THE APPLICATION OF COMPENSATORY RULES TO MODEL PRIVATE SECTOR LAND USE INVESTMENT

van de Wetering, A. and Del Mistro, R.[1]

Africon Engineering
1040 Burnett Street, Hatfield. Tel: (012) 427-2724. E-mail: Adrivdw@africon.co.za
[1]University of Pretoria

ABSTRACT

There is a belief that private sector investment occurs in non-optimum locations in terms of the development of the city. If urban planners were able to understand private sector decision-making, they could plan to change investors' current behaviour into investing at locations that are considered more optimal in terms of the city as a whole rather than the individual investor. This creates a need to predict the probability of private sector investment in a proposed development location, node or corridor.

Decisions may be made in two stages: in the first stage, alternatives are screened by some non-compensatory process, and in the second stage, the remaining alternatives are evaluated in more detail, perhaps with a compensatory decision rule

In compensatory decision-making, the favoured option is selected by optimising a single objective function. It is reflected by multi-attribute utility models and is widely accepted as reflecting a rational procedure of choice

This paper investigates the use of compensatory rules to model private sector land use investment. Stated preference interviews were used to collect data. Logit modeling was used to set up a model.

It was found that developers have a specific mind-set on where they want to develop. It is however possible to change their location decisions by providing certain incentives. The study has been successful in providing guidelines as to the change and the amount of change needed in existing attributes to induce that the investment be made in specific areas.

1. BACKGROUND

Urban land use and transport are closely inter-linked. The spatial separation of human activities creates the need for travel and the transport of goods, and is the underlying principle of transport analysis and forecasting.

Inefficient cities (in terms of planning objectives) are created due to the private sector not investing as per plan. Planners and decision-makers in public authorities make decisions on the desired location of private sector investment and transportation planning policies based on forecast land use, without being able to consider the factors affecting the location choice of private sector property investors / developers. If these decision-makers were able to understand private sector decision-making, they could plan to change investors' current behaviour into locating at locations that are considered more optimal in terms of the city as a whole rather than the individual investor.

This creates a need to predict the probability of private sector investment in a proposed development node or corridor.

The study described in this paper was aimed at developing an understanding of the logic behind private sector decisions to invest in development. Once such an understanding was reached, a model to predict the probability of private sector investment in a proposed area was developed. It is not expected that the model will be able to model individual decision-making; but rather to provide an indication of the probability that an investment will occur at a specific location.

The study was conducted, using two methods: first, using a qualitative survey technique to explore decision making behavior in new contexts and the second using the stated preference technique to develop a quantitative model of the decision making process. Stated preference provides the opportunity for respondents to make choices between hypothetical options.

The following assumptions were made:

- Private sector investment is based on rational decision-making.
- Rational decision-making could be based on compensating between the attributes of competing options, eliminating options on the basis of one aspect at a time or other methods.
- Modeling cannot reflect, a single decision, but can possibly reflect the probability of a choice being made and build an understanding of what can prompt private sector investment decisions.

The basic idea of rational decision-making is that each person has a set of given alternatives and knows the consequences of each. Based on a formula the rational person will make a decision. There are a number alternative theories applied to decision making which depend on the end goal, but in each theory the individual is trying to make an OPTIMAL decision (March & Simon).

2. INVESTMENT DECISIONS

Investment has to do with the creation, enlargement and protection of wealth. All investors have two main targets (Isaac, 1998). Firstly, they want the 'return' to be high. Secondly, they want this return to be dependable and stable. The investor is often faced with a series of investment instruments competing for the available funds; there are three major investment areas, fixed interest securities, company stocks and shares, and real property (Hargitay & Yu, 1993)(Isaac, 1998).

The market in real property contrasts with that of the other two investment areas (Isaac, 1998). The property industry shows a cycle of activity, which reflects the general business cycle (Isaac, 1996). The rate at which development takes place depends on the availability of financial resources, which in turn depends on the economic growth phase of the economy (Cloete, 1994). The demand for development in a location comes from one of three situations namely growth of an industry, emergence of a new industry or relocation of existing business (Schmenner, 1982).

Once a firm needs to build a new facility or relocate, the selection process follows two stages. The first stage involves the selection of a region and the second the selection of a specific site within the selected region (Kotler et.al., 1993). The regional selection is based on overall economic criteria related to the factors of production (Kotler et.al., 1993)(Hack, 1999). Many of the factors, influencing the selection of a region are the same as the factors used for selecting a site. They are often just applied differently.

Decisions may also be made in two stages: in the first stage, alternatives are screened by some non-compensatory process (e.g., elimination-by-aspects), and in the second stage, remaining alternatives are evaluated in more detail, perhaps with a compensatory decision rule.

It can be assumed that an individual uses a set of criteria or objectives on which to base his or her choice. A set of rules needs to be designed to reflect to what degree the components of the objective function are being achieved. The rules need to reflect compensatory and/or non-compensatory decision-making. A compensatory or non-compensatory distinction is made on the basis of whether a gain in one attribute can be traded for drawback in another or not. If trade-offs are not permitted the choice strategy is non - compensatory.

In compensatory decision-making, the favoured option is selected by optimising a single objective function. It is associated with multi-attribute utility models and is widely accepted as reflecting a rational procedure of choice (Shiloh et. al., 2001). In contrast to compensatory processes, non-compensatory choices do not involve "trade-off" behaviour (Foerster, 1978). Non-compensatory processes aim at a 'good enough' rather than the best choice and are thus considered by many as less rational (Shiloh et. al., 2001). Individuals seem to have personal bias towards using either compensatory or non-compensatory decision strategies (Shiloh et. al., 2001).

In this study, compensatory rules were assumed to apply, because of the robustness of the utility maximisation models.

3. OVERVIEW OF THE STUDY

The theories behind the methodology is that of the stated preference technique and utility maximisation. The term "stated preference" refers to a number of possible ways of asking consumers about preferences, choices, ways of choosing options and so forth (Louvier & Street, 2000).

The stated preference approach assumes that the decision-maker makes the choice that will maximize his/her utility from that choice (compensatory decision-making). This approach is based on random utility theory and attempts to estimate the probability of an individual choosing a given option on the basis of the relative attractiveness of the option, which may or may not be influenced by his/her socio-economic characteristics. (Arentze & Del Mistro, 2002). The multiple logit model used in this study is:

$$P(i) = e^{f(i)} / \Sigma e^{f(x)} \qquad [1]$$

Where P(i) is the probability of choosing alternative i; and f(i) is the utility function of alternative **i**. The objective in building location choice model is to determine the utility function for each alternative. A linear utility function was used where

$$F(x) = ax_1 + bx_2 + cx_3 \qquad [2]$$

The study commenced with the identification of the attributes through the literature review and several open-ended interviews with developers and investors (See Section 4.1). Thereafter followed the experimental design. The design strategy was to offer discrete choice situations. To consider all effects, a full factorial design is needed. The number of attributes (a) and the number of levels each one can take (n), determine a factorial design (n^a) (Ortuzar & Willumsen, 1994). For this experiment there are 5 attributes with 3 levels and 1 with 4 levels, thus 3^5 x $4^{1,}$ which means that 972 profiles would be needed to consider all effects. This is not practical since so many options will tend to induce fatigue in the respondent and reduce the quality of the responses (Ortuzar & Willumsen, 1994). Instead, a fractional factorial design was used. The actual design was derived from the experimental designs by Kocur (Kocur et. al., 2000). This resulted in a questionnaire with 25 choice pairs. Then the data was collected, by interviews using the stated preference questionnaire. 17 Stated preference interviews were conducted, 2 respondents were interviewed twice, once with only 2 options and once with the 'neither' option included.

To measure the goodness-of-fit, a log likelihood-ratio index, rho-squared (ρ^2), is calculated.(Louvier & Street, 2000). Because of the small sample size, the rho-squared values might indicate a better fit than is really the case.

Three sets of data were derived from the responses to the questionnaire; namely:

- The first based on the choice between two options
- The second based on two options and the do-neither option
- The third based on the ranked value of choice.

LIMDEP (Greene, 1998)(an econometric software package) was used to obtain the coefficients for the equation. These coefficients were used to construct nine different equations. Out of the set of stated preference interviews, three different data sets were set up. The same answers were just presented in different formats. The first data set, shows all the choices made. The second data set shows only the final choice. This means that if the 'neither' option is chosen, you cannot see which alternative would have been preferred. The last data set, Ranking, contains ranked data.

Each data set was run three times. The first time, all attributes were used. With the second run, only the location attributes were used. With the third run, alternative specific values were used, instead of the generic values.

The equations were compared on the basis of the following criteria:

- The best / good Rho-square value
- The signs of the attributes must be logical
- The attributes must be statistically significant
- The modeled answers must compare well with the real answers; and
- The equation must be useful to simulate real life situations

The best equation was selected for further analysis The elasticities of the attributes was tested to determine the relative impact of the various attributes. Direct elasticity measures the percentage change in the probability of choosing a particular alternative in the choice set with respect to a given percentage change in an attribute of that alternative (Louvier & Street, 2000) (Kocur et. al., 2000).

4. RESULTS OF THE STUDY

4.1 Relevant attributes

The relevant attributes were identified by interviewing 10 developers and investors in informal interviews, using open-ended questions. Each developer or investor was asked to list the most important factors in location choice, they were also asked to explain why these factors are important. The developers were then asked to illustrate by example how they have made decisions in the past.

Each respondent listed a number of factors, which he/she considered important when making location decisions.

It was decided that 5 attributes would be used in the questionnaire namely, cost (scale) of the development, equity stake, return on investment, time to construction and location. Four locations were used in the alternatives presented to the respondents, namely: up-market area, suburbia, the CBD and near a township.

4.2 Utility functions

Table 1 provides the results of the nine LIMDEP analyses. Only equation 1 is discussed further in this paper.

Table 1. Coefficients And Statistical Measures For Equations.

Equation	Basis of equation		Constant/ Probability	Cost (Rmillion)	Equity (%)	Return (% above interest)	% Let	Time to construciton (month)	CBD	Township	Suburb	Upmarket	ρ^2
1	All choices; Generic values		Constant	-0.008	-0.036	0.093	0.023	-0.042	-0.831	-1.288	0.812	1.276	0.425
			P	0	0	0.002	0	0	0	0	0	0	
2	Final choice; Generic values		Constant	-0.014	-0.075	-0.018	0.008	-0.072	-0.910	-0.901	0.722	1.299	0.55
			P	0	0	0.688	0.032	0	0	0	0	0	
3	Ranked data; Generic values		Constant	-0.013	-0.055	-0.069	0.014	-0.059	-0.815	-0.876	0.707	1.150	0.411
			P	0	0	0.025	0.0001	0	0	0	0	0	
4	All choices; Location only		Constant	N/A					-0.367	-1.108	0.527	0.954	0.317
			P						0	0	0	0	
5	Final choice; Location only		Constant	N/A					-0.540	-0.861	0.524	0.887	0.369
			P						0	0	0	0	
6	Ranked data; Location only		Constant	N/A					-0.497	-0.865	0.531	0.845	0.237
			P						0	0	0	0	
7	All choices; Alternative specific values for CBD, Township, Suburb & Upmarket	C	Constant	-0.009	-0.042	0.065	0.015	-0.044	N/A				0.143
			P	0.036	0.010	0.21	0.0002	0.0003					
		T	Constant	0	-0.003	-0.332	-0.009	0.016					
			P	0.998	0.966	0.043	0627	0.790					
		S	Constant	-0.005	0.0020	0.145	0.028	-0.054					
			P	0.437	0.991	0.163	0.0007	0.012					
		U	Constant	-0.007	-0.012	0.248	0.035	-0.035					
			P	0.066	0.772	0.1873	0.1443	0.2538					
8	Final choice; Alternative specific values for CBD, Township, Suburb & Upmarket	C	Constant	-0.013	-0.097	-0.093	-0.010	-0.076	N/A				0.580
			P	0.065	0.0001	0.243	0.158	0.001					
		T	Constant	0.004	0.193	-1.201	-0.093	0.188					
			P	0.614	0.066	0	0.0005	0.040					
		S	Constant	-0.050	-0.067	0.298	0.044	-0.181					
			P	0	0.025	0.051	0.0003	0					
		U	Constant	-0.142	-0.388	1.820	0.199	-0.334					
			P	0	0	0	0	0					
9	Ranked data; Alternative specific values for CBD, Township, Suburb & Upmarket	C	Constant	-0.012	-0.069	-0.083	-0.007	-0.066	N/A				0.431
			P	0.037	0.001	0.137	0.094	0.0004					
		T	Constant	-0.005	0.175	-1.125	-0.073	0.178					
			P	0.343	0.036	0	0.0003	0					
		S	Constant	-0.037	-0.039	0.212	0.034	-0.142					
			P	0	0.063	0.075	0.0001	0					
		U	Constant	-0.130	-0.344	1.649	0.186	-0.300					
			P	0	0	0	0	0					

Equation 8 had the best Rho-squared value. But seven of the signs of the coefficients do not seem logical and six of the attributes cannot be proven to be statistically significant. Therefore it was decided look at the equation with the next best rho-squared value. The second best rho-squared value was 0,556. This equation had one coefficient with an illogical sign; that of rate of return, but at the same time it cannot be proven that rate of return is in fact statistically significant.

When the modeled answers of this equation were compared to the real answers, it only provided 56% correct answers.

Ultimately the choice_all equation (with generic coefficients) was selected. The utility function of the choice_all equation is as follows:

$$\text{Utility} = -(0.008*\text{Cost})-(0.036*\text{Equity})+(0.093*\text{Return})+(0.023*\text{Let})-(0.042*\text{Time})-(0.831*\text{CBD})-(1.288*\text{Township})+(0.12*\text{Suburb})+(1.276*\text{Upmarket area}) \quad [3]$$

It has the third best rho-squared value. It is also the only equation in which all signs appear logical. It certainly seem to be the best, for the 1st choice with 71% correct answers and 59% for the final choice. The first choice is the choice between the two alternatives and the final choice includes the "neither" option. The equation would also be useful to simulate the real life choice situation, because in real life the developer will choose only one option, this could also be not to develop.

5. POLICY TESTING

This section deals with the application of the "best" model to test the impact of various attributes on location choice.

5.1 Basic conditions

Some basic conditions for development were identified. During the stated preference interviews, respondents often explained why a specific choice was made. These comments were used to identify the basic conditions. *Percentage equity* was an important attribute, an equity stake greater than 20% was considered to be unacceptable. It could however be accepted when 80% of the property is pre-let. The minimum *percentage let* that would be accepted in an upmarket area was as low as 20%, since the developers believe that the development would be fully let by the time of completion. It was assumed that there is a linear relationship between percentage let and percentage equity. A *time to construction* of 24months would be unacceptable. These basic conditions were used to draw a conceptual diagram (see Figure1) of when, on average, a developer would feel comfortable to develop, when all else is favourable (e.g. in upmarket area and rate of return bigger than interest rate). The highlighted area indicates favourable conditions for development.

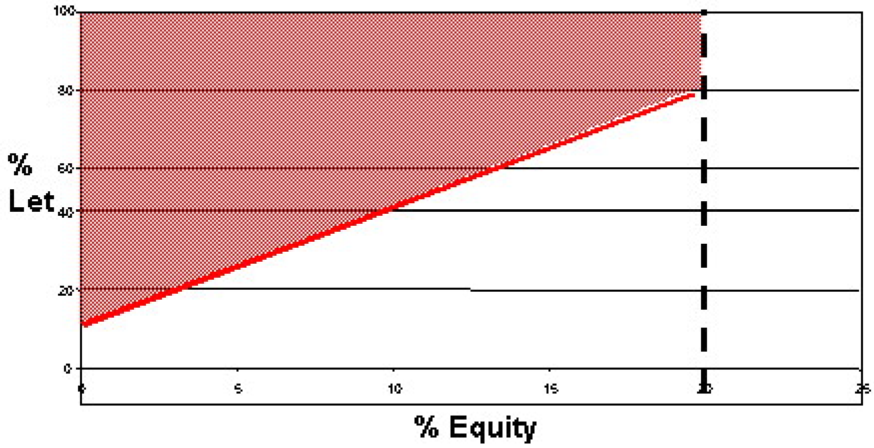

Figure 1. Basic conditions for development.

5.2 Model Application

The model was applied to the following hypothetical example:

A developer wants to develop a R10 million, office development. The developer has potential tenants for 30% of the development and needs to provide an equity stake of 10%. The time to construction for the development is estimated to be 18 months.

His first choice would be to locate in an up-market area (with a probability of 58,5%). In comparison to the up-market area, the model predicts the following probabilities for locating elsewhere:

- A 23,4% probability of locating in the suburbs
- A 10,9 % probability of locating in the CBD
- A 7,2% probability of locating in a township area

The developer would therefore probably not develop in any of the other areas. Intervention will be needed to change this decision. The graphical application in Section 5.3 explains the different policy options.

5.3 Graphical Application

Intervention is needed to change the location choice of a developer from e.g. an up-market area to the CBD. Of the six attributes (size, percentage equity, rate of return, percentage let, time to construction and location), municipalities can only intervene in four:

- *Percentage equity*; by e.g. granting a long term loan, providing the land at little or no cost to the developer, so that less equity is needed;
- *Rate of return*; by e.g. providing equity at low interest rates or reducing property tax as an incentive which will reduce the operational;
- *Percentage let*; by e.g. being a major tenant; and
- *Time to construction*; by either putting a moratorium on development in the up-market areas for a specific time, or by granting development rights in areas that are not attractive to investors, without a long rezoning or development approval process.

From the equation it is apparent that the rate of return only has a minor effect on the utility function, compared to the other three attributes. Therefore it was decided to only use percentage equity, percentage let and time to construction in further analysis.

The equation was set up in a spreadsheet. The values of the attributes for the preferred location (e.g. upmarket) were kept constant with percentage let at 0% and percentage equity at 20%. By keeping this constant and at the worst level, the values of the attributes of the alternative location would indicate the differential of the attributes. Percentage equity of the alternative location was set at 0, 5, 10, 15 and 20% respectively and the percentage let was then modified until the probability of choosing the alternative location reached 50%. This was repeated for a 0, 6 and 12 month saving in time to construction. In other words the time to construction period for the preferred location was e.g. set at 18 months and that of the alternative location at 18, 12, and 6. Cost and rate of return were kept constant and equal throughout, to prevent them from influencing the probabilities.

Having a probability 0,5 of locating in e.g. in the CBD could also be interpreted as 50% of all development going to the CBD. The differential values were then plotted on curves (Figure 2).

The curves clearly indicate a linear relationship between percentage let and percentage equity, except where boundary conditions prohibit it (cannot have more than 100% let or less than 0% equity). The larger the percentage equity required, the larger percentage let is needed to initiate change for a given construction period. For every 5% increase in the differential in equity there is an 8% decrease in the differential of percentage let that is needed.

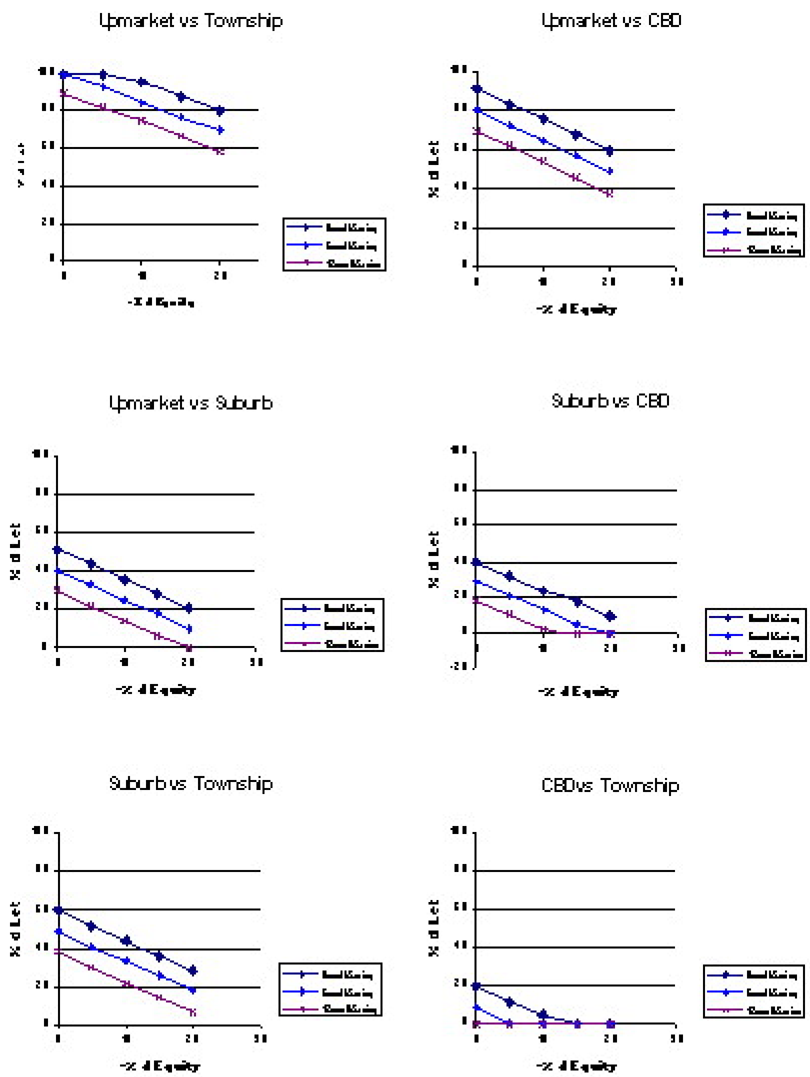

Figure 2. Attribute differences and 50% probability of choosing location.

Time to construction does not affect the shape of the curve; it does however move the curve vertically. A saving in time increases the influence of the change in percentage let and percentage equity.

Similar graphs could be drawn for any probability.

<u>5.4 Example of graphical application</u>

A worked example is used to explain the meaning and use of the curves. The example in Section 5.2 continues:

The developer hands in an application at the City Council for a R10 million office development in an up-market area. The council would prefer that development take place in the CBD. The developer has potential tenants for 30% of the development and needs to provide an equity stake of 10%. The time to construction for the development is estimated to be 18 months.

The percentage change needed in the percentage equity and percentage let, to have a 50% probability that the developer would choose to locate in the CBD are shown by the valeus indicated in Table2

Table 2. Change needed in % Equity and % Let.

Change in equity	**Change in % Let**		
	0 month saving	***6 month saving***	***12 month saving***
-0%	+92	+81	+70
-5%	+84	+73	+62
-10%	+76	+65	+54
-15%	+68	+57	+46
-20%	+60	+49	+38

(cyan)	Not applicable	(green)	Applicable

Table 2 shows the increase in % let required to achieve a 50% probability that the developer will choose to locate in the CBD faced with the reduction in % equity and time to construction. Some of the increases in % let and % equity are not applicable because of current % let (i.e. can only increase by 70%) and % equity (can only be decreased by 10%). Only the options highlighted in green are feasible strategies to induce developers to locate in the CBD rather than in the up-market area.

Thus to convince the developer in this example to develop in the CBD instead of in the up-market area the following options are available:

- 10% equity with 100% let and a time to construction period of 6 months;
- 5% equity with 92% let and a time to construction period of 6 months;
- 0% equity with 95% let and a time to construction period of 12 months; or
- 0% equity with 84% let and a time to construction period of 6 months.

All these options are subject to the expected rate of return in the CBD being the same as in the upmarket area. Applying these strategies would provide and probability of 50% that the developer will change his/her mind. In practice the authority could approach all developers in the hope that 50% would 'choose' to develop in the location considered to be desirable by the city rather than where the private secgtor wodu choose to; e.g. in the CBD.

6. CONCLUSION

As a result of this study, the following conclusions can be drawn:

- There are various factors that investors / developers take into account in making a decision on a development. The most important are with the cost of the development, percentage equity, rate of return, percentage let and specific.
- Developers have a specific mind-set on where they want to develop. It is however possible to change their location decisions by providing certain incentives.
- The study has been successful in providing a methodology on the amount of change needed in existing attributes to increase the investment in areas other than those usually selected by property developers.
- It still remains very difficult to direct development away from the up-market areas to the townships and the CBD. The intervention needed is quite substantial. This is due to the large negative influence a township or CBD location has on the perceived utility function. It could however be that once developers start moving to the CBD or the townships, that these locations would become more attractive due to the presence of these developments. The first developments could serve as a catalyst to other development in these areas.

- The probability of choosing an alternative with an upmarket location is less sensitive to change in its attributes than the other alternatives.
- The probability of choosing an alternative with a township location is more sensitive to change than any of the other alternatives. This means that a larger change in the attribute size is required to effect a reasonable change in probability.
- The stated preference technique provided useful results. It is a valid technique to explore further.

7. RECOMMENDATIONS

It is recommended that further research be conducted with regard to the following aspects;

- The other attributes that could have been used. Rate of return for example was expected to make a much bigger contribution to the decision than it did, it could be that the concept of rate of return was misunderstood or misinterpreted.
- The qualitative measures that could be tested.
- More developer segments could be used.
- A comparison between sub-areas of the up-market areas.
- Test the decision-making using non-compensatory rules. From the open-ended interviews and comments made during the completion of the questionnaire, it became clear that some developers might use non-compensatory decision-making (wholly or in part) rules to make their decisions. Some aspects are simply not negotiable.
- Tighter specifications of some of the variables (e.g. Rate of return at what point in time)
- Modelling within the inherent environment, the property cycle.
- Comparing models developed using Stated Preference with those developed using Revealed Preference data

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Africon Engineering
1040 Burnett Street, Hatfield. Tel: (012) 427-2724. E-mail:Adrivdw@africon.co.za
[1]University of Pretoria

Biography

Adri van de Wetering

After graduating with a B.TRP (Town and Regional Planning) degree, Mrs van de Wetering was a full time MSc (Transportation planning) student at the University of Pretoria. She completed her MSc degree in August 2002. She joined Africon in July 2002 in the Transportation Division as a Transport Modeller / Planner.