HIGH RISE AND LAND COSTS; A THEORETICAL FRAMEWORK

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Abstract: In the Netherlands, the number of realized high-rise projects is limited. Land owners and developers are searching for conditions and boundaries under which high-rise is feasible. The research started on high rise costs with literature review, and by interviewing experts working on high-rise projects and cost modelling. One of the outcomes of the descriptive model is the increase of costs with the increase of height. Land costs are equally important. As is the case for rent levels land costs depend most of all on location. Traditionally land costs are determined based upon the value of land, in which gross floor area is leading. For the developer lettable floor area and efficiency is leading. A sub model is set up for land costs in which the land owner as well as the developer can maximise their profits within reasonable limits. This model will be further developed and discussed in the field.

Keywords: High rise, Initiative design phase, Integrated building cost model, Land costs, Real estate & urban economics**.**

1. INTRODUCTION

This paper elucidates one of the items belonging to a more extensive research 'High Rise Ability' (De Jong, Oss et al. 2007, De Jong 2007). One of it's tentatively conclusions is the increase of building costs with the height in combination with the decrease of efficiency of floor plans, again with the height. Those effects lead to a limitation of the feasible building height, at least if the building costs are the main perspective. Land cost takes up another substantial part of the investment. High rise in the Netherlands is in most cases a combined action of the developer, taking the initiative and the local government providing land and setting the rules. The developer as well as the local government may have, with different arguments, reasons to reach a certain height. The developer wants to realise a certain volume for its investor or the future owner. With a given plot size, the required height is almost a mathematical result. Some developments may require the establishment of an icon or a landmark. The local government wants to create a certain density on a location in optimising land use.

The developer, confronted with the feasibility boundaries in height, may search first for an internal solution of the problem. A different subdivision is the first focal point, lowering the cost of land in favour of the building cost. This standard Dutch residual approach, in which land cost is related to the gross floor area, is no longer an option for high rise above a certain height. Alternatively, an external approach is possible. If the external economies are taken into account, the group of stakeholders and contributors can be enlarged. Further research will focus on these externalities.

2. BUILDING COSTS AND EFFICIENCY

High rise ability is a research project in order to clarify the economic boundaries in the Dutch context. Building costs have a large impact. But impact and size are different entities. The share of building costs, as a part of the construction costs, takes a humble place in the total process, because:

- Building costs are only a part of the total investment. In the feasibility study land costs and other additional costs may have a larger impact and are more negotiable.
- Value creation means more to a project then only looking at the cost side of the balance, in which the building costs or even the investment may be treated as a fixed figure, or based upon indices and the required gross floor area.
- Compared to life cycle costs building costs, as well as the total investment costs, are only a fragment, although the design itself may have a large impact on the life cycle costs,
- Looking at the turnover of the building in its life time the building costs become really modest. The impact of design and building costs on this turnover in terms of a building (not) meeting the needs of the user can be huge.

At the same time proper understanding of building costs is vital. Where market, rental revenues and land costs are hard to adjust on a given location, all participants are looking at the design, which has to provide the way out. The designer must consider the needs of the future users in order to trigger the willingness to pay. Feasibility is depending on the balance between revenues and expenditure (Fig. 1). The total investment is for a substantial part depending on building costs in its relation to the design. The building costs becomes even more crucial because other items like building site costs, fees, taxes, interest and so on are related to the building costs, at least in the early stages, where the percentage approach is very common.

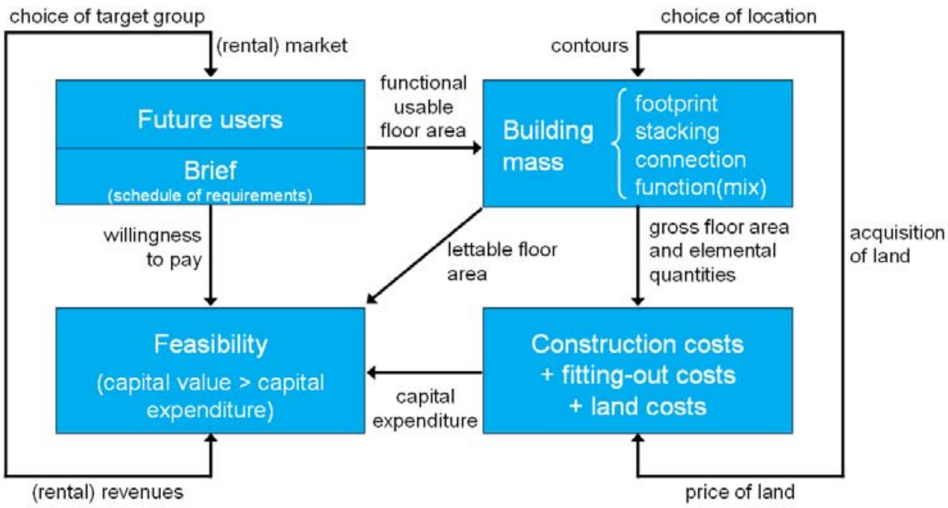


Figure 1: Development of buildings (Soeter et al. 2005)

2.1 Specific costs of high rise

There are many definitions of high rise/tall buildings buzzing around in the world. In this research the physical lower limit of 70 meter is used, due to the fact that from that height up specific regulations are required in the Netherlands.
A more appealing definition is given by the Council on Tall Buildings and Urban Habitat: "A tall building is not strictly defined by the number of stories or its height. The important criterion is whether or not the design, use, or operation of the building is influenced by some aspect of tallness." (CTBUH, 2007) Otherwise it is just a case of stacking floors. With respect to this definition high rise projects are buildings in which specific measurements with regard to that height are taken.

The definition of the Council includes specific measurements and therefore specific costs. The peculiarity of these additional costs is listed by Langdon (Langdon and Watts 2002, Watts 2002, Reus 2004):

- Increased wind loadings and heavier frames.
- Vertical transportation requirements, particularly elevator capacities, speed, zoning etc.
- Larger capacities of plant and distribution systems together with the increased pressures/hydraulic breaks required to deal with increased vertical distances.
- The effects of scale and complexity on the movement of materials and labour.
- The risks associated with the uniqueness of high rise and the fact that these risks are exacerbated by scale and the need to access a limited pool of skills and expertise
- The potential interest in including elective security and safety enhancements in response to possible risks.

One of the means given in literature to cope with these effects is the introduction of a height charge: a factor that brings the additional costs for the specific conditions into account. An elaborated example of such a height charge is given by Gossow (2000).

The research 'High rise ability' (HRA) should result in a design model for building costs and financial feasibility of high rise. Costs will be the main focus for feasibility, especially where the model will function as a decision tool. Other aspects of feasibility (revenues, value creation, sustainability, social acceptance etc.) may have a larger impact. The objective is to get a detailed estimation of building costs of high-rise office buildings in the initiative and early design phase, while limiting the number of required design parameters to those known at the initiative phase.

The research started with a state-of-the-art literature review, and by interviewing experts working on high-rise projects and cost modelling. This resulted in an integrated model, which is now being evaluated in practice. The modelling approach is based on the previous modelling approach for the initial cost estimate for office buildings, Svinsk (De Jong 2006) and the PARAP research (Bijleveld and Gerritse, 2006). The starting point for these modelling approaches is best described by Gerritse (2005).

The characteristics of high rise buildings are described and the essential parameters are defined. This interim result (Oss 2007) is represented in figure 2.

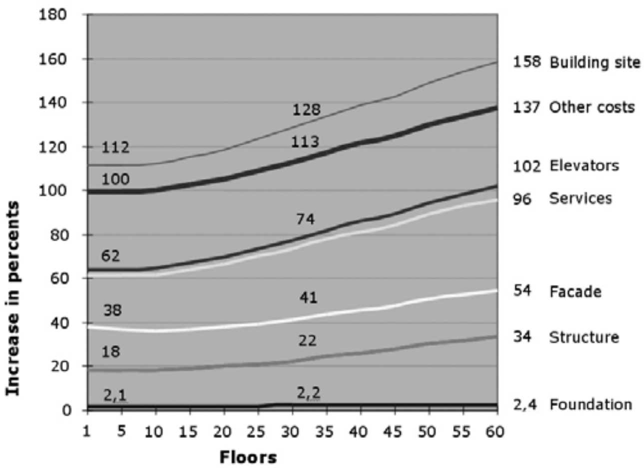


Figure 2: Increase of building costs (Oss 2007)

Where the first graph (Fig. 2) gives the stacked costs, Figure 3 gives a more clear presentation of the contribution of the single elements. Here all the results are combined in a single graph and stacked per 10 floors. It can be noted that structure, installations, elevators are the main risers (contributing to the total direct building costs with an average of respectively 16, 25 and 3 %).

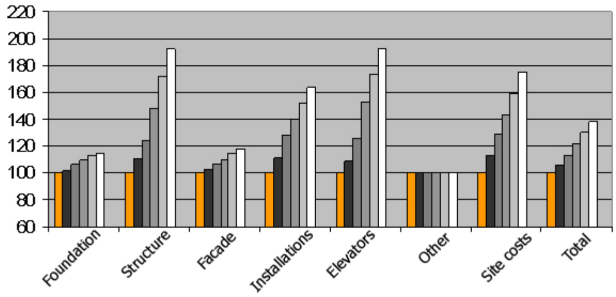


Figure 3: Increase of building costs per element (Oss 2007)

2.2 Efficiency of high rise

Where the expenditure is determined by the building costs per gross floor area (gfa), the revenues are based upon the lettable area (la). Feasibility of high rise is a matter of controlling the efficiency of the building. Efficiency is in this case defined by the ratio between lettable/leasable area and gross floor area. Not only the building process itself but also the high rise building in use may be compared to the making of a ship model in a bottle. Every piece of material has to pass the bottleneck, making the logistics, the vertical transport, exceptionally important.

Table 1: Building efficiency (Langdon 2002)

Number of floors	Efficiency (%)
2 to 4	88 – 91
5 to 9	84 – 88
10 to 19	77 – 85
20 to 29	75 – 83
30 to 39	74 – 79
40 +	72 – 77

Langdon (2002) shows that while the costs are increasing with the height, the earning capacity of the building is decreasing, in which the vertical transport with the 5 % of the gfa for the elevators takes its substantial contribution. The graph with a similar result of the HRA-model (Fig. 4) shows a similar decrease of efficiency, but here the number of floors is combined with the floor area.

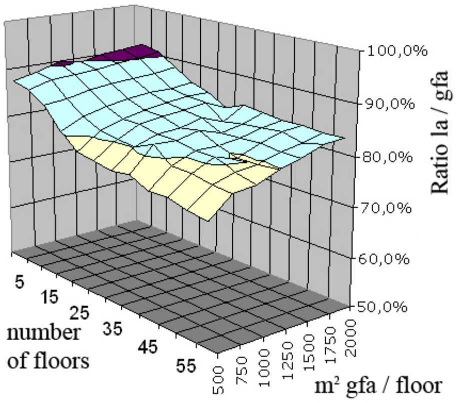


Figure 4: Ratio gross floor area and lettable area (Oss 2007)

Figure 4 shows the effect of the height on the ratio gross floor area versus lettable area. As can be seen on the gfa/floor axis the difference between small floor plans and larger floor plans can be dramatically. The worst results in the sense of efficiency and feasibility are appearing with tall buildings with small floor plans. However, Dutch regulation (daylight requirements for office workers) obstructs the application of Sears-tower like floor plans (67.5 x 67.5 m^2). Floor plans like the one of the 'Nationale Nederlanden' (the tallest office in the Netherlands until the end of this year) are more likely (22.5 x 45 m^2). The graph above could be simplified into a linear expression (average floor size of 1000 m^2) in which the efficiency is decreasing with around 0.40 % per floor.

3. LAND COST

Building costs and efficiency have a national character due to national legislation. Feasibility is much more defined by location and the market and therefore has a national as well as a local aspect. As stated by a colleague working in the Hong Kong environment: "Land costs are so dominant, it does not matter how you make high rise, as long as you make it!" Educational projects have been showing that certain high rise designs are not feasible in Rotterdam, while the same design would be feasible in Amsterdam, where the higher rent level sufficiently compensates the higher cost of land. The supply of land is an activity of the local government in The Netherlands. It is normal for the municipality to buy up land which is zoned for development in the ensuing period, if necessary using its powers of compulsory purchase to ensure compliance on the part of land owners, to provide infrastructure, and to sell the sites on to construction firms for development (Evans 2004). In this way The Netherlands are very different from Britain and the USA. The municipality interferes in the setting of land prices. They exercise a functional land-price policy. For commercial real estate prices are based on the standardized residual value approach, based on average construction costs and additional expenses assumed pro function (Van der Post 2007).

Table 2: National differences in land policy structures (Van der Post 2007)

Implemented conditions	**Amsterdam**	**Houston**	**Frankfurt**	**Stockholm**
Dominant actor	Local government	Market	Market	Local government
Public ownership	Substantial (80 % municipality)	Only open space	Only open space	Substantial (70 % municipality, 20 % state)
Land supply	Public body	Private	Private	Public body
Interference in land price setting	Yes	No	No	No
Protection private spatial property	Weak	Strong	Strong	Weak
Coordination planning system	Restrictive	Free	Free	Restrictive

This Dutch approach clarifies why development of high rise is a combined action of the developer and the municipality as stated in the introduction; it is almost impossible to neglect the local authority. In general the planning system is working well (Evans 2004). A problem for high rise occurs where a 'standardized approach' based on 'average cost' is used, where the number of high rise projects is still very limited. Combined with the fact that the functional as well as the residual value approach are based on prices per gfa, the increase of building costs and the decrease of efficiency, developers are looking at the local authorities to acknowledge the specific situation and to modify the conditions.

4. MODELLING LAND COST

The value created with a high rise project could be represented by the rent per square metre gross floor area (1). This rent will increase with the height due to the additional value of the height. It will not necessarily be a straight line. Comparable with high rise apartments where penthouses are sold easier then mid rise apartments, the highest office floors will give another status then the 20th floor in a 60-floor building. Also time will influence this line. Reaching the highest height in the city may cause a temporarily jump until another building will take over this 'top position'.

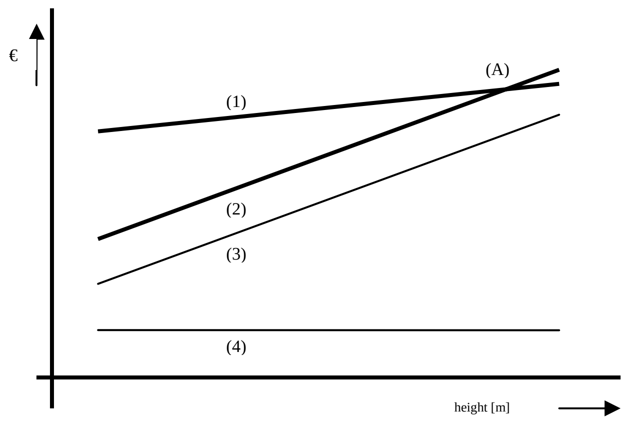


Figure 5: Value and costs related to the height

With a fixed size of the plot and a continuous floor plan, the total value of the building is represented by the area enclosed by (1) and the axis. Theoretically the positive contribution of the additional value of the height could be less then the negative contribution of the efficiency. However, this area of possible solutions should not appear due to the fact that developments will come to a standstill when these conditions are met.

(1) $f(x) = y1 + ax$

The value of y1 is most of all depending on the location and for the lesser part of the quality of the building. Further elaboration of this value is a project based activity of brokers where a more scientific approach is done by Koppels (Koppels, Remøy et al. 2007).

The second line (2) represents the investment costs. These costs are increasing by the height. The investment costs are divided in land costs, building costs and additional costs. Some elements in the additional costs may have a relation to the height, but in general it can be treated as a fixed sum per m2 gross floor area. In some cases parts of the additional costs are represented as a percentage of the building costs, where the total financial endeavour is in stake. Land costs are given by a fixed sum per m2 gross floor area.

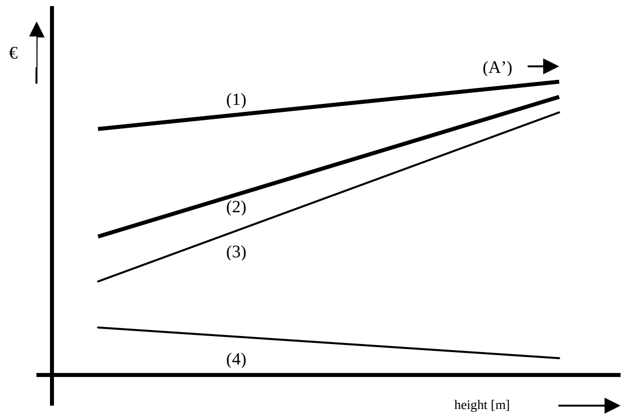


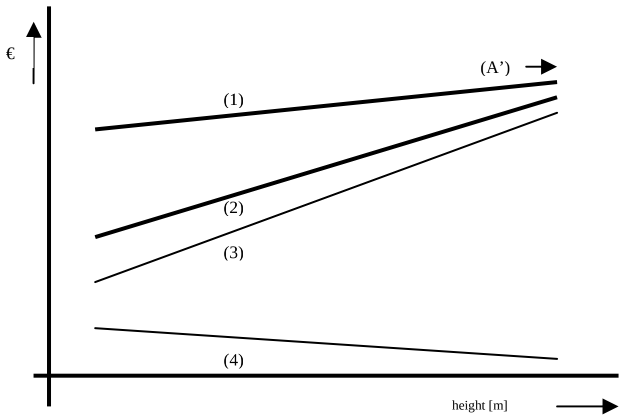
Figure 6: Adjustment of land costs

The investment costs (2) are divided into an increasing line for the sum of building costs and additional costs (3) and a horizontal line for the land costs (4).

Table 3: Input model

Input	**Values**	
length	45	m
width	22,5	m
building costs	1067	€/m^2
increase of building costs per floor	0,80	%
additional costs	40	%
land costs	500	€/m^2 gfa
decrease of land costs per floor	1,00	%
efficiency	90	%
decrease of efficiency per floor	0,40	%
rent	200	€/m^2 la
increase of rent per floor	0,25	%
rent period	15	years

As long as the investment is lower then the total value developers could be interested in this project. Point A could be presented as a breakeven point. The common interest for both the developer as the land owner is to shift point A to the right. The general idea is that if the land owner compensates some of the additional costs of the increasing height by a certain decrease per floor of the land costs still the total revenues of both parties will increase. The values of these parameters are arbitrary, and will depend on circumstances, but as shown by figure 7 and 8, the general conclusion may be that it is hardly possible to reach an internal solution in which land owners as well as developers are gaining by reducing the land costs resulting in additional floor space.



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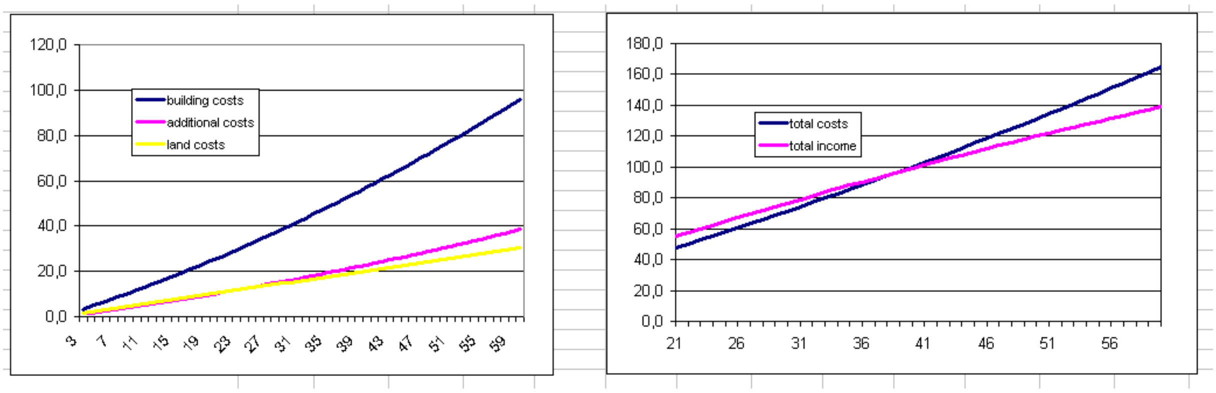

Figure 7: Total costs (building, additional and land costs) in € in relation to total income without the decrease of land costs per floor

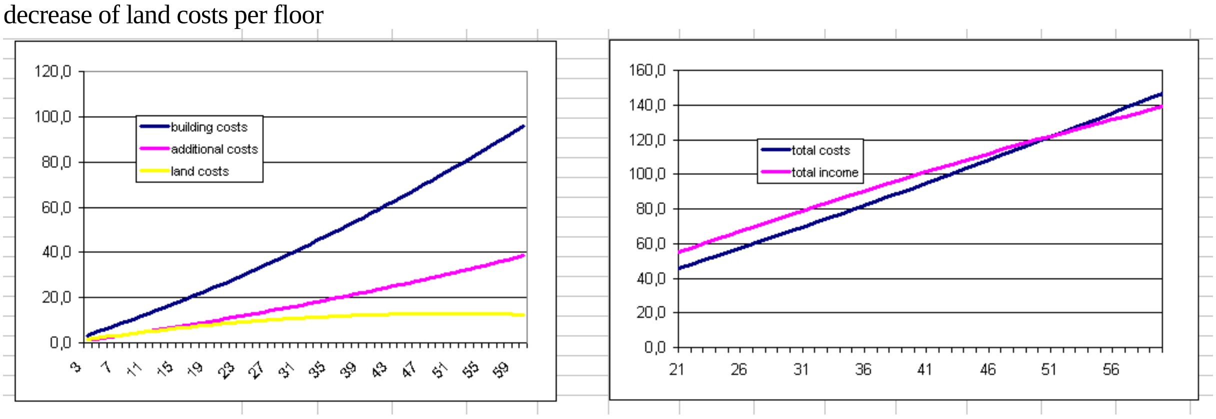

Figure 8: Total costs (building, additional and land costs) in € in relation to total income with the decrease of land costs per floor

An increase of building costs by 0.8 % per floor may not look impressive but it means that the addition of the 50th floor will cost 80 % more compared to the addition of a low rise floor (De Jong, Oss et al. 2007).

5. EXTERNAL (DIS) ECONOMIES

5.1 Economic externalities

Externalities are endemic in urban areas. Indeed external economies, positive externalities, are one of the reasons why cities exist (Evans 2004).

Land owners will point out that the logical party to contribute to the increased building costs will be the users of the high floors. If they are not willing to pay the required rent, than ‘there is no market’. Based on a sample of 105 high rise buildings, using hedonic price modelling Clapp (1980) showed some existence of relations between number of floors, density and rent. At the other hand Sabbagh (1991) illustrated the difficulties to get users in a skyscraper. Depending on the market situation the user will ask for a lower rent because of the traffic time in order to reach the desired top floors.

In case the land owner is the local government differentiation in land prices are used for planning strategies: if the municipality requires social housing they will reduce the land price for such a function. Also high rise requires these kinds of steering attributes. One of the qualities of Amsterdam is its historical inner city. The market is willing to pay high rents in this area, giving a good financial base for high rise. At the same time the inhabitants and the municipality are convinced tall buildings will destroy this historical quality. Coding and pricing prevents the establishment of high rise in the inner city. At the same time city planning is creating options for high rise in surrounding areas like the second ring and the Zuidas. Searching for the right balance between steering in the development and contributing to the cities financial situation is partly based on trial and error.

5.2 Social externalities

Skyline development by high rise zoning is appreciated by the majority of the public, while solitude tall buildings in low rise areas meet considerable resistance. Where the historical value could still be calculated in an economic model, it will require different techniques to quantify the public appreciation, the well-being of the society, touching the main objective of planning.

This well-being is even more influenced by the way high rise is contributing to a sustainable society. The huge mass of material, relatively a lot of façade and high service requirements, against enhanced land use, optimised infrastructure and better options for sophisticated measurements. Modelling of sustainability has many similarities with modelling of building costs (De Jonge 2005, Van den Dobbelsteen 2004, 2006). Both approaches break down the total building concept into its elements, and determine the contribution of the element to the total (ecological) costs or the environmental load.

6. FURTHER RESEARCH

Further research will first of all be concentrated on the elaboration of the design model. The multiple regression analysis will be used in the Dutch context for evaluating the results of the HRA-model, on the output level, and controlling the amount of user activities at the input level. However, the core will be formed by designer rules.

At the same time the demand for expanding this design model in a model for feasibility is increasing. Controlling density, ratio between residential and office floor space, zoning, as well as sustainable aspects (energy consumption, environmental load, pollution) will be incorporated into a model as ingredients for the determination of the land price on a building level, in combination with the costs for the land owner for the minimum price level. This relation between public demands and externalities will be explored in a case study. A high rise office designed as a sustainable tall building will be compared with a similar volume in a low-rise design. The research question will be the sustainability of high rise including the use of land. The result should clarify if such an approach will raise sufficient arguments in order to consider compensation of the building costs. An additional question raised by this approach is if sustainability is a sufficient driver for willingness to pay, requiring market research.

7. REFERENCES

Bijleveld, SW, and Gerritse, C (2006). PARAP/Rgd-tool for budgeting, cost estimating and floor area analysis of office building designs. In F. Scheublin et al. (Eds.), *Adaptables '06*. Eindhoven: Eindhoven University of Technology.

Clapp, J. M. (1980). "*The Intrametroplolitan Location of Office Activities*." Journal of Regional Science 20(3).

CTBUH (2007) High Rise Database, Available at: http://www.ctbuh.org/Resources/Resources-HighRiseDatabase.aspx

Dobbelsteen, A. v. d. (2004). *The Sustainable Office*. Building Technology, Architecture. Delft, Delft University of Technology. MSc: 493.

Dobbelsteen, A. v. d. (2006). *Appels, peren en bananen, milieuvergelijkingen van gebouwen, stedelijke plannen en werkconcepten*. Amsterdam, Weka Uitgeverij BV.

Evans, A. W. (2004). *Economics and Land Use Planning*. Oxford, Blackwell Publishing.

Gerritse, C. (2005). *Kosten-kwaliteitssturing in de vroege fasen van het huisvestingsproces*. Delft, DUP Science. (English translation, Controlling Costs and Quality in the Early Phases of the Accommodation Process, will be published in 2007)

Gossow, V. (2000) *Schlüsselfertiger Hochbau*. Wiesbaden: Vieweg

Jong, P. de (2006). Educational Use of an Element Based Cost Model for Office Building in the Initiative Phase. *3rd International SCRI Symposium*. Delft, University of Salford.

Jong, P. de (2007). High Rise Costs. *4th International SCRI Symposium*. Salford, University of Salford.

Jong, P. de, S. v. Oss, et al. (2007). High rise ability. *ERES*. London, CASS.

Jonge, T. d. (2005). Cost effectiveness of sustainable housing investments. Delft, DUP.

Koppels, P., H. Remøy, et al. (2007). The significance of Building and Location Characteristics for the Economic Performance of Office Property: A Delphi Approach. ERES. London, CASS.

Langdon, D. and S. Watts (2002). Costs of building a 48-storey tower in Central London. *Building* (6).

Oss, S. v. (2007). *Hoe hoger hoe duurder*. Architecture, Real Estate & Housing. Delft, TU Delft. MSc.

Post, W. v. d. (2007). Vacant Land and Vacancy Rates. *ERES*. London, CASS.

Reus, C. (2004). Kosten van hoge woongebouwen. *Wonen in de wolken*. I. v. Exel. Amsterdam, DRO.

Sabbagh, K. (1991). Skyscraper: The Making of a Building. New York, Penguin Group USA.

Soeter, J.P. et al (2005) *Real Estate Economics, Finance and Planning*, Delft: TU Delft

Watts, S. (2002). *Cost. Tall buildings: a strategic design guide*. Z. Strelitz. London, RIBA Pub.