of the expanded model.

Figure 7 – 25 Expanded AHP model



Another feature of the model is that it is non survey-based and, unlike some of the alternative methods, does not require a large amount of market data to operate. It is more suitable to the day-to-day operation of a valuer. From the case studies, it can be seen that the model has a high degree of tolerance. A preferred stigma factor is returned disregarding whether the given range of probable stigma factor is narrow (2% - 6%) or very broad (5% - 30%). Further, the model is time independent. The change of risk perception over time can be easily accommodated in the model. The valuer may make the necessary allowance by suitably rating the criteria. Criteria may be easily added or removed from the model according to the change of risk perception.

Nevertheless the model requires the carrying out of complex calculations that are too difficult to be done manually. The learning curve of the required mathematics is too steep of most valuers. Fortunately, this problem can be overcome by using the suitable software and computing equipment. Critics may say that this is a black box approach, but this is not a problem. As long as it helps valuers get the answer, it is a good method. It should be noted that the model suggested here is flexible and can be changed by the valuer to suit his or her need. The 16-criteria model demonstrated in this study took less than an hour to complete. Once the model is

constructed, it can be repeatedly used. Although it may appear to be a bit complicated to use the model, the process is actually no more complicated than a discounted cash flow analysis.

7.10 Conclusion

There are different methods to value contaminated land. The impaired value approach is by far the most logical and popular method. Where there is no stigma impact on a particular contaminated property, the impaired value can be readily assessed. However, when stigma exists, the valuer will find it difficult to apply this approach because of the difficulty in quantifying the stigma impact. The reason is that stigma is a conceptual thing that is not entirely based on market evidence. There are several methods to estimate the stigma impact, but they are not satisfactory.

Research from overseas and in Australia show that stigma factor can be expressed as a percentage of the unimpaired value of the contaminated property. There are a number of criteria affecting the stigma factor. The wide array of criteria can be best handled by a MCDM method. In this study, AHP is the chosen MCDM method. Using the AHP approach, a MCDM model is constructed on the basis of 16 criteria. In this research, for the purpose of simplicity, only one criteria layer and three alternatives are included in the model. In real life, if the valuer thinks fit, the number of probable stigma factors and layer of criteria may be changed to suit the requirement.

The test results of the six case studies are encouraging. The test results show that the model is indifferent to the range of alternatives, it works equally well from a narrow range (2% - 6%) to a very wide range of (5% - 30%). The reassessed values were within acceptable ranges. The 'margin of error' is mainly due to the fact the impaired values are reassessed with hindsight knowledge. Although the revaluations are assumed to be carried out on the same conditions as the original valuations, valuers may nevertheless have been influenced by subsequent information about the site. One way to narrow the gap caused by the hindsight valuation is to have one or more sub-criteria layer for consideration. It is also constructive to allow more probable stigma factors in the model such that the choice of target stigma factors can be further refined.

No doubt some well experienced valuers may estimate the most probable stigma factor using the existing 'guesstimation' or 'gut-feeling approach' without difficulty. However the skill is difficult to master and difficult to justify. The proposed AHP model fills the gap by providing a more scientific and systematic alternative to help less experienced valuers assess stigma factor. The model may also help the well experienced valuers to verify the accuracy of their 'guesstimates'. The model is not for valuers without any experience in contaminated land valuation. Under the Code of Ethics of the API and the provision of the Valuers Registration Act 1975 (NSW), valuers are not allowed to accept jobs outside his or her expertise.

Critics may argue that the three probable stigma factors are arbitrary figures. This allegation is not entirely without ground because the probable stigma factors are based on the valuer's experience or intuition. However, one should note that the figures are not the result of a blind guess, they are based on expert opinion.

In comparison with the current 'guesstimation' or 'gut-feeling' approach, the AHP model is a much improved approach. It provides a structured and transparent decision making framework for the valuer. It requires the valuer to consider not just one but three probable stigma factors (it could be more). In addition, the valuers are explicitly required to consider and rate each criterion relating to the probable stigma factors. This is a more logical, scientific and defensible alternative to the current practice. With the help of the appropriate software and computer equipment, a valuer can easily carry out the stigma factor assessment. The model is suitable for the day-to-day operation of a valuer. Nevertheless, it should be noted that the model requires

the valuer to firstly estimate a range of probable stigma factors. If the valuer is unable to do this or if the data inputs are unreasonable, the model is unable to give a reasonable answer. Since the valuer needs to apply personal judgement when using the model, different valuers will get different end results from the same model. The model cannot change the nature of valuation and turn it from an inexact science into an exact science.

Another important feature of the model is that it is time independent. The change of environmental risk perception over time is directly reflected in the necessary ratings required by the model. Unlike statistical method such multiple regression analysis which requires the construction of a new model for each circumstance, the AHP model can be used in different circumstances. The valuer needs only to rate the criteria accordingly to available evidence of the target property. Even if a particular criterion is no longer appropriate, the valuer needs only to assign a zero rating to it. There is no need to change the model. Likewise, new criteria (concerns) may easily be added to the model. More detailed consideration of the criteria can be easily carried out by incorporating the appropriate number sub-criteria layers to the model.

In comparison with other contaminated land valuation methods, the impaired (affected) value approach coupled with the AHP stigma factor assessment model has obvious advantages. It does not require the conduct of any survey for individual valuations and does not require the availability of a large amount of contaminated land sales data for analysis. Valuers need not to have special knowledge to carry out the valuation. The complex calculation is taken care of by the computer and relevant software. The idea of rating criteria and alternatives is completely within the existing knowledge of valuers. Hence the learning curve of using the model is relatively gentle.

The model suggested here does not mean to be definitive. Its simple structure is aimed at demonstrating that it is a workable method to assess stigma factor. The model shown here only provides a framework upon which a more detailed model can be built. The stigma factor is only one of the many valuation elements that a valuer has to exercise judgement. Since the model works with the stigma factor, it has a potential to be extended to assess other valuation-related elements that a valuer has to exercise judgement. Accordingly, it is possible to apply a suitably modified model to assess valuation elements such as yields, vacancy rates, rental value and prices. Given the advantages, it is worthwhile for the relevant professional body to consider further verifying the validity of the model and promoting the approach to the valuation profession.