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Potential Transformation of Vacant Offices into Housing: a Decision Support Tool

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***Abstract*:** *The purpose of this paper is to support a better decision regarding the choice of the most suitable vacant office to house new tenants. In order to achieve that a decision support tool (DSS) based on two methods is propose: discrete choice mode, specifically multinominal logit (MNL) and multiple-criteria decision analysis (MCDA). The possibilities of this tool have been tested on a generic case study. Although applying decision tools for the building transformation projects have been already thoroughly studied, this paper suggest specific tool that supports the transition form an office space to the housing for young people. As an addition, willingness to pay (WTP) for certain housing characteristics is assessed as well.*

Keywords: *sustainable transformation, MNL, MCDA, WTP, DSS*

1. Office Development Trends in the Netherlands

A small oversupply within the office market is necessary to react on the dynamics of the market. A "healthy" vacancy rate should be around 5% till 7% of the stock [1]. It is well known that the vacancy rate in the Netherlands related to the office market is "unhealthy" for several years (Fig. 1). To indicate the size of this problem, some facts will be addressed. The office stock within the Netherlands consists of 49,4 million m² of which 7,3 million m² is vacant, this means a vacancy rate of 14,7% [2].

This imbalance can be explained due the fact that the labour force stops growing, the "new way of working" is gaining popularity and the surface area per workplace per employee decreases [1]. In order to prevent extended vacancy, it is necessary that a substantial portion of the outdated stock on the market will be removed [3]. One way to do this is through transformation of vacant real estate. However it is not realistic to expect that the vacancy problem will be completely solved by transformation. Location and quality play a crucial role in this issue. For example transformation of one building located on a mono-functional office location into housing units will not be feasible in both financial and social way [1]. Most common problems that ensure that a project is not feasible are depreciation, location, layout or the collaboration with the municipality [1; 4-5].

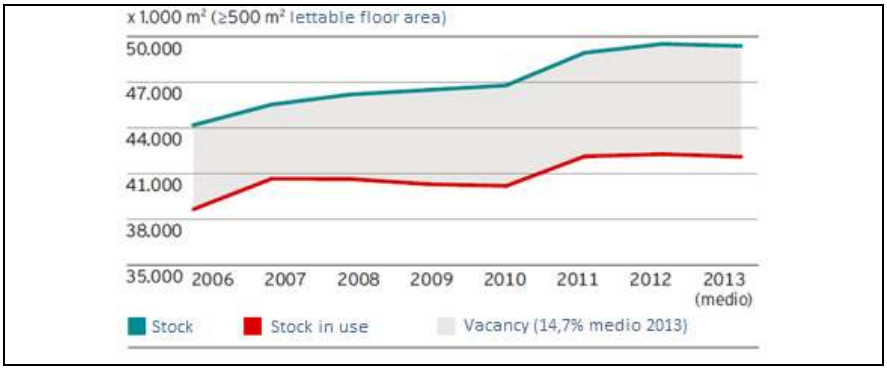

Fig. 1: Office stock in use [2].

2. Transformation Process and Potential for Improvement

Traditional development process has several phases [6]. The biggest differences between the traditional construction process and the transformation process can be noted within the initiative phase. Even more precise it differs mainly in one product in the initiative phase; a feasibility study needs to be more elaborated. Feasibility studies in this case provide an analysis of the location, functional, technical, financial and environmental aspects regarding existing but also the future project.

As mentioned, it is not realistic to expect that the office vacancy problem will be completely solved by transformation. However, it could be the favourable decision for some of the investors. An investor has the goal to optimize the exploitation of vacant offices by maximizing returns and minimizing risks. In the Netherlands, a lot of vacant offices are available for transformation which gives difficulties in the quick assessment process regarding the potential for transformation. This potential is based on many parameters and sub-parameters, for example market, location, building and finance. All these factors collectively determine the possibilities and potential of transformation. Despite everything, transformation of vacant offices only makes sense when the new building function(s) is in need. The supply must match demand, in terms of their characteristics and location of the building [3; 7].

Therefore, this paper suggest how to optimize the decision making process of transformation process within the initiative phase. This requires the proper information at this phase, in order to control the process and risks. Such information in this paper will be referred as attributes which are related to mention aspects counted for any real estate feasibility study. Housing choice decisions are complex in which many attributes are involved [8]. However, not all attributes are equally important from the perspective of the different actors in the transformation process. For example attributes regarding the Dutch building decree and other necessary permits are (most of the times) only concerning the developer and investor. Next to this there are also certain attributes and characteristics that will give the potential tenant (target group) sufficient utility so that they are more willing to rent certain housing units. These attributes depend upon the defined target group(s), but will always include price and location. Therefore, in this paper the attributes are distinguished between two types: (a) related to the future tenants preferences; (b) related to the estimates of transformation potential by investors. Overall, these attributes can be divided into the following categories: functional, technical, cultural, legal and financial. Because of these multiple factors and actors, the decision of an investor to investigate whether a transformation project is feasible or how to minimize the risks is difficult and requires a support.

3. A Decision Support Tool for Transformation of Office Space

A decision support system (DSS) is a system that improves and supports decision-making capabilities of an individual [9]. Additionally, the term system refers to the information-processing devices (software programs) that actively engage in the decision-making process [10]. This article emphasizes the possibility of using decision support tools to select the most optimal vacant office building that will be used for housing of young tenants. The benefits of using DSS in urban development practice in transformation projects has been already reported [11-19].

3.1. The Concept Design

The design of this DSS consists of three main parts (Fig. 2). First part responds to the preferences of the potential future tenants while the second part responds to the transformation potential estimation of investors. In the concept design, they are both referred as Quick Scan check. Both of the Quick Scans are further used to deliver a feasibility study for every potential vacant office thus making the final, third part of this DSS.

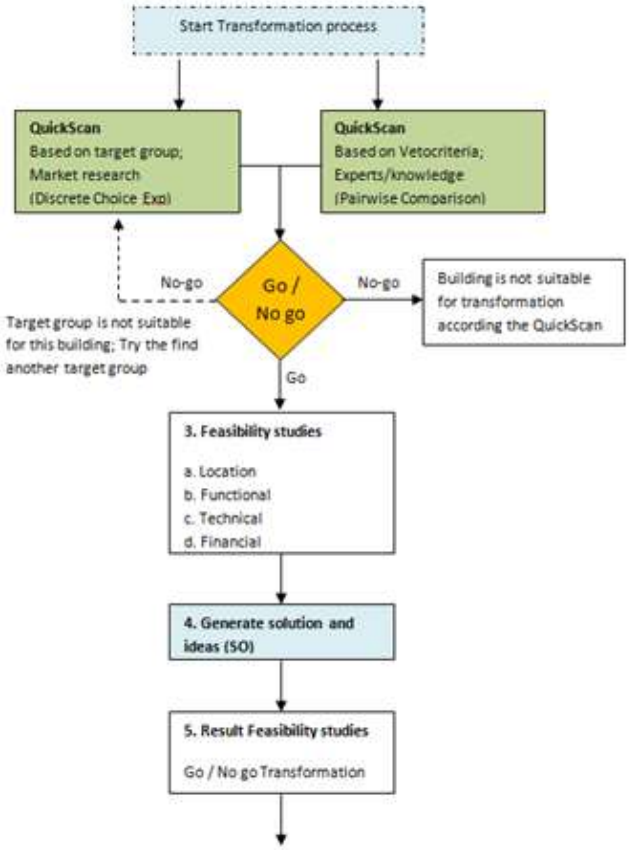

Fig. 2: Decision Support Tool Concept Design.

First, market research for housing future tenants has been performed. A discrete choice model or more specifically multinominal logit (MNL) model has been used to reveal the preferences of the potential future tenants and covers the first type of mention attributes. By applying a MNL, it is possible to assess the different utilities for housing alternatives. In addition, the willingness to pay (WTP) for this specific alternative could be calculated, and the WTP will be further used as a guideline for the potential rent. Second, the building transformation potential can be evaluated based on second set of already mentioned attribute types by using multi criteria decision analysis (MCDA) based on the knowledge and experience of experts involved in the transformation process. These criteria in the figure above are called vetocriteria. Third part is financial feasibility; it plays a central role in the investing decisions of companies and investors. Therefore, the discounted cash flow (DCF) model has been applied for this purpose. Input for DCF is results from "quickscan". On one hand, the potential rent is based on the WTP estimated from MNL model and the investment costs are based on a MCDA "multiplied" with the cost approximation for different level of transformation in the Netherlands [3, 7, 20].

3.2. Discrete Choice Models

The aim of this discrete choice experiment is to understand the preferences of future tenants regarding possible housing units realized with transformation. Knowing the desired mix of attributes might guarantee the success of a transformation project. As previously mentioned, the aimed market segment exists of young people, a rapidly mutating and moving target group.

The discrete choice modelling approach requires that a representative sample of customers make choices in simulated situations derived from realistic variations of market offerings. The performing of a discrete choice model experiment typically comprises of three steps. First, using market assessment, customer interviews, case studies, industry data, literature reviews, focus groups, and other information sources, a list of drivers that are believed to influence customers' purchasing decisions is compiled. Once the list of choice drivers is finalized, experimental design techniques are used to develop many realistic versions of service offerings. Next, choice experiments are constructed that ask respondents to select one out of two or more alternatives available to them in a series of choice sets. In the final phase, econometric models based on responses from a representative sample of potential future customers are used to identify empirical key patterns in the survey responses,

providing a relative weighting for each driver and, if considered necessary, for interactions among drivers. Developers and managers can then select the optimal combination of attributes to develop a profitable and sustainable value proposition that, under normal competitive constraints, will maximally leverage their available resources.

Many studies have been investigating various attributes that influences a housing choice. For example, price, size location, greenery, parking facilities and accessibility type of housing units, outdoor space are thought to influence housing preferences and housing choice behaviour substantially [e.g., 3, 8].

A housing choice decision research of young people is influenced by very dynamic life events and frequent changes in career path [8]. In that regard, student housing providers and organisations in the Netherlands have conducted quite some research on students' housing choice behaviour in the Netherlands [e.g., 3, 8]. In these studies, price, size, condition of the complex, shared versus private facilities and accessibility of city centre, facilities and campus were found to be important in housing choice decisions for students.

The attributes and their levels that are used in this paper are given below (Table II). The attribute levels represent the levels assigned to an attribute, the levels used in this experimental design were either nominal or ordinal.

3.3. Multiple Criteria Decision Analysis

Multiple-Criteria Decision Analysis (MCDA) is a discipline that explicitly considers multiple criteria in decision-making environments, especially when there are conflicting criteria that need to be evaluated. Structuring complex problems and considering multiple criteria explicitly leads to more informed and better decisions.

It is often desirable in decision analysis problems to elicit from an individual, the rankings of attributes according to the individuals preference and to understand the degree to which each attribute is preferred to the others. A common method for obtaining this information involves the use of pairwise comparisons, which allows an analyst to convert subjective expressions of preference between two attributes into numerical values indicating preferences across the entire group of attributes. In solving a multi-attribute decision problem, one needs to know the importance or weights of the not equally important attributes to evaluate alternatives with respect to the attributes. Therefore, all judgments of the various pairwise comparisons are summarized in a comparison matrix [21]. In real-life decision problems, pairwise comparison matrices are rarely consistent. Nevertheless, decision makers are interested in the level of consistency of the judgments, which somehow expresses the goodness or "harmony" of pairwise comparisons totally, because inconsistent judgments may lead to senseless decisions. It was shown [21] that a pairwise comparison matrix is consistent if and only if it is of rank one. When a pairwise comparison matrix is consistent, the normalized weights computed from this matrix are unique [22]. The set of attributes, their weights and source of data have been shown in the next subsection (Fig. 3).

Further on, the normalized weights are scaled to fit in a transformation score with a range from 0 to 100 and classified into one of the five transformation classes (Table I). This class distribution is based on the construction costs per transformation class [3, 7, 20].

TABLE I: Building Costs

Transformation class	Intervention	Costs	Cost indicator transf.*
1 = Very suitable for transformation	Light	Low costs	40% * modernization
2 = Suitable for transformation	Modernization	Limited costs	50% * SPA
3 = Limited suitable for transformation	Strong	Moderate costs	145% * modernization
4 = Hardly suitable for transformation	Very strong	High costs	200% * modernization
5 = Not suitable for transformation	Strip-rebuilt	Very high costs	120% SPI

4. Estimating Market and Site Potential

To collect the data related to the first set of attributes a discrete choice experiment has been design and on-line survey tool was used to collect the feedback from 441 respondents. For the second set of attributes additional survey has been conducted to collect the preferences estimated by pairwise comparison from 8 experts.

For the MNL model will be here only explain in the terms of WTP since only this part is used to make an assessment of the feasibility of a certain vacant office. *β levels* are coefficient estimates of the MNL model. *β price* is the coefficient second level price attribute that is chosen as a closest to mean of all choices by respondents. When dividing *β levels* and *β price* coefficients we are able to estimate WTP. Therefore, within the column WTP, the real price per m^2 is given that young people are willing to pay when certain level occurs in the offered housing alternative.

TABLE II: Tenants' preferences: MNL and WTP

Attributes	Levels	βlevels	βprice	βlevels / βprice	WTP
Facilities	Shared facilities	-1.527	-0.261	-5.85	2.77
	Semi-private fac.	-0.723	-0.261	-2.77	5.85
	Private facilities	2.250	-0.261	8.62	8.62
Housing unit	Room	-0.718	-0.261	-2.75	1.59
	Studio	-0.416	-0.261	-1.59	2.75
	Apartment	1.134	-0.261	4.34	4.34
Outdoor space	None	-0.844	-0.261	-3.23	1.07
	Balcony	-0.278	-0.261	-1.07	3.23
	Garden	1.122	-0.261	4.30	4.30
Distance to City Centre	3km < Distance	-0.441	-0.261	-1.69	0.51
	1km < Dist. ≤ 3km	-0.133	-0.261	-0.51	1.69
	Distance ≤ 1km	0.574	-0.261	2.20	2.20
Distance to Puclic Transport	3km < Distance	-0.493	-0.261	-1.89	0.38
	1km < Dist. ≤ 3km	-0.099	-0.261	-0.38	1.89
	Distance ≤ 1km	0.592	-0.261	2.27	2.27
Storage space	Not available	-0.306	-0.261	-1.17	0.37
	Outside the building	-0.096	-0.261	-0.37	1.17
	Inside the building	0.402	-0.261	1.54	1.54

Looking at the MCDA results (Table III), the following can be concluded. The experts found the main categories, functional (46%) and technical (29%) the most important categories in terms of transformation potential. The underlying idea to consider the category functionality so important could be that this category includes several criteria that are not able to change and on which the investor has no influence. In addition to this, the technical category is important because these criteria could bring high potential construction costs, what could make it harder to realize financial feasibility. From a functional point of view, the criteria expansion possibilities (26%) and flexibility (24%) are the most important. Expansion possibilities might increase the chance of financial feasibility, when basic transformation without expansion is not feasible. The investor does not need to make more acquisition costs, to realize more floor area to let. In addition to this, it is advantageous when a vacant building consists out of large flexible rooms. In this case the investor does not need to demolish a lot of the interior and the layout of the building can be organized freely. From a technical point of view, the criteria state of construction (23%) and asbestos (17%) are the most important. The state of construction is clearly important because it could bring high cost when the state is not good. Also asbestos plays an important role. When a building is older than 1992, there is a presence of risk. In advance an investor does not know to what extent asbestos can be present, that is why it is important to do an asbestos inventorying for building older than 1993. Another conclusion to be made is that in terms of importance all other criteria are equal to each other. Criteria that have very little influence on the transformation potential are the main category cultural (8%) and the criteria Administrative support (14%) under the main category legal (17%). Both categories contain aspects which are less important to the transformation potential of a building, but are more important in the personal feeling towards the location and building comparing to the investor.

For the case study an existing office described completely with the two sets of attributes. The feasibility has been estimated on the discounted cash flow model. It has as the major input WTP for given and selected attributes levels that are representing incomes and from the other set of attributes it is possible to estimate average expenses for a certain type of a transformation class.

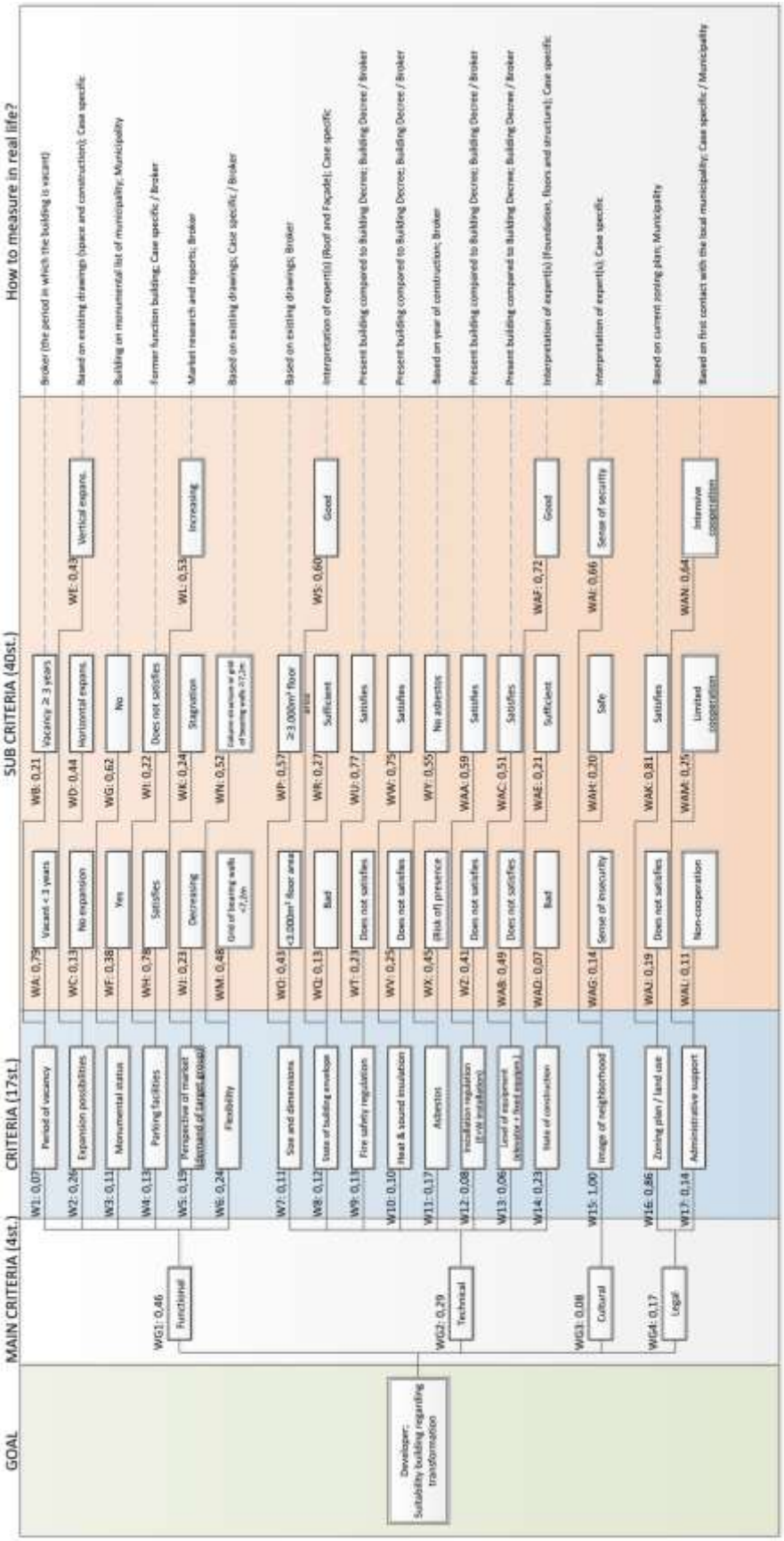

Fig. 3: MCDA: investors' estimations: MCDA.

5. Conclusions and Discussions

The results of both the MNL model and MCDA are used in a support tool that can help an investor to give an substantiated answer to the question whether a vacant office building is suitable for transformation into housing for young people or not. Therefore, the potential of a vacant building is observed from two perspectives, demand and supply side. This ensures that the process of assessing the vacant building is more efficient. Financial feasibility plays a central role in the investing decisions of companies and investors. In the support tool the financial feasibility is tested according the DCF model. Hereby the potential future rent is based on a MNL model estimates translated into WTP. Next to this, the investment costs will be based on a cost indicator which is justified by the use of a MCDA based on the experts' opinion.

Regarding the target group preferences it is remarkable that not the high level of price but the attribute levels concerning shared facilities, semi-private facilities and no outdoor space have the biggest negative influence on housing choice behaviour. The attribute levels as private facilities, apartment and garden have the biggest positive influence. Of course this is also reflected in the willingness to pay.

Resulting from the MCDA, the experts found the main categories, functional and technical the most important categories in terms of transformation potential. From a functional point of view, the criteria expansion possibilities and flexibility are the most important. From a technical point of view, the criteria state of construction and asbestos are the most important. Criteria that have very little influence on the transformation potential are the main category cultural and administrative support.

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