TÉCNICO LISBOA

The Adaptive Reuse of Office Buildings in London

Guidelines for a Multi Criteria Decision Analysis Strategic Approach

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Architecture

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Abstract

1.1 Context of the Research

"When planning our buildings we cannot afford to stand still, year by year standards are improving; the office building that was built in the early post-war years began to look a little dated by the 1960s and now in the 1970´s that same building will probably require extensive modernization and adaptation to bring it into line with modern requirements. It is reasonable to assume that the rate of change in the office standards is accelerating". (CALUS, 1974)

The above statement, written whilst observing office transformations which occurred in previous decades, was forecasting the imminent revolution in light of increased use of personal computers, building services, internet, sustainability, new working methods or the property and financial crisis that characterized the sector in the following three decades.

The city of London, a global hub for finance and services, is a living testimony to this change.

Intrinsically related to the economy and Information Technology (IT), office developments were transformed decade after decade to meet evolving demand requisites. Whilst a limited number of buildings were able to prevail and function properly within its intended use throughout its life cycle, many others would either become outdated and useless a few years after its completion, in one of the world´s most competitive real estate markets. The property development booms that occurred in the last decades produced millions of square feet of office space as a similar amount was simultaneously being left vacant, in both prime and secondary locations due to an oversupply or lack of demand, greatly accentuated in economic downturns.

The downturn periods nevertheless alerted people to the importance of profiting from pre-existing buildings thus creating new potential for vacant or underperforming buildings, either by changing the way they are used or by changing their original use. Office buildings in particular, exposed and affected as they are to the above fluctuations, cannot be built as required to meet their present use expectations. Once built, they should be built to last(Ratcliffe, et al., 2006), as a reflection of the years and resources required for its development, real estate value, environmental footprint or presence and significance in the city.

The conversion of office buildings to alternative uses emerging in the 1990´s was predicted at the time to slow down in the following years (1.3). However, recent reports and figures show that they have not only slowed down as predicted, as they have been growing steadily in the last decade and have alarmingly increased in recent years, in particular relating to residential purposes (Lichfield, N. & Partners, 2011) (2.2).

Millions of square feet of office space are still underperforming, vacant, or awaiting redevelopment, many in prime locations, and built within the last thirty years (DTZ , 2013). However, at the same time, increasing construction rates of offices in recent years (DTZ , 2013) show that demand still exists. Hence, many office buildings are clearly inadequate to meet today´s demand expectations, reinforcing the urgency to make the most of the existing fabric.

1.2 Research Question and Objectives

Looking at the radical transformations which occurred over the last century (2.1), it seems apparent to conclude that an office building´s life is becoming shorter its utility less secure as time passes. It is also clear that we can no longer continue to waste the resources spent on their development, nor to promote demolition as a long term approach to facing the unpredictable, yet inevitable, transformation of the office sector or the current instability of local and global economies.

If there is a demand for space for alternative purposes, it seems natural that redundant office buildings could provide space, as an economic and sustainable form of property development, (Anderson & Mills, 2002) envisaging the urban regeneration of our cities and improving the character of the built environment.

However it is less clear how office buildings can meet such demand if they have been designed to respond to a specific use pattern within a specific time which no longer exists.

From this, the below questions were raised narrowing the focus of the research:

- *How to determine which alternative uses are worth full assessing to a redundant office building?*
- *Which aspects should be excluded and which should be considered for appraising their potential?*
- *Where demand exists for certain uses, which buildings would perform best to accommodate such uses ?*
- *What are the preferences of those alternatives and how to assess their performance in office buildings?*
- *Where demand and supply do not match, which tools can increase the chance of likelihood of success in the conversion process?*
- *How is it possible to resume the investigation in an expeditious appraisal to be used by any party involved in their conversion and rehabilitation, actively promoting and enhancing this practice?*

From the above, the research question can be summarized as:

- *How to assessed and evaluate the alternative uses for a redundant office building in London, in a generic and expeditious manner, which warrant further investigation using well known and long established architectural feasibility studies and real estate development appraisals ?*

The main objective is, under this perspective and within the London market context, to define and construct a methodology that is able to appraise an adaptive reuse rehabilitation performance. Consequently alternative uses will be recommended, for a specific building in a specific location, by matching their characteristics with the preferences of each alternative use considered, whilst assuming that with a narrower gap between the two, the easier and more probable is the success of the adaptive reuse.

1.3 Structure and Methodology

Chapter 1 sets out the research question and the objectives, listing the most relevant previous investigations on this theme, thus justifying the purpose of this paper, and defines the scope, limitations and methodological approach. The dissertation is then divided into three distinct parts, with the purpose of providing an overview of the investigation's context and summarising what has been written in existing literature; developing the research question and constructing the methodology; and then applying this to a real world case study as an evaluation of the model constructed, enabling further discussion.

Part I, consisting of Chapters Two and Three, aims to investigate and understand the context of the investigation and summarize what has been written in the literature on office buildings and their adaptive reuse.

Chapter Two provides an overview of the evolution of office building typology throughout the twentieth century in London, understanding the impacts of major socioeconomic and real estate market aspects on building design and condition (2.1). The results of the analysis are summarized so that we may comprehend the transformation within each development period leading up to the present (2.1.4). This summary also enables us to determine the causes of obsolescence whilst suggesting the aspects that should be considered for appraisal (4.2.3). The conversion activity in recent decades is also summarized, in particular to apartments, comparing reports published during the 90's, when activity increased, with articles written in more recent years (2.2). The current and emerging demand for office space and housing are presented to reinforce the relevance of the research question (2.3).

Chapter 3 will first investigate the life cycle of office buildings and discern potential difficulties to predict the future market trends (3.1.1).

The definitions of obsolescence and redundancy will be explored (3.1.3), further clarifying the causes on the office property in particular, whether Originating from the supply or alternatively the demand (3.1.2) with potential options to address such conditions being discussed (3.1.4). The adaptive reuse instrument is then defined (3.2.1) and explored its potential as an instrument towards sustainability in property development (3.2.2) and urban regeneration (3.3.3). The available, physical, tools that enable and optimize the adaptive reuse of an office building are then researched (3.3), an essential aspect that enables the understanding of the adaptability of each *criterion* considered, further reflecting their respective importance.

Part II constituted by Chapter Four, constructs the Adaptive Reuse Appraisal Model for Office Buildings in London. Chapter Four constructs, with the elements previously gathered, the Adaptive Reuse Appraisal Model (ARAM). First, the scope, field and limitations of the model are defined, and thus establishing which appraisal method is most adequate (4.1.1) The Multi-Criteria Decision Analysis (MCDA) is selected and its structure explored in detail though the international literature (4.1.2; 4.1.5), envisaging the following steps to be taken in the investigation.

Firstly, the scope of the appraisal is further narrowed (4.2.1) and the possible alternative uses selected and re-arranged into workable sections, continuing previous research on the subject (4.2.2).

Secondly the relevant criteria is identified and grouped into workable sections (4.2.3). Aspects that relate to the building location (4.2.4) are separate from those related to the building location (4.2.5) and all related aspects are further researched in the literature, whilst considering the scope of the investigation and the available time and resources. For the location criteria *descriptors* were constructed on each aspect that enable us to evaluate a specific location; for the physical criteria were suggested the preferences of each alternative use on each aspect in order to estimate how well a specific use applies to a certain building.

Part III consisting of Chapters Five and Six is where the investigation will apply the model to real and ongoing adaptive reuse case study as an evaluation of the investigation, resuming the conclusions attained and enabling further discussion. In Chapter Five the case study and its adaptive reuse are firstly understood, considering the history of the site and the building, its current location and the characteristics of the existing building (5.2) and the building proposed (5.3). The location is then evaluated (5.2.1) followed by the physical characteristics of both existing and proposed buildings (5.2.2) so the improvement may also be assessed. The results will be discussed (5.2.3) and the discrepancies suggests that a financial appraisal would be beneficial for its comprehension, which may challenge the model constructed as well as its scope. In this sense, an overview to the long established real estate valuation methods is provided. The Discounted Cash Flow (DCF) method is selected and carried out on all alternatives, and the results have been interpreted.

Chapter Six summarizes the main findings and proposals, states the strengths and weaknesses of the research and points out future research.

Additionally, the Appendices comprise the elements necessary for a comprehensive understanding and evaluation of the methodological approach and the Case Study. They include the alternative uses considered (A.1), the case study images and drawings (A.2), a questionnaire which was completed by key decision agents involved in the case study development proposal (A.3), the MACBETH data (A.4, A.5) and finally the financial appraisal exercise carried out to the case study (A.6).

	Building Space					Building Fabric					
Office Period	*1* Floor Depth (m)	*2* Window to Core (m)	*3* Slab Height (m)	*4* Internal Grids (m)	*5* Efficiency (NIA:GIA)	*6* Loading (kN/sqm)	*7* Insulation (mm)	*8* Power (W/sqm)	*9* Structure Type	*10* Facade Type	*11* Expected Condtion
1900 - 1950	n/a	n/a	3.5 to 5	n/a	n/a	5 (1910) 2.5 (1930)	Not Required	n/a	Load bearing masonry walls; Steel frame and brickwork walls.	Brickwork	*Low.* Major structural works required from façade to core.
1950 - 1970	10 to 12	n/a	2,9 to 3,2	0.6 / 0.9 (p)	n/a	2.5 to 5 4 (typ.)	25 mm	n/a	Concrete frame;	Pre-cast concrete panels	*Low to Medium.* A complete refurbishment with substantial structural repairs.
1970 - 1980	>12 - 20	n/a	3.2 to 3.6	0.6 / 0.9 (p)	n/a	2.5 to 5 4 (typ.)	60mm	n/a	Concrete frame;	Pre-cast concrete panels; fully glazzed	*Medium.* Services / façade obsolete, structural reinforcement required.
1980 - 2000	18 / 40	n/a	4	1.2, 1.3, 1.5 (p); 6 x 9 (c)	n/a	2.5 to 5	100mm 200mm	45	Pre-stressed concrete frame; Steel frame	Fully glazzed, curtain wall systems ;	*Medium to Good.* Services to be replaced, Façade to be pottentially obsolete.
2000 - 2010	12 to 21	6 to/ 12	3.1 to 4.2	1.5 (p); 7.5, 9, 12 (c)	80% - 85%	3 (GF) 2.5 (TF)	250mm	25	Reinforced concrete frame, Steel frame; mixed solution	Fully glazzed, curtain wall systems ; natural ventilated;	*Excellent* . Only minor changes to services are expected. excellent environmental performance

Table 1 : Office buildings physical preferences per development period. Source: Author

Crossed References : (Gold & Martin, 1999); (BCO, 2009)(Gann & Barlow, 1996)(Lichfield, N. & Partners, 2011)(Salway, 1986)
1 . External Building Depth (m) ; 2 . Window to Core Depth (m) ; 3 . Typical Floor Slab to Slab Height (m) ; 4 . Internal Structural (s) and Planning (p) Grids (m) ;
5 . Plan Efficiency, Net Internal Area : Gross Internal Area (NIA:GIA) ; 6 . Typical Slabs Structural Loadings (kN/sqm) ; 7 . Insulation Required, if with the same U-Value (mm) ;
8 . Power Provision (W/sqm); 9. Structure Type ; 10 . Façade Type ; 11 . Expected Condition ;

Criterion			Component		Degree of Changeability	Value Function Type
A.1 Macro Location	A.1.1	Distance to Centre			xxxxx	P
	A.1.2	Accessibility	A.1.2.1	Public Transport Access	xxxxx	p
			A.1.2.2	Private Transport Access	xxxxx	P
			A.1.2.3	Parking Provision	xxxxx	P
	A.1.3	Amenities	A.1.3.1	Infrastructural Amenities	xxxxx	P
			A.1.3.2	Cultural and Recreational Amenities	xxxxx	P
			A.1.3.3	Services Amenities	xxxxx	P
	A.1.4	Environment	A.1.4.1	Built Environment, a), b)	xxxxx	C
			A.1.4.2	Natural Environment, a), b)	xxxxx	C
A.2 Micro Location	A.2.1	Street Character	A. 2.1.1	Street Environment, a), b)	xxxxx	C
			A. 2.1.2	Street Position	xxxxx	P
			A. 2.1.3	Street Access	xxxxx	P
			A. 2.1.4	Pedestrian Flow	xxxxx	P
			A.2.1.5	Noise Levels	xxxxx	P
	A.2.2	Building Position	A. 2.2.1	Building Presence	xxxx (d/r/e)	P
			A. 2.2.2	Building Views	xxxx (d/r/e)	P
			A. 2.2.3	Building Orientation	xxxx (d/r/e)	P

Degree of Changeability : Impossible (xxxxx) ; Very Difficult (xxxx); Difficult (xxx); Relatively Easy (xx); Easy (x)
Tool for Changeability: Extension (e); Demolition (d); Replacement of Components (r);
Value Function Type: Natural (N); Proxy (P); Constructed (C)

Table 2 : Location Criteria Structure. *Source: Author*

Criterion			Component		Degree of Changeability	Value Function Type
B.1 Building Space	B.1.1	Plot	B. 1.1.1	Plot Access	xxxx (d/r/e)	P
			B. 1.1.2	External Space	xxx (d / e)	P
			B. 1.1.2	Car Park Space Provision	xxxx (d)	P
	B.1.2	Size	B.1.2.1	Slab Height, TF	xxxxx	P
			B.1.2.2	Slab Height, GF	xx (d)	P
			B.1.2.3	Building Depth	xxx (e)	P
	B.1.3	Configuration	B.1.3.1	Core(s) Location	xxxx (d / r)	P
			B.1.3.2	Column Grid	xxxxx	P
			B.1.3.3	Plan Configuration	xxx (e / r)	P
B.2 Building Fabric	B.2.1	Structure	B.2.1.1	Slab Strength, TF	xxx (d/e)	P
			B.2.1.2	Slab Strength, GF	xxx (d/e)	P
	B.2.2	Envelope	B.2.2.1	Opening Ratio	xx (d/r)	P
			B.2.2.2	Daylight Factor	xxxx (d/r)	P
	B.2.3	External Character			xxx (d/e/r)	P

Degree of Changeability : Impossible (xxxxx) ; Very Difficult (xxxx); Difficult (xxx); Relatively Easy (xx); Easy (x)
Tool for Changeability: Extension (e); Demolition (d); Replacement of Components (r);
Value Function Type: Natural (N); Proxy (P); Constructed (C)

Table 3 : Physical Criteria Structure. *Source: Author*

	Office				Residential				Hotel							
	Secondary		Prime		Secondary		Prime		Secondary		Prime		Retail		*Universal Building*	
	N(0)	G (100)	N(0)	G (100)	N(0)	G (100)	N(0)	G (100)	N(0)	G (100)	N(0)	G (100)	N(0)	G (100)	N(0)	G (100)
Plot Access	1P,0C	1P,1C	2P,1C	2P,1C	1P,0C	1P,1C	1P,1C	2P,1C	2P,0C	2P,1C	2P,1C	2P,2C	1P,0C	3P,1C	2P, 1C	3P, 2C
External Space (y/n)	n	y	n	y	n	y	n	y	n	y	n	y	n	y	n	y
Parking Space	1c +12b / 1500sqm				1.5c + 1b / Dwelling				1c / 10 units				1c + 1b / 1500sqm		n/a	
Slab Height TF(m)	3,1	3,5	3,3	4,1	2,4	2,8	2,8	3,2	2,8	3,1	3,1	3,4	4	6	3,1	3,5
Slab Height, GF (m)	3,3	4,1	3,6	6	2,4	2,8	3,2	3,8	3,1	3,6	3,6	6	4	6	4	6
Building Depth (m)	14	20	16	40	12	15	15	18	12	18	16	20	18	40	14	18
Core(s) Location (m)	18m (1co) / 45 (2co)				7,5+9 (1co) / 30 (2c)				18 (1co) / 35 (2co)				18 (1co) / 45 (2co)		16 (1co) / 30 (2co)	
Column Grid (m)	7,5 / 9 / 12				6	7	7	8,5	6	7,5	7,5	9	5	12	7,5	
Plan Efficiency (%)	0,65	0,5	0,55	0,4	0,35	0,2	0,25	0,1	0,4	0,25	0,3	0,15	0,7	0,5	0.40	0.20
Strength, TF (kN/sqm)	2,5	3	2,5	3	1	2	2	3	2	3	2	3	4	5	2,5	3
Strength, GF (kN/sqm)	3	5	3	5	2	5	2	5	3	5	3	5	5	5	3	5
Opening Ratio(%)	30	50	40	60	20	40	30	50	20	40	30	50	0	20	30	50
Daylight Factor(%)	0,8	2	2	3	1	2	2	3	0,5	1,5	1,5	2,5	0	1,5	2	3
External Character	+	++	++	+++	+	++	++	+++	+	++	++	+++	+	++	++	+++

Table 4 : Physical Criteria Preferences - Universal Building Characteristics. *Source: Author*

External Character Levels : Very Good (+++); Good (++); Decent (+) ; Poor (-) (Considering the quality of the façade and the adequacy to each use)
Crossed References (4.2.3) : (Kincaid, 2002);(APR, et al., 1992);(Barlow & Gann, 1993);(Douglas, 2006);(Sigworth & Wilkinson, 1967) (Freer, et al., 1999); (Markus, 1979); Building Regulations Approved Documents (2013); British Standards; Construction and Design Management (2007); (LDA, 2010); (BCO, 2009);(Battle, 2003); (RICS, 1997); (Neufert & Neufert, 2012); (PKF, 2001);(Littleford, 2012); (Ratcliffe, et al., 2006); (Wilkinson, et al., 2008); (Miles, et al., 1991);(Havard, 2008)

1.4 Conclusions and Main Findings

The opportunity to study the alarming obsolescence of office buildings and the vast demand for their conversion to other uses in the complex city of London provided a unique insight into both fields.

The most noticeable and original contribution of the investigation was the construction of the Adaptive Reuse Appraisal Model (ARAM) to Office Buildings in London (4), through a Multi-Criteria Decision Analysis (MCDA) approach. The model can be used as a tool to evaluate the potential to convert offices, in London, to other uses prior to (1.2), or assisting on (5.3), the long established architectural feasibility studies and development appraisals, considering its location (4.2.4) and physical criteria (4.2.5). Although not being able to embrace all details involved it can still open new opportunities in those fields.

The adaptive reuse appraisal can also be carried out to determine the performance of a proposal (5.2) as a design guidance which is able to measure the impact of each adaptive reuse tool on each criteria and evaluate their efficiency to accommodate the new use (5.2.2). Since it does not require any architectural or development expertise, it can be used by any of the *decision agents* (3.2.2) involved in the adaptation of an existing office building. Furthermore, it can be used in new office developments as well, embracing a strategic approach for a future re-use and ensuring the robustness of the design options.

Prior to the model construction, a significant amount of themes were researched and a few conclusions can be remarked from their investigation.

a) From the literature overview of the characteristics of office developments throughout the past century (2.1), the physical preferences of each building across the main development periods were summarized (2.1.4). This table is incomplete since some of the information is either dispersed or contradictory. Nonetheless it help us to understand the radical evolution of office building characteristics and requirements, bringing to light the reasons for obsolescence in some aspects when compared to today's standards.
b) From the office' conversions in London (2.2) and the present and emerging market conditions (2.3) it was remarked that the research carried out just over a decade ago, predicting the downturn of the activity, were incorrect. Neither the crisis in the office market or the boom in residential property values of the last years could have been forecasted. The demand and opportunity for conversions is steady rising, reinforcing the aims of the investigation.
c) Also, from the literature, the types and causes for office buildings obsolescence were summarized (3.2) suggesting the role of their adaptive reuse towards urban regeneration (3.3.3).
d) To the four adaptive reuse physical tools (3.3) previously identified *(Kincaid, 2002)*, a fifth tool has been distinguished, the *replacement of components* (3.3.4), an aspect partially perceived in the *selective demolition* tool. Because of its specificity, it was considered as relevant as the other tools, particularly notorious in the scope of the investigation (3.4.4).

Equally, other themes and remarks emerged during the construction of the ARAM:

e) It was necessary to narrow the alternative use options for office buildings for the practicality of the appraisal model. Therefore, a previous methodology developed by the University College London *(Kincaid, 2002)* to determine possible uses in the adaption of buildings, was extended and focused on the investigation subject (4.2.2). The resulting uses were then rearranged in seven groups, which also consider their prime and secondary characteristics (A1);
f) The evaluation criteria constructed attain a new summary of the aspects relevant for an adaptive reuse of office buildings to the alternative uses identified. The locational criteria, which required the definition of descriptors (4.2.4), are a tentative approach to transform the subjective and relative appreciations of location aspects to a comparable scale across all uses. Equally, the physical criteria gathered disperse any contradicting information (4.2.5) summarized in a table which enable a comparison of the physical preferences of each use. From the latter, a suggestion of the physical characteristics of the universal building was raised, which more easily accommodates different alternative uses.

Finally, from the Case Study, further remarks were attained and further discussions enabled:

g) The selected case study confirms the strong potential of adaptive reuse to avoid redevelopment;
h) The weighting process in location criteria (5.2.1) and physical criteria (5.2.2) suggests the relative importance of each criterion to each use and, additionally, the average of importance of each criterion in all uses, aspects which may also become relevant in new development appraisals;
i) The results attained show the clear obsolescence of the existing building in its current use (5.2.2) and the clear non-obsolescence of the building site (5.2.1). Furthermore, they confirm the physical improvement that is being proposed and its further adaptability to accommodate other uses;
j) The financial appraisal carried out (5.3) suggests that the use being proposed in the case study to be the most valuable. The discrepancy with the location and physical appraisals´ results reinforce the importance of the cost benefit criteria on an adaptive reuse appraisal;
k) Finally, and from the above, a significant change in the purpose of the model constructed is suggested. In the concept of *highest and best use,* i.e. the most probable use of a property which is physically possible, appropriately justified, legally permissible, financially feasible, and which results in the highest value of the property being valued *(IVS, 2003),* the model constructed can assist in presenting the *appropriate justification* and *physical possibility* of the alternative use, for an office building in London, which is suggested to be the highest and best use for that building.