

# NEXT GENERATION DECISION SUPPORT INSTRUMENTS FOR THE PROPERTY INDUSTRY – UNDERSTANDING THE FINANCIAL IMPLICATIONS OF SUSTAINABLE BUILDING

Dr. David LORENZ MRICS<sup>1</sup>  
Prof. Dr. Thomas LÜTZKENDORF<sup>2</sup>

- <sup>1</sup> Lorenz Property Advisors - Chartered Surveyors, Schwarzwaldhochstr. 47, 76571 Gaggenau, Germany  
d.lorenz@property-advisors.de
- <sup>2</sup> Department of Economics and Business Engineering, Chair of Sustainable Management of Housing & Real Estate, Universität Karlsruhe (TH), Kaiserstraße 12, 76131 Karlsruhe, Germany  
thomas.luetzkendorf@wiwi.uka.de

*Paper to be presented at the World Sustainable Building Conference (SB08)  
Melbourne, Australia, 21-25 September 2008*

Keywords: sustainable building, decision support, feedback-mechanisms, value, risk, quality assurance

## Summary

The mainstreaming of sustainable development in property and construction is not only possible but realistic, even in the short to medium term. But for this to happen, a fundamental change to how we understand and value our built environment has to be achieved and the feedback-mechanisms within the property and construction industry have to be altered. This requires the development and application of new decision support instruments capable of bridging the gap between economic, environmental, social and cultural measures and components of property value. The paper investigates the basis for improved decision support by referring to three deep-seated obstacles currently hampering the implementation of sustainable development principles within the industry which are: (1) the increased application of financial modelling within a property context without taking into account the major differences between financial and property assets, (2) a fundamentally flawed understanding of the concept of property value, and (3) the absence of feedback-mechanisms that incentivise change. It is argued that the prerequisites for the development of new decision support instruments are (1) a sensible integration of property as a distinct asset class within portfolio theory, (2) further development of the understanding of the concept of property value, and (3) an improvement of the information flows between actors of property markets on the basis of building files. Such a framework would provide the basis for more scientific market analysis and would allow developing and applying new instruments for valuation, risk assessment, and overall quality assurance.

## 1. Introduction

Due to the shift in public perception of climate change and environmental degradation as real phenomena, recently the interest in sustainability has risen almost exponentially; both outside and within the property and construction industry where the topic is now sometimes being marketed as if it were new. The central importance of buildings in achieving sustainable development goals has been well-established for many years; as well as the knowledge with regard to the methods and financial benefits of more sustainable design, construction and management of buildings. What has been missing so far was awareness among market participants that sustainable property investment and management is, indeed, a highly profitable exercise and that refurbishing the existing building stock represents the most cost-effective solution available for tackling the looming environmental crisis. The current situation which sees all major actors more or less concerned with sustainability issues and the pressure for action constantly rising creates a real opportunity for achieving a broad market penetration for sustainable buildings and respective investment and management strategies. But this major opportunity will pass by unused if a restructured approach to how we understand and value our built environment cannot be achieved and if the informational basis and information links (i.e. the feedback structure) within the property and construction industry remain unchanged. Failure in this regard will result in 'greenwashing' the industry without addressing the roots of the problem. To be more precise: any effort solely focused on limiting the negative impacts of poor design and unsustainable property investment and management practices (i.e. anti-social behaviour, hostile public spaces, social conflicts, occupational diseases, contaminated land, contribution to climate change and biodiversity loss, urban sprawl, and the urbanisation of the countryside) without addressing the underlying value-systems and the feedback-

mechanisms that motivate behaviour will remain insufficient. Instead, these efforts are “only trying to keep the old world ticking for as long as possible” as du Plessis (2003, p. 2) expressed it while having the majority of current sustainable construction solutions in mind. This diagnosis also applies to narrow-minded endeavours to implement sustainable development principles within the wider and highly influential property and interlinked financial markets.

## **2. Basics for improved decision support**

Sustainable development in property and construction can no longer be perceived as mostly a technical matter of improving buildings' or the construction industry's performance. Sustainable development will not flourish if it is narrowly conceived and executed in a sectoral manner. Linkages need to be drawn with the investment, lending and insurance industries, with the larger social and economic agendas and policies, and between the different jurisdictions of responsibility at the governance level. The sheer complexity of this task requires, amongst other issues, new decision support instruments and information systems. It also requires 'hybrid' qualifications among professionals combining, for example, technical, economic, ecological and sociological expertise. The nature or 'design' of these decision support instruments as well as the necessary information links that have to be established can best be explained by referring to some of the major obstacles currently hampering the implementation of sustainable development principles within the industry.

### **2.1 Mathematical modelling & the concept of property value**

Property is increasingly being seen as a distinct assets class besides stocks and bonds. This is due to an ongoing consolidation of financial and property markets and because it has been demonstrated that property improves the risk-return ratio of mixed-asset portfolios. For this reason, financial modelling and investment analysis practices are now extensively applied within the property industry to problems of risk premium determination and valuation with a constantly growing interest in financial valuation techniques and models such as discounted cash flow analysis, capital asset pricing, so called multi-factor models or real options theory. The aforesaid has been described as “the intrusion of the financial method in the real estate field” (d'Amato, 2008). Although property valuation and investment analysis represent the major mechanisms that allow environmental and social considerations to be aligned with economic return (Lützkendorf and Lorenz, 2005), the problem is that mainstream property valuation and investment counselling practice increasingly treats property as an asset class with just another degree of liquidity, even if we do not have a deep knowledge of the value of liquidity. This practice rests on a dangerous illusion since it fails taking into account that property assets do have major environmental and social impact with tangible consequences for our everyday life and well-being (d'Amato, 2008). Consequently, whenever these techniques are applied without taking into account the specific nature of property assets and investments and without prior adjustment to the subject matter of investigation and inquiry, the advice given on that basis is likely to be misleading.

So it does not come as a surprise that the role of mathematical modelling in a property context is a controversial one: On the one hand, it appears that the 'mathematization' of property economics and investment analysis has 'gone a bit far'; i.e. financial modelling in a property context is sometimes being carried out as an art for art's sake by transforming the original property problems into pure mathematical ones. Within this practice it is the mathematics theory and formal language that forms the subject matter and problem to be analysed and not the real-life problems of property investment, ownership and management. With a focus on economics in general Dillmann et al. (2000) argue that mathematics is a valuable and useful tool which economists should and must apply as long as its use is economically sensible. However, “the dangers of going beyond the 'frontier' of what is economically sensible occur when economists depart from the actual (empirical) subject matter because of the applied mathematical instruments, when the underlying value judgments are not, or only insufficiently, taken into consideration, when the recording and measurement of empirical magnitudes as an economic problem is underestimated or is even subordinate under the requirements of the formal language, and when the process of mathematization is considered as a substitute for the process of 'Verstehen' [i.e. understanding]” (Dillmann et al., 2000, p. 260). This frontier is crossed by the application of mathematical modelling in the property industry whenever it departs from and disregards the subject matter. As a consequence, mathematical modelling in a property context should be regarded meaningful (or even permissible) only in cases when the limits and conditions of validity – such as the underlying value-systems – are clearly displayed (see also: Szira, 2000). On the other hand, however, mathematical modelling is seen as the essential tool for analysing non-economic components of property value in economic contexts. There has recently been a shift away from 'modelling tools' towards the 'market itself' or, to be more precise, towards a better understanding of the market base of property value and the processes shaping it (see: Kauko, 2008). Unfortunately, the theory and concept of property value has been an almost entirely neglected area of property related research and education.

The value of a thing consists in its recognized fitness for attaining an end, or in its recognized utility. Utility can be defined as the capacity of a thing to serve for the satisfaction of human needs. According to Menger (1871, p. 120) the value of goods is always “the necessary consequence of human knowledge that the maintenance of life, of well-being, or of some ever so insignificant part of them, depends upon control of a good or a quantity of goods. [...] The value of goods arises from their relationship to our needs, and is not inherent in the goods themselves. With changes in this relationship, value arises and disappears.” The basic goal of property valuation is to provide a measure of the utility derived through the access to and control of property. The value of property is determined through the flow of services it is capable to provide for the satisfaction of human needs; i.e. the increment in well-being dependent upon it, or – what is the same – the impairment of well-being which its loss must bring about (see: von Mises, 1949, p. 120). However, the isolated analysis of financial variables and their subsequent transformation into a one-sided understanding of the economic value of property has led to an artificial separation of economic, environmental, social and cultural measures and components of property value. This understanding is fundamentally wrong and misleading since it fails recognising that, in truth, the different components of property value are intrinsically linked and non-divisible (see Figure 1). Property, or the process of investment and management, has the capacity to create (or destroy) value consisting of different components. A fixation on economic value alone and an understanding of economic value as the end of all things does not make a great deal of sense. The increasing recognition among the wider public but also within parts of the property and construction industry that the maintenance of life and well-being depends – to a significant degree – on the environmental and social performance of buildings and the built environment means that the current understanding of property value needs major revision. In fact, it is becoming evident that a property’s economic value also depends on the building’s capability to create and protect environmental, social and cultural values and that an isolated analysis of mere financial variables is no longer (and has never been) adequate for capturing the apparently re-discovered concept of property value.

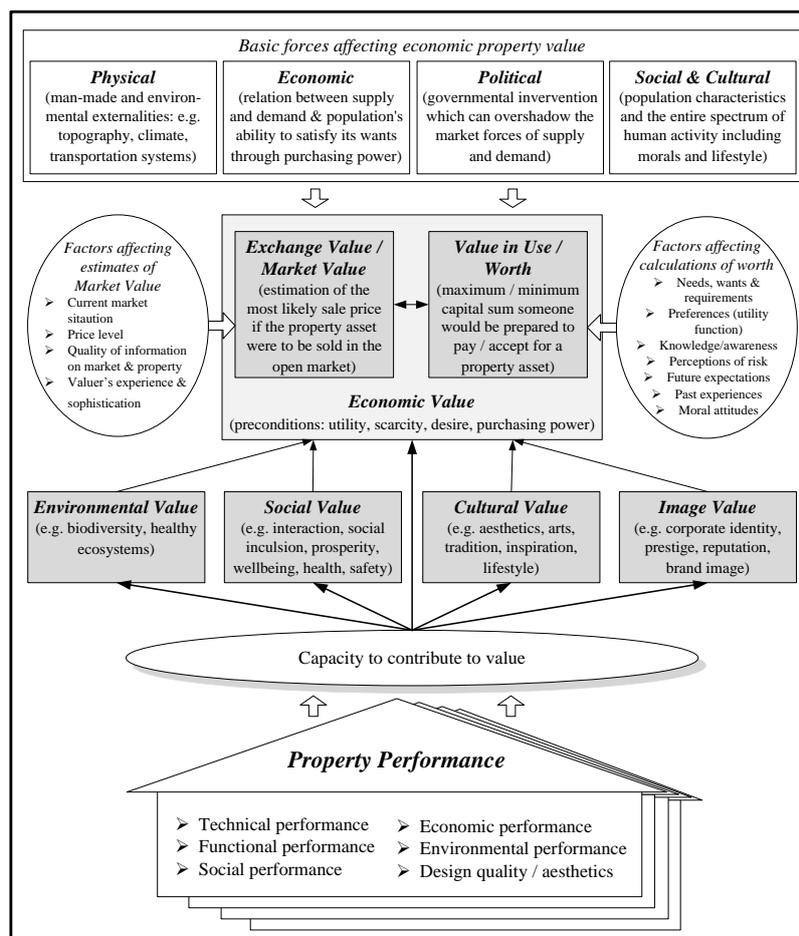


Figure 1 Property value map

In addition, there is an emerging concern that property valuations are conducted without appropriate value theory in place; i.e. a lack of professional foundation. Canonne and Macdonald (2003) investigated in detail the extent to which over 100 major North American textbooks on property valuation as well as a wide num-

ber of property valuation manuals, treaties and anthologies cover the theory of economic value and its history. They come to a sobering conclusion: “the theory of value [...] is systematically neglected” (Canonne and Macdonald, 2003, p. 113). This is due to the fact that economists in the twentieth century have turned away from the analytical study of value to concentrate on the apparently more tangible econometrical analysis of prices. “To positivists, empiricists and others who value ‘fact and logic’ over ‘vagueness and ambiguity,’ any theory of value is vague and ill-determined. For this reason neoclassical economists have given up the notion altogether” (Klamer, 2003, p. 192). It appears that the property profession has put aside the theory of value not because the issue had already been solved but because the issue had appeared too complicated. “It is much more comfortable to technically concentrate on prices and price models than to go into the domain of deductive speculation and intellectual conceptualization, which is prerequisite to the study of the nature of value, and this is quite contrary to the usual inductive nature of economics” (Canonne and Macdonald, 2003, p. 116). However, this is a critical issue because future progress in the field of valuation does not lie in the further development of mathematical modelling techniques but lies in the discovery of the relation between man and his environment (Schmutz, 1948). Given the dearth of valuation literature addressing the theory and concept of property value as well as the links to sustainable development issues it does not come as a surprise that contemporary property valuation practice fails to account for all the factors that determine the competitive position of property assets in the changing marketplace. Consequently, contemporary valuation practice bears the risk that estimates of property values are being distorted and that misinformed and unsound decisions are being made on the basis of these valuations. This may be one of the deeper causes for unsustainable behaviour in property and construction markets.

## 2.2 Loops of feedback and adaptation & information exchange

It is important to realise that the mainstreaming of sustainable property investment and management is constrained by a misalignment between suppliers and those demanding property assets for occupation and/or investment. This misalignment became known as the *vicious circle of blame*. However, the circle can be broken by providing actors with appropriate feedback on both the environmental and social aspects of building performance as well as on its various interrelations with financial performance and property value. In this regard, the traditional focus on those actors directly involved in construction has certainly been helpful but not sufficient. The involvement of additional groups of actors such as property professionals, banks, assessors and certifiers as well as research and educational institutions is an absolute necessity (see Figure 2).

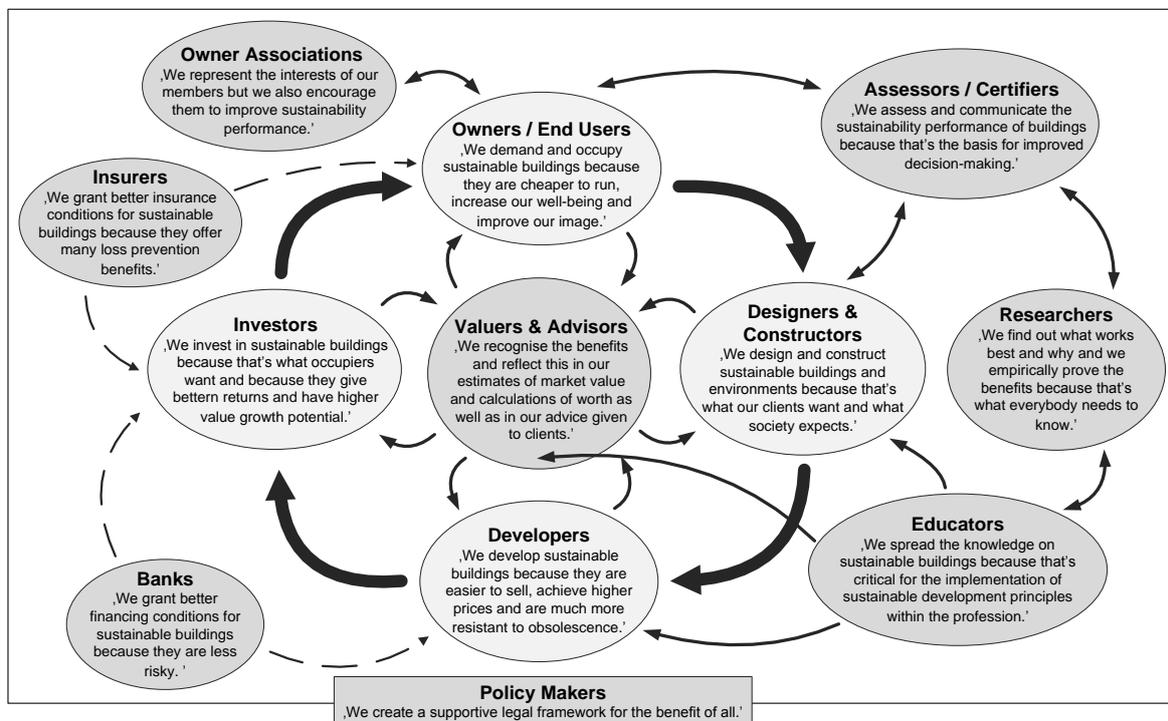


Figure 2 Virtuous loops of feedback and adaptation

The interplay between all these different actors as well as the information flow needs to be organised in such a way that the knowledge regarding the benefits of sustainable buildings pervades all areas and is accounted for within the highly influential processes of valuation, investment counselling and risk analysis. At the moment, the problem is that the feedback-mechanisms that motivate and incentivise change are not yet

fully in place. One principle of sustainable development is that measures and actions within all sectors and at all levels of society are adjusted and re-calibrated through loops of feedback and adaptation. However, actors across all business sectors and also in property and construction markets are cut-off from feedback. "They know nothing of their impacts on people, culture, health, or the environment. They subsist only on the shallowest feedback: direct internal financial returns" (Kiuchi, 2003). This is dangerous and leads to a false statement of corporate accounts since huge and growing external cost categories are ignored. Shareholders may not notice these unstated costs while in contrast stakeholders do (Kiuchi, 2003). Expressing this in the property context: if building owners and investors know nothing or very little about the real performance of the buildings they buy, use and operate, (i.e. if they are cut off from feedback delivered by triple bottom line monitoring), then these buildings cannot be improved systematically in pursuit of both individual and collective well-being. The alternative is for property professionals to begin assessing and reporting value creation through sustainable design, incentivising change and more sustainable behaviour. The added value appropriated to sustainable design will underwrite a restructured approach and a radical change to how we understand and value our built environment. The end result is the emergence of a pro-active, self-perpetuating loop driving further change and even more sustainable behaviour.

A precondition for assessing and reporting value creation through sustainable design and for installing appropriate feedback-mechanisms within the property industry lies in overcoming existing information asymmetries. What is needed is a systematic description of major characteristics and attributes of buildings for various purposes such as valuation, risk assessment and certification; i.e. a reliable and cost-effective source of information for property professionals. An appropriate source of information in this regard are building passports or building files which have been discussed in Europe since a considerable period of time. However, building files are yet only issued occasionally on a voluntary basis. In addition, building files are not yet standardised. The introduction and dissemination of building files in property markets is currently hampered by ambiguous and unclear perceptions regarding their informational content and function. Usually building files are either seen as a kind of building manual, as an extended construction and building specification, as a quality assurance system or even as a label or certificate. However, the interpretation of building files put forward in this paper is that of an 'information container' which supports the exchange of information between actors in property and construction markets (see Figure 3).

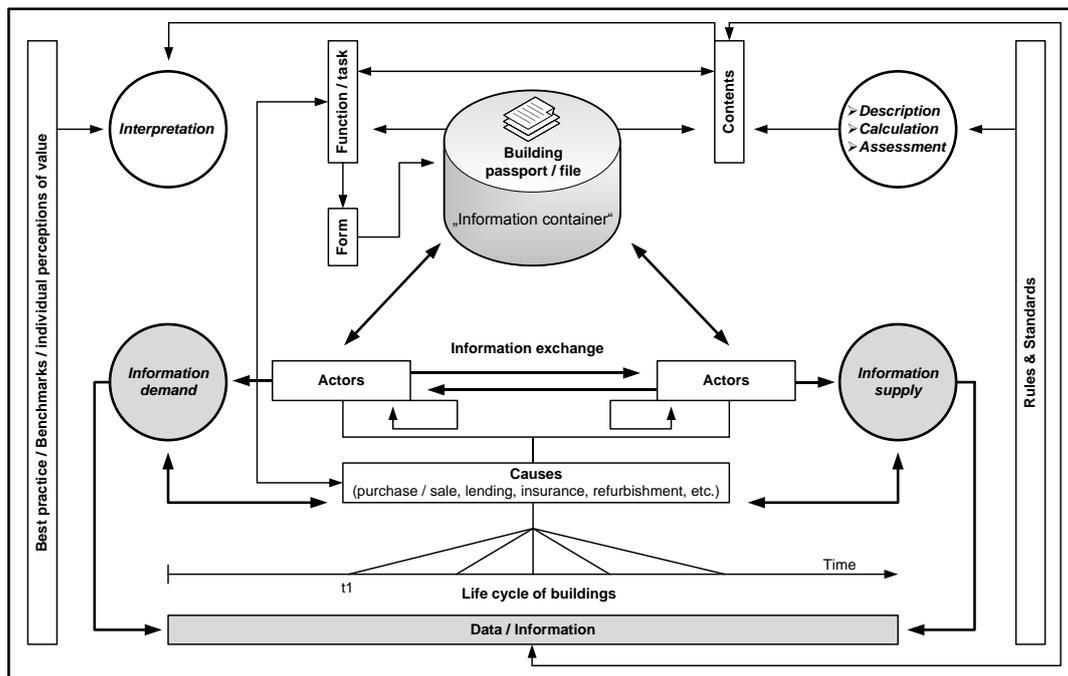


Figure 3 Information flows between actors of property markets on the basis of building files

There exists a clear need for provisioning, extending and updating building related information along the life cycle of property assets. This information has to be gathered and compiled on a scientifically robust basis during the planning phase as well as during the subsequent phases of operation and refurbishment. In this regard it is important to realise that different actors fulfil different roles and have different standpoints and goals. They therefore need different kinds of information in different formats tailored to the requirements of specific decision making problems accompanying the life of buildings. Building files can be used to serve this informational demand as they are capable of providing different kinds of information for different actors. They

could contain information on the following issues: construction method; building materials; statics; heat and sound insulation; fire safety; operating costs; maintenance and repair; demand for and consumption of different resources/media; etc. For the further development of the informational content of building files it is recommended to foster the development towards performance-based building information as well as to compile a list of key characteristics and attributes which would best serve different actors in different decision-making contexts. The latter issue could be addressed through efforts undertaken by the large organisations for property professionals such as the Royal Institution of Chartered Surveyors (RICS).

### 3. Next generation decision support instruments

Next generation decision support instruments for the property industry will have to fulfil a variety of roles and purposes. First, they will have to address the imperfection and asymmetry of information. In today's property markets investors and their professional advisors are forced to analyse and evaluate various aspects of building performance and the attractiveness of a particular location in great detail while they are simultaneously required to take into account a variety of complex institutional influences and externalities at global, regional and national level. The success of property investments and the competitiveness of investors and their professional advisors strongly depends upon knowledge and on the capabilities and sophistication to assess, interpret and understand the increasing complexity of factors from diverse sources of real estate information (see: Castells, 1996). This means that decision support instruments will have to allow for inter-linking information from sources such as market and transaction databases, building files, sales portals, land registers, geographical information systems, national statistics bureaus, etc. in order to enable property professionals to fulfill their role as 'information managers' in a market where the distribution of information is traditionally considered asymmetrical. Second, decision support instrument will have to allow professionals to assess and communicate (in understandable formats) the accuracy and reliability of both their estimates of values, risks and costs as well as of the quality of the applied valuation, risk analysis, management, construction and refurbishment processes. This will involve addressing notions of uncertainty and probability as well as the issue of traceability (see: Lorenz et al., 2006). As there has already been a lot of loss of both credibility and faith in the property and finance industry in general and in the valuation and counselling profession in particular (due to overvaluation, misleading advice and speculative behaviour that has recently led, amongst other issues, to a global crisis in property and interlinked financial markets), professionals will have to apply tools and measures not only for 'quality assurance' of products and processes (see Figure 4) but also to make their 'thought processes' explicit and to give clients a better understanding of the nature and risks of property investment and financing.

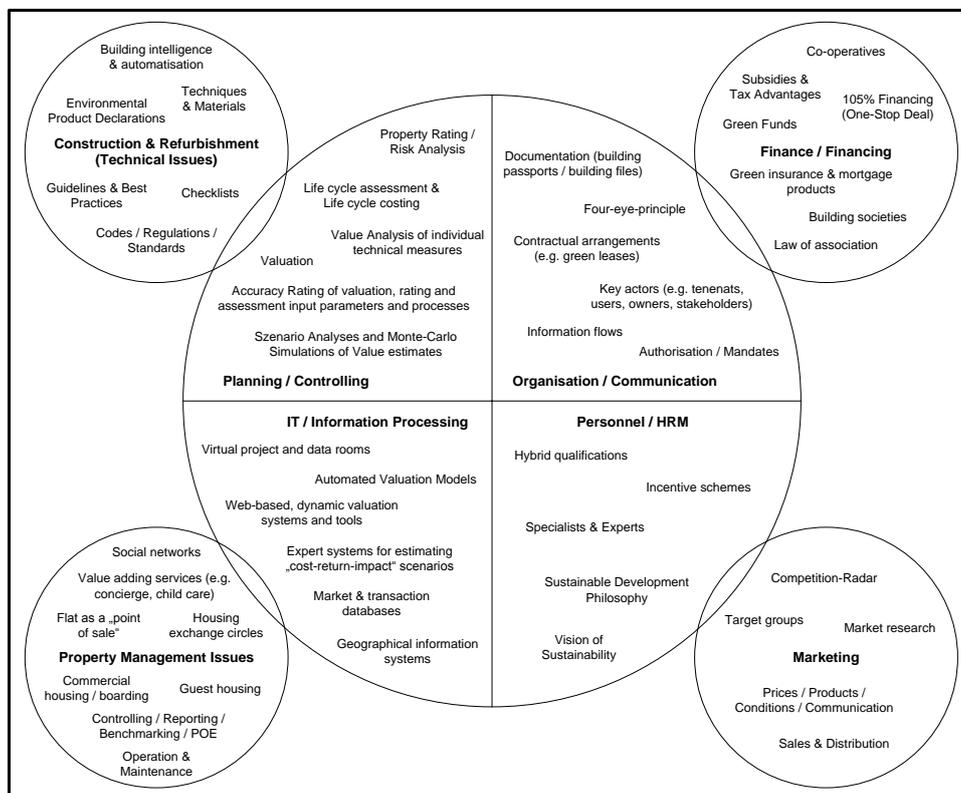


Figure 4 Overview on instruments, tools, measures and key issues for Overall Quality Assurance

Finally and most importantly, decision support instruments will have to bridge the gap between economic, environmental, social and cultural measures and components of property value and help to establish the necessary feedback-mechanisms that incentivise and drive change in the property industry. This requires a synergy we have not seen so far; i.e. an integration of the traditional methods and tools for valuation, risk analysis and cost estimation with the methods and tools developed by the sustainable building community for assessing and communicating the contribution of buildings to sustainable development. The connection, though yet missing, between these two kinds of methods and tools is seen in the introduction and widespread dissemination of building files within the property and construction industry. The challenges and difficulties in creating next generation decision support instruments lie as much in the further development of IT-systems and tools as in the improvement of the informational data basis available in the property industry. This will be shown by briefly referring to the development of new instruments for the following areas: valuation and risk assessment.

As the perception of property as a commodity is currently changing to emphasize sustainability-related building characteristics and performance aspects as important determinants of a property's worth and market value, valuation practice must change accordingly. It has therefore been argued that advanced valuation methodology – like hedonic pricing techniques – can and must be applied in order to continuously monitor market behavior and shifts in value perceptions in order to provide a more scientific basis for the price or value adjustments that have to be made to account for the benefits of sustainable design features not solely reliant upon the knowledge, judgment and experience (or inexperience) of the individual valuer alone (Lorenz et al., 2007). But the application of advanced valuation methodology can only provide meaningful results on the relationships between environmental, social and financial building performance if the quality of building descriptions contained in property transaction databases does allow drawing such conclusions. Unfortunately, at the moment this is not the case since we do not yet have performance-based building descriptions in property transactions databases. This issue has been investigated in more detail by a recent survey carried out at the University of Karlsruhe on the content and scope of transaction databases in Germany. The survey comes to sobering conclusions: Only a minority (8%) of valuation expert committees (the major source of property transaction information in Germany) has made preparations to extend the scope of transaction databases by including information from the recently introduced energy performance certificates while the majority is still considering this issue or does not even know about the relevance of the information contained within these certificates (Kertes et al., 2008). However, the state of affairs may not be much better in other countries where property markets are considered to be much more transparent and price information is more readily available; performance-based building descriptions are arguably missing in almost all transaction databases. So valuers are left alone when forming an opinion of value for the foreseeable future as it will take years to accumulate the informational data basis necessary to empirically underpin a valuer's decision to provide a 'valuation bonus' for a sustainable building or a 'valuation reduction' for a conventional one.

The situation is very similar with regard to the further development of instruments for assessing property risk (so-called property ratings). Developers of property rating systems (mainly banks and rating agencies) have started creating links for the direct and indirect integration of sustainability issues within rating methodologies and processes. But if the results of building assessment tools are to be used to support the rating process, then the flow of information can be organized in different ways and the question arises whether partial results of building performance assessments should be used to provide the informational basis for certain aspects of property ratings, or if the overall building assessment result should be integrated into property ratings as a separate rating category? Nonetheless, the use of property ratings in their current form already allows distinguishing more clearly between conventional buildings and more sustainable ones within property financing and risk-analysis processes (Lützkendorf and Lorenz, 2007). But if financial intermediaries acknowledge the economic impact of sustainable design, such acknowledgment will be credible in the longer term only if the sustainability performance of a building is reflected in the lending terms. Some banks are already offering special lending terms for energy-efficient, environmentally sound and/or sustainable buildings. However, there is a need to verify whether this is the result of marketing activities or certain grants-in-aid, or whether it is in fact due to a better understanding of the correlation between risk assessments and lending terms? Only in the last case would this represent a breakthrough with wide-ranging implications. And again, such conclusions can be drawn only on the basis of data combining performance-based building descriptions on the one hand and financial performance information (in this case: loan default rates) on the other hand.

#### **4. Outlook**

The challenges imposed by sustainable development for property professionals, their professional bodies and their educational institutions are unprecedented – in terms of importance, urgency and scale. And as the concerns are slowly changing from worries about environmental degradation and loosing species to fears about losing the services that keep our own species – and its civilization – thriving (WBCSD, 2007), the solu-

tions and actions undertaken to address this challenge are likely to be entirely different from current 'best practice' in construction, property investment and management. Addressing this challenge will require as much a 'technical solution' (in terms of developing new decision support instruments, building knowledge, and establishing new information links) as it will require a 'moral solution'. Is it so difficult to realise that due to information asymmetries actors in property and construction markets operate in a permanent prisoner's dilemma and that we would all benefit from more agreeable behaviour (see: Hume, 1751 and Kuhn, 2003)? Apparently, the profession stands at the crossroads of deciding between travelling along 'the road of value and agreeableness' (which involves acknowledging the principle of enlightened self-interest which states that individuals who act to also further the interests of others ultimately serve their own self-interest) or pursuing business-as-usual and experiencing the 'tragedy of the commons' (see: Lloyd, 1833), a social trap that involves a conflict over finite resources between individual interests and common goods which finally dooms the resources in question.

## References

- Canonne, J. and Macdonald, R.J., 2003, *Valuation without Value Theory: A North American "Appraisal"*, Journal of Real Estate Practice and Education, Vol. 6, No. 1, pp. 113-162.
- Castells, M., 1996, *The Rise of the Network Society, The Information Age: Economy, Society and Culture, Vol. I*, Blackwell Publishing, Oxford.
- Dillmann, R., Eissrich, D., Frambach, H. and Herrmann, O., 2000, *Mathematics in economics: some remarks*, Journal of Economic Studies, Vol. 27, No. 4/5, pp. 260-270.
- d'Amato, M., 2008, *Personal correspondence*, 22 March 2008.
- du Plessis, C., 2003, *Boiling Frogs, Bursting Dykes, Sinking Ships and the End of the World as We Know It* [online], International Electronic Journal of Construction, 14 May 2003, Available at: <URL: [http://www.bcn.ufl.edu/iejc/pindex/64/du\\_plessis.pdf](http://www.bcn.ufl.edu/iejc/pindex/64/du_plessis.pdf)>, [Accessed at: 29 March 2006].
- Hume, D., [1751] 1898, *An Enquiry Concerning the Principles of Morals*, In: Green, T.H. and Grose, T.H. (Eds.), *Essays: Moral, Political and Literary*, Longmans, Green & Co., London.
- Kauko, T., 2008, *From Modelling Tools towards the Market itself – An Opportunity for Sustainability Assessment?*, International Journal of Strategic Property Management, Vol. 12, pp. 95-107.
- Kuhn, S., 2003, *Prisoner's Dilemma* [online], Stanford Encyclopaedia of Philosophy, Available at: <URL: <http://plato.stanford.edu/entries/prisoner-dilemma/>>, [Accessed at: 12 March 2006].
- Kiuchi, T., 2003, *What We Learned in the Rainforest: Nature's Lessons for the Green Building Industry* [online], Available at: <URL: <http://www.future500.org/speech/2/>>, [Accessed at: 12 March 2006].
- Klamer, A., 2003, *A pragmatic view on values in economics*, Journal of Economic Methodology, Vol. 10, No. 2, pp. 191-212.
- Kertes, J., Lützkendorf, T. and Lorenz, D., 2008, *German Property Transaction Data Survey*, Universität Karlsruhe, unpublished research, for further information contact: [thomas.luetzkendorf@wiwi.uka.de](mailto:thomas.luetzkendorf@wiwi.uka.de).
- Lloyd, W.F., [1833] 1980, *W. F. Lloyd on the Checks to Population*, Reprint of: Two Lectures on the Checks to Population, In: *Population and Development Review*, Vol. 6, No. 3, pp. 473-496.
- Lorenz, D., Trück, S. and Lützkendorf, T., 2006, *Addressing Risk and Uncertainty in Property Valuations – A viewpoint from Germany*, Journal of Property Investment & Finance, Vol. 24, No. 5, pp. 400-433.
- Lorenz, D., Trück, S. and Lützkendorf, T., 2007, *Exploring the relationship between the sustainability of construction and market value*, Property Management, Vol. 25, No. 2, pp. 119-149.
- Lützkendorf, T. and Lorenz, D., 2005, *Sustainable Property Investment: Valuing sustainable buildings through property performance assessment*, Building Research & Information, Vol. 33, No. 3, pp. 212-234.
- Lützkendorf, T. and Lorenz, D., 2007, *Integrating Sustainability into Property Risk Assessment for Market Transformation*, Building Research & Information, Vol. 35, No. 6, pp. 644-661.
- Menger, C., [1871] 2004, *Principles of Economics*, Translation of 'Grundsätze der Volkswirtschaftslehre' [online], Published by: Ludwig von Mises Institute, Available at: <URL: <http://www.mises.org/etexts/menger/Mengerprinciples.pdf>>, [Accessed at: 24 March 2006].
- Schmutz, G.L., 1948, *The Evolution of the Interpretation of Appraisal Principles*, The Appraisal Journal, January 1948.
- Szira, T., 2000, *The illusion of exactness*, Journal of Economic Studies, Vol. 27, No. 4/5, pp. 495-508.
- von Mises, L., 1949, *Human Action – A Treatise On Economics*, 4th edition, Fox & Wilkes, San Francisco.
- WBCSD, 2007, *Markets for Ecosystem Services – New Challenges and Opportunities for Business and the Environment* [online], Available at: <URL: <http://www.wbcd.org/Plugins/DocSearch/details.asp?DocTypeId=25&ObjectId=MjY2ODM>>, [Accessed at: 24 March 2008].