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The Economics of Sustainable Tall Buildings

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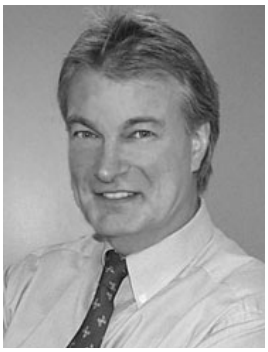

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The Economics of Sustainable Tall Buildings

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Abstract
In this article we approach sustainability within the tall building sector through the framework of the Triple Bottom Line. Drivers, opportunities and barriers to sustainable tall building development are described. Consideration of these factors highlights a lack of benchmarking data on which to base legislation, investment decisions, and tenants' property choices. Quantification of traditionally unmeasured benefits of tall buildings, particularly with respect to necessity, infrastructure, and building use, is required to explore the case for classifying and quantifying their sustainability. The industry stakeholders will only attend to these wide-ranging issues if opportunity for financial profit is improved by their inclusion. Thus, integration of sustainability data throughout the supply and demand sides of the industry must be translated into financial costs and benefits. The collection, analysis and dissemination of this information is a major challenge and opportunity which is of current relevance to the tall buildings market internationally.

Keywords: Sustainability, Tall Buildings, Infrastructure,

Introduction

Sustainability is an evolving concept that is becoming increasingly mainstream with the staged implementation of legislation derived from the Kyoto Protocol regarding emissions of CO2. Non-governmental agencies are providing voluntary frameworks by which companies and individuals can have their sustainability performance qualified, for example ISO14001 and FTSE4GOOD. Corporations are publicising and promoting their commitment to the sustainable agenda through inclusion of Corporate Responsibility (CR) statements in their advertising, press releases, interviews and annual reports.

The construction industry, and therefore the built environment, is an important contributor to the sustainability agenda. In the UK, construction and occupation of buildings is thought to be responsible for around 50% of CO2 emissions (Stern, 2007), and society depends on the construction industry to provide the infrastructure and occupiable buildings without which it would not be able to perform economically.

Sustainability performance measures applicable to the construction industry include direct reductions of: embodied energy, material use, waste, non-renewable energy consumption, CO2 emissions, pollution, and water use. There is much legislation covering energy efficiency and renewable energy measures, all of which tends to address the building as a stand-alone object, without regard to its impact in the broader context. Yet, "sustainability" is a greater and more complex consideration, greater than the current means to measure (and therefore improve) sustainable performance in buildings.

A more holistic view would tackle attendant aspects such as impact on infrastructure and transport utilisation; longevity of the building and its components in primary use and re-use; contribution to the community at large; productivity of the building's occupants; land utilization; urban sprawl, etc. The infrastructure platform upon which tall buildings are placed is at least as important as the buildings themselves. This is of particular relevance to emerging economies with burgeoning cities and high population densities.

Whilst not providing all the answers, this paper attempts to 'square the discussion', by outlining the need for a greater breadth of consideration in order that tall buildings may be assessed on their true range of impacts, good or bad. It also draws attention to the need to consider the critical impacts of infrastructure provision, particularly in a world with an expanding, and rapidly urbanising population.

Triple Bottom Line (3BL)

Defining sustainability, and planning ways of achieving sustainable performance, has led to a range of definitions, models, and action statements. Perhaps the most inclusive of these is the Triple Bottom Line (3BL), for measuring an organisation's economic, social, and environmental success. Another way of expressing this is the three P's of Profit, People and Planet.

The Kyoto Protocol asks us to "recognise that various actions to address climate change can be justified economically in their own right". The same is true of actions directed at social improvement. Pursuing the 3BL requires early consideration of the impact of a tall building's design on people and the planet: the capital

and future costs of available interventions and their benefits - benefits that should be measured in sustainability terms (e.g. CO2 emissions) at all stages of the building life cycle. The potential effect upon the current and future value of the building is a further criterion for consideration.

Figure 1: The Tower produced for Profit

The tower as an economic product (see figure 1) should become the tower as an economic, social and environmental product, meaning that the current focus on profit will need to spread to embrace the people and planet spheres.

The Current Situation: 3BL and Construction

The building lifecycle can be split into three distinct phases: Develop – Use – Re-Use (see Figure 2). Though an over-simplification, it may be observed that the overwhelming focus of construction projects is financial profit at the development phase. This implies little consideration of people or planet during the 'creation' phase of the project.

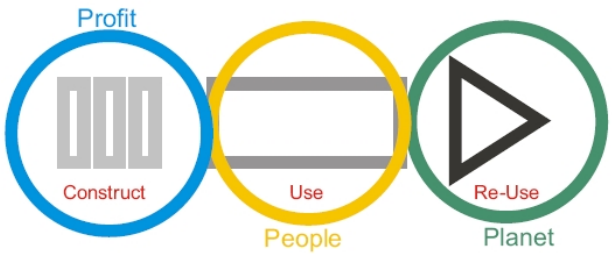

Figure 2: Tower Lifecycle and 3BL

Profit focus tends to be intensified for tall buildings, not least because of the cost premiums and other delivery challenges that are associated with height. Davis Langdon's Tall Buildings Cost Model (Watts & Kalita, 2007) identifies and considers these issues in more detail. With pressure on the traditional bottom line - and the wish to avoid unnecessary prolongation of an already long and involved gestation period - developers understandably incorporate sustainability measures that will ease their project through the planning process with minimum fuss and cost.

Developers will therefore do what is necessary to meet legislative demands, where these are feasible. Although there is evidence that attitudes are changing in some markets, with developers looking to what is possible, as opposed to what is required, this is yet to become widespread international practice.

The result is that, generally, the impact that the built product, or the property asset, will have during its life cycle of use and beyond is rarely recognised. This suggests that major parts of the sustainability equation are being missed - but herein lies opportunity.

Energy Efficiency

Perceptions that towers are the 'gas guzzlers' of the property world are debatable. It is true that, in principle, they may use more embodied energy due to their higher material content (heavier frames, more facades per square meter of floor area, etc) and more energy-in-use (because of pumping requirements and more intensive lift use in particular). However, not only is there very little data to substantiate this argument, but balanced analysis should cover all aspects of the building's life cycle, energy use, emissions, business efficiency, economic momentum, and its overall impact on the environment.

Staff Efficiency

People benefits (productivities) may be difficult to quantify, but are of great importance, considering that staff costs represent some 85% of the total cost (see figure 3) of a building over its life time. Again, lack of available objective data in this area is an issue, but one that should not prevent the introduction of measurement in respect of staff recruitment, retention, absenteeism and overall staff satisfaction.

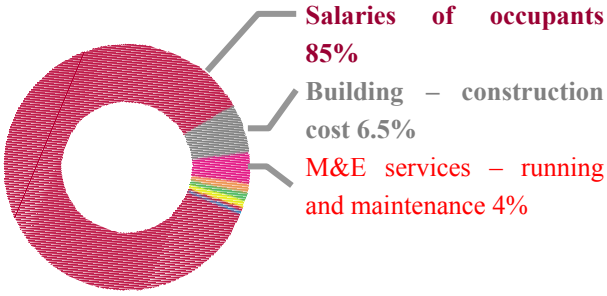

Figure 3: A breakdown of business costs across the whole building lifecycle

'Contextual' Issues

Even the above factors do not complete the story. Issues beyond the building itself have to be addressed, as will be discussed later in this paper.

A new and more broadly dimensioned framework is therefore required, to correctly gauge the sustainable

performance of tall buildings, including their social and commercial impact; and reliance upon their infrastructure platforms to underpin their performance as sustainable property assets. The current lack of such a consolidated approach presents opportunities for improvements - in both approach and output data - some of which are considered in the following section.

Sustainability Opportunities for Tall Buildings: Building Design

Operating Efficiencies

The CO2 emissions which derive from all buildings equate to a significant contribution to depletion of fossil fuel reserves, with strong arguments suggesting a major contribution to global warming. With "energy-in-use" accounting for the bulk of this figure, the link between the way buildings are used (and designed for use), and this burden on the planet is as uncomfortable as it is unavoidable.

Though the principles have been established for a number of decades, life cycle costing techniques are generally not practised on most building projects. Without the feedback from such "long term tools", it is impossible to reach reliable conclusions about the relative merits of tall buildings in respect of increasing operating efficiencies or reducing their operating costs. ("If you can't measure it, you can't improve it", Kelvin). However, accepting that energy costs form a small part of the annual operating bill for a typical office occupier, a new framework for whole life models has to additionally consider energy usage (and therefore CO2 emissions).

Occupiers place great importance on the factors affecting their core business and, given the predominance of staff costs in overall operating cost, it is not difficult to see why. The opportunities for tall building designers could therefore be thought of as two-fold:

- Provision of space that is attractive, flexible, healthy and productive.
- Incorporation of energy efficient systems and plant.

Building Form

Vertical shape and lateral geometry are the most influential cost drivers for tall buildings, and alternative forms are sometimes (but not always) reviewed - and their relative pros and cons established - at project feasibility stage. Shape is rarely considered for its ability to create other benefits - and this is perhaps where several opportunities for tall building designers rest. Such opportunities include:

- Orientation to optimise climatic conditions: solar gain, day-lighting, wind harvesting, etc.
- Shaping to create optimal structural systems and wind load response.
- Co-coordinated environmental strategies that consider services and façade designs, and building form together, e.g. natural ventilation.

Tall buildings are well placed to incorporate beneficial changes such as those above, in that they are likely to influence thinking and innovation given their shape and scale which interact physically with the climate.

Economies of Scale

Sustainability benefits can be derived during the construction process through modern methods of manufacture and off-site fabrication. Such processes can be considerable contributors to the construction programmes and economic viability of tall buildings, especially where repeating elements allow for reductions in waste and improvements in buildability, tolerances, logistics, and on-site safety. Capitalising on computerisation of design through use of parametric Building Information Management software - such as Digital Project, used on Russia Tower, Moscow - means that coordination costs of fabrication and installation can be reduced while design freedom is increased.

Landmark towers, perhaps more than any technical challenges, encourage the pursuit of perfection. Honing design, standardising and aggregating purchasing specifications can provide substantial economies of scale. For example, on a current project the rationalisation of an already individually inexpensive opening mechanism for external wall louvres saved millions of US dollars because of the quantity involved.

Mix of Uses

Mixed-use towers such as the Shard at London Bridge and the AOL Time Warner building in New York offer benefits in terms of risk and overall marketability. Creating office, hotel, and residential space, within one building mitigates some of the market risk that single purpose developments pose for investors and developers. Mixed use buildings also offer the opportunity to better integrate recycling of waste heat and water, and reduce peak service loads.

Innovation

The history of the skyscraper is inextricably linked to improvements in technology, use of new materials and innovation in methods of design and construction. Some would argue that it has enabled us to build taller and offer more 'comfortable' internal environments which has contributed to our buildings becoming less sustainable. The challenge for technology is therefore to allow us to build towers more efficiently, more sustainably and to create internal environments that are comfortable, productive and energy efficient.

New technologies are in development that could offer significant material benefits. Through Biomimesis and nanotechnology, new products are coming to market such as anti-reflective façade coatings with designs based on moths' eyes! Technological advances, such as the use of blast furnace slag in high-strength concrete, offer both performance and sustainability benefits. Innovations in sustainability which are tried and tested in tall buildings will contribute to increasing the sustainability of the construction and property sectors as a whole.

Sustainability Opportunities for Tall Buildings: The Tower in Context

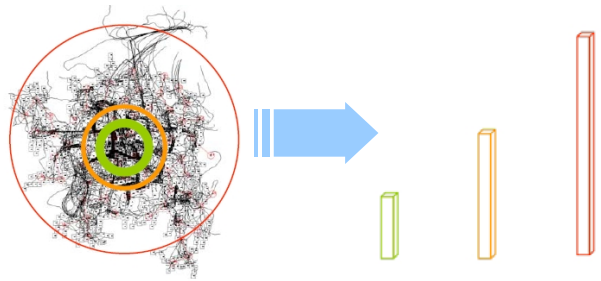

Figure 4: Tall Buildings and their Sphere of Influence

While the preceding sustainability discussion has focused on the tall building as a stand-alone object, its value in sustainability terms is heightened by its overall relationship with its urban setting and infrastructure. These complementary factors are difficult to quantify and compare, but nonetheless critical, as the tall building's sphere of influence, on a city and its infrastructure, spreads far beyond its own footprint. (see figure 4).

Clustering

Tall buildings' efficient use of scarce land resources is an inherent advantage and one that combines with shared development at transport hubs when tall buildings are constructed in clusters. This principle dates back to the American towers of the early twentieth century, which were clustered to concentrate large groups of people within walking distance of each other and their transportation systems.

Sprawl

Vertical rather than horizontal expansion avoids the detrimental effects of urban sprawl and maximises the potential to maintain and enhance the public realm.

Context

The development of a tall building within the context of its immediate surroundings, with respect to the historic and future development of the city, is an important part of 'cultural' sustainability. Where there is economic and social value in the visual heritage of a city, the clustering of tall buildings allows for increased density, thus economic vibrancy and infrastructure efficiency, without compromising the "look and feel" and "culture" of the city as a whole.

Given patterns of economic and population growth, the most pressing aspect of context is infrastructure and it is arguably the most important contribution to the success of fast developing metropolises. It has direct implications across the 3BL and warrants further discussion here.

The Necessity of Infrastructure in Emerging Economies

It is estimated that in 2007, the proportion of the world's population living in cities passed the 50% mark. Urbanisation in Europe, the Americas, Japan and Australia is stable at above 70% while the populations of Africa, China and India are urbanising rapidly. The realisation of commercial benefits, shared amenities, health, education and security, depends on providing sufficient infrastructure for transport, water, waste and power. Historic and continuing population migration has and will place eccentric demand on existing infrastructure and will necessitate the provision of infrastructure where none exists.

This population movement to cities has implications across the 3BL. In People terms, such rapid urban influx has caused 'first arrival' slums, which are hazardous to health, human safety and the infrastructure of cities themselves, without creating economic wealth for their inhabitants. When it comes to infrastructure planning it is an inescapable reality that cities which continue to grow, without proper investment in infrastructure that takes account of the *entire* urban community, will ultimately expand to a point where infrastructure is stretched or broken beyond repair.

Meeting Infrastructure Needs

The infrastructure of London is groaning at the seams, but the question is how much money needs to be spent to bring it back to a standard that matches the current and forecast future needs of a world-class city. This is not the case in cities such as Sao Paulo, Calcutta or Cairo, where the amount to be spent is not the relevant challenge, but whether the infrastructure that exists is fixable or extendable at all.

An argument has been advanced that the infrastructure of these cities is broken beyond repair, with one of the scenarios put forward being that entire new cities may be required, in close proximity to the old with, over time, a decant of old cities' populations into new urban environments with the infrastructure and amenities to properly support their populations. In South Korea the Government recognised that the continued spiralling growth of Seoul was not sustainable. It therefore, some three years ago, master planned Songdo, an entirely new city close to the international airport at Incheon, some 25 miles from Seoul. In Mumbai a federation of politicians, professionals and businesses is proposing the phased, but complete rebuilding of housing for the poor, a plan that includes construction of 15,000 tall buildings in its first phase, necessitating enormous investment in supporting infrastructure. The national concern is that such measures are carried out in a sustainable manner.

Given the extent to which global resources for construction are stretched to meet current demand, some innovative thinking will need to be developed to meet Asia's key elements of infrastructure:

- Transportation – road and rail; bridges and tunnels
- Storm water and waste drainage
- Disposal and recycling of waste products
- Potable water and water for irrigation, industrial cooling and the like

- Electricity, gas and other energy sources for heat and light

All of the above must connect to the transport terminals, ports and airports essential to trade and movement of people.

Social requirements for the provision of education and healthcare may also be considered to be integral parts of 'infrastructure', in that, without their contribution, the essential "pillars of society" are not sufficiently in place to create an economically sustainable urban environment.

The 'shopping list' for those pieces of the infrastructure platform which are essential to sustainable existence will place enormous demand on the global supply chain and international procurement solutions. getting the economics right, will be a prerequisite. Creative financing will form one part of the solution, with particular reference to public/private partnerships (PPP) which will enable, or indeed accelerate, development of essential infrastructure, on commercial terms which enable attractive return on investment over time.

However, a greater challenge may be in sourcing and transporting the construction plant, materials, components, and people to build the various elements of infrastructure platforms which, accepting the current level of global competition for such resources, does seem to be a complex issue. China currently demands some 25% of the world's supply of cement, and India's demand for such strategic materials has yet to reach its full potential.

Trying to square the environmental impacts implicit in the production of reinforced concrete, structural steel or other materials that are necessary to build the infrastructure platforms with any form of 'green index' will be difficult. Given that today's material production methods hardly qualify as "friends of the earth". If all of the above seems something of a paradox, then it probably is one. However, reconciling necessity with sustainability *is* a problem, for the world, one that cannot be solved in the context of business as usual.

Current Drivers of Sustainability

Legislation

To date, drivers towards sustainability seem to be more 'stick' than 'carrot': regulation through legislation being responsible for the majority of carbon savings in construction.

In the UK there is a trend towards taxation of power-hungry, wasteful, or unsustainable construction activities. This is seen in Landfill Tax, Climate Change Levy, Aggregates Tax, and similarly motivated government directives and regulation such as the Energy Performance of Buildings Directive (EPBD), implemented in the UK as building regulations, which is the driver behind recently introduced requirements for energy labelling of buildings. Each of these legislative measures is set to apply increasingly demanding targets and higher penalties for non-compliance.

However, some existing targets are either 'paid lip service' or are unrealistic in their requirements. The Greater London Authority's Renewables Target is a good example. The requirement that 10% of a building's energy is derived from renewable sources is achieved on virtually no new commercial buildings. The recent announcement that the level will be raised to 20% has developers up in arms.

Recognition and Certification

The range of certifying bodies that promote sustainable activities has grown rapidly in recent years. At the corporate level there is recognition from stock market indices: Companies listed on the Dow Jones Sustainability Index (DJSI), or the FTSE4Good index, have met globally recognised CR standards (such as ISO14001) and their inclusion within these indices is based on their leadership across a range of criteria such as strategies for climate change, energy management, and human resource development. These indices provide a broad indicator to investors that the companies they are investing in or through are aiming to be sustainable in their business activities and conduct.

The EPBD will soon require that buildings are assessed and labelled according to their predicted energy performance prior to sale or lease. This will be recorded on an Energy Performance Certificate (EPC) which will give a building a rating based on comparison with energy performance benchmark data. Buildings that are publicly owned or occupied will have to show a current Display Energy Certificate (DEC) that details actual energy usage for the previous year. The public availability of energy usage data is expected to be a strong driver towards reductions in energy use.

The achievement of BREEAM UK, LEED USA, Green Star Australia, or other recognised market ratings brings "branded sustainability" credentials to projects, although global benchmarking is difficult due to the differences in the local context of the ratings systems and their differing rates of uptake.

These voluntary certification schemes are under constant revision as technological advances and scientific knowledge offer new ways of achieving and measuring sustainable performance. Context-specific revisions are also made to weightings of the measures in different countries. For example, the United Arab Emirates LEED-based system will prioritise water-use. However, the feeling persists that whilst the intentions of the certifying bodies are sound, they are not necessarily incentivising the development of truly green buildings.

Incentivisation of sustainable design

Enhanced Capital Allowances (ECA) is one way of driving investment in sustainable technologies. ECA grants offer 100% tax relief across a list of energy and water saving plant and machinery installations. ECAs are intended to make expensive installations that have long pay-back periods, affordable in the short-term, yet the associated costs of sourcing listed products and the administration required to claim the ECAs reduces uptake. Cynically, the clearest opportunity for inducing

sustainable agendas for London's tall buildings is the granting, or refusal, of planning permission.

Beyond legislation?

The UK Association for the Conservation of Energy (Guertler et al, 2005) predictions for carbon savings in office buildings are based on predicted uptake of sustainable design and interventions.

Their view that only 11% of investors/owners would move beyond legislative requirements (and contribute 16% of carbon savings) must be tied to a recognition of upfront costs and will only properly emerge from a visibly stronger tie between the validity of sustainability measures and their value to occupiers, and thus impact on building valuations.

One thing is certain: as standards demanded by both regulation and the market inevitably rise, there is a risk that tall buildings, if built to today's standards, will be considered second or third tier accommodation well within their useful structural and financial lifetimes.

Barriers to Sustainable Performance

The forgoing section surmised that the principal driver behind current endeavours to improve the sustainable performance of new buildings is legislation. The tendency for the individual commentaries to end with 'however' statements suggests that the status quo also presents a number of potential barriers to materially improving such performance. These barriers include:

Inconsistencies in Regulation and Legislation

Regulation and legislation regarding sustainability and buildings is still in its infancy. There are a number of overlapping and arguably conflicting statutory and advisory requirements. For example, Part L of the Building Regulations in the UK effectively demands that tall buildings employ double wall ventilated and sealed facades, precluding the adoption of natural ventilation.

Validity of Sustainability Interventions:

There is resistance to implementing technologies when the benefits to both developer and tenant are unclear or hidden. For example, there are questions over the benefits of on-site generation, particularly while technology has not reached its full potential for energy harnessing, and when a more holistic analysis of energy use and provision could show a greater benefit from investment in properly sited (non-urban) solar or wind farms, and biomass generators.

As an example, embodied energy does not seem to be adequately covered by regulation, such as in renewable energy targets. In the case of building mounted wind-turbines in urban sites, the energy displaced (i.e. the reduction in demand from the grid) could quite possibly never surpass the energy embodied in the turbine during its creation, installation and maintenance.

A recent scheme in London proposed a number of wind turbines on its roof, with an accompanying capital cost of £500,000. The calculated saving in energy costs was £240 per annum. It therefore offered no financial payback, and the carbon payback was questionable as the embodied energy in manufacturing (and ongoing maintenance) was ignored. Yet it formed part of the key sustainability strategy – i.e. planning strategy – and this on a low rise building.

Fragmented Nature Of Property And Construction Industries

The lack of vertical and horizontal integration in the property and construction industries presents barriers at a number of levels.

Collaboration between policy makers, clients, professionals, occupiers and supply chains could provide well-planned tall building developments on a suitable infrastructure platform, that are built efficiently (possibly with shared consolidation/distribution centres, even shared procurement strategies) and match end-user requirements – all driven by an overall sustainability agenda.

Lack Of Information

At present neither developer nor tenant seem to know what they should be providing or wanting, largely because of the limited information available to both. Developers follow legislation that requests reductions in energy usage, which has minimal impact on the direct economic cost to building tenants, for whom energy costs are small in comparison to other outgoings such as staff and rent (In London energy costs can be as low as 1-2% of rental costs).

Many tall buildings in existence fail to provide a satisfactory sustainability response. Of the current crop of landmark towers being built in London generally less than 1% of their total construction costs (and therefore a fraction of one per cent of their total development costs) is spent on sustainability measures.

The maximisation of opportunities and addressing of potential barriers provide the keys to future sustainable performance.

Keys To The Future

New modes and means of measuring, holistically, the energy impact of buildings will, once established, make clear the benefits or failings of sustainable design and development across the 3BL.

The speculative development of a sustainable green building is based on an expectation that market conditions will reward the investment. As this market is still young, the risks to the early adopter are uncertain, and it is through the development of the sustainable tall building market, and a quantifiable increase in return that the industry will fully develop. The 3BL will only be achievable if first the Profit is proven.

Legislation, though flawed, continues to be refined. But this too requires a greater understanding of the full sustainability spectrum. There are, perhaps, two fundamental changes that are required from the industry to direct policy and practice:

1. A proper presentation of the true 3BL costs of sustainability initiatives, through robust modelling techniques that address all relevant issues.
2. The establishment of a firm link between the building product and tenants' needs and desires, so that the developed modelling tools can also incorporate value inputs.

Quantifying And Modelling Sustainability

Measures of cost, floor area, tonnes of materials, net to gross ratios, are common to current feasibility models. Whole life costs and benefits (that should include, among other things, embodied energy, building longevity, etc) are not. Neither are the more complex (but high value) factors associated with staff productivity and the quality of the internal environment. Nor the even more problematic 'contextual' issues that include: sprawl reduction; increased density; infrastructure use; clustering; commuting durations and modes. Yet all these factors and issues affect sustainable performance across the 3BL and should be modelled such that the traditional feasibility calculation, based on Profit, includes benefits to People and Planet.

An improved understanding of the 3BL based on the outputs of such models would clearly help to forge the product-value link. Minimal awareness or formal recognition of the added value arising from better building performance in-use causes a disconnect between project value and improved design standards. The value attached to achieving a higher (sustainable) design standard is rarely quantified financially. In the absence of a recognised framework to quantify such value it tends to be value-engineered out of designs even though engineers and architects will argue that great benefits can be achieved through reduced operational costs, improved user well-being or improved corporate/client 'image'. It becomes a requirement on the designers and consultants to provide the 3BL rationale such that when a client decides for sustainable design, they buy into quantified benefits, not just green platitudes.

Value & Market Differentiation

The valuation of the tall green building market, and thus the size of the opportunity is difficult to ascertain. The European and UK valuation methodologies (TEGOVA and RICS) do not include energy efficiency during a building valuation. EPCs and DECs will take many years to spread throughout the building market, and fears at the Energy Efficiency in Buildings project (Kornevall, 2007) are that they will not sufficiently differentiate the sustainable building market as most buildings will fall into roughly the same category. The potential People benefits, and wider Planet cost-benefits also go unreported and are not directly included within valuations.

Agents find that the range of occupiers they encounter have, as yet, no set pattern of response in respect of sustainability. That said, the level of awareness is rising rapidly up the corporate occupier agenda and no one wants to be seen to be out of step, or exposed, in the same way that all companies want to be seen to have a good CR rating. This move away from the agents' traditional criteria of cost and location is being influenced not only by CR issues, but also through the increasing importance of occupiers' Human Resource requirements for attractive, healthy, flexible and productive space.

As data from the stock and property markets becomes available for collation with 3BL data, the risks and opportunities for the differentiation of investment decisions will become more accessible to all - developers, designers, constructors, funders and end users. This will enable the financial realisation of 3BL benefits, such that they can be included in Net Present Value calculations and Cost-Benefit Analyses.

For developers and consultants the same data needs to be translated into salient benchmarks that effectively differentiate sustainable performance at the design stage, allowing prediction of the up-side and down-side risks for sustainable profit maximisation.

Finding and making explicit the benefits that accrue to investors and to tenants - and creating buildings that maximise these features - is the challenge that is faced in the market for sustainable buildings. Measuring the sustainability impact of tall buildings means taking account of the much larger area of influence created by the tall building. By its infrastructure requirements, size, visual presence, and potential for wealth creation, the tall building reaches far beyond its immediate surroundings, and covers much more of the 3BL.

Conclusions

The importance of "Sustainability" has risen, and continues to rise, up the agendas of governments, corporations, funders, developers, designers, constructors and advisors to the built environment. Creation of the built environment has a large part to play in the drive to meet Kyoto targets because of its contribution to CO2 (and toxic) emissions. It also builds the blocks of wealth creation, and houses the working and living populations, globally. Together, these represent the basic elements of the 3BL for the construction industry.

Tall buildings are used by cities and corporations competing on the world stage to meet their needs, signpost their intentions and prosperity. The overriding challenge and opportunity for such high profile towers is to confirm their positive effect upon the environment and society. This should be considered not only through the provision of green iconic towers (and 'green' needs to be properly defined) but in the context of the important part that tall buildings can play in development of sustainable communities. There is also no point in placing a sustainable tall building on an unsustainable infrastructure platform.

To achieve sustainable benefits there are a number of shortcomings which need to be addressed, including: uncoordinated legislation that fails to clearly link cause and effect; insufficient incentives to developers; the

fragmented nature of the property and construction industries; and the lack of coherent framework for all of the issues that influence the sustainable credentials of a high rise (or other) scheme.

It is this last point that forms the crux of this paper and one that places a brake on many of the initiatives for sustainable performance: there is a need to understand and articulate the complete sustainability argument, so that all stakeholders in a tall building development can make informed decisions based on consistent and comprehensive information. Currently, the focus often falls on navigating a tower proposal through the planning process whilst maximising profit. This is understandable, given that developers are in business to make profit, but the economic issues are much wider than initial capital cost, and account needs to be taken of the influence that initial cost has, not only on whole life costs, but on economic, social and environmental whole life value.

Tall buildings face a number of significant challenges to success which has traditionally been measured as return on investment. Planning, design, and technical constraints place pressures on costs, programme and value - and their risk profile. Developers are therefore unlikely to incorporate sustainability measures that increase cost, time or bottom line uncertainty, especially if their value is not recognised in the market.

The perception that tall buildings must - by virtue of their height - be more unsustainable than their shorter less resource-intensive counterparts does need to be drawn into balance. It may be so when a tall building is considered in isolation, but little or no data seems to exist to holistically verify the assumption. Critically, this perception ignores a broad range of factors that could have a positive influence on the sustainability equation. These factors should include analysis of embodied energy at the beginning of the building life cycle through to its re-use/redevelopment (see figure 5). The importance of staff costs and productivity, and the wider contextual issues of urban development: sprawl, transport systems, mix of uses, and quality of environment should also be drawn in and considered, providing a 'circle of analysis' that supports the sustainable economics of tall buildings.

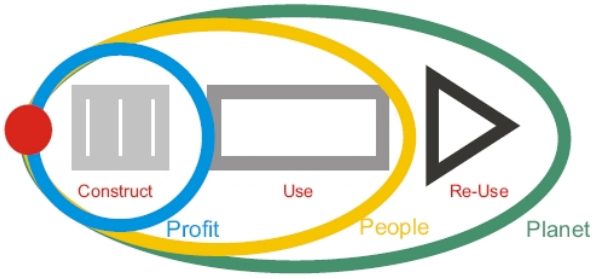

Figure 5: Integrating 3BL benefits by considering at outset

All of this presents a seemingly complex scenario, but one that can perhaps be framed into three fundamental issues:

- The sustainable performance of tall **buildings**.
- The integration of tall buildings into a sustainable **infrastructure**.
- The assessment of market perception and requirements that will affect the **value** of sustainable enhancements to both tall buildings and their 'platforms'.

At present, tall buildings, certainly in London, do not invest significant amounts of money on sustainability enhancements, whether these are energy conservation measures or renewable technologies. Rather, developers tend to incorporate what they are compelled to do, probably because:

- Many of the options are not technically feasible.
- There is no clear or strong evidence that potential enhancements will materially affect the 3BL.
- Operational costs are not quantified because they do not affect developers' appraisals nor feature prominently in tenants' priority lists.
- Legislation is somewhat disparate and in part unrealistic.
- Rental predictions are not raised to reflect a better quality building (and we have to ask ourselves: is it a better building?).

In short, the assessment of building performance is flawed, the impact of infrastructure is virtually ignored and, perhaps because of this, value does not seem to feature in the equation. It is therefore unsurprising that no party has the means to differentiate buildings on a sustainability scale.

Increasing market awareness and the ability of end users of the building product to measure real value according to the 3BL will encourage a stronger tie between developer and tenant (see figure 6).

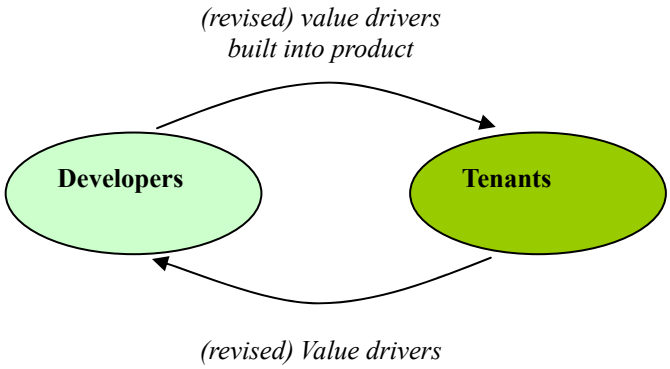

Figure 6: Cycle of Market Awareness

This will clarify value as well as cost drivers and produce buildings that are more valuable to each party, and society at large.

For tall buildings innovation will be especially important. Their prolonged development periods mean that they must be at the cutting edge of design and employ sufficient flexibility to accommodate future progress in products and technology.

The key will be defining what needs to be measured, collecting data and developing tools to measure and interpret it. Davis Langdon, CBRE and Aedas are about to embark upon a preliminary study to formulate such a tool.

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