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ADJUSTED OBJECTIVES AND IMPROVED DECISION STRUCTURES TO INDUCE SUSTAINABLE DEVELOPMENT VIA REAL ESTATE AND CONSTRUCTION

Dipl.-Ing. (Univ.) Barbara Hausmann, M. Sc.

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Vorsitzender:

Prof. Dr. Michael Suda

Prüfer der Dissertation:

1. Prof. Dr. Klaus Richter
2. Prof. Dr.-Ing. Jürgen Schwarz
   Universität der Bundeswehr München
3. Prof. Dr.-Ing. Annette Hafner
   Ruhr Universität Bochum

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München, den 27.07.2017 Barbara Hausmann

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ABBREVIATIONS

ADP	Abiotic resource Depletion Potential
AP	Acidification Potential
AVA	Angebot Vergabe Ausschreibung (German)
BauNVO	Baunutzungsverordnung (German)
BauPVO	Europäische Bauproduktenverordnung
BayBO	Bayerische Bauordnung (German)
BGB	Bürgerliches Gesetzbuch (German)
BGF	Brutto Grundfläche (German)
BHGKG	Bayerische Hausbau GmbH & Co. KG
BIM	Building Information Modeling
BMUB	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
BREEAM	Building Research Establishment's Environmental Assessment Method
BRI	Brutto Rauminhalt (German)
C2C	Cradle to Cradle
CAD	Computer Aided Design
CEEC	Comité Europeenne des Économistes de la Construction
CEN	Comité Européene de la Normalization (European Committee for Standardization)
CEO	Corporate Executive Officer
CO_2	Carbon Dioxide
CSR	Corporate Social Responsibility
DBU	German Federal Foundation for the Environment (Deutsche Bundesstiftung Umwelt)
DCF	Discounted Cash Flow
DGNB	German Sustainable Building Council (Deutsche Gesellschaft für Nachhaltiges Bauen)
DIN	Deutsches Institut für Normung
DJSI	Dow Jones Sustainability Index
DVP	Deutscher Verband der Projektsteuerer
e. g.	Example given
EC	European Commission
ELCA	Environmental Life Cycle Assessment
EnEV	Energy Saving Ordinance (German: Energieeinsparverordnung)
EPBD	Energy performance of buildings directive
EPD	Environmental Product Declaration
ESL	Estimated Service Life
ETICS	External Thermal Insulation Composite (German: Wärmedämmverbundsystem)
EU	European Union
GDP	Gross Domestic Product
GFZ	Geschossflächenzahl (German)
GHG	Greenhouse Gas
GWP	Global Warming Potential
HOAI	Honorarordnung für Architekten und Ingenieure
HQE	Haute Qualité Environnementale
IBU	Institut Bauen und Umwelt (Germany)
IFC	Industry Foundation Classes
IPCC	Intergovernmental Panel for Climate Change
ISO	International Organization for Standardization
KG	Kostengruppe (German)

LCA	Life Cycle Assessment
LCC	Life Cycle Cost
LCI	Life Cycle Inventory analysis
LCM	Life Cycle Management
LEED	Leadership in Energy and Environmental
LOHAS	Lifestyle OF Health And Sustainability
NUWEL	Nachhaltigkeits- und Wertermittlungsleitfaden (www.nuwel.ch)
NIMBY	Not In My Backyard
PCR	Product Category Rules
REC	The Real Estate and Construction sector
RED	Real Estate Development
REITs	Real Estate Investment Trusts
RIC	Real estate development – Investment – Contractor
RICS	Royal Institute of Chartered Surveyors
ROI	Return On Investment
RSL	Reference Service life
SCBA	Social Cost Benefit Analysis
SD	Sustainable Development
SDI-model	Sustainable Development Inducing model
SIA	Schweizer Ingenieur- und Architektenkammer
SLCA	Social Life Cycle Assessment
SME	Small and Medium sized Enterprises
SMRS	Sustainability Measurement and Reporting System
t	Tons
UNEP	United Nations Environment Programme
VOB	Verdingungsordnung für Bauleistungen (German)
VOF	Vergabeordnung für freiberufliche Leistungen (German)
VOL	Vergabe und Vertragsordnung für Leistungen (German)
WBCSD	World Business Council for Sustainable development
WCED	World Commission on Environment and Development
WF	Wohnfläche (German)
WLC	Whole Life Costs
WTP	Willingness To Pay

SUMMARY

Sustainable development stands as regulative target and societal goal that has become the regulative target in the EU for policy making. We may expect that sooner or later sustainable development is going to be the most relevant societal measure. As a consequence management decisions will have to induce sustainable development.

This implies for real estate and construction activities that decisions will have to be made in view of the goals of sustainable development. There are the early management decisions that influence construction, operation and dismantling processes the most and therein determine the contribution of real estate and construction to sustainable development. Strategic management wants to face this responsibility. Therefore, innovative solutions for management decision making have to be found which help to induce sustainable development by means of real estate and construction.

In this study, first, sustainable construction and the contribution of construction to sustainable development are introduced. On this base, aspects are identified where the current concept of sustainable construction fall short in meeting the demands of sustainable development. It results that currently management decisions lack decision support on life cycle effects, social aspect and resource efficiency. Deficiencies are identified in the lack of operative targets and management tools that link the different project phases of real estate and construction.

Besides costs, quality, time and service provision, the corporate and institutional performance will be measured by the dimension of sustainable development. This study suggests that the interdependencies between real estate development, real estate investment, and contractors have the potential to induce positive (and negative) effects on sustainable development. These effects result from production processes and consumer strategies.

The complex causal chains of processes and information in real estate and construction are assessed in view of the demand of sustainable development. To this end, information flows of a real estate company are analyzed how information is transferred among the different actors.

These findings are complemented with the theory of sustainable consumerism. If real estate is seen from the perspective of sustainable consumerism, effects of sustainable development can be seen in the corporate responsibility profile as well as in the sharing and taking of responsibility. However, apart from planning and production (of construction), also the consumer is responsible for the occurring effects.

As results of the study, the following can be summarized:

- Social aspects of sustainable development can be found along construction processes. These have to be integrated into the assessment of the moving target sustainable development as well as the end-of-life of construction projects, constructions and construction products.

- The effects on sustainable development have to be assessed in an homogenous way. The homogenous integration of social and economic demands is lacking.

- Furthermore, the sharing and taking responsibility is an important basis of sustainable development.

- This holds also for the technical quality. Technical quality has an direct impact on end-of-life opportunities.

- To reach the targets of sustainable development, efficient processes are necessary. Construction processes can be supported by a material passport and a model-based information management, especially for the engineering of dismantling.

- Both, “real estate” and “construction” result in a building, but hardly anybody is fluent in both languages. Therefore, a model-based view is described to systematically link information flows, using existing control channels for decision and information support. In a further step the model is developed as an expert model for the separability of construction, to create databases and to define relevant scarcities in the context of resource efficiency.

ZUSAMMENFASSUNG

Nachhaltige Entwicklung steht als regulatives Rahmenwerk und ist gegenwärtig für jegliche Strategiebildung in der EU nicht mehr wegzudenken. Es ist zu erwarten, dass nachhaltige Entwicklung künftig das am meisten relevante gesellschaftliche Maß sein wird. Also müssen Managemententscheidungen nachhaltige Entwicklung induzieren.

Dies gilt auch für Immobilienwirtschaft und Bauwesen: Managemententscheidungen müssen in Hinblick auf Ziele nachhaltiger Entwicklung hin getroffen werden. Frühe Entscheidungen sind weichenstellend für den weiteren Bau-, Nutzungs- und Rückbauprozess und beeinflussen den Beitrag von Immobilienwirtschaft und Bauwesen zu nachhaltiger Entwicklung. Strategisches Management möchte dieser Verantwortung begegnen. Innovative Lösungen sind gefordert, die den Anspruch an nachhaltige Entwicklung in immobilienökonomische Entscheidungen integrieren, um nachhaltige Entwicklung auch durch den Immobilien- und Bausektor zu induzieren.

In der vorliegenden Studie wird zuerst das Konzept der nachhaltigen Entwicklung eingeführt. Auf dieser Grundlage werden Aspekte identifiziert, wo das gegenwärtige Konzept des nachhaltigen Bauens dem Anspruch einer nachhaltigen Entwicklung nicht gerecht wird. Dies hat zum Ergebnis, dass momentan Managemententscheidungen in der Immobilienwirtschaft und im Bauwesen keine Entscheidungsunterstützung hinsichtlich Lebenszykluseffekten, sozialen Aspekten und Ressourceneffizienz haben. Diese Defizite sind das Fehlen operativer Ziele und Managementtools, die die verschiedenen Projektphasen von Immobilienwirtschaft und Bauwesens verbinden.

Hinzu kommt, dass die Performance von Unternehmen und Institutionen neben Kosten, Qualität, Zeit und Serviceleistung in Zukunft auch über die Dimension der nachhaltigen Entwicklung definiert werden wird. Die vorliegende Arbeit identifiziert die Zusammenhänge zwischen Immobilienentwicklung, Investoren und Auftragnehmer als verantwortlich für positive (und negative) Effekte auf nachhaltige Entwicklung. Diese Effekte resultieren sowohl aus Produktionsprozessen als auch aus Konsumstrategien.

Die komplexen Zusammenhänge von Prozessen und Informationstransfer werden im Hinblick auf den Anspruch nachhaltiger Entwicklung untersucht. Dabei werden Informationsflüsse aus Sicht eines Immobilienunternehmens analysiert.

Diese Ergebnisse werden mit der Theorie des nachhaltigen Konsums vervollständigt. Wenn Immobilienwirtschaft aus der Perspektive nachhaltigen Konsums betrachtet wird, kann man feststellen, dass Effekte nachhaltiger Entwicklung sich im Profil der Unternehmensverantwortung zeigen. Neben dem Anbieter eines Produkts ist auch der Konsument verantwortlich für diese Effekte.

Als Ergebnisse kann Folgendes zusammengefasst werden:

- Soziale Aspekte nachhaltiger Entwicklung sind entlang des Bauprozesses und der Produktion von Bauprodukten zu finden. Diese müssen in die Bewertung hinsichtlich des „moving target“ Nachhaltige Entwicklung mit einbezogen werden, ebenso das Lebensende von Baukonstruktionen und Bauprodukten.

- Die Auswirkung auf Anforderungen von nachhaltiger Entwicklung müssen homogen bewertet werden. Hier fehlt bisher die gleichwertige Integration von sozialen und wirtschaftlichen Ansprüchen.

- Die Förderung und Gewährung von Eigenverantwortung ist wichtig, damit nachhaltige Entwicklung passieren kann.

- Genauso darf die technische Qualität nicht außer Acht gelassen werden. Diese wirkt sich direkt auf die Phase des Lebensendes aus.

- Um den Forderungen nachhaltiger Entwicklung gerecht zu werden, braucht es effiziente Prozesse. Bauprozesse können durch einen Stoffpass und ein modellbasiertes Informationsmanagement unterstützt werden, insbesondere hinsichtlich der Ingenieurleistungen für den Rückbau.

- Beide, Immobilienwirtschaft und Bauwesen resultieren in Gebäuden, aber kaum jemand spricht fließend beide „Sprachen“. Um Informationsflüsse systematisch zu verbinden, ist eine modellbasierte Sicht beschrieben, die schon existierende Informationskanäle nutzt. Das Modell kann in einem nächsten Schritt als Expertenmodell verwendet werden - für die Trennbarkeit von Konstruktionen, dem Aufbau von Datenbanken und um relevante Knappheiten im Kontext der Ressourceneffizienz zu definieren.

1. INTRODUCTION TO THE CONTEXT OF REAL ESTATE, CONSTRUCTION AND SUSTAINABLE DEVELOPMENT

Every decision-maker in a corporate context faces the challenge of meeting the demands of sustainable development. The society expects entrepreneurial and management decision-making to induce sustainable development on the long run. Leadership and management are trying to anticipate the future and seeking for operational advice and decision support, wishing for controllable issues. The following prerequisites form the background and constraints of the study. Intuition solves many problems. Under this constraint, Micic stresses to change the question of relevance of future related information (Micic 2014). He argues, the question we are facing is not, what is relevant information? As this will lead to the answer we already know brought up by our intuition. The question has to be, what might become relevant? The second question has to be how can we get it relevant? Only then, we can be able to see something new, maybe good or bad (Micic 2014). The question, how to make things relevant, was seen as essential task for the study. How can sustainable development reach relevance in the context of real estate and construction? To enable a future functioning of the construction sector, investments are necessary. The stakeholders of the construction industry must generate this financial volume for investment. Still, environmental protection and corporate social responsibility needs economic functionality as basis. Within the question to make a qualified investment decision in the real estate and construction branch, European policies influence the entrepreneurial context. Due to that reason, this study looks at European policies and their goals and targets. One target of European Union besides sustainable development as societal goal is, to boost SME and generate employment.

A market is growing slowly but constant named as Asset Management, Property Management and Facility Management. All technical, infrastructural and commercial tasks are services (Pfnür 2011). In real estate and construction, decision-making in the initial phase has far-reaching effects on further performance in many ways. Though in order to go towards harmonized methods to fulfil the different goals and scopes of stakeholders along the construction process, research contributions are still needed (Lasvaux et al. 2014). Additionally, real estate and construction industries need an in-depth discussion of issues of corporate responsibility and thus a development of skills in dealing with the conflicting objectives in the field of sustainable development (van Wezemael and Derron 2014). Certification systems have been established to follow the target, to show sufficient sustainable development performance in construction, for the planning and construction phase. Still, those are often ex post in practice. The quality of these systems is one of the decisive factors on the sustainable development performance in practice.

The essential part of the early planning phase is real estate development. This phase is responsible, together with other phases, to induce sustainable development. Real estate development is a time consuming and demanding task. Many different decisions influence the performance of the construction project in very different aspects. Different decision support information and tools exist. Unfortunately, the separation of individual influences of these decisions on sustainable development is difficult. Construction operation professionals are engineers. The construction sector provides a unique product, which integrates technical, economic and legal influences in a complex way. The rules of economy are valid for the construction sector (Diederichs 1999).

This is in particular due to interdependencies between the trifold dimensional demands of sustainable development. Vice versa, information and data inducing sustainable development is difficult to identify. Still, long-term economic success requires a stable natural and human environment as resource source (Belz 2007). Furthermore, the German Federal Ministry of environment, nature protection, construction and reactor safety requires the whole building life cycle to be addressed and to develop supporting methods and tools (BMUB 2014).

In this study, systematic structural interdependencies for real estate decisions and their potential improvements are investigated in view of better addressing the demands of sustainable development. Furthermore, “sustainable construction” is assessed critically in the light of the common understanding of sustainable development and a broader view on sustainable construction proposed, considering the trifold dimension of sustainable development.

2. APPROACH ON SUSTAINABLE DEVELOPMENT IN THE CONTEXT

This section contains the description of sustainable development as a concept and the context of real estate and construction. The research gap is illustrated. This part presents the objective of the study, to investigate ways to induce sustainable development by real estate and construction decisions. The chapter serves as a framework for the study and presents the theoretical approach, the state of art and the need for research. This chapter describes the state of art as background of the problem.

2.1. The context sustainable development, real estate and construction

The concept and regulative target sustainable development has made an amazing career and cannot be left out in international policy (Belz 2007). The construction and real estate industry contributes on the one hand to climate change, on the other is affected heavily by its consequences. These industries are therefore pursuing a twin strategy (mitigation and adaption) (Lützkendorf 2011). It is clear that the three factors market, performance and profitability are not adequate targets to solve the societal, economic and environmental challenges in the future (Diederichs 1996). European society is aware of those problems. The societal pressure will rise due to climate change, which will have a great impact on regulation, standardization and corporate responsibility (Rottke and Landgraf 2010). The EU strategies aim at sustainable development. The European Parliament Committee on the Environment, Public health and food safety calls on the Commission to propose the full implementation of the circular economy principles and requirements in the building sector and to further develop the policy framework on resource efficiency in buildings; this includes developing indicators, standards and methods as regards land use and urban planning, architecture, structural engineering, construction, maintenance, adaptability, energy efficiency, renovation and reuse and recycling (Pietikäinen 2015). This means for real estate industry that the importance of sustainable development will increase (Rottke and Landgraf 2010).

Sustainable development is highly dependent on management decisions and economic success criteria. Development and sale of real estate as well as the optimization of the portfolio are complex processes, which are influenced by diverse factors and stakeholders. Those have different and sometimes contradictory impacts, influences and preferences. Sustainable development is confined to management decisions depending on generating economic output. Consequently, social and environmental benefit arises if profitability is assured on the company side. Management decisions of real estate companies have an impact on sustainable development by means of the building sector. Developing, designing and trading construction is a complex process, involving many different agents with different “preferences” regarding economic value and the definition of sustainable development. Sustainable development will never

be operational in that sense. Sustainable development is gaining increasing importance for real estate economy. Focus is not only the economic aspect, but also social responsibility. Resulting advantages are competitive advantage, risk control and long-term benefit. The endeavor to promote entrepreneurial initiative is increasing in real estate industry. Diederichs (1999) forecasts that environmental oriented companies, which will be due to circular economy regulations and waste standards companies in the construction business should care for environmental conscious products.

The field of action of sustainable development, real estate and construction stand as a special role of engineers of the future. This understanding supports the theoretical approach of this study. Engineers of the past mainly focused upon the technical and economic feasibilities of systems design, engineers of the future will have the responsibility to address the entire spectrum of sustainability aspects, including the economic, environmental, social and multi-generational dimensions. Engineers, together with other members of society much increasingly address the rapidly evolving challenges of global warming are causing or will cause in areas of widespread environmental pollution, resource depletion, rising human populations, and increasingly severe threats of food, water and energy securities. These are some of the urgently needed dimensions for transforming the engineering profession onto a much more proactive, holistic and dynamic profession, which goes far beyond what it´s presently. Consequently, instead of only focusing upon the design or improvement of a product or process, the paradigm for 'sustainable engineering' requires dynamic, holistic, integrative analyses of present and future product life cycles, entire supply chains and the eco-systems upon which truly sustainable societies are totally dependent (Alwi 2014). This means, engineers cannot focus on technical and economic feasibility of a system design only. The challenges of global warming brought about by widespread environmental pollution, resource depletion, rising human population, and multiple threats to food, water and energy securities. This requires a paradigm shift in engineering thinking and ways to find and test solutions. The evolving engineering paradigm increasingly calls for engineers to consider the whole spectrum of sustainable development (Alwi 2014). Over the last years, sustainability moved to mainstream in the real estate industry with an emerging status exceeding the initial certification of only highlighted development projects with green building labels (RICS 2015). Furthermore, life cycle assessment (LCA) activities are taking influence on construction activities.

Real estate development can be seen as an essential part of the early planning phase; decisions taken during real estate development therefore have far-reaching consequences for the final sustainability performance of a building. The design stage as part of production is investigated concerning the influence of decisions made whilst this phase on sustainable development. Construction waste minimization at the design stage is a key strategy in effective waste reduction.

To be able to integrate aspects which induce sustainable development into corporate processes, applied science is an option to provide methods and tools for the development of decision-making and offers chances for sustainable development as societal goal as well as sustainable company management and thereby corporate social responsibility (CSR). As further task, consumerism is addressed as relevant topic in the study. The consumption patterns are one way to address sustainable development. The non-sustainable consumption patterns are a critical obstacle on the way to sustainable development (Belz 2007).

Sustainable development and sustainable construction

There exists still considerable uncertainty on the definitions of sustainable real estate, even though sustainable construction, as well as sustainable real estate, has gained in public awareness. Frequently, sustainable construction is reduced to "environmentally conscious construction". In this context, the concept sustainable development needs further refining for being able to discuss sustainable-development-inducing effects in the real estate and construction context. Still, there is no universally accepted definition of, and no unique solution for, sustainable buildings (Passer et al. 2015). Most approaches deal with eco-efficiency on company or product level, due to available methods. The concept of sustainable development is a regulative idea (Werner and Scholz 2008). The regulative ideas inspire and guide societal learning and forming processes, they will never be fully and conclusively operational. Brundtland (Brundtland et al. 1987) explains sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs. (…) Thus, in the final analysis, sustainable development must rest on political will (Werner and Scholz 2008).

In general, for sustainable construction, these points can be taken as state of art of the coverage of the topic. During the last decades, the development of the construction design and construction details influenced the increasing requirements related to the energy performance of buildings, notably of the implementation of the European Energy Performance Directive in national building codes and legislation. Lützkendorf (2011) divides the existing literature on sustainable building topics into publications on:

- Sustainable design, planning and construction processes;
- Methodological basis of sustainability assessment s of buildings, and the development and application of certification systems;
- Further development of sustainable-building basics related to natural science and engineering, as well as respective construction systems and components;

- Analyses with a political, microeconomic and social science focus (ranging to and including the field of corporate social responsibility);
- Methods, instruments and processes of sustainable property investment.

Different topics and strands of research related to sustainable building are identified and shown in figure 1:

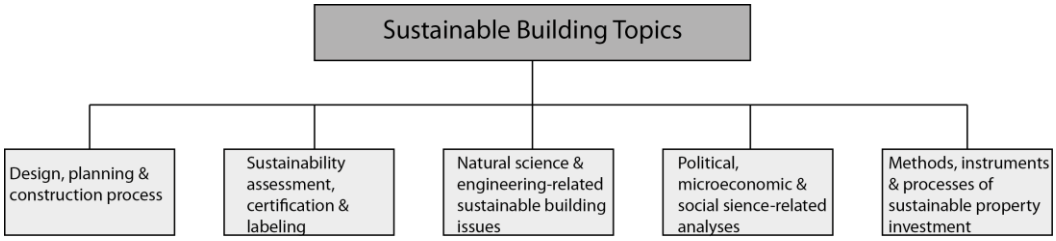

Figure 1: Sustainable building topics, Lützkendorf et al. 2011

Targets of sustainable construction or sustainable buildings are described by Schwarz et al.(2013):

- *Environmental dimension:* To minimize pollutants and environmental impacts by construction activities and real estate means to choose environmental conscious construction products and reuse materials. It is important to minimize waste and energy consumption, to increase the regenerative energy supply and reduce non-regenerative primary energy consumption. The measurable elements as energy and material flows as well as their environmental impact (emissions) are taken as indicators. The environmental impact of buildings is quantified via life cycle assessment and energy balancing.
- *Social dimension*: Provides information on the building attractiveness for the users. The decisive aspects are needs and expectations of the tenants as comfort, health, emissions, thermal and acoustic comfort and functionality. The sociocultural aspects describe the subjective attractiveness of the building. Value stability and long-term attractiveness on the market is secured by social aspects.
- *Economic dimension*: The minimization of life cycle costs (for materials) is described by economic aspects. The life cycle costs integrate the production, utilization and operation of the building, restoration, modernization and demolition. The target of life cycle thinking is, to find an economic optimized planning alternative, to minimize the life cycle costs and optimize revenues. Value stability is one aspect of the economic dimension.

Life cycle thinking is getting into the focus and has been a part of the understanding of how organizations should deal with their environmental and sustainable responsibilities by including the whole value chain since the 1990ies. Life cycle thinking can be implemented in different ways, including for example life

cycle assessments as a part of designing more sustainable products and product systems. IBU states[1] that the political circumstances in EU as well as in Germany take life cycle thinking to the construction context. The standards under development[2] make this topic relevant for construction materials and construction products. The German Federal Ministry of environment, nature protection, construction and reactor safety has brought up a guideline on sustainable construction (BMUB 2015). Here, a holistic approach of the building over the whole life cycle – from construction material extraction until the reuse of the demolition material enables to respect the principle of sustainable development. In short, sustainable construction requires to integrate the trifold demand of sustainable development in all life cycle phases of the building homogenously. The basis to avoid harmful impacts is set in the early planning phase (BMUB 2015).

Certification

Sustainability certification is an upcoming business branch in the real estate and construction sector (Zimmermann 2011, Schwarz et al. 2013). Sustainable buildings have a higher market value (Schwarz et al. 2013). It is investigated in scientific studies whether sustainability certifications and criteria do have financial impact. In most studies, due to lacking data, the effect of real estate certification was assessed. They found that, sustainability assessment is mostly regarded as an environmental issue and not giving so much attention to the functional, social and economic performance (Koukkari et al. 2012) (Schwarz et al. 2013). Furthermore, there is not yet a consensus base method to guide the weightings assignment (Koukkari et al. 2012) and energy efficiency is only one aspect of a sustainable property (Meins et al. 2010, Schwarz et al. 2013). The rising energy prices are only one example of long-term changes that are anticipated today. Other changes, including global warming, demographic changes, and changing social standards, are aspects that can be covered by a holistic sustainability assessment. Some of these developments can also have an impact on the value of real estate. The property owners are becoming increasingly aware of this: sustainability features seem to matter increasingly to these owners (Meins et al. 2010) when constructing sustainable means to take responsibility for environment, society and the single human being (IBU 2014). The statement serves as an important argument to take real estate and construction as scientific field of investigation. The real estate and construction business bear good conditions to integrate aspects of sustainable development. Real estate and construction can play and important role compared to other economic sectors (Rottke and Landgraf 2010). The existing certification systems do not serve yet as decision-support tools for the early planning phase. A method to

[1] http://bau-umwelt.de/hp358/Nachhaltiges-Bauen.htm, accessed on 19.01.2015
[2] http://bau-umwelt.de/hp358/Nachhaltiges-Bauen.htm, accessed on 19.01.2015

assess sustainable development inducing potential for the early development and planning phase have to be found.

Responsible property investment in this context means maximizing the positive effects and minimizing the negative effects of property ownership, management and development on society and the natural environment in a way that is consistent with investor goals and fiduciary responsibilities (Rottke and Landgraf 2010). As sustainable building is meant to be a building that contributes through its characteristics and attributes to sustainable development (Rottke and Landgraf 2010). Meins et al. (2010) formulate the state of art of sustainable development and it´s utilization in the construction context that the term 'sustainability' is applied in general and for property in particular far too frequently and usually inaccurately. The reasons for this are the complexity of the subject area and the fact that there is a lack of a satisfying definition. In addition to the environment, current sustainability concepts concentrate increasingly on society and the economy, e.g. the triple bottom line approach. Therefore, a clear differentiation of sustainability, especially from 'green building' definitions, has to take place (Lützkendorf et al. 2011). To follow the definition of sustainable development, which rose from the Brundtland Report, this definition that property is sustainable if it provides long-term environmental, social and economic benefits or at the least avoids harm in these areas can be used (Meins et al. 2010). The existing approaches to define and substantiate the sustainability of property generally concentrate on technical aspects and, therefore, implicitly on environmental sustainability – see, amongst others, HQE, LEED, BREEAM, etc. (Meins et al. 2010). Finally, the upcoming importance of materials in the context sustainable construction and sustainable development due to environmental impact reduction, because of the general focus on CO_2 reduction (Van Dijk et al. 2014) energy use will decrease, resulting in a relative growth of impact of materials and water. A sensible material use becomes increasingly important in the quest for environmental impact reduction, since solar energy is abundantly available and prospering technological innovations in this field is within the bounds of possibility. If, for example, the energy impact is reduced to 10%, the relative impact of materials increases to about 80% and water to approximately 10%. This means that in the future, sensible material use needs growing consideration (Van Dijk et al. 2014).

There is a transition from a previously predominantly qualitative (e.g., presence of green roofs) to a predominantly quantitative evaluation (e.g., calculation and evaluation of the GWP). The management of data both on the life cycle of buildings (perspective of object of assessment) and in the life cycle of buildings (perspective of a process of the life cycle of the building) becomes important (Van Dijk et al. 2014).

2.2. Research gap and objective

An important guiding principle for the study is that long-term economic success deserves a stable social environment as well as an intact environment as resource source (Belz 2007). The environmental protection e.g. has the elimination of poverty as prerequisite. The tension of harmony (sustainability) and conflict (sustainable development), of consensus and dissent are constitutive elements of the concept sustainable development (Belz 2007).

The question arises whether it is possible to step beyond the current coverage and enlarge the spectra of sustainable buildings by breaking down the extended view on sustainable development to sustainable buildings. The resource questions, long-term thinking, orientation towards quality and social production processes should be regarded in addition to existing concepts, aiming at the interdisciplinary approach and competence development by the trial to meet the demands of the target sustainable development.

In a corporate context, it is a challenge for the management of an enterprise to integrate complex scientific knowledge and diverse postulates of relevant stakeholders in the decision process. The corporate responsibility as voluntary contribution of business companies to sustainable development beyond statutory requirements unites responsible corporate action in business operation. To implement theoretical knowledge on sustainable development in practical management decisions, suitable tools and access techniques are required. Interdisciplinary research is an access technique, which is able to open science-based findings for decision-making in practice.

Still, the question arises whether sustainable development is induced beyond criteria of any sustainability certificates. Some standards and regulations are yet existing and under development to describe sustainability and sustainable development. For construction, aiming at sustainability, and at gaining higher prices in rent and sales, certification is applied. Still, decision-makers are lacking applicable information on effects of life cycle, sociocultural- and resource efficiency. They need innovative ways to integrate demands of SD into real estate economic decisions.

The real estate development is part of the early planning phase. The early phase needs a way to allow the induction of sustainable development. Taking into account that sustainable development should be induced by real estate development, which has been tried by diverse decision support tools from different disciplines for buildings, assessment tools from economics and LCA from the environmental sciences, the induction of sustainable development is still lacking an holistic approach. It is widely known that sustainable development means a regulative idea with trifold demands.

There are very few approaches on the induction of sustainable development, beginning in the very early phase. There are few studies investigating case studies of a real estate company for developing action strategies (Schwarz et al. 2013). The existing tools in economics, environmental sciences and civil engineering can complement each other and support the comprehensive approach of sustainable development by help of the construction sector (respectively real estate development). There are no studies analyzing environmental, economic and social effects for the real estate development in a homogenous approach. This means, the research gap is that decisions in the early phase should induce sustainable development.

Numerous research activities about life cycle assessment applied to buildings, and more recently to civil engineering, have risen over the past decades, but no studies have been realized by construction owners concerning LCA research activities and their linking in practice (Lasvaux et al. 2014). There is a need for sustainability evaluation process, which should map the value chain and address problems that relate to the three dimensions of sustainability (Mastoris et al. 2013).

As objective of the study stands the integration of the demands of sustainable development in real estate decision-making. The aim of research is to suggest an understanding of the system how sustainable development is/can be induced via real estate development decision-making. Therefore, the current coverage of sustainable construction in view of the general demands of sustainable development is investigated in the study. For the implementation of the demands of sustainable development in operational daily business, strategy development needs to be linked to strategic management. This means, to assess, how can the real estate development process as decision-making process during the early planning phase be oriented towards inducing sustainable development? What are the risks and chances for a real estate company in terms of real estate development, marketing and business processes? Is it possible to develop an evaluation concept that demonstrates the evaluation of the potential for inducing sustainable development by real estate and construction processes? The current common understanding of sustainability in the real estate and construction is enlarged in this study by the holistic understanding of sustainable development. The material related decision-making bears potential for sustainable development. The demands of sustainable development will lead to further social aspects together with the material relation.

These questions of the dissertation lead through the study:

1) How can the objective, the induction of sustainable development, be implemented into the economically oriented decision-making structure of real estate development?

2) How to develop the holistic framework for analysis of the three dimensions of sustainable development by means of real estate and construction?

The results expected by the study are, first, to enlarge the coverage of social aspects beyond comfort and health. Next, to understand the trifold dimension of sustainable development for construction activities. Furthermore, to design a process development for real estate activities and last, to develop an approach for the assessment of development for real estate decision in relation to construction activities and to find an approach for the contribution to sustainable development for the corporate level.

Guidance to the reader

As a guidance to the reader, the structure of the study shows two main aspects. On the one hand, the study focuses on the importance of concept and management decisions in real estate and construction. On the other hand, the study aims at deriving strategies for real estate and construction management decisions from the comprehensive understanding of sustainable development, which includes all the three dimensions of sustainable development.

The study integrates a business ethic part, a process management part and environmental scientific approaches. The methodological part shows a detailed description of the structure. Besides the structured text, the study works with citations and footnotes. The footnotes serve to the reader as further information, which is interesting background. In addition, excursions, which provide background information, help to illustrate the study and at the same time, keep it condensed. The results and discussion part (chapter 4), has for each sub-chapter a small summary.

3. CONCEPT OF THE STUDY AND METHODOLOGY

Interdisciplinary studies require the integration of different scientific disciplines to investigate practical problems in an applied research context. In this study, concepts and methods of sustainability sciences and construction sciences have to be linked and integrated into the context of a real estate company. The embedded case study approach according to Scholz and Tietje (2002) has been chosen as research methodology to conceptualize the practical research context of the real estate company. This chapter describes the research design including materials, methods, and data.

3.1. Case study research

An integrated real estate company develops in collaboration with construction management sciences and life cycle and management of material flow context the research topic. The chosen case study company is one of the large integrated real estate companies in Germany and bundles a corporate group's wide-ranging construction and real estate activities. With a portfolio valued at approximately 2.5 billion euros, it holds a leading position in its core market, Munich, in particular. The range of services it offers covers the business segments project development and real estate.

The real estate company would like to develop climate-and resource-conscious solutions on the long run without using any certification process, case study research seems as adequate approach. Therefore, the case study company has granted access to corporate processes and documents. The study should develop answers for a business enterprise on resource questions. To follow this task, a scientific approach has to be designed.

As case[3], the real estate company Bayerische Hausbau GmbH & Co. KG has been selected. For this study, the approach proposed by Scholz and Tietje (2002) has been selected to support the research design. Coming from psychology and neurosciences, embedded case study research can be applied also for management sciences and civil engineering, (Scholz and Tietje 2002). Scholz and Tietje (2002) applied this method in planning sciences[4] (Scholz and Tietje 2002). The following statements describe the

[3] "A qualitative analysis starting from the real-world level is an indispensable part of case analysis." (Scholz and Tietje 2002)

[4] "Embedded case study in contrast to a holistic case study involves more than one object of analysis and is not limited to qualitative analysis alone."

characteristics of embedded case studies[5] for the development of a scientific approach. In this study, an embedded multiple case study has been chosen for an intrinsic inquiry. Embedded case studies are a method to integrate theoretical knowledge and application-based knowledge. Embedded case studies are used in business sciences. For the case of construction management business administration, embedded case study is an applicable method to integrate the disciplines engineering, construction management economics and sustainability sciences. A descriptive case study uses a reference theory or model that directs data collection and case description. It tests, whether and in what way a case can be described when approaching it from a certain perspective. (..) Theory testing is done in a qualitative way. However, as in traditional hypothesis testing, specifications for the cause-impact chain have to be formulated before case analysis (Scholz and Tietje 2002).

Excursus I: Case study method. A case is seen from a specified perspective and with a special interest. Cases are subject to evaluation, because scientific and practical interests are tied to them (Scholz and Tietje 2002). The case study approach is an empirical inquiry that investigates a contemporary problem within its real-life context. Understanding the problem and its solution requires integrating a myriad of mutually dependent variables or pieces of evidence that are likely to be gathered at least partially by personal observation (Scholz and Tietje 2002). A crucial component of case studies is an integrative evaluation – an evaluation that integrates viewpoints from such diverse disciplines as ecology, economics and sociology (Scholz and Tietje 2002). Embedded case studies involve more than one unit, or object of analysis and usually are not limited to qualitative analysis alone. The multiplicity of evidence is investigated at least partly in subunits, which focus on different salient aspects of the case. An embedded case study allows for a multiplicity of methods that may be applied within the subunits. Thus, hypotheses may be formulated, quantitative data sampled (Scholz and Tietje 2002). For a scientifically sound, effective and efficient study of cases, the following steps give a structure according to Scholz (Scholz and Tietje 2002):

- Case representation and modeling methods to characterize the case and analyze its current problems and its development;
- Case evaluation methods to select one alternative that we prefer over the others, taking into consideration everything we definitely know about the case, what we consider uncertain;
- Case development and transition methods for creating alternatives;
- Case study team methods for enhancing personal experience related to the case and solution-finding performance.

[5] "The more complex and contextualized the objective of research, the more valuable the case study approach is regarded to be. Thus, the use of case studies is becoming an increasingly respected research strategy in the following areas: Policy research, community sociology, management studies, psychology, medicine and neuropsychology, educational sciences, planning sciences, civil engineering, environmental sciences. Most of the time, the case study approach is chosen in research fields where biographic, authentic, and historic dynamics and perspectives of real social or natural systems are considered (...). Using the approach of knowledge integration, the embedded case design is appropriate to organize different types of knowledge, such as different stakeholder or disciplinary perspectives." (Scholz and Tietje 2002)

To reach constructions as output, social resources, capital and environmental resources have to be transformed. Constructions are buildings and infrastructures, etc., which use construction products. The building or infrastructure itself then in the end is a product, often sold by a real estate company. This study sees real estate and construction as the output of constructions as products or the sum construction products, which have a certain transformation process of social resources, capital and environmental resources. This way of thinking on constructions, construction processes and construction products and last, real estate, is shown in Figure 2.

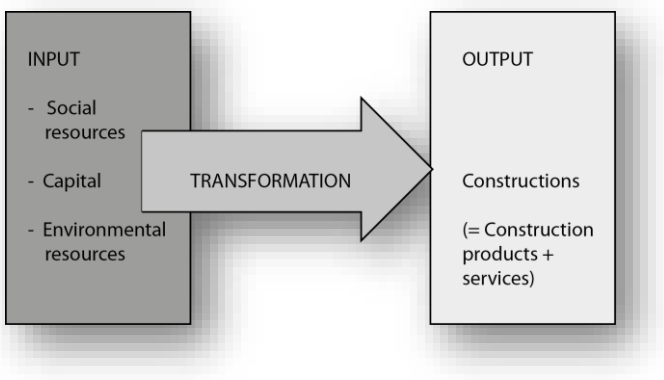

Figure 2: Construction products and services as result of the transformation process

To find answers, the problem shall be approached from different disciplines. The conceptual framework and scope of this study is the transformation of real estate and construction processes. To investigate the transformation process means to look at targets and instruments of real estate and construction processes and their consequences. This study focuses on the real estate development and construction process with its special targets and instruments.

As mentioned, the early planning phase is the phase of high influence on further development. This study takes a closer view on the decision-making along the transformation process with emphasis on the early planning stage. It focuses on the possibilities to influence the material relevant transformation process and the impact on sustainable development of the construction, within a life cycle perspective. To establish a target system with the aim, to induce sustainable development by early decision-making, the concept of sustainable development has to be clarified first. The responsibilities of different stakeholders in the building process are identified. Therefore, business ethics literature, real estate, construction management literature, and normative developments are assessed.

For data collection, sustainable development in its trifold dimension as regulative framework is broken down from conceptual level amongst the framework level to the product level. The information integra-

tion in standards, real estate development processes and tools for decision-making in real estate development is analyzed regarding the integration of the trifold demands of sustainable development. The study offers:

- The assessment of the demands of sustainable development;
- The identification of relevant decision-making processes in real estate and construction as existing channels of control;
- The assessment by using an embedded case study;
- The linkage of identified aspects to the identified processes in real estate development;
- The identification of possible implementation of findings for practical application.

3.2. Selected method for knowledge integration

Descriptive case study[6] research guides the data collection. This study applies case study method, but does not serve as further development of descriptive decision theory. The methodological concept is developed in a theoretic way and is tested afterwards. As a first operative step, the cause-impact chain is shown, as second step, the case is assessed. For the assessment of the case, the Brunsvician lens (Scholz and Tietje 2002) is used for qualitative-quantitative information integration as scientific method for knowledge integration. A formative scenario analysis describes the case. The Brunsvician lens helps to approach the task and develop a system model[7] of decisions and impacts. These are:

- For *understanding:* Find out and illustrate a list of crucial aspects by investigating processes;
- For c*onceptualizing:* Identify the principal players (experts, major agents, individuals or institutions);
- For *explaining:* Choice of details of the case, databases, tools, documents, literature.

[6] "A descriptive case study uses a reference theory or model that directs data collection and case description. It tests, whether an in what way a case may be described when approaching it from a certain perspective. (..) Theory testing is done in a qualitative manner. However, as in traditional hypothesis testing, specifications for the cause-impact chain have to be formulated before case analysis." (Scholz and Tietje 2002)

[7] "Modelling is reductionistic by definition. Models reflect reality in a symbolic way. The development of models of part of the socio-economic system requires dealing with three difficulties related to the complexity of the socio-economic system: Definition and reduction of the number of elements and their interconnection (transitions), i.e. definition of processes and flows representing." (Scholz and Tietje 2002).

Figure 3 illustrates the conceptualizing and representing the framework according to the Brunsvician lens, derived from theoretical level to the specific case study. To approach the problem, existing control channels have to be used (Busse 2012).

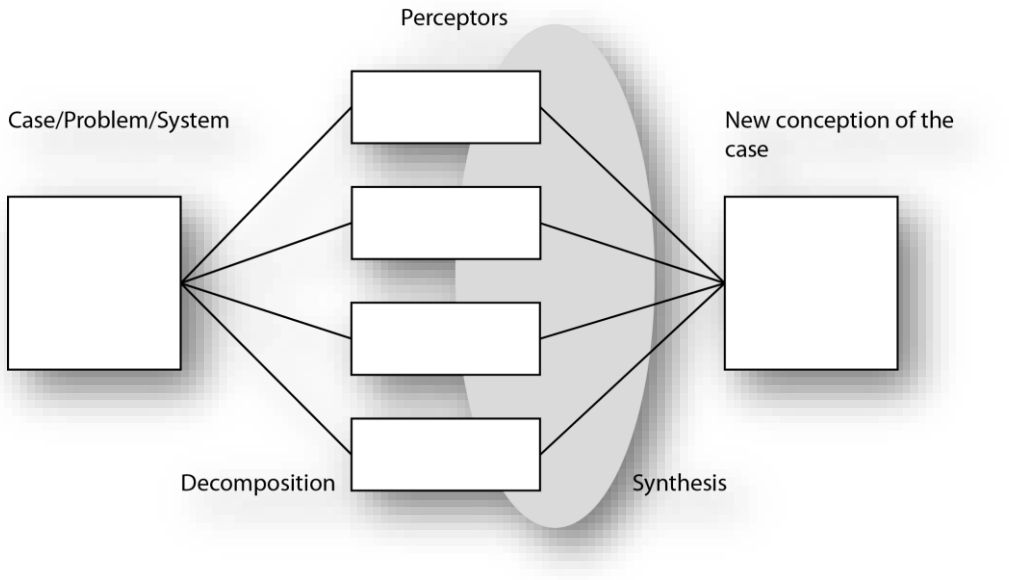

Figure 3: Model of the Brunsvician lens, Scholz and Tietje 2002

Scholz suggests steps for structuring the Brunsvician lens (Scholz and Tietje 2002). Case and goal are defined (A) and system properties are described (B, C). A synthesis (D) and new composition of the case (E) is shown. This system model identifies problem (A), decomposition (B), perceptor (C), synthesis (D) and new composition. The research question of this study stands as problem (A). Building level, portfolio level and corporate level are taken to decompose the case, as it can be applied for a real estate company (B). As perceptor (C) stands the corporate perspective, the user perspective and the financial perspective. For the synthesis (D), engineering tasks, management tasks and the life cycle perspective are taken into consideration. The new composition (E) is structured by corporate activities (processes, strategies), societal goals (regulations) and risks (finance), see Figure 4.

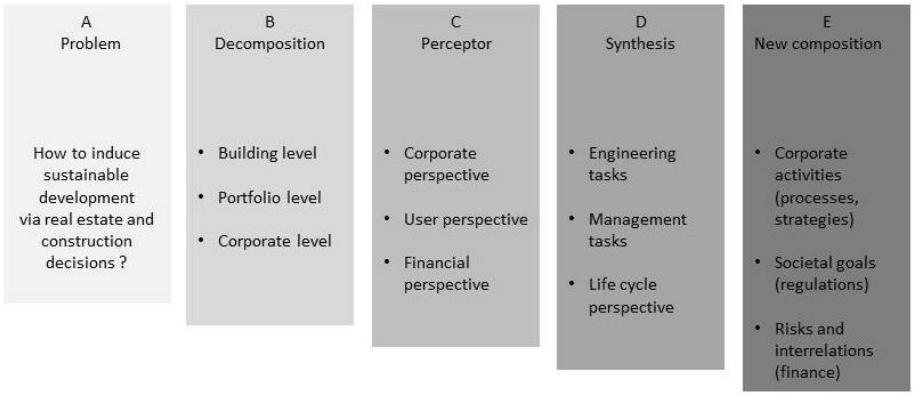

Figure 4: System of case understanding using the Brunsvician Lens

The main principal stakeholders are identified. These are real estate developer, investor, and contractor. In this study, the problem is decomposed into building level, portfolio level and corporate level. As perceptors, corporate, user and financial perspective are chosen. Impact variables are derived from the demands of sustainable development (see 4.2.) and the identified risks and chances (see 4.1.).

3.3. System conceptualization and data collection

The methodology for the assessment of the system modeling[8] is described. The target is to identify deficiencies in the coverage of sustainable construction in view of the demands of sustainable development in general and to identify the potential to induce sustainable development via real estate decision-making and construction. Therefore, actors and elements of the decision process are identified and described. The investigation of the case follows the multi criteria approach.

A workflow is derived and shown in Figure 5.

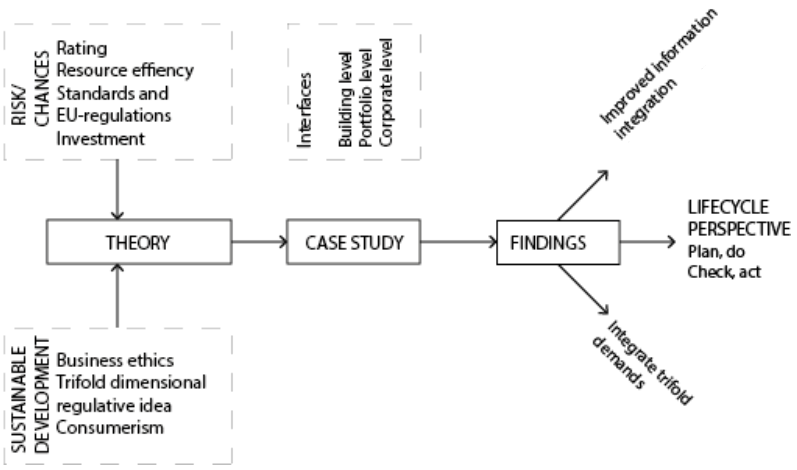

Figure 5: The concept of the research process

Real estate decision-making influences the choice for construction systems, construction products and thus affects material choice. Sustainable development as societal goal stands as target, not the sustainability of single companies or single buildings. As constraints to develop an analysis framework, real estate decisions have to be assessed to find effects, which induce sustainable development in the real estate and construction context. The different stakeholders act along the real estate and construction

[8] "Modelling can be thought of as both a very specific type of synthesis and an embedded case design. (…) The specific contribution to the synthesis can be shown in a Brunsvician lens model. It is clear that knowledge integration is primarily the integration of disciplines. (…) Mental models do have a significant relevance within the modelling process. Different interests may be included by the determination of control variables or goals." (Scholz und Tietje 2002)

process. Those influences affect demands of sustainable development. New in this thinking is the inclusion of ethics and consumerism theory together with the trifold dimensional approach of sustainable development. Any future company performance evaluation changes from cost, quality and service only to the contribution of company activities to sustainable development. That is why this study tries to elaborate decision support for qualitative decision-making on corporate level. For approaching the problem, existing control channels are used as it was proposed as scientific approach by the postulate that a sustainable decision-making practice must be initiated via control channels of the actor-specific benefits (Busse 2012). This study investigates information integration in concept level, framework level and product level, as illustrated in Figure 6.

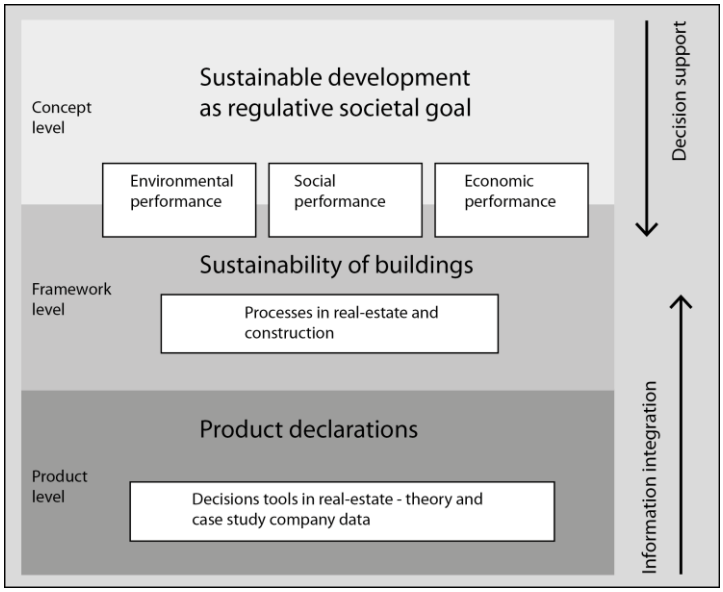

Figure 6: Levels of information integration the study

Existing concepts available in literature concerning economic, environmental and social demands of sustainable development, existing concepts, which integrate sustainable development in business strategy and existing concepts, which approach sustainable development to the needs of real estate development, have been assessed to identify the demands of sustainable development. The St. Gallen management model is used to explain the different approaches of real estate economic thinking from the case study company's perspective. The institutional aspects, real estate business fields, engineering, development, management, economics, sociology, and their interferences are identified by using the St. Gallen management model for explaining the general context.

The case study company (BHGKG Bayerische Hausbau GmbH & Co. KG, München) is an integrated real estate company that works in all the phases from real estate development to real estate management on all levels. Different projects serve as data sources for the case. On the one hand, all corporate processes form the case. These corporate processes have been looked at in more detail in three projects: a

project of the real estate development phase, a project in the planning phase and a project in the construction phase.

Data have been collected in this study in two ways. First, business ethics literature from Belz (2007), Vogt (1999, Vogt et al. 2009), Blazejczak (2004), and Forsman (2013) is taken into consideration. Weber-Blaschke (2005) presents concepts to bridge the gap from resource management literature to real estate and construction sciences. Sustainable development in civil engineering and real estate economics is recently discussed in Busse (2012), Hafner (2012), Lasvaux et al. (2014), Lützkendorf (2011), and Schwarz et al. (2013). The literature is surveyed and main findings are compiled.

Second, document research helps to describe relevant business processes. These are described in the company´s strategy description and the process manual. The real estate development and project management decision support tools provide qualitative and quantitative data. Quantitative data mainly come from real estate economic investment calculations and cost calculations. In detail, this includes the asset management calculation, portfolio management assets and property management. The qualitative data result from decision support tools and documents. These are competition documents, design and planning, meeting protocols, and concept papers. Last, focused interviews are conducted as expert interviews (Scholz and Tietje 2002). Table 1 shows an overview on assessed topics, methodologies of investigation and data sources.

These sources and investigation methods have been considered to assess qualitative and quantitative company data about the implementation of information in decision-making as shown in Table1. These are for qualitative data: expert interviews, documents, the business model and the strategic orientation of the case study company, shown in standard processes. For quantitative data, these are applied calculations and decision tools.

Step	Topic	Methodology	Investigation method	Data sources
I	- Demands of sustainable development - Construction processes	*Step A:* - Assessing each part of the trifold dimension of sustainable development *Step B* - Choice of core and shell as system *Step C* - Choice of the elected scientific method	*Economic aspects* - Step 1: literature analysis - Step 2: Case study analysis	- Business literature - Environmental scientific literature - Engineering and real estate economic literature
			Environmental aspects - Literature analysis	- Regulation and certification in building sciences - LCA in environmental sciences
			Social aspects - Step 1: focus separating building production as argument beyond building comfort - Step2: literature analysis and case study analysis	- Business ethics literature - Interviews (case study) (tendering, sales, project management, asset management, contractors, sustainability consulting, real estate development) - Document research (competition, tendering, corporate documents, project development, management documents, planning)
II	- Real estate development decisions - Real estate processes - Real estate corporate decision-making	- Descriptive decision theory - Qualitative-quantitative research	- Case study research - Document research	Qualitative-quantitative data: - Corporate processes based on St. Gallen Management Model - Real estate decision tools (Asset management, portfolio management, project development, project management) - Construction processes - Construction process tools (competitions, design, planning, construction planning, tendering)
III	Possibility of implementation in development decisions	Description of effects of decision-making *(system analysis)*	- Analysis of causal interdependencies and deficiencies Investment-real estate development-contractor - Results of Step II - Identify change and decision-structure	
		Implementation	Link the analysis of interdependencies to the result of research question STOFFPASS research project	

Table 1: Overview on data sources and investigation methods of the study

4. DEMANDS OF SUSTAINABLE DEVELOPMENT, REAL ESTATE AND CONSTRUCTION PROCESSES AND THEIR INTEGRATION

According to Busse (2012) a sustainable decision-making practice shall be initiated using existing control channels of actor-specific benefits. To sketch the control channels in the context of the study, corporate real estate and construction processes, circumstances, decision structures, values and benefits as well as technical requirements are described in this part of the study. The induction of sustainable development is investigated using the interrelation real estate development – investment – contractor and verified by statements of expert interviews. Finally, an information management approach is derived to integrate complementary aspects of sustainable development into existing decision support channels.

4.1. Corporate processes, structures, values in real estate and construction

In this part, real estate and construction processes and structures are described and complemented with the values and decision processes of the case study company. Furthermore, characteristics of the real estate and construction sector and relevant decision support in real estate development and management are introduced. This part aims at identifying information flows and structures of influence and control to clarify interdependencies in the real estate and construction process.

4.1.1. Real estate decision-structures

Very different stakeholders influence these decisions and processes: in the construction process of a building, real estate development, contractor, and the client/investor are involved with different and sometimes contradictory preferences. According to the Brunsvician Lens, this chapter is part of step C, describing the perceptors.

A	B	C	D	E
Problem	Decomposition	Perceptor	Synthesis	New composition

Tasks of real estate development

The definition of real estate economy by Schwarz et al. (2013) is taken as a basic understanding of economic thinking in real estate. This thinking builds up an important base, as it refers to an integrative approach on real estate as interdisciplinary task, includes life cycle thinking and takes for granted that construction processes and service processes merge. Real estate economy contains all service processes bound to the life cycle of real estate. The production processes and service processes merge (Schwarz

et al. 2013). Real estate economy (in a wider sense) contains all economic functions, which service processes result in the economic asset real estate or real estate is an essential production factor to achieve economic outcomes out of real estate involved in the service processes (Schwarz 2013 et al.). Real estate are economic goods in the form of property respectively rights similar to land plot rights, buildings with additional items. Their costs and side effects influence under a certain time aspect the target of economic subjects (Pfnür 2011). The tasks of real estate development are described amongst others by Diederichs (1999) and Schwarz (Schwarz 2013 et al). According to these authors, the main variables of real estate development concerning sustainable development are economic competition while ensuring economic, social and environmental conscious effects. The project development is based on municipal and supra-regional planning, which can be summarized under area development. The tasks of project development include in particular site and market analysis, the definition of occupant requirement programs, processing (which means the definition of the construction structure and facility systems and standards for an early cost calculation) and investment analyses. The project development is to combine factors location, project conception and capital in order to create a project that as consequence results competitive and job-creating for the micro economy and therefore is permanent rentable for macroeconomic, social and environmental matters (Diederichs 1999). Via project development the factors location, project idea and capital have to be combined that from a microeconomic point of view competitive, employment generating and – assuring as well as macroeconomic socially and environmentally responsible real estate projects can be created and used permanent financial viability (Schwarz 2013 et al.).

Excursus II: Decision-making. Decision theory is committed to problem solving. Problems arise when an unwanted state should be transferred into a wanted target state. The main characteristics of problems are that the means for achieving the target state are unknown (Werner and Scholz 2002). The issue of the theory of normative decision analysis is the rational choice of means. It treats the question of how one alternative action can be determined out of a set of alternatives that best achieves a given (or assumed) target state. The structural search for the best possible alternative to reach a given target under given constraints is considered a rational choice. This rationality of the choice of means has to be clearly distinguished from the rationality of the choice of ends (Werner and Scholz 2002). Information on the value structure of the decision-maker appearing in the "target plan" as a model of the decision-maker. The target plan covers factual matters the decision-maker strives for and the intensity; it is of purely subjective nature and hast axiomatic character. The target plan regulates the setting up of the model of the decision field (Werner and Scholz 2002). A rational choice can only be made if a decision-maker has more than one action to choose (Werner and Scholz 2002).

Real estate developers are responsible for the conception and performance of new project developments as well as for the revitalization of existing objects (Rottke 2010). Often, real estate economy is illustrated as a house. The house of real estate economy, which is widely used, shows an overview on relevant stakeholder. These stakeholder and interests meet in this initial phase. The real estate development is

according to Diederichs (1999) of common economic advantage. The house of real estate economic structures real estate economic terms (Schulte 2005). Figure 7 shows the concept:

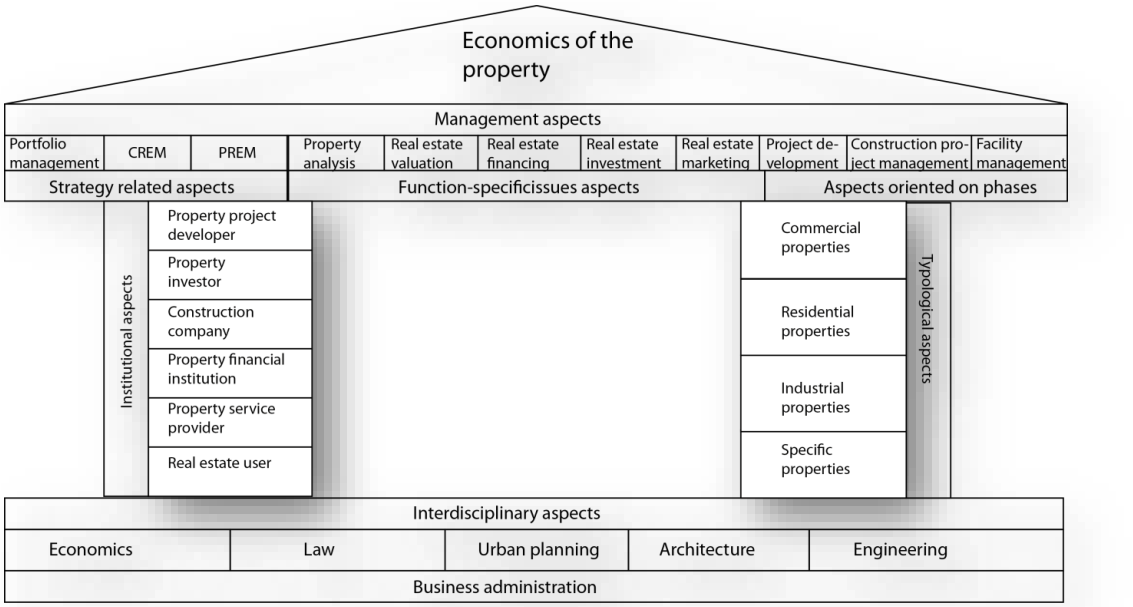

Figure 7: Fields of interest, stakeholder in real estate economy[9]

Real estate economy has different aspects, which are usually addressed in different scientific disciplines. Business economic aspects, management aspects meet institutional demands and technical as well typological aspects of real estate, and information interferes. The basic discipline is business economy. Real estate economy as scientific discipline is based on the understanding shown in Figure 7. The subject of real estate economy is the declaration and design of real decisions concerning real estate connected economic subjects. These are real estate companies, but also the state, non-property companies (industrial, commercial and service companies, churches, private investors including family offices and foundations). The real estate economy does not define itself as branch business economy as its application goes far beyond real estate economic tasks. The real estate economy transforms insights of business economy, macroeconomics, law, urban planning, architecture and engineering (Rottke 2010). Rottke distinguishes various important stakeholders: besides the user and investor, he identifies project developers, contractors, finance institutions and service provider as important stakeholder groups (Rottke 2010).

[9] http://www-wiwi.uni-regensburg.de/Institute/IREBS/Schulte/Home/index.html.de, accessed on 24.07.2015

Still, the “economic efficiency and sustainability of real estate are significantly predetermined by reflections and decisions in the early development phases when decisions are taken on utilization, space concepts and building standards. An important task is to keep in mind while talking on real estate and construction that the characteristics of property on the one hand results in financial economic targets and on the other hand, technical problems are provoked by construction tasks. This means, institutional-functional and technical issues merge.

The real estate economic process chain shows up stakeholder and their interdependencies in the real estate sector, which is illustrated in Figure 8.

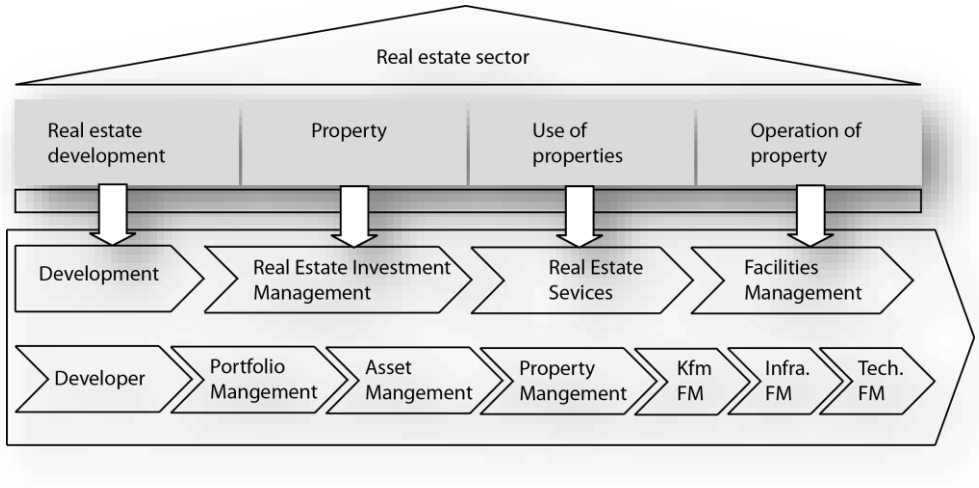

Figure 8: Real estate economic process chain, Pfnür 2011

The project phases are divided into three main blocks, namely real estate development, project management and facility operation. An interdisciplinary basic understanding of real estate thinking helps to prepare the later described initial planning phase.

Real estate development has different tasks, which are shown in Figure 9. In the real estate development process, the wishes of the owner has to be managed and evaluated by means of planners in regard to the framework given by authorities.

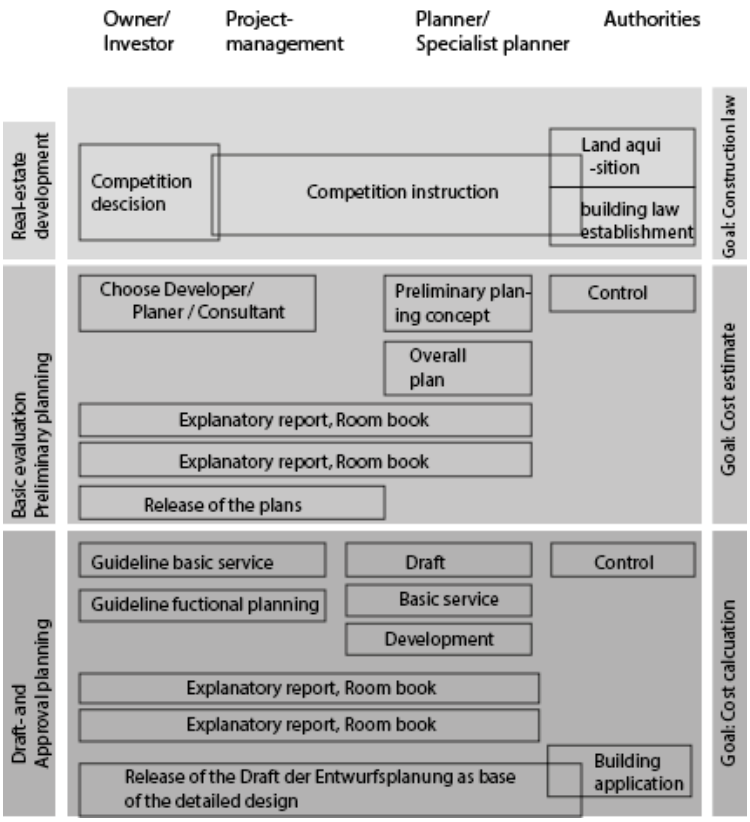

Figure 9: Tasks of real estate development.

Next, real estate management should be clarified. The tasks of real estate management are the appropriate use of non-adequate used land properties, amelioration of urban environmental conditions and improvement of quality of life. Furthermore, preservation of macroeconomic promotion by primary employment of architects, planners, lawyers, accountants, contractors, service providers, subcontractors as well as an increase of workload in construction economy. Real estate economy integrates techniques, institutions and business fields. The main business fields related to real estate and construction are real estate appraisal, real estate finance, real estate development, corporate and public real estate management, real estate investment, life cycle real estate management.

Besides technical characteristics of real estate and construction tasks, real estate developers and construction companies are driven by institutional interests; these interests are being followed along the different phases of a development and construction project in interaction with different stakeholders (Pfnür 2011). The real estate investment management cares for portfolios and real estate business fields. The targets and possibilities for the investor are investigated and investment decisions are prepared and controlled (Pfnür 2011). Figure 10 illustrates this:

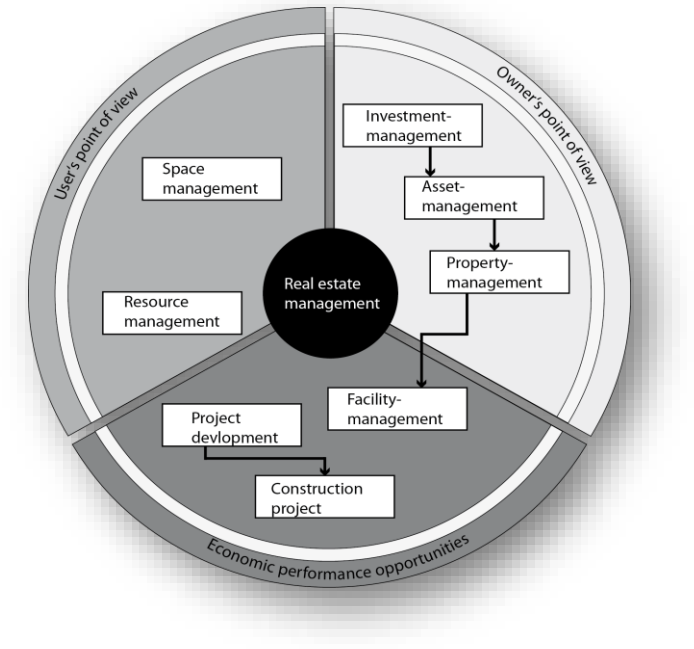

Figure 10: Elements of institutionalized real estate management, Pfnür 2011

Portfolio management takes the set targets of real estate investment management. The portfolio management is the strategic management of bundled real estate (portfolio), which is determined by the influence amongst assets, which do have impact on the target. The potential for economic success by a systematic portfolio management considers relevant framing conditions. The portfolio strategy steers the implementation on portfolio level and controls the targets. The tasks of real estate portfolio management are the steering (organization and implementation) of the portfolio realization (Pfnür 2011) (Kämpf-Dern and Pfnür 2009). For the case study company, it provides different benchmarks and evaluates analysis.

Real estate asset management means the strategic object management of a real estate portfolio about the interest of the owner whilst the management phase and the interface to the concept phase, acquisition and conversion. The aim is, to reach targets set by the portfolio management for one or more objects, as well as the identification of value increase potential (Kämpf-Dern and Pfnür 2009).

Property Management describes the operational management of real estate objects about the interest of the investor (Kämpf-Dern and Pfnür 2009). For the case study company, it guides the execution of technical and accounting tasks (tender accounting, refurbishment) according to the targets set by the asset management.

Project development is linked to the asset management. Very early, the asset management steps into the planning of the project development and evaluates feasibility and market implementation.

Table 2 shows the levels of real estate investment and their tasks.

Levels		Tasks
Portfolio Management	Portfolio-planning	- Inventory and analysis of the portfolio according to yield-risk-cash flow respectively to the service contribution and requirements of the investment management; - Research of portfolio relevant information on international, national and regional markets and sectors; - Development of the portfolio strategy (targets, transactions and real estate developments) in accordance with the investment management; - Cash-flow-modeling, economic calculations and scenario analysis on portfolio level; - Creation of portfolio-relevant business plans including budget allocation on object level; - Choice, steering and controlling of employees and internal and external service providers (for economic, technical and infrastructural services and operative legal consultancy); - Controlling and analysis of income/expenditures and identification, initiative, controlling and steering of efficiency measurements; - Support of due diligences, transactions and provision of object/ location relevant data; - Tendering, management and controlling of service, maintenance and modernization measures; - Operative rental management according to the rental strategies, marketing and tenant services; - Consultancy for the Asset Management regarding operative questions on object level (location, tenant structure, technical object changes); - Income and expenses respectively costs and yields for operative management support; - Coordination and supervision of rental and object accounting including transaction and dunning processes (rent, additional expense, deposits, insurances, taxes).
	Asset Management	- Analysis and valuation of the portfolio, identification and initiation and steering of the portfolio performance and relevant investment opportunities; - Initiation and organization of Due Diligence-activities on portfolio level and strategic management of the transaction management; - Decision-making and decision preparation with relevant impacts on the portfolio performance (transactions, project developments, refurbishment); - Consulting of the investment management and the investor/ tenant in valuation questions and financial, legal and process relevant portfolio questions - Organization of accounting and liquidity management on portfolio level.
	Controlling, reporting, risk management	- Monitoring and safeguarding of the object performance and initiating of adaption measures; - Controlling of object budgets; - Analysis and valuation of results/ performance of the property management, facility management and other service providers regarding the target or benchmark and initiative of necessary adjustment measures; - Risk management on object and process level; - Safeguarding of the documentation on object level and reporting to the portfolio- or investment management.

Table 2: Real estate investment management levels, Pfnür 2011

Real estate asset management has close relations to portfolio management. Whilst the portfolio management often has a superregional emphasis, market knowledge is essential for asset management. Furthermore, portfolio management is orientated towards the corporate finance economy, whereas asset management sketches the real estate chances and risks for managerial action. Different assumptions exist on type and scope of the support by portfolio management concerning transactions. Now, the asset management service provider has a different profile of competencies then a corporate asset management service of a construction corporate group. These profiles will merge in the future (Pfnür 2011). Figure 11 shows real estate economic management disciplines. Real estate is understood as investment.

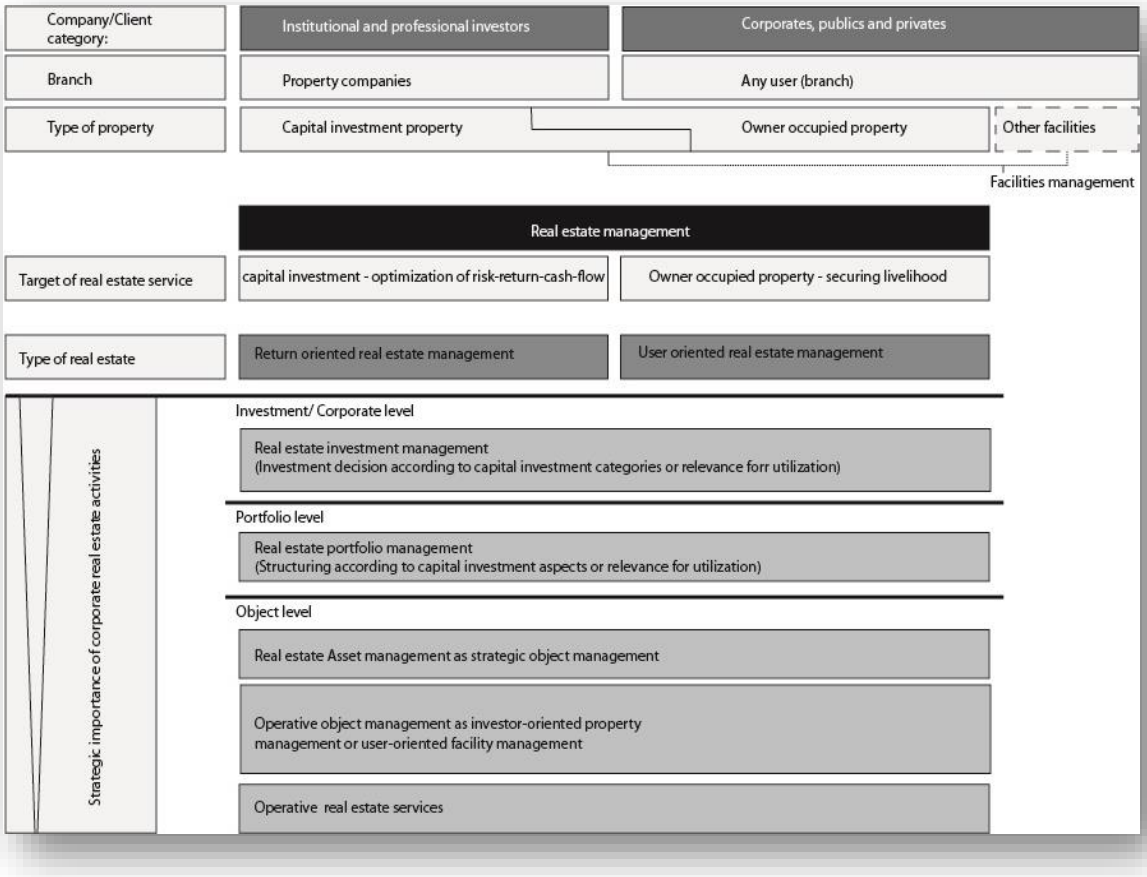

Figure 11: Real estate economic management disciplines, Pfnür 2011

To show relevant institutions for a better understanding, the following figure shows a systematization of institutions in real estate economy according to Schwarz et al (2013) see Figure 12.

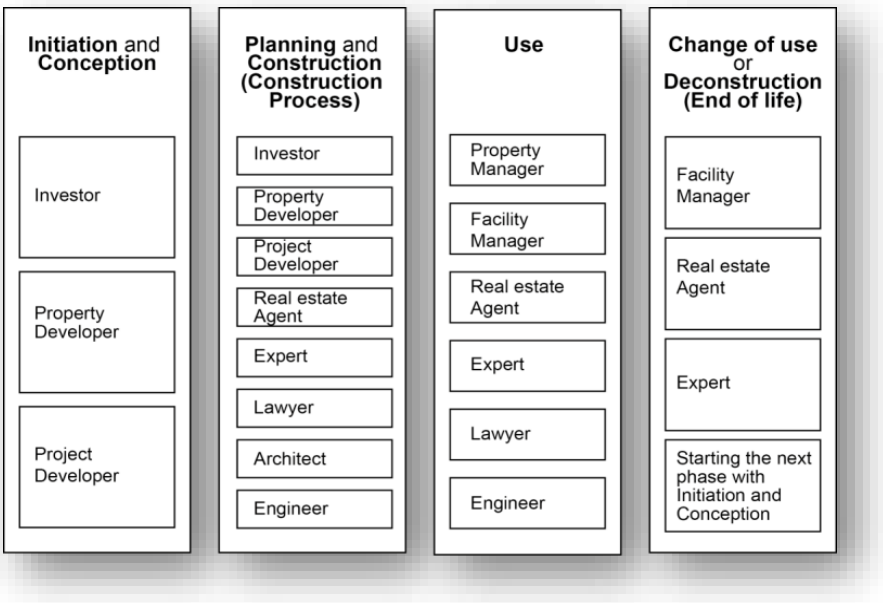

Figure 12: Institutional systematization of real estate economy, Schwarz et al. 2013

The initial phase of decision-making on real estate and construction determines long-term effects of processes and especially on cost, time and quality. The influence and control structures of the "initial planning phase" are the key to understand how decisions taken during this phase limit the room for actions further down the planning process. The main project phases and stakeholders in the real estate and construction process in the classic understanding of real estate development are shown in Figure 13. The initial planning phase[10] is not only decisive for further effects along the development and construction process (Diederichs 1999) it is only the decisive phase from a sustainability-scientific and environmental-scientific point of view (Hafner 2012, Weber-Blaschke and Faulstich 2005, Lasvaux et al. 2014). Generally speaking, the initial planning phase can be described as project initiation and project conception with a focus on the construction and use phase of a building.

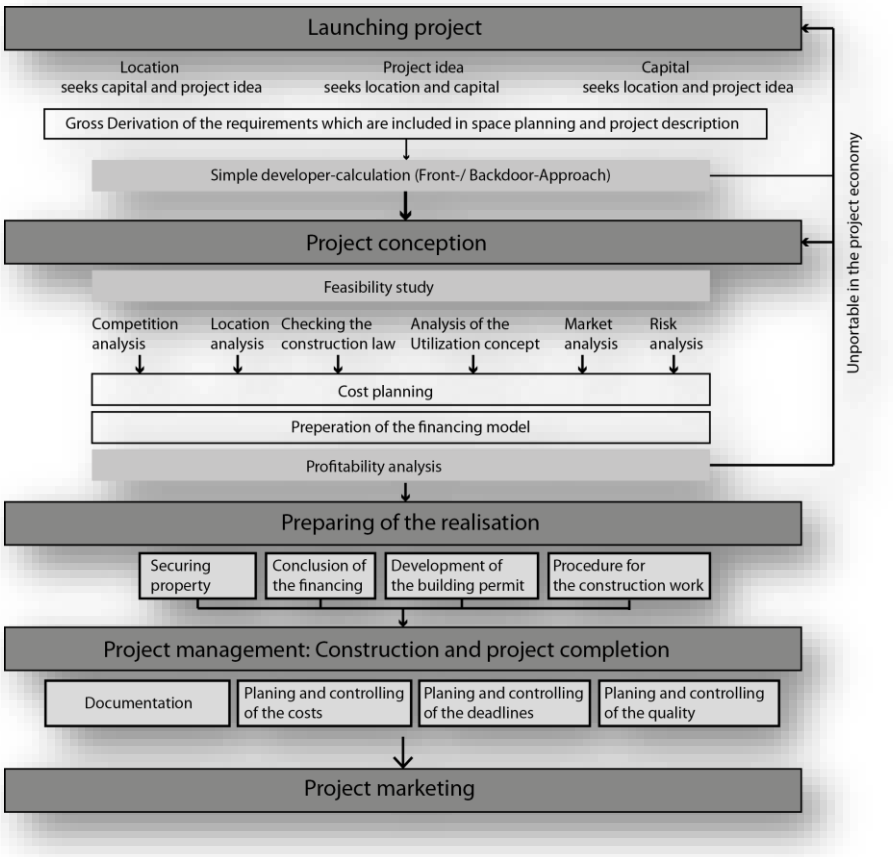

Figure 13: Real estate development and project tasks, Pfnür 2011

The target group of tenants and investors is classified according to location conditions in the project development phase. This allocates price segments. Table 3 lists phases, sequences, tasks in connection with management issues and combines project phases defined by HOAI and DVP. The end-of-life phase

[10] The performance of construction projects has to be adjusted to targets of spatial planning but has to follow the urban development planning which is in Germany fixed in federal law. (Pfnür 2011)

of a project has been added. This table shows that DVP and HOAI do not implement the whole life cycle of real estate and construction. The phases associated with different goals but the same target, to secure the best results for the project were merely taken from Sandoval-Wong (2012). An overview on different understandings is shown in Table 3. Different phases are often used to describe tasks of real estate development and construction life cycle. A description of the meaning of life cycle of real estate can have different views. According to project phases, regulations for the calculation of salaries of German architects and engineers (HOAI and DVP) link the project phases to different engineering tasks for further calculation of salary. In an attempt to classify and describe examples of existing decision-support tools for asset management, as well as to juxtapose them opposite discrete stages for asset management implementation, the six “what’s” of asset management are mentioned: What do you own? What is it worth? What is the deferred maintenance? What is its condition? What is the remaining service life? What do you fix first? (Vanier 2001). Table 3 summarizes the different understanding of phases and tasks of different approaches used in real estate and construction decisions.

Project management is the phase of realizing a construction project and requires an early choice of further project organization by the investor. With the decision for realization, the design is taken into the next step.

Phase	Project sequences	Project tasks	Sequence of tasks	Management	Project phases investor	Phases HOAI	DVP project levels
Raw stage		First idea	Initial preliminary studies and project approval	Project development	Program definition		Project preparation
Development	Strategy definition	Formulation of requirements			Conception phase	Basic evaluation	
		Idea and conceptualization	Preliminary study				
		Solution strategies					
		Project definition					
		Requirements (resources/ management)					
		First incentives on the concept	Feasibility study				
	Project initiation	Description of essential features (utilization, volumes, metrics, capital, idea)				Preliminary planning	Planning
		Feasibility study					
		Object characteristics (raw)	Detailed studies				
		Rates of return (raw)					
		Project development calculation					
	Project concept	Project definition					
		Revision of the viability using feasibility studies					
		Analysis of market, location, utilization, environmental impact, profitability, risk		Project management	Planning phase	Design planning	
		Selection process	Design			Approval planning	
	Preliminary project	Definition of quality					
		Definition of timeframes	Draft valuation / Project conception			Execution planning	Construction preparation
		Definition of costs					
	Project concretion	Integration of project characteristics			Implementation phase	Preparation of tender	
		Authorization by the project management	Project definition				
		Construction tendering and contracts					
		Object characteristics Rates of return Planning permission process	Construction and controlling			Assisting at the evaluation	
Execution	Tendering	Comparing offers Placing application					
	Project implementation	Project construction, project management (controlling cost, quality, time)				Object supervision	Execution
		Commissioning					
Utilization	Maintenance	Facility, commercial, infrastructure and communication management	Utilization	Facility management	Initial operation	Control and documentation	Project completion
		Managing of life cycle aspects					
		Thinking on new concepts First ideas and conception			Utilization and operational phase		
End-of-life	Strategy Development	Formulation of requirements	New concept	Project development			
		Solution strategies Resources and management formulation Project definition					
		First initiatives on the concept					

Table 3: Phases and tasks of real estate to construction

An important point in real estate development and construction is the decision of the investor to realize a project after the real estate development. According to IREBS (IREBS 2014), two main approaches for economic validation can be identified: the front door-approach and backdoor-approach, shown in Figure 14. The front door-approach takes the investment as selling price and derives the economic success. The backdoor-approach takes an economic target and derives the estimated selling price. These both ways result in a real estate product, but differ in economic targets.

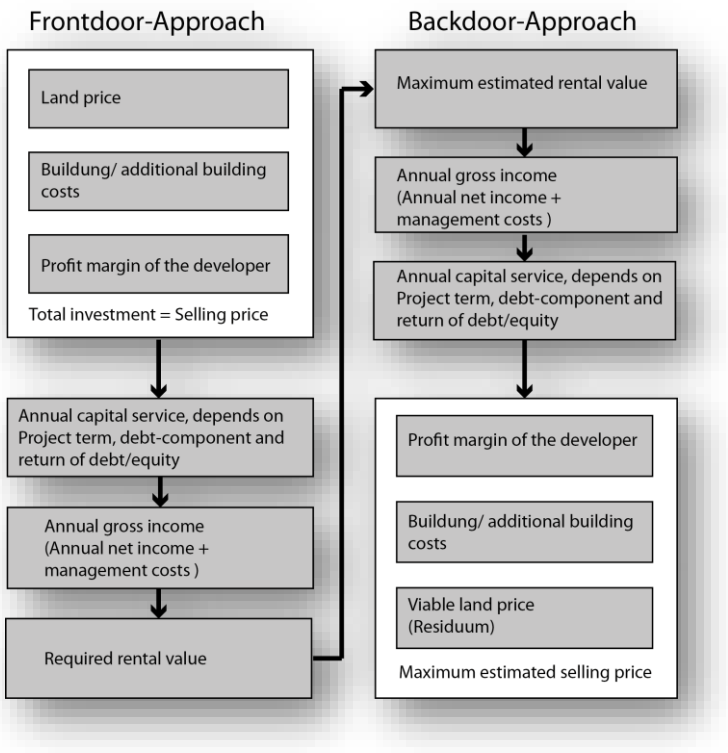

Figure 14: Choice of economic approach in project development, IREBS 2014

An important tool in real estate economics for determining the yield of the project is the development calculation. Diederichs (1999) describes the development calculation as procedure, where the total investment amount is compared to the total annual rental income and the rent multiplier is determined. The trading profit is the difference of the sales proceeds and the investment sum. The simple development calculation maps the investment phase adequately (Diederichs 1999). Weaknesses of this approach lie in the determination of the proceeds of the sale. As long as investors are willing to purchase objects based on rent multipliers this is no longer a problem. When investors work with detailed economic calculations, dynamic calculations are suggested (Diederichs 1999). Added value is the target for project development.

Several developer strategies can be divided, on which real estate development decisions and the development calculation are based:

- Service – developer: gains – in financial returns of the company;
- Trader – developer: Exit-Strategies (achieving optimized return on investment by capital gains);
- investor – developer: return on investment via portfolio properties, added value also via rent).

Real estate economic thinking and investment has to evaluate costs and market. Costs (building costs, financial costs, overhead expenses) and revenues (rental income, sales proceeds and miscellaneous receipts) can be calculated (trading profit). Yet, the evaluation and determination of the project yield depends on the level of knowledge to the project handling.

The investor defines targets concerning cost, time schedule and standard. These targets are followed by a biggest possible efficiency. This is also important for choosing the form of project organization. Processing means to define fundamental parameters for the design planning:

- Definition of the horizontal and vertical building structure;
- Definition of building and technical finish standards;
- Conception of technical building services.

Results of the processing are basics for the economic efficiency calculation with the necessary precision of basic equipment standards and technical standards.

The scheme of project steps shown in Figure 15 contains the classic interpretation of the tasks of real estate development (Diederichs 1999):

Figure 15: From real estate development to facility management, Diederichs 1999

Technical requirements in construction coming to pricing

Transferring real estate economic thinking to finally technical characteristics of a building and back needs the contractor as information bearing and decision-supporting stakeholder. The production process of real estate and construction is challenging[11]. Coordination and motivation as challenge in construction are due to a division of work processes amongst many stakeholders of different branches and jobs, which are different planners and in construction different contractors with different capacity ranges. Challenges for the construction sector are strong competition[12] and dealing with an interdisciplinary context. The business administration in the construction context is increasingly determined by economic, legal and organizational issues in addition to the traditional technical problems (Diederichs 1999). Still, about 30 contractors are involved in an average construction project.

Pricing in construction is characterized by the separation into private investors and public principals. In Germany, public principals have to follow VOB regulations for tendering and price building. Placing of orders, contract design and handling of construction works is in Germany, respectively Bavaria, regulated mainly by following legal instruments: process standards and contract standards. These are VOB German construction contract procedures for building works, DIN 1960 contract procedures for building work, Bayerische Bauordnung (BayBO 2007), and technical standards. Legal instruments are for public tendering and the communication via adequate media: VOB A/B/C, VOL, VOF and sector regulations. For private tendering, laws to competition restriction and tendering, BGB and VOB count. According to VOB/A, only such offers should be taken into consideration, which provide a perfect technical execution and warranty under rational construction operation conditions and economical management (Diederichs 1999).

Real estate business management

The assessment of corporate activity for responsibility is suggested, because it seems that the business model is conditioning the decision logic of senior management and has to be addressed first in firms that want to make significant eco-sustainability improvements (Willander 2013). Furthermore, a sustainability-oriented culture of responsibility is the prerequisite and target of a sustainability-oriented management (Bieker 2005). A real estate company brings together real estate development, investment

[11] The real estate and construction sector has a significant environmental and economic impact on the society. At the same time, the sector is associated with low levels of innovativeness and productivity. One reason for this is the fragmented value chains in the industry. The fragmentation is visible both horizontally and vertically at a project level, multiplied along the temporal axis and posing several challenges from the life cycle perspective. Due to this fragmentation, almost all innovations in real estate and construction sector have to be negotiated with one or more actors within the project coalition. (Rajakallio 2013)

[12] "Strong competition in the construction and real estate industry is challenging the management of real estate, planning and construction companies increasingly" (Diederichs 1999)

questions and contractor information. For informed qualitative decision-making, decision structures and information flow have to be analyzed. Construction projects as the real estate companies´ products are dependent on stakeholders involved in construction processes, aiming at managing time, cost and quality. Here, a spotlight shall be put on real estate as a product with construction as production processes. The corporate processes of the case study company are analyzed. Therefore, it makes sense to apply a general model to assess corporate processes. In this case, the St. Gallen Management Model (Rüegg-Stürm 2004), shown in Figure 16, was chosen, as it is easily applicable. According to St. Gallen Management Model, the components in which the company acts are society, environment, technology and economy. Topics of interaction are brought to the company by different stakeholders and postulate solutions. These are norms and values, resources and societal interest. Stakeholder interests are a central problem, as this affects corporate added value activities (Bieker 2005). Essential management questions can be structured by the use of this model without losing the general context.

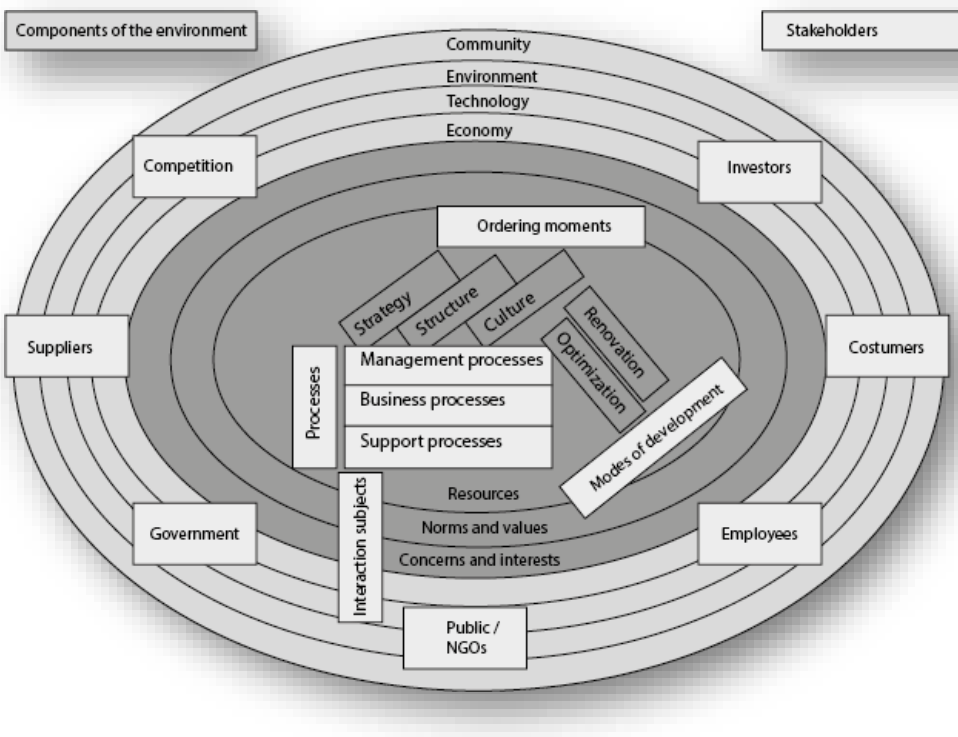

Figure 16: St. Gallen Management Model, Rüegg-Stürm 2004

Ordering moments of the case study company are corporate culture, strategy and structure.

Figure 17: Ordering moments of the case study company

The current corporate decision-making in the case study company is shown in Figure 18.

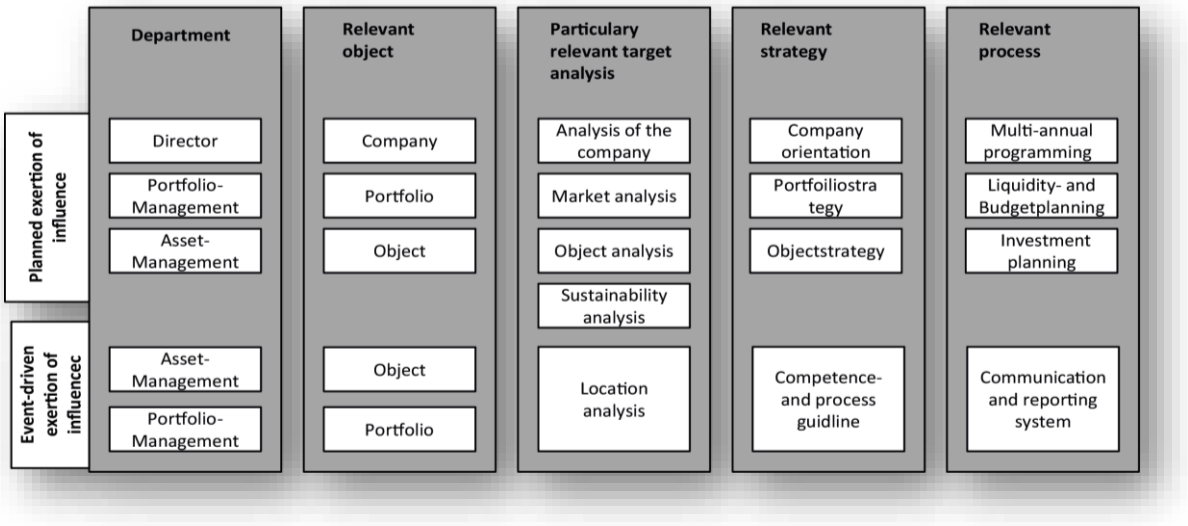

Figure 18: Object-relevant decision structure in the case study company

Following strategies are listed for the case study on strategic level: the real estate company is pursuing the portfolio-strategy in a multiannual programming. This is providing the guideline for the company and is controlled once a year. This affects the liquidity planning. Hereby, the focus lies on the return optimization as well as a risk-or-chances consideration regarding location and history. On object level, the object-strategy (strategic object planning) operationalizes itself in a once-a-year performed object-check. This is aiming to receive knowledge on investment and liquidity planning as well as feedback on the portfolio strategy. Infra-annual topics, situational questions are regulated by competencies in the company (planned-not planned), and associated towards actors. These rules are according to the business process management directive project development, project management, asset management and port-folio management. Non-scheduled decisions are taken after a careful decision preparation by the com-pany´s management board.

4.1.2. Risk management for a real estate company

Valuation as a challenge for the investor and risk management as a challenge for the real estate developer are covered in this chapter. Hence, this chapter focuses on economic aspects of sustainable development in the context of real estate and construction.

Challenges for the investor and real estate development

According to the Brunsvician Lens, this chapter is amongst others, part of step B, which describes the decomposition of the case.

A	B	C	D	E
Problem	Decomposition	Perceptor	Synthesis	New composition

Challenging task for investment decisions are the determination of property value. The links and relationships between the different components of property value are complex, interwoven, sometimes conflicting and not yet fully resolved. However, a limited or one-sided understanding of the concept of property value gives rise to the risk that estimates of property values fail to capture or even recognize evolving changes in the needs of the market participants, become distorted and that misinformed decisions are made on the basis of these valuations. This is one of the deeper causes of unsustainable (i.e. environmentally and socially harmful) behavior in the property and construction markets (Lützkendorf et al. 2011). Figure 20 illustrates the circumstances of the value according to Lorenz and Lützkendorf (2011). Real estate financing is of important economic importance. This is due to the close interrelationship of private property financing and construction. The question arises, what is the value of real estate and construction. Some approaches already deal with sustainable development. One of sustainability relevant findings is that practically, the market is responsible for real estate value[13]. The value-oriented reflections crystallize the core problems of real estate valuation. One argument is that the comparability of real estate and construction is insufficient and not completely possible (Pfnür 2011). Further a clear definition and fulfilment of valuation principles in terms of tasks of decision-makers is difficult, and the supply of information as prerequisite of valuation (Pfnür 2011). Valuation follows first the life cycle of real estate. After that, a valuation can be performed according to the purpose. Often, the purpose has a legal background (taxes, balance sheet, insurances). The next group of valuation purposes is the property management (Pfnür 2011). The market value therefore is based on the imagination of an objective value. There are three different procedures:

[13] "There is no generally applicable definition of real estate value. In practice, the concept market value has become prevalent. (Meins et al. 2010)

- *Sales comparison approach* determines the value of an object by comparing the prices of similar objects;
- *Income capitalization approach* determines the value using a calculation of overall return on investment;
- *Cost approach* procedure which bases on land plot and construction costs

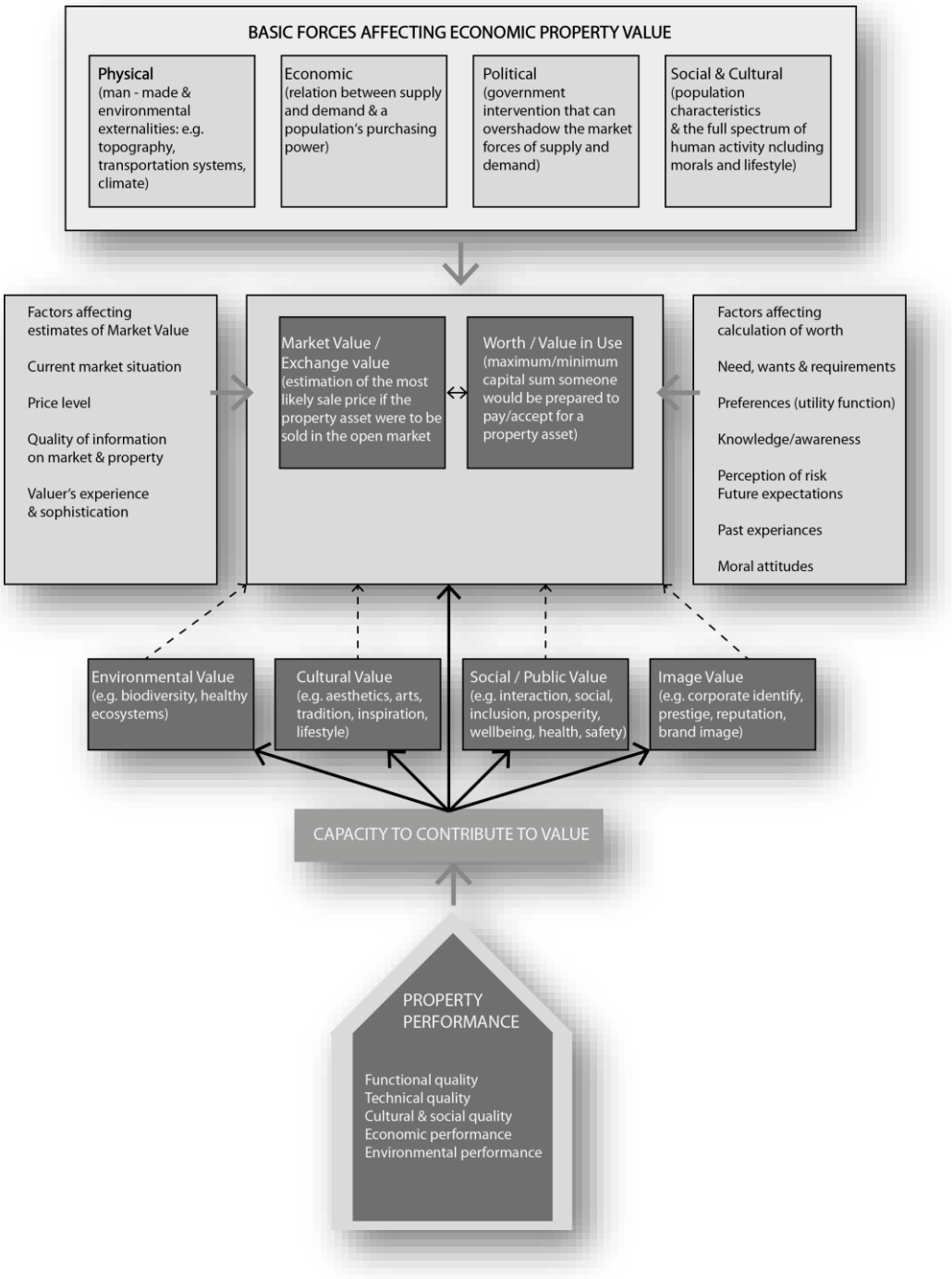

Figure 19: Value map of real estate, Lützkedorf et al. 2011

The International Valuation Standards define market value: The estimated amount for which a property should exchange on the date of valuation between a willing buyer and a willing seller in an arm's-length

transaction after proper marketing wherein the parties had each acted knowledgeably, prudently, and without compulsion. A further common definition is the value in use or worth. A further common definition is the value worth. According to RICS, worth is a specific perception of an investor of the capital sum which he would be prepared to pay (or accept) for the stream of benefits which he expects to be produced by the investment. Both price and value are in line with the market, while worth is subjective and based on the particular requirements of the client. In the property market, a valuation is often defined as the best estimate of the exchange price of the building and calculation of worth is the value at the end of the period under consideration is calculated by income capitalization. The market value results from the sum of the discounted cash flows (DCF) within the period under consideration and the residual value. The discount rate plays a central role in the determination of the market value. An important task of the discount rate is the consideration of those risks, which are not otherwise considered in the DCF, i.e. by the cash flows (Meins et al. 2010).

Real estate differs from valuing assets in many different features. Property is an immobile asset and is characterized by a high level of longevity. Each property is singular, on the one hand, because of its geographic and topographic uniqueness and, on the other hand, as a result of the large number of variable building characteristics. In contrast to shares, for example, the price of real estate cannot be determined without a transaction-taking place because each property is unique. Instead, a property's value needs to be estimated as an approximation of the price (Meins et al. 2010). Meins et al. find challenges[14] for property valuation, as quantifying the value of real estate is ultimately based on estimates: first, the lack of transparency (valuation black box). Second, the tendency of valuations to lag behind market trends (valuation lag).

Valuation black box: The definition and determination of the discount rate used in the DCF method are not specified in detail – neither in real estate practice nor in the international valuation standards or in the international accounting standards The basis of this is the return on a risk-free capital investment. Risk premiums for the general real estate risk as well as for the property specific risk are added to the return on the risk-free capital investment. In addition to this approach, a more empirical approach is often applied in practice. In this case, market data are used as a basis to determine the discount rate. Depending on the property risk, which is estimated individually, this empirically determined rate is adjusted upwards or downwards. Not all valuation reports disclose how the discount rate was derived and whether or which of the risk components were used. The discount rate is therefore similar to a 'black

[14] For the DCF method, the assumptions regarding future cash flows as well as the choice of the discount rate determine the value. (Meins et al. 2010)

box'. This is particularly problematic because the discount rate is one of the value drivers with the greatest leverage (Meins et al. 2010).

Valuation lag is the accuracy of the value determined primarily depends on which factors are included in the valuation and on which basis of data and experience these factors are quantified. The worth of real estate depends to a large extent on the development of exogenous framework conditions. For some of the framework conditions, long-term changes can be anticipated today. These include climate change, demographic changes or rising energy prices. A weakness of current valuation methods is that in their attempt to base the valuation on empirical evidence, they are forced to rely on market data. While market data obviously reflect market expectations of the future, they are still influenced by past trends. It is therefore in the nature of valuations that new market trends are reflected with a certain time lag. This creates a time slot of insecurity for valuers and leads – among other things – to an initial failure to take the consequences of long-term changes into account. Since many sustainability features are related to emerging long-term developments, this leads to a failure of valuations to take value-relevant sustainability features into account. This may be aggravated for those DCF valuations that are not based on new rental agreements and which have fixed rents (as is commonly the case in Switzerland) because here the income cash flows are based on market data that may be several years old. In general, the DCF method works well when market participants have homogeneous expectations. Its limits are revealed, however, when market participants have heterogeneous expectations. In sum, the 'valuation lag' leads to valuers lagging behind the market when it comes to integrating value-related sustainability features in their assessment of a property's value (Meins et al. 2010).

Real estate is amongst others sustainable if it is capable to deal with long-term developments respectively bear a small risk/high chance to loose/gain value on the long run (CCRS 2011). Experts have to assess this potential (CCRS 2011). The NUWEL[15]guideline links traditional valuation characteristics and sustainability characteristics and creates a list out of that. This is an overview on valuation and risk relevant information, but has diverse problems in data acquisition and information management (CCRS 2011). As arguments for that is a lack of homogenous descriptions of real estate by e.g. building/ material passport which address a life cycle supporting documentation (CCRS 2011).

NUWEL guideline shows for sustainable construction, how sustainability can be operationalized and integrated into valuation (RICS 2012, CCRS 2011). Basics are (RICS 2012):

- Some selected real estate characteristics have proved their relevance on value;

[15] www.nuwel.ch, accessed on 09.09.2015

- Sustainability relevant characteristics of real estate should be implemented in valuation and risk analysis. The influence should be quantified and – if not possible – written down in the assignment;
- The quantification of aspects must be transparent.

Valuation is of interest of financial stakeholders. Still, the location is the most important factor of economic valuation (SIA 112/1). Meins states that under the influence of political and economic circumstances (construction cost, tax, currency development and economic growth) and a future regulative pressure of finance and capital markets, the interest in sustainability factors will rise (Meins et al. 2012). Important financial stakeholders for the built environment are classified as Table 4 presents:

Interests	**Actors**						
	Financial sector		Additional financial stakeholders				
	Banks and other financiers	Insurance companies	Project developers	Real estate and housing companies and corporations	Property funds and REITs	Individual and institutional investors - long-term interests	Individual and institutional investors - short-term interests
Construction cost/ aditional construction costs	□		■	■	□		
Operating costs - attributable to tenants	□			□	□		
Operating cost - non-attributable to tenants	□			■	■		
Whole life Costs	□			■	■		
Rent level	□			■	■	□	□
Risk	■	■	■	■	■	■	■
Risk-to-return ratio	■	■	■	■	■	■	■
Investment performance	■		■	■	■	■	■
Profit	■	■	■	■	■	■	■
Economic value/stability and development of value	■	□		■	■	■	
Corporate image and ranking	■	■	■	■	■	■	■

Table 4: Classifying financial stakeholders, Lützkendorf et al. 2011

Amongst sustainable building topics, methods, instruments and processes of sustainable property investment as one strand are identified (Lützkendorf et al. 2011):

- Investor behavior and attitudes;
- Sustainability and risk analysis;
- Sustainability and property valuation;

- Performance and measurement reporting;
- Principles strategies and guidance;
- Cost-benefit studies, transaction and market data analyses.

Financial stakeholders are connected to certain costs, which have a cost structure in construction. Figure 20 illustrates costs and processes.

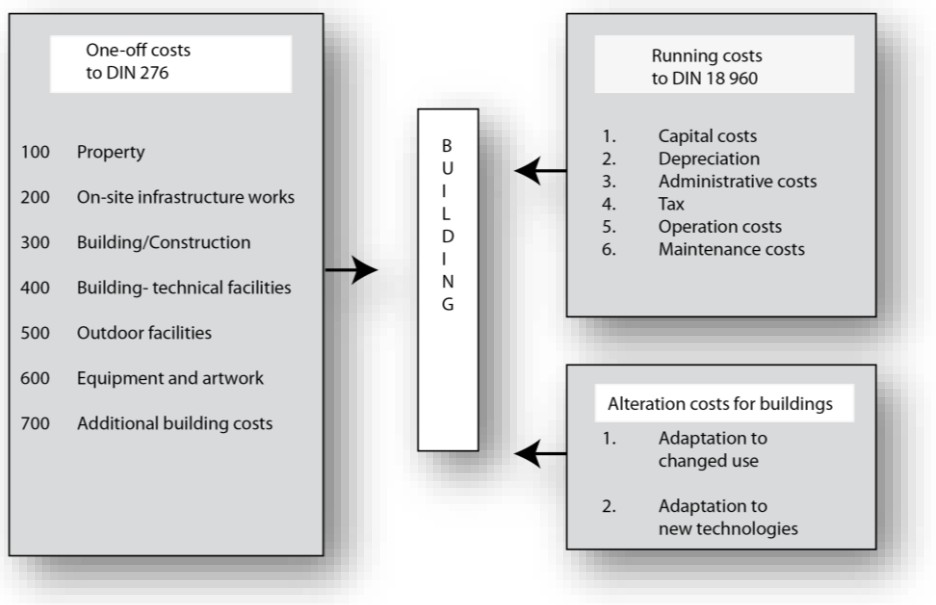

Figure 20: Integral construction cost policy , Pfnür 2011

Important for the understanding of the motivation of an investor is the portfolio perspective, due to the fact that the financial performance is the main target of investors (Meins 2010), which means return on investment (yield, net cash flow, change-in-value yield; etc.) and risk (volatility, sharp ratio, vacancy). A portfolio is stable if it gains a higher return at the same risk (Meins 2010). The interrelation of objects and risks are shown in Figure 21.

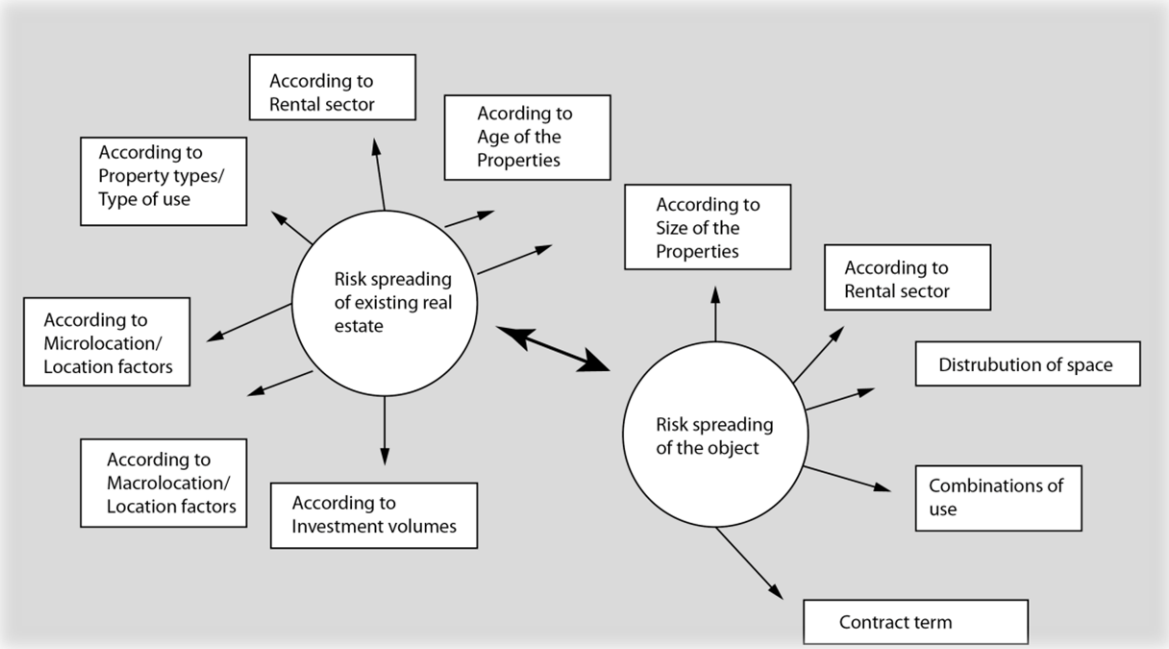

Figure 21: Risk and portfolio management, Meins 2010

Real estate and construction decisions have to implement risk awareness. These risk management incentives for real estate and construction are described in Table 5 by Meins (2010).

Context	Risk	Description
Material decisions	Supply chain risk	stable, affordable raw materials
	Environmental regulation	Restrict or ban of materials
	Consumer protection	
	Product safety	
Property valuation	Valuation uncertainty	Due to market trends
	Lack of transparency	
	Valuation lag	
Portfolio management	Total return	Combination of investment asset alternatives
	Net-cash-flow yield	
	Value change return	

Table 5: Risk management incentives, Meins 2010

Risks on object level are identified by Reimoser (2013) as first, early and clear investor and stakeholder decisions; second, the quality of architecture: location, flexibility, Zeitgeist and last, a simple process- and communication handling (Reimoser 2013). Next to the risk of investment and valuation, real estate development bears risks. Chances and risks of real estate development are a long production duration, a long use-phase, long capital lockup, high transaction cost, low substitutability, high investment cost and difficult convertibility into cash (Schwarz et al. 2013). These risks are listed in Table 6.

Motifs (Chances) and Risks of the project development
Motifs:
1. Association of real estate management activities in one hand
2. Lack of objects suitable for investment
3. Influence on rentability
4. Higher object quality
5. Lower total costs
6. Appropriate use of adequately covered use land
7. Improvement of the urban/regionally environmental conditions and heightening of the quality of life
8. Macroeconomical environmental promotion and economic development
9. Increase of the capacity utilisation in the building industry
External Risks:
1. Development risk
2. Subsoil risk
3. Permit risk
4. Financial Risk
Internal Risk
1. Geological risk
2. Quality-, cost- and deadline risk
3. Organisation risk

Table 6: Chances and risks of real estate development, Diederichs 1999

It can be stated that risks and chances are not quantified enough regarding sustainable development. An in-depth assessment on risks and chances cannot be done. This means that sustainable development is a rising challenge due to societal and political pressure, but still is lacking definition and implementation in real estate and construction. This general challenge can be made approachable for the context of real estate and construction. The challenge lies on corporate, portfolio, object and construction product level. The challenge affects the user and the investor. It can be addressed in material decisions, portfolio decisions, asset management decisions and portfolio decisions.

Corporate responsibility in the context of real estate and construction

Companies think of sustainable development as important for strategy building to reach efficiency, growth, advantages on the market and financial security. For example, the DJSI Dow Jones Sustainability Index is one of the most comprehensive and globally recognized indices that track US firms´ sustainability activities (Kurapatskie und Darnall 2013). Environmental issues and concerns related to climate change are attracting public attention in Europe (European Commission 2012). This development has resulted in increased interest in measuring, monitoring and communicating the environmental properties of goods. Resource efficient corporate processes do not only make sense due to regulative demands (VDI 4800-1). The complex challenge of responsibility in real estate and construction is described in comparison to industrial products. The product "building" is marked in comparison to many other industrial products through its complex formation process, its diversity of materials and its long use phase. The product "building" therefore cannot be assigned to a single responsibility. Designers and engineers have the potential to create products with a higher overall eco sustainability performance, but if not aligned with how the firm’s senior management thinking about profit and growth, they will not

get it through in the decision process (Willander 2013). Therefore, it is necessary to address the business model first in firms that want to make significant sustainability improvements (Willander 2013).

The capability model provides a structured approach to gradually build the capability of organizations to manage more complex problems using more complex processes. Rather than specifying specific sustainability measures, the framework builds the capacity of actors to make effective decisions based on their understanding of the local situation and according to their values and priorities. These boundaries of the LCM capability maturity model (Finkbeiner 2011) corresponds to the St. Gallen Management Model (Ruegg-Stürm 2002). Table 7 lists the life cycle management maturity according to Finkbeiner (2011).

Maturity level	Decision process	Boundaries	Metrics
Qualified	Visible team-based trade offs	Project	Binary yes-no compliance; process outputs
Efficient	Rule-based trade-offs to achieve company goals	Enterprise	Process inputs/ outputs; eco- efficiency
Effective	Fact-based trade-offs to balance value chain goals	Value chain	Cradle to grave integrated across value chain
Adaptive	Value-based trade-offs to co-develop company goals & public expectations	Society	Sustainability, resiliency

Table 7: LCM capability maturity model, Finkbeiner 2011

4.1.3. Material information in decision processes of real estate and construction

This part describes the process of generation and documentation of information in real estate and construction processes as well as life cycle thinking. According to the Brunsvician Lens, this chapter is part of step B, which describes the decomposition of the case.

A	B	C	D	E
Problem	Decomposition	Perceptor	Synthesis	New composition

Material information in real estate and construction decisions

For construction activity, materials are extracted, processed and incorporated, which are removed from the environment[16]. Whilst construction is first built and then operated, maybe refurbished several times and finally dismantled all based on substances contained in construction material in life cycle aspects. Schwarz (Schwarz et al. 2013) allows seeing real estate as production result with intermediate- and final investor. If a building is seen as the sum of construction products and construction processes, effects inducing sustainable development occur during the production processes of building products and the building as a product – and do have to be taken into consideration when discussing the impact on sustainable development. Figure 22 shows the sources of information amongst the building life cycle. Different stages incorporate different information. Sustainable development is influenced by the whole building life cycle. But real estate development in common informs its stakeholder by means of some construction process aspects and the use stage. End of life stage for example does not play a determining role yet, still, this stage has an impact on sustainable development.

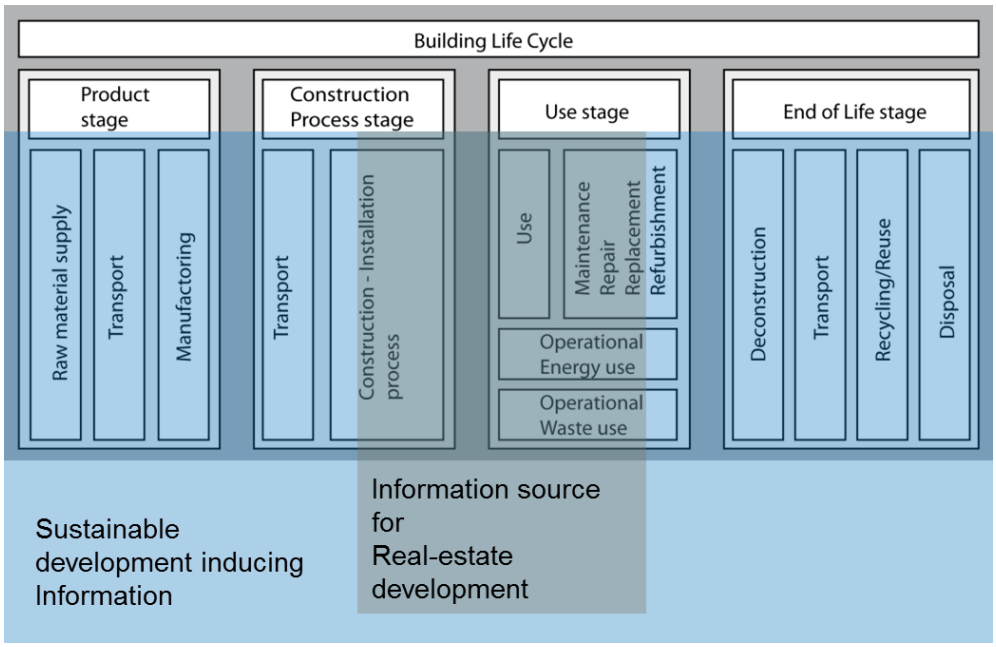

Figure 22: Building life cycle information sourcing.

Different levels of information in real estate and construction are coming from construction product, building and portfolio level. Development and management of real estate and construction within different project phases depend on cost calculations. These numbers are integrated in real estate development tools and decision support, which also do have effect on the marketing and investment strategic decisions. Technical qualities, pricing and further qualities on materials, constructions, and the building

[16] In Bavaria, there are 110 tons of construction products per inhabitant included in buildings. (Faulstich et al. 2006)

are the base of portfolio performance. The following tools can be mentioned as decision support tools for real estate development:

- The dynamic pre-investment analysis including investment valuation and stock valuation;
- An integrated stock-investment valuation;
- The resolution, which contains technical details, legal framing and budget calculation.

For the cost calculation in real estate development, inputs are pricing cost, capital cost, life cycle cost and technical cost. Technical costs are developed on information structured according to the series of standards DIN 276, a German series of standards for cost estimates of building processes. The building structure is able to orientate the types according to the series of standards DIN 276On international level, this standard is represented by the CEEC Code of Measurement for Cost Planning (CEEC 2008). For decision support reasons, costs are structured according to this standard, which creates the conditions for the comparability of the results of cost calculations on the basis of the results of planning. The series of standards DIN 276 respectively CEEC Code of Measurement for Cost Planning can be identified as a connection amongst building process steps, cost information and description of qualities of materials and constructions.

For eco-informed material choice, the work of Ashby (2013) is applied mainly in mechanics, but enlarging the field of application. Ashby plots are preparing diverse information, and used for material choice in mechanical engineering, but for construction only applied in science. Information on material is incorporated in building material. LCA describes the environmental relevant information. The construction elements cannot directly be separated into the origin material. Separability is a very important point. Material relevant information is based on the cost calculation, which means one group (KG 300), which bears mainly masses and another group (KG 400) which bears information on follow-up costs (energy consumption, durability, lifetime). This material relevant information goes, based on the cost planning, from the investment decision on to the planning, budget allocation, tendering, pricing, construction phase onto the warranty phase, and finally results in construction quality and building culture. Finally, this interdependency is shaping the corporate profile. Finally, as supporting structure in Europe, CEEC Measurement for cost planning can be identified (for Germany KG 300/KG 400). If this understanding is linked to the different phases of real estate production, the dependency on the cost calculation is visible.

The assessment of the origin of materials and services is regulated in EN 16309. Certificates of origins of materials, levels of safety of workers whilst material extraction are demanded, as well as a docu-

mented product implementation and quality management systems. European construction products regulation (BauPVO 2012) defines to make demolition, recycling and reuse easy to access. As example to access material information, any documentation on real estate and construction can be structured along the following levels of information integration suggested by EN 15978, using building level, element level and component level, as illustrated in Figure 23.

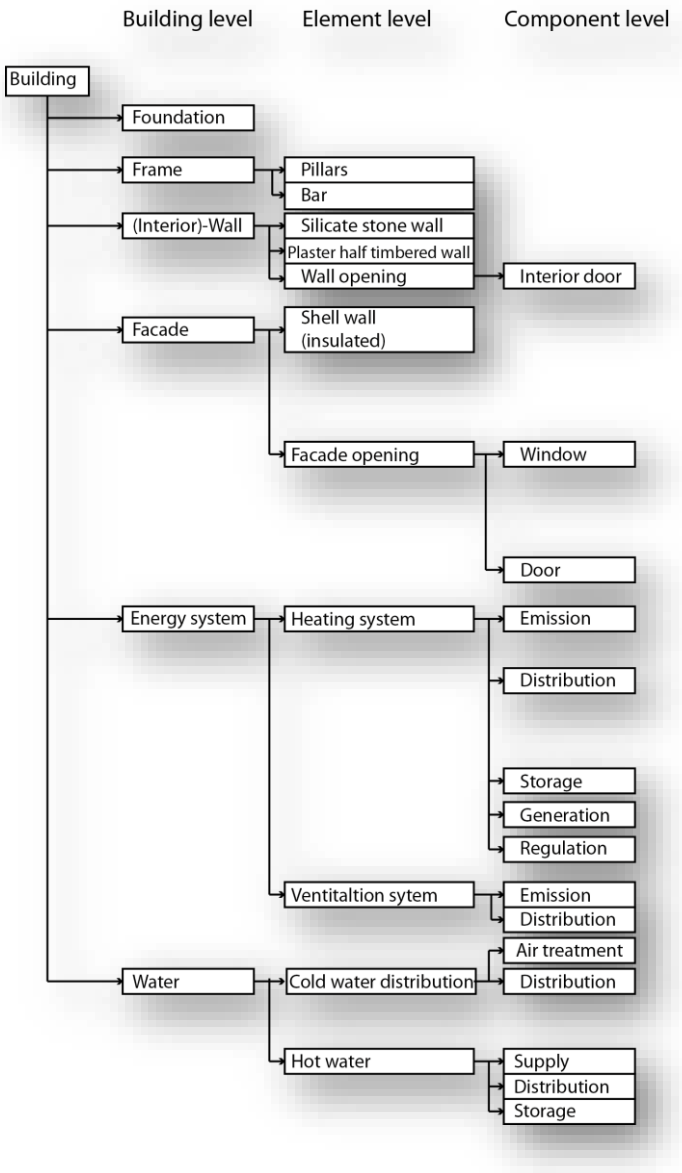

Figure 23: Environmental building information and levels, EN 15978

Building level, element level and component level are illustrated in Figure 23 (for Germany, foundation, frame, wall and façade are defined in KG 300. Energy systems and water are part of KG 400. In Germany, information on processes on time and qualities meets cost information in an object based model. DIN 276 is device-oriented, structures the costs and serves as cost information for the investor. The planning phases and construction processes give a structure. Qualities are described and communicated

in Germany according to VOB. The material information is included in the construction elements. The production and manufacturing process is addressed in VOB/C (Germany). Furthermore, the construction elements are defined by several planners and planning disciplines.

Furthermore, information is coming from devices and processes. Still, real estate economics and investment calculation are not used to handle device-oriented information (according to e.g. the series of standards DIN 276). This means that at the moment, there is a lack of material information when real estate economics is applied. Figure 24 shows, how information on the same item (building, construction element, construction product, construction material) is integrated from the different structural or processes as approach, which provide material information. This information management requires a model-based view to integrate process information and device-oriented material information.

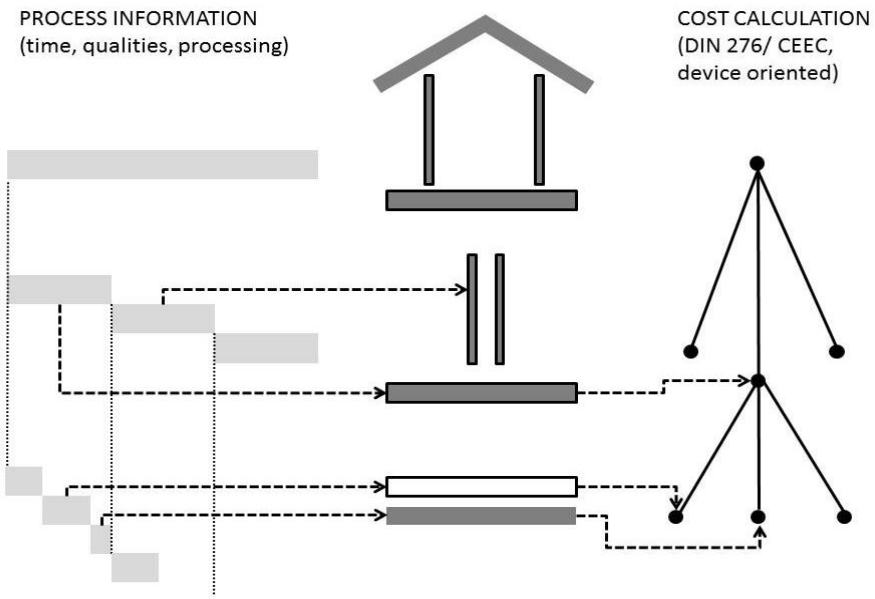

Figure 24: Object model in a hierarchical structure

Information is transferred along the project steps. A material passport can support the material information transfer amongst the different project steps of real estate and construction. Figure 25 illustrates the information transfer amongst different phases or project steps. Taking into account phases and tasks of real estate and construction (see Table 3), it can be stated that end-of-life options can be seen as subject of the early decision phase. A material passport can appreciate of this thinking. This was elaborated in the study STOFFPASS (Ott and Hausmann 2015). A material passport aims to support the information management amongst the construction processes. It aims at environmental effectiveness and environmental relief by efficient material use and focused management of material flows. This is shown by a material documentation and described by the material relevant performance of resources. A

material passport as a tool of analysis allows to reach and therein influence environmental relevant material features and construction characteristics. On building level, existing real estate processes concerning investor habits and construction activity are applied. Existing controlling instruments and performance tools (e.g. tendering, cost processes, certification and environmental information carrier) are linked and combined in a quantitative way (which materials are used, where are the data) and qualitative way (of which importance is which information). In short, the material passport assesses the information exchange amongst different decision-makers in the conceptual phase, the planned material and construction choice and hereby management.

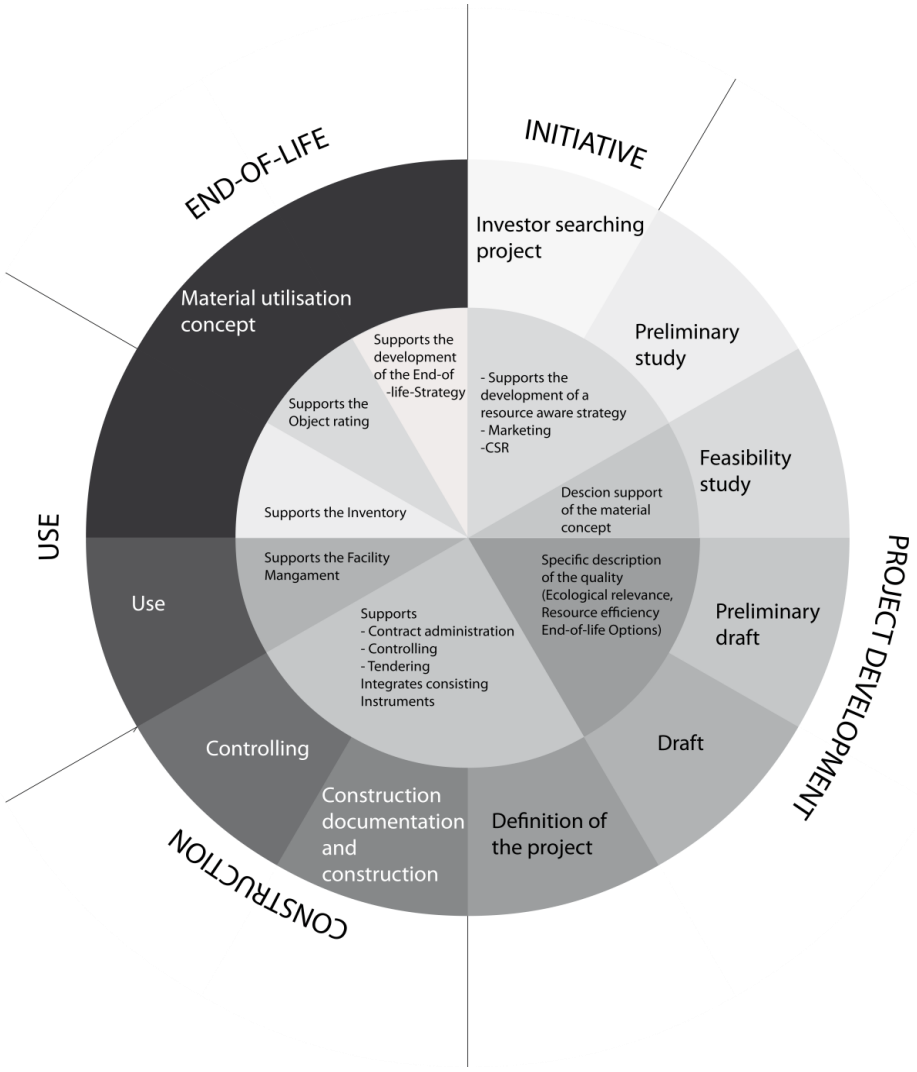

Figure 25: Information transfer amongst project phases

Life cycle information, real estate and construction

Life cycle costs present the sum of all costs generated by a building from its development to the demolition (SIA 112/1). Often, higher investment costs in the early project phase generate lower operating costs. The operating costs often reach along the life cycle a higher amount than the investment costs

(SIA 112/1). Low operating costs should be a target. In the sense of sustainable development, the construction and operating costs should be aimed at, which guarantee the financing of property until to the dismantling. This means also that investments can be amortized over their lifetime that in the end, means are available to replace the building (SIA 112/1). For the choice of quality and service life of the construction parts, the service lifetime should be taken as reference for decision-making. A simple way to replace construction elements supports low costs (SIA 112/1). The user habits can be influenced in a positive sense, but only predicted in a limited way. This is also valid for disposal behaviors and therefore recycling options. Beyond that, future recycling technologies will need information transfer on materials on construction.

Sources of information are environmental product declarations (EPDs). EPD use life cycle assessment (LCA) as a method to investigate the environmental performance of products and technical systems. LCA is a well-established assessment methodology in the building and construction sector. Life cycle assessment (LCA or life cycle analysis) is a technique used to access environmental impacts of a product at different stages of its life. This technique takes a “cradle-to-grave” approach and looks at environmental impacts that occur throughout the lifetime of a product from raw material extraction, manufacturing and processing, distribution, use, repair and maintenance, disposal and recycling.

LCA already serves to assess buildings and construction products in building certification systems and for environmental product Categories. LCA based EPD increasingly become a default communication format for construction product manufacturers, e.g. based on EN 15804. In sustainable building certification schemes, particularly in those of the DGNB and organizations across Europe, LCA of buildings is well established as default mechanism. In both areas – product LCA for EPDs and building LCA for certification – the method has matured from research into daily application and planners increasingly use LCA for decision support during the planning process. As some problematic issues whilst creating LCA models of existing buildings, major uncertainties that influence have been found:

- Service life (moral and technical) of building and particular parts;
- Change of building use;
- Social and urban changes;
- Technological progress in transport methods, construction processes, ways of disposal, recycling etc.;
- Legal changes;
- Insufficient data on environmental performance of materials and building components.

Also, calculation rules seem to bring up difficulties for decision-support. The major challenges are addressed and set in the overall European context (Finkbeiner 2011):

- Inconsistency of legislative guidelines and standards[17];
- Inconsistency in LCA approach for labelling schemes: Building labelling schemes use their own individual sets of calculation rules for building LCA;
- Reference service life: besides basic principles, data about average service lives and laboratory findings regarding repair, refurbishment and maintenance of construction products are so far very rare.

But still, LCAs are mostly used for documenting the consequences of already established choices and decisions or completed construction projects, and are to a lesser extent used as a planning tool for simulation of consequences of different choices in various phases of the construction process or though the lifetime of a building (Finkbeiner 2011). There has been steady progress in advancing life cycle assessment methods. However, application of LCA in business decision-making has lagged.

Life cycle Management (LCM) is a business approach to manage the total life cycle of products and services. It follows the life cycle thinking that businesses, through the activities they must perform, have environmental, social and economic impacts. LCM is used to understand and analyze life cycle stages of products and services of a business, identify potential economic, social or environmental risks and opportunities at each stage and create ways to act upon those opportunities and reduce potential risks.

Life cycle Costing (LCC) (or life cycle cost analysis) is the total cost analysis of a process or system. This includes costs incurred over the life of the system and is frequently used to find most cost-effective means for providing goods and services. The concept of LCC life cycle costing as cost management method aims to gather and optimize all incidental costs during the whole lifetime of e.g. constructions (Engelhardt 2015).

Excursus III: LCC Life cycle cost analysis. A life cycle cost (LCC) analysis calculates the cost of a system or product over its entire life span. The LCC is the sum of investment cost and the annual operating cost discounted over the lifetime of the product. LCC is calculated by the following equation:

$$LCC = PC + \sum_{1}^{N} \frac{OC_t}{(1-r)^t}$$

investment cost (PC), annual operating cost (OC)

[17] The different available standards (e.g. ISO 14040, ISO 14044, EN 15804, EN 15978) differ from each other regarding Life Cycle Impact Assessment (LCIA) and other LCA related methodological aspects.

LCC is defined as a technique, which enables comparative cost assessments to be made over a specified period of time, taking into account all relevant economic factors, both in terms of initial costs and future operational costs (ISO 15686-5). It is important to notice that traditional LCC is purely economical and does not take into account environmental aspects. LCC in a narrow sense is described without revenue. Still, taxation problems are not assessed properly.

Life cycle-cost analysis means that not only production/achievement costs influence the investment decision. In fact, costs resulting from operation and liquidation have to be considered. Here, the life cycle-cost calculation steps further than the investment calculation (Engelhardt 2015) (EN 60300-3-3). It is of fundamental importance for life cycle philosophy to understand the life cycle of a system respectively the construction work (Engelhardt 2015). Still, on international level, life cycle cost is not understood in a homogenous way. In Canada and Great Britain for example, LCC stands for the whole costs on construction part level. The life cycle costs (as understood in Germany) are defined as Whole Life Costs (WLC) (Engelhardt 2015). According to ISO 15686-5, WLC also compromise external costs and revenues. This understanding is illustrated in Figure 26.

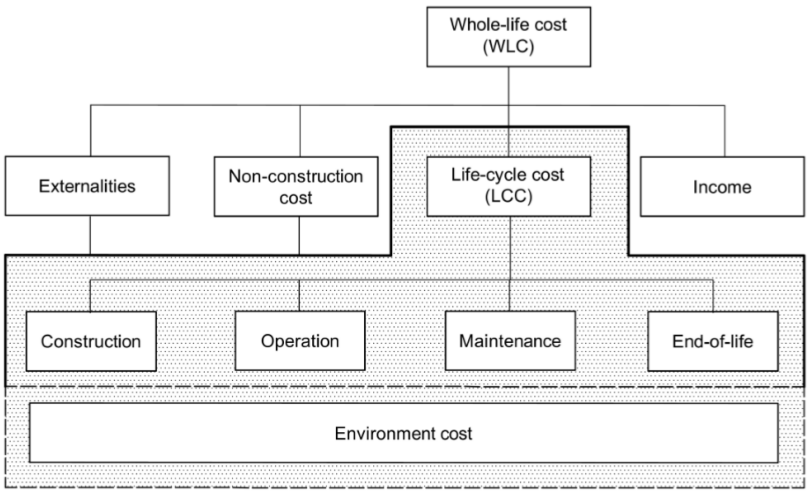

Figure 26: LCC and WLC, ISO 15686-5

In the real estate and construction context, different approaches address the term life cycle. This is on the one hand a facility management optimized approach. Furthermore, business management sees real estate as a product of a real estate company. So, life cycle has an impact on construction as a consumer product, as construction should be planned about the technical state of art but also in to the life cycle (SIA 112/1). The building life cycle starts with the acquisition of raw materials. It proceeds through the manufacture of products, construction work processes, actual use including maintenance, refurbishment and operation of the building, and finally at the end-of-life, deconstruction or demolition, waste processing in preparation for reuse, recycling and energy recovery and other recovery operations, and disposal of construction materials. Information from these activities is needed to assess the impacts and

aspects of the building (EN 15643-2). Impacts and aspects specific to the building fabric during the building life cycle shall meet the requirements of EN 15978 and shall be taken from the relevant modules of information such as Type III environmental product declarations and other relevant sources that comply with requirements of EN 15804.

Figure 27 shows the impact of information on decisions along the life cycle of buildings:

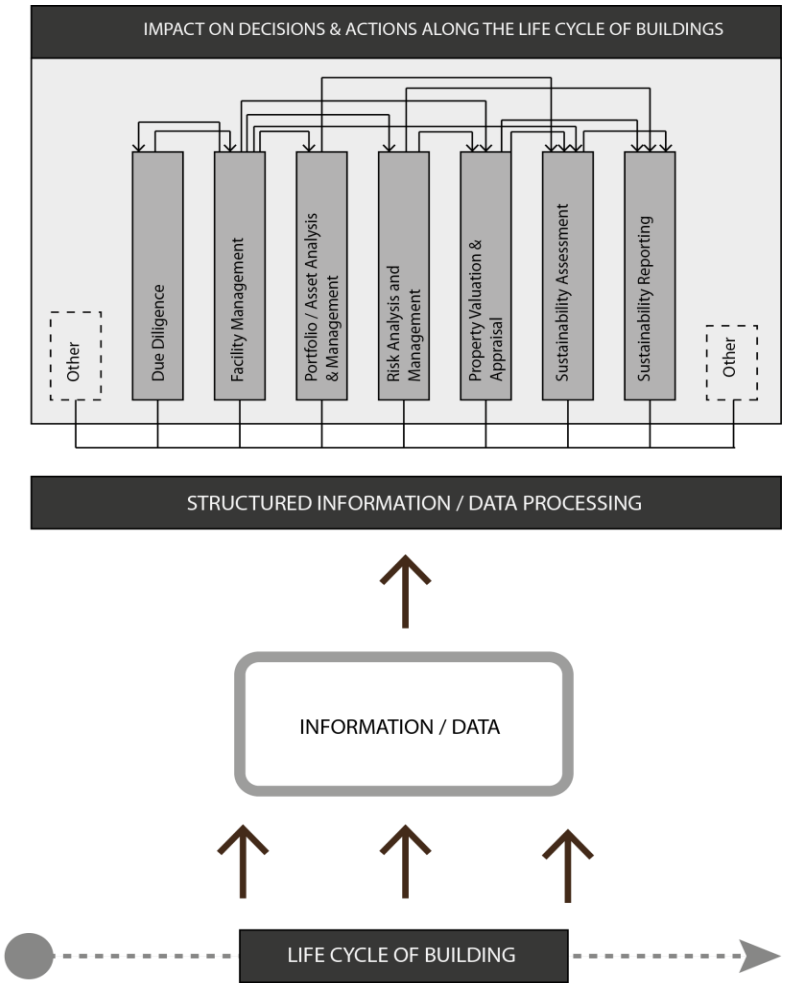

Figure 27: Building life cycle information to management decisions

The life cycle costs of sustainability certificates do not show the real life cycle costs. They only serve the comparison purpose of buildings. This is due to a lacking of standardization and a different view on costs (Reimoser 2013).

Willander finds business models as responsible for linking material flows to effects on sustainable development (Willander 2013). Construction and demolition wastes have increasingly serious problems in environmental, social, and economic realms. There is no coherent framework for utilization of these

wastes, which are disposed both legally and illegally (Marzouk 2014). Wang et al. (2014) identified six critical factors, which can influence effective construction waste minimization:

- Large-panel metal formworks;
- Prefabricated components;
- Fewer design modifications;
- Modular design;
- Waste reduction investment and economic incentive.
- Increasing scarceness of primary raw materials leads to a heightened focus on secondary materials. The excursus below introduces this topic.

Excursus IV VDI Resource efficiency. Recently, Verein Deutscher Ingenieure (VDI) has dedicated it´s work in "VDI Ressourceneffizienz" to basic support for the further development on concepts aiming at resource efficiency. Coming from the engineering side, VDI resource efficiency is important, as mostly resource questions are discussed amongst environmental scientific groups. Beyond that, resource questions are answered in the engineering and construction business by energy saving and pricing mainly. VDI as an important stakeholder for regulations is therefore an interesting part of the discussion. For the assessment of resource efficiency, it is key to determine the purpose of a product or service. This purpose is defined as the function of the product or service. This function has to be quantified in a physical way. The function has to be specified to determine the functional unit, and set into reference according to the LCA standard ISO 14044. Furthermore, the system boundary of the product system or organizational system has to be drawn, depending on the goal and scope of the assessment (Ploetz et al. 2009).

Excursus V Recycling. Recycling is defined according to EN 15643-1 as any recovery operation by which waste materials are re-processed into products, materials or substances whether for the original or other purposes. Recycling operations include:

- Recycling of organic substances which are not used as solvents (including composting and other biological transformation processes);
- Recycling of metals and metal compounds; and
- Recycling of other inorganic materials.

Arguments are, the potential savings in terms of energy and capital have long been obvious. The savings in terms of reduced environmental impact are less obvious but increasingly important. The obstacle to greater use recycling has been the fact that economies of scale still favor large primary mining and smelting complexes over necessarily smaller and less centralized recyclers. However, this advantage is declining over time as the inventory of potentially recyclable metals in industrialized society grows to the point that efficient collection

and logistic systems and efficient markets, justify significant investments in recycling. Increasing energy and other resource costs, together with increasing costs of waste treatment and disposal, will favor this shift in any case. However, government policies, driven by unemployment and environmental concerns, taken together, can accelerate the shift by gradually reducing taxes on labor and increasing taxes on extractive resource use (Ayres 1997).

Excursus VI Cascade use. Deposits from urban infrastructure, mainly the building stock, are a potential major source of secondary resources (Höglmeier et al. 2015). The study found that, considerable amounts of recovered wood is in suitable condition for a resource-efficient use in cascades can be expected to originate from the building stock (Höglmeier et al. 2015). Resource cascading is a method to enhance the efficiency of resource utilization by a sequential re-utilization of the same unit of a resource for multiple high-grade material applications followed by a final use for energy generation (Sirking and ten Houten 1994). Thereby, primary raw materials are saved and positive effects due to the substitution of finite materials by renewable resources can be increased (Gustavsson and Sarthre 2011).

Excursus VII Cradle to cradle (C2C). "The Cradle to Cradle (C2C) theory has set ground in the Netherlands, presenting a new 'eco-effective' theory inspired by the systems of nature. It propounds that environmental impact reduction can provide a positive economical impulse to stakeholders, in contrast to current sustainable approaches, which are considered costly investments and limiting prosperity. C2C has already been practiced internationally in industrial process design and building related projects for companies such as Herman Miller, Ford, Philips, Nike and the Republic of China. Similarly, the Dutch building industry warmly received this approach, and considers it as a solution to the problems discussed above. At the time that C2C slowly settled in the Netherlands, it got several professionals and scholars from the field of sustainability. The main comment was that this new theory was not something new. It argues, for instance, that several decades ago, at least five concepts for sustainable design were already developed and that, according to him, C2C is the most poorly detailed one of them. Furthermore, the building industry is struggling to put this theory into practice. Some municipalities and regions enthusiastically took up the challenge of implementing C2C as basis for their plans. However, after stating their intentions concerning Eco effectiveness and arranging these intentions in project principles, the municipality and region's agencies had difficulties adopting them in practice. This suggests that it is difficult to grasp C2C." Van Dijk et al. (2014) state, "recently, the C2C theory set ground in the Netherlands, propounding that environmental impact reduction can provide a positive economical impulse to stakeholders. The building industry has warmly received this approach. It sees this as a solution to the above-mentioned burden. However, if the building sector wants to implement C2C into their practice, a paradigm shift is required.

Therefore, the sector must overcome the many difficulties it encounters while striving for an eco-effective built environment. Current sustainability strategies focus on reducing the negative environmental impact of buildings. The systems theory of C2C however aims at a positive impact; this could suggest that the state-of-the-art becomes inadequate when adopting C2C as a strategy for improvement." (Van Dijk et al. 2014) review contemporary systems theories and analyze them in the light of cradle to cradle, focusing on closed or continuous materials cycles. The paper finalizes by describing the "hiatus in and correspondence between these current theories and C2C theory". They found that "C2C provides new features that help continue materials, energy and water cycles, just as the contemporary theories provide potentially useful additional material for C2C. Moreover, it reveals a striking difference between the state-of-the-art and C2C." (Van Dijk et al. 2014) propose as an approach of thinking on materials, a hierarchy– (1) prevention, (2) re-use, (3) recycling, (4) incineration (for energy production and waste condensation) and (5) disposal (through landfill) – should preferably contain only steps (1), (2) and (3) and discard the remaining two – end-of-pipe – solutions. This asks for an approach in which waste does not exist, and in which flows of, for instance, materials stay in a continuous system: in continuous materials cycles." (Van Dijk et al. 2014).

ISO 15686-5 identifies as whole life cost non- construction cost, life cycle cost (LCC), income and externalities. LCC is structured within construction, maintenance, operation, occupancy and end-of-life. ISO 15686-2 describes procedures that facilitate service life predictions of building components. It provides a general framework, procedures and requirements for conducting and reporting such studies. It can also be used as a checklist for the assessment of the completed service life. Estimating the future cost of constructing, operating and maintaining the building gives clients advance notice of the costs of ownership, and Life cycle assessment (LCA or life cycle analysis) is a technique used to access environmental impacts of a product at different stages of its life. This technique takes a "cradle-to-grave" approach and looks at environmental impacts that occur throughout the lifetime of a product from raw material extraction, manufacturing and processing, distribution, use, repair and maintenance, disposal and recycling.

In real estate economic thinking, it is important to understand the meaning of *total useful lifetime*, which is the choice between the physical lifetime and the economic lifetime. In the real estate and construction context, life cycle costs are often measured according to facility management parameters (repair, maintenance, cleaning, operation), dismantling and new building. This has to be regarded to determine and predict cash flows. The question arises, which kind of information and which quality of information is suitable to handle future challenges on the choice of service lives, end-of-life options, material information, construction quality and economic success. The different choices of timeframes do have impact on different cost amounts, which is illustrated in figure 28.

Timeframes according to life cycle orientated frameworks are (Reimoser 2013):

- Technical service life of materials and plants;
- Functional lifetime/ service lifetime;
- Tendering contract (e.g. 10 years);
- Further contracts (e.g. 30 years);
- Sustainability certification (e.g. 50 years);
- Demanded amortization time (e.g. 41 years).

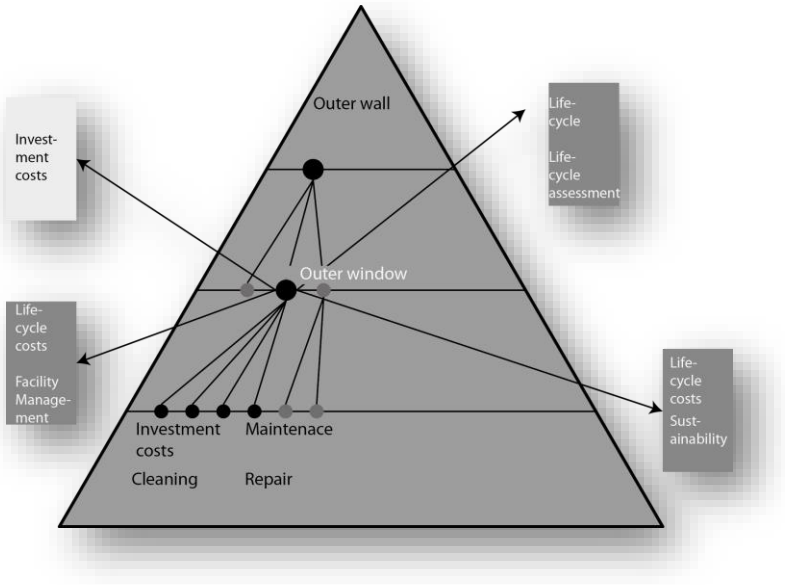

Figure 28: Modelling life cycle costs, Reimoser 2013

Summary of chapter 4.1:

This chapter describes the generation and documentation of information generated in real estate and construction decision-making in the context of material selection. The main postulates are:

- Deconstruction and recovery, in particular efficient recycling, are not yet considered in mainstream management approaches for material information;
- Real estate decision phases can be linked to construction decision processes;
- Economic, environmental and social impacts from the corporate environment and stakeholders on corporate structures and processes can be addressed via the St. Gallen Management model;
- Life cycle thinking of environmental scientific approaches and life cycle thinking in real estate and construction can be linked;

- A building related material passport can support material information for management decision-making along the construction life cycle;
- A model-based view can link process information and product/device-oriented information.

4.2. Demands of sustainable development in the real estate and construction context

In this chapter, sustainable development as societal goal is described in more detail. On the one hand, this part identifies sustainable development as a decision-guiding regulative idea. On the other hand, production and consumerism are identified as determinants for sustainable development. The real estate development, investment and contractor are identified as key players as regards the potential contribution of real estate and construction to sustainable development. Beyond that, standards in the context sustainable construction are assessed in the light of sustainable development. Last, gaps and overlaps of sustainable construction and sustainable development are identified.

4.2.1. Approach to the trifold dimension of sustainable development

Sustainable development stands as a societal target, which cannot be ignored any longer. This part explains sustainable development as regulative idea from the perspective of business ethics. The trifold demands of sustainable development are broken down to real estate, construction and its stakeholders. This serves to link the conceptual level of sustainable development to the operational level of real estate and construction processes.

The demands of sustainable development as a societal target

According to the Brunsvician Lens, this chapter is part of step B, and describes the decomposition of the case.

A	B	C	D	E
Problem	Decomposition	Perceptor	Synthesis	New composition

The concept of sustainable development has made an amazing career and has become one of the fundamental safeguards of national and international policies. In principle, sustainable development means to lower resource consumption and at the same time maintain economic capability and the social cohesion on an accepted permanent level. In the practical implementation, a significant demand still exists in many areas (Hafner 2012). Various surveys have shown that the willingness to act sustainably is quite

high in the population. However, behavior in the practice differs significantly from the expressed preferences (Wallbaum and Buerkin 2003, Hafner 2012). Schlör et al. (2014) lists the common known influences on the concept sustainable development and it's upcoming into strategy development. Scholz and Tietje (2002) discuss sustainable development as a regulative idea, which implies decision situations with multiple and thus unclear targets – as ill-defined problems (Werner and Scholz 2002), which are typical for decision problems in the context of sustainable development. The basic structure of ill-defined problems consists of the initial state that can be described, of a target state that is insufficiently known. Furthermore, it consists of a problem solving strategy by identifying and passing barriers by applying old and newly developed methods. The target state can even change over time, as scientific progress and changes in public values require re-evaluation of the current state, the assumed target state, and of the methods applied for problem solving. It can even seem appropriate to talk about an insufficiently known changing target state or just of target direction. The assumed target state in its current understanding is a temporary, normative concept (Werner and Scholz 2002). Sustainable development reflects an environmental and socioeconomic frontier of modern times. However, the ideal of lowliness or sufficiency economy do not bear viable alternatives. The ethical-political guideline of sustainable development is a new definition of prerequisites, limits and borders of progress. Instead of a constant increase of goods, Diefenbacher (2001) finds the security of environmental, social and economic stability of human habitat as central reference value of societal development and political planning activities. In addition, Blazejczak and Edler (2004) see the orientation towards sustainable development as defining quality of life away from individual welfare towards a societal context (Blazejczak and Edler 2004). Only light- resource welfare is able for justice: sustainable development does not only stand for resource efficiency, but beyond that for a new cultural orientation (Diefenbacher 2001). The leading target of material circles and time rhythm of nature-embedded development replace the philosophy of infinite growth (Diefenbacher 2001).

The EU chose sustainable development for policy development. To respond to the actual key policy challenges, recommendations of the European Commission (2014) are focusing on:

- Create growth and jobs;
- Provide incentives to overcome barriers to improving resource efficiency;
- Put a proper value on resources;
- Provide clear information and measure progress;
- Promote new business models.

Excursus VIII Weak and strong sustainability. The sustainability concept has been refined since its general definition by Brundtland in the late eighties. Currently, two distinct degrees of sustainability are used and under debate, namely the weak and the strong sustainability (Frischknecht 2010):

- Weak sustainability: total capital shall remain constant; natural capital stocks can be diminished as long as it is compensated by gains in the man-made stock (substitutability concept);
- Strong sustainability: natural capital shall be kept constant, independent of man-made capital (non-substitutability concept).

In addition to the political level, the concept sustainable development even has increased attention of companies, because the public ascribes to them responsibility for solving these problems (Bieker 2005). So, why does a company feel responsible and for what purpose? Economic literature and literature on ethics[18] provide an answer. In addition, economy recognizes that non-monetary gains are more sustainable than the balance sheet value, and accepts that transparency and responsibility towards stakeholders are always part of the core business (Busse 2012). In the context of business ethics, Ulrich states that in neoclassic mainstream economics, the strict efficiency thinking is present as professional credo in theory and practice. Consequently, efficiency is introduced as criterion of normative order without any reflexion on other values for action or institutional structures (Ulrich 2004).

Still focusing on efficiency as the sole decision criterion causes problems, as not everything considered as economically rational is practical. An economic activity finds itself in the context of basic ethical questions of sense and legitimation of economic action. Economic ethics includes not only the teleological-ethical dimension (sense) but also the deontological-ethical approach (justice) (Ulrich 2004). The two dimensions "serving a good life" and creating "fair values" are illustrated in Figure 29. The theory of Ulrich talks on values. This means the duty to reflect, which values, which question of sense and legitimation are followed to serve a good or fair life.

[18] "If a move away from the strictly quantitative growth-oriented decision-making culture would be considered, the existing rules of the market would have to be questioned. (…) The definition of these tasks would be part of an ethical discussion (…) To enforce sustainable development, all social actors have to be able to identify opportunities for the development of own and community welfare" (Busse 2012)

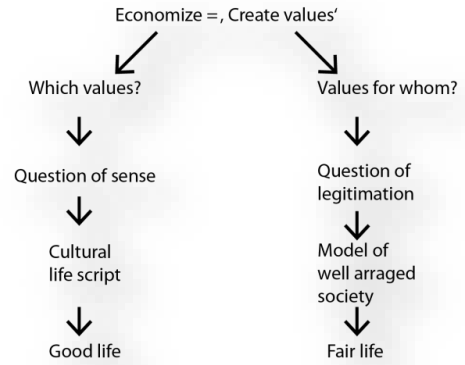

Figure 29: Two dimensions of economic ethics, Ulrich 2004

Vogt (2004) states that sustainable development as a principle represents a contemporary and necessary complement to the three classical social principles personality, solidarity and subsidiarity. In this explanation, sustainable development as a principle refers to the dignity and responsibility of a human being as person. This approach relates to the transcendental philosophic approach of Kant´s ethic, as it puts the human being as person and responsibility bearing in the middle of ethical-political conception (Vogt 2004). The three issues of economic sense (Ulrich 2004) illustrate this decision-context. Efficiency questions confront decisions on sense and fairness of economic activity. Figure 30 shows the understanding in a simple scheme.

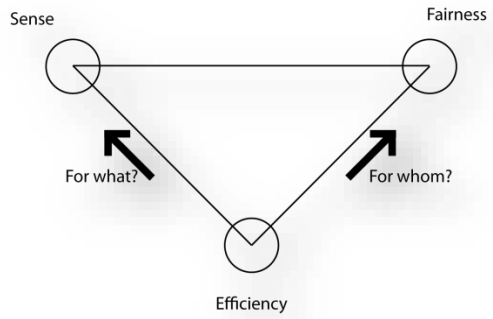

Figure 30: Issues of economic sense, Ulrich 2004

In the following, ethic demands are brought up to link the concept of sustainable development to an economic business case, as is the real estate and construction context. "Economic ethics is an interdisciplinary approach, which reflects the economic value creation persistently due to its reasonableness in the context of peoples´ lives. Today´s mainstream economics thus reflects an economic activity only out of the system logic of a market. According to Ulrich (2004), the neo-liberal logic of the global market, on which the governmental frameworks of national markets compete with each other, leads to the fact that international competitiveness counts most (meaning economic efficiency) and no longer the criterion of serving a good life. Consequently, the primacy of ethics over market logics is being reversed (Ulrich 2004).

Most of the existing evidence in literature on demands of sustainable development originates from studies on business economics. These studies are mostly working with quantitative data, e.g. Forsman (2013). Property and investment literature dealing with "sustainability" often condensates debated theories and reviews existing approaches (Lützkendorf et al. 2011). Several studies focus on different responsibilities of the decision-maker as institution and finally as individual.

The following compiles the findings of different authors from construction science, economics, and environmental science, which stress the personal or institutional responsibility for effects of sustainable development. Table 8 presents derived criteria to develop framework categories regarding responsibility.

Responsibility	**Stakeholder**	**Author**
Corporate as public institutions act in a public way	Companies	Ulrich (2004) Bieker (2005)
Accept that transparency and responsibility towards stakeholders are always part of the core business	Economic actions	Busse (2012)
Long-term economic success requires stable relationships	Individuals, companies	Belz 2007
Ability to identify opportunities for the development of own and community welfare;	All social actors	Busse (2012)
Initial decisions in the building process bear specific responsibility	Initial building process phase	Hafner (2012), Weber-Blaschke and Faulstich (2005), Lasvaux et al (2014)
Inducing sustainable development happens via processes and decisions	Real estate development, investor/ building owner	Hafner (2012), Weber-Blaschke and Faulstich (2005)
High responsibility on follow-up effects of initial decisions	Real estate development decision-making	Hafner (2012), Weber-Blaschke and Faulstich (2005)
Effects on sustainable development induced by construction	Real estate development, investor, owner	Hafner (2012), Weber-Blaschke and Faulstich (2005)
Any responsibilities concerning real estate as a product	property owners, investors, many stakeholders	Weber-Blaschke (2005)
Long-term consequences	Real estate development/ initial decision	Lasvaux (2014)
Non-sustainable consumption patterns as key point to sustainable development	Consumers/ investors	Belz (2007)
Principle of Kantian ethics, sustainable development complement of classical social principles	Individualist	Vogt (1999)
Reflection of economic values due to the sensibility in regard to human life	Business ethics	Ulrich (2004)
Sustainable development as ethical-political concept	Decision-maker	Vogt (1999)
Steady economic growth with business opportunities across the whole economy	Use and recovery of resources in the economy	European Commission (2012)
Ethics step beyond economy	Global market	Ulrich (2004)

Responsibility	Stakeholder	Author
Economic rationalization is about to destroy human rationality	Society	Ulrich (2004)
Secure environmental, social and economic stability of society	Politics	Diefenbacher (2001)
Future jobs and competitiveness, as a major importer of resources, are dependent on our ability to get more added value, and achieve overall decoupling and a systemic change	Recovery of resources in the economy	European Commission (2011)
Material flows and time rhythms have to be considered.	Corporates, politics	Diefenbacher (2001), Vogt et al. (2009)
Index of Sustainable Economic Welfare measures welfare not with gross domestic product but on criteria of sustainable development.	Corporates, politics	Diefenbacher, (2001)
Companies make decisions that affect people and the environment, directly through their own operations or indirectly through their value chain.	Companies 'operations, value chains	Mastoris et al. (2013)
In a world with growing pressures on resources and the environment, the EU has no choice but to go for the transition to a resource-efficient and ultimately regenerative circular economy.	Transition to a resource-efficient circular economy	European Commission (2011)
Our future jobs and competitiveness, as a major importer of resources, are dependent on our ability to get more added value, and achieve overall decoupling, through a systemic change in the use and recovery of resources in the economy. According to the OECD, this could lead to steady economic growth with business opportunities across the whole economy.	Future jobs and business opportunities	European Commission (2011)
Since the knowledge of direct and indirect consequences of human action continuously increases, are to act responsibly by people (as consumers, citizens or employees) and enterprises to provide comprehensive ethical and moral requirements. "Implementing resource questions and social demand in management decisions has extensive consequences on society as well as on the company.	Consumers, individuals	Belz 2007
Provide attractive locations for regional production	Politics	Blazejczak und Edler (2004).
We are in a period of economic transition. The "cowboy economy" of the past is obsolescent if not obsolete. Environmental services are no longer free goods, and this fact is driving major changes	Environmental services are no free goods	(Ayres 1997)

Table 8: Criteria to develop categories – responsibility, compilation

Economic imperative (improve competitiveness), social imperative (safeguard cohesion), environmental imperative (limit throughput) and institutional imperative (strengthen participation) take responsibility as main topic.

Within the discussion on sustainable development, a discussion on societal goals and reasonable indicators and target values arose. Sustainable development stands as new definition of prerequisites, limits and targets of progress. The concept sustainable development as regulative idea aims at the global preservation of natural resources, social justice and economic freedom for our and the following generations.

In the context sustainable development, the environmental and climate change discussion, biodiversity, water, emissions and immissions, gender, human rights, are discussed. As summary of Table 8, the following categories are considered responsible for the induction of sustainable development:

- Individual responsibility;
- Corporate/ institutional responsibility;
- Initial decision phases and strategy development;
- Create jobs;
- Create business opportunities;
- Provide attractive conditions for production;
- Preservation of utility of resources and recovery of resources;
- Sustainable development goes beyond environmental protection;
- Reasonable indication is more reasonable than efficiency;
- Create values in correlation to human living;
- Need of transparency;
- Own and community welfare opportunities.

These points are widely known, but not yet fully implemented in real estate development, real estate management and construction. As one reason can be mentioned that sustainable development is a decision problem. To pursue this thought, Table 9 compiles the main issues and corresponding authors from philosophy, environmental science, business ethics and engineering that have worked out sustainable development as a decision problem.

Sustainable development in its trifold dimension is a multi-dimensional decision problem. The integration of the postulated trifold demands of sustainable development is a challenge, which has given rise to a broad array of literature from, for instance, business management, philosophy and engineering literature.

The trifold demands have to be linked and integrated to become operational in the decision context of sustainable development. This holds also for real estate and construction as well as construction processes and construction management.

Sustainable development as problem	Author
Sustainable development as regulative idea	Scholz and Tietje (2002)
Problem of interactions	Vogt (2004)
Type of decision situations with unclear targets	Scholz and Tietje (2002)
Targets as ill-defined problems	Scholz and Tietje (2002), Werner and Scholz (2002)
Initial state that can be described	Scholz and Tietje (2002)
Target state that is insufficiently known	Scholz and Tietje (2002)
Problem solving strategy by identifying and passing barriers by applying old and newly developed methods	Scholz and Tietje (2002)
The target state can even change over time	Werner and Scholz (2002)
Insufficiently known changing target state or just target direction	Werner and Scholz (2002)
The assumed target state *sustainability* in its current understanding is a temporary, normative concept	Werner and Scholz (2002)
Sufficiency economy concept does not serve the problem.	Diefenbacher (2001)
Sustainable development stands as s new measure for success	Diefenbacher (2001)
Sustainable development means an ethic orientation	Diefenbacher (2001)
Environmental services are no longer free goods, and this fact is driving major changes	Ayres (1997)
Methodological approach of sustainable development lies in the explicit holistic approach of environmental, economic and social aspects.	Vogt (2004)
Environmental imperatives can be misunderstood to demand more regulation instead of creating space and structures for freedom.	Vogt (2004)
Sustainable development is anthropocentric	Vogt (2004)

Table 9: Criteria for the framework category development.

As Rottke and Landgraf (2010) point out, economy and environment influence each other. This is also relevant for real estate economy as part of business economy (Rottke and Landgraf 2010). Figure 31 shows the interrelation of the systems ecology and economy according to Rottke and Landgraf (2010).

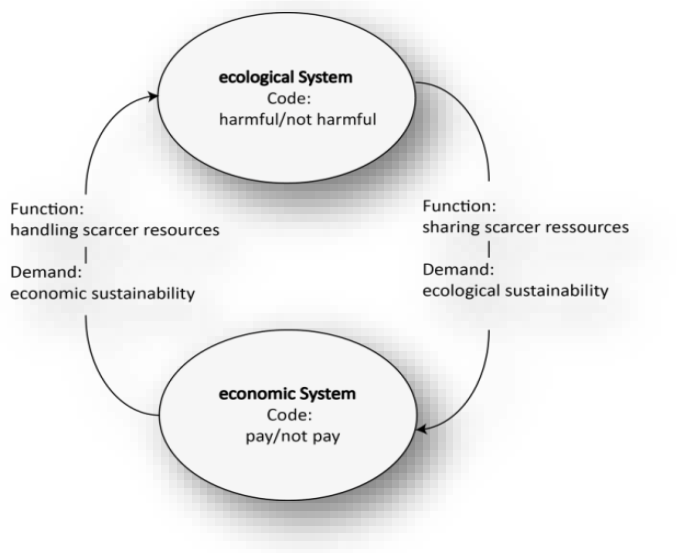

Figure 31: Interdependencies of the systems, Rottke and Landgraf 2010

Production, consumption and sustainable development

According to the Brunsvician Lens, this chapter is part of step B, and describes the decomposition of the case.

A	B	C	D	E
Problem	Decomposition	Perceptor	Synthesis	New composition

Natural resources are limited. Consumer and producer habits challenge these limits. There is widespread agreement that the consumption and production patterns, particularly in industrialized countries, are not sustainable. It can be concluded that industrialized countries should take the lead in changing this consumption and production patterns in terms of sustainable development.

Consumption is expected to grow in the areas that limit the resource consumption and allow the same or a better standard of living. Thus, the contradictory demands imposed on the consumer are resolved in a solomonic way. It should be consumed in a way that other generations also can consume (Belz 2007).

Producers are said to be responsible for the choice of materials and production systems, and so for the resulting impact in an environmental as well social way. The impacts can be reduced by increasing the efficiency or choosing less harmful materials or reducing the resource needed. Table 10 preserves a short view on the effects inducing sustainable development by production and consumption:

Sustainable development in production patterns	Author	Approach on consumption patterns
Sustainable treatment of production factors	Blazejczak (2004)	Are production factors being treated in a sustainable way?
Functional capital preservation	Blazejczak (2004)	How does the product affect the functional capital preservation?
Companies have at the level of service provision processes, products and services to solve the company-specific sustainability problem	Bieker (2005)	Which are the company´s specific processes, products and services relating to sustainability?
Sustainable consumption can guide production patterns	Belz (2007),	Consumption motifs regulatory gains, demand effects, cost efficiency and technical assistance
Sustainable consumption can guide production patterns	Belz (2007), Schlör (2014),	Consumer choices have a significant effect on impacts in environmental and social kind, and therefore also potential to alleviate environmental problems

Table 10: Production/ consumerism and sustainable development.

Consumer choices have a significant effect on impacts in environmental and social kind, and therefore potential to alleviate sustainability related problems (Belz 2007, Lonzano 2010). Some possible motives behind the decision to care for the environmental and social impacts of products are regulatory gains, demand effects, cost efficiency and technical assistance (Lonzano 2010). Sustainable development includes according to Schlör (2014) consumption and production. However, in order to understand the trajectories of the greening of industries, it is no longer sufficient to focus on single firms.

Investment behavior and construction in the light of sustainability

This chapter bridges the investment behavior in real estate to sustainable consumerism. According to the Brunsvician Lens, this chapter is amongst others, part of C, describing the findings and description of the risks, situation and processes of the perceptor.

A	B	C	D	E
Problem	Decomposition	Perceptor	Synthesis	New composition

Real estate is a special investment asset. Real estate is unique, common conclusions cannot be applied directly on any specific building. In contrast to shares, bonds and finance market funds, investing in real estate offers the possibility to invest in financial assets (e.g. real estate funds) or in the building itself. Next to yield, consumption advantages arise (Just et al. 2014). The main reason for efficiency increase of an asset portfolio is due to the independencies of real estate value development compared to the share market. Real estate investment trusts (REITs) and real estate shares are dependent on the stock exchange risk (Just et al. 2014).

Buildings are a long-term investment associated with environmental impacts over a long duration and fundamental environmental responsibility, which aims at a long-term view with an understanding that initial design decisions have a significant impact over a building's service life.

The ideal real estate strategy is shown in Figure 32. This figure shows that a property strategy is yet existing at the moment, when a real estate product is taken into investment decision-making by a real estate provider. On the long run, this means, the property strategy has to be assessed whether sustainable consumerism shall exist in the real estate context.

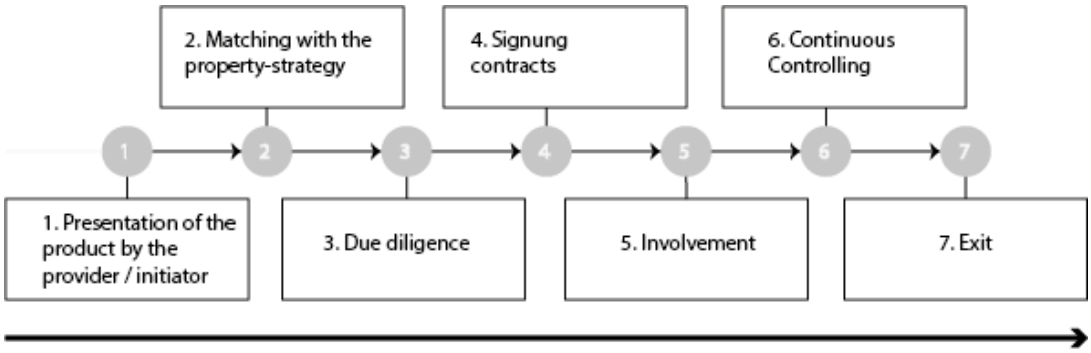

Figure 32: The way to a real estate investment, Pfnür 2011

Sustainable development is induced by inter alia sustainable buildings. Out of real estate economic view, a building is sustainable, respectively contributes to sustainable development by preservation of value, as mentioned in the introduction. A process to approach a description of value of a building, valuation was introduced yet as discipline in this study. In the case of investment, valuation is closely related to market participants, their value system and measures, which determine their willingness to pay and thus influence the economic value of property assets in the market place (Lützkendorf et al. 2011). The value systems and measures of market participants are shaped by various factors, including social, cultural and economic background and living conditions, levels of education and knowledge, and experiences (Lützkendorf et al. 2011).

Figure 33 illustrates the view of an investor on important real estate topics. For the third-party use, it is important to keep in mind the contracts. For the location of the property, it has to be decided, whether the character or a certification supports best. As manager, fund manager, asset manager, facility manager, property management are involved. Contracts are important determinants.

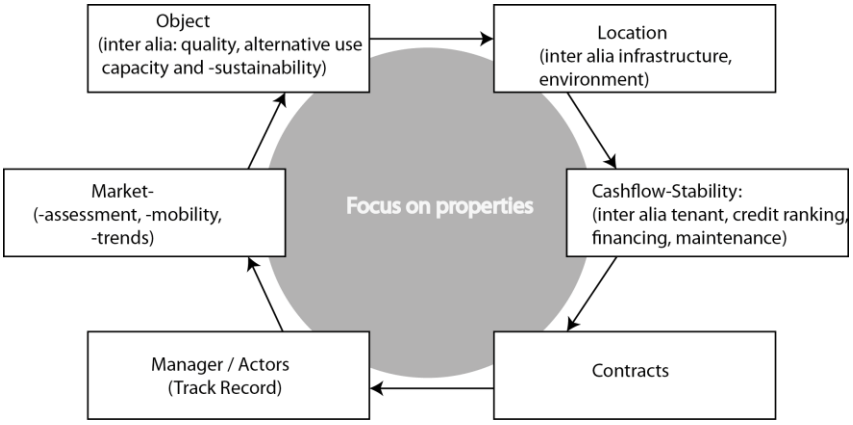

Figure 33: The view of an investor on real estate.

Meins and Burkhard (2014) find that it still needs to be clarified how sustainability aspects can be integrated in other valuation methods that are currently being used. This contributes not only to the ongoing debate on sustainability and valuation, but also to other aspects of property management. To know, which property features contribute to the value of a property in the long-term is relevant to almost every decision during the life cycle of a property: during the planning and building stage, as well as when making renovation and dismantling decisions, or in purchase and sales decisions (Meins et al. 2010).

The concept of life cycle costs in construction was determined by the target of the investor, the economic performance of a project or marketing. In this regard, user requirements (rental income, location, aesthetics) determine life cycle philosophy in modelling (Engelhardt 2015). Along with changes in society´s values and concerns, the choices people make (and their willingness to pay) are now, more than ever, also influenced by an increased interest in taking responsibility towards society at large and the environment, for various reasons (e.g. image gains, risk to reputation, convictions). Consequently, aspects that are not directly measurable may also play a role in the property formation process, i.e. the assessment of single buildings´ contribution to sustainable development or their value for society, culture and the environment slowly enhances and complements the other, more traditional drivers and components of property value (Lützkendorf et al. 2011).

The dimension of success of the investor is shown in Figure 34. This illustrates that economic performance is measured in risks and benefits, which base on costs, use and risk assessment.

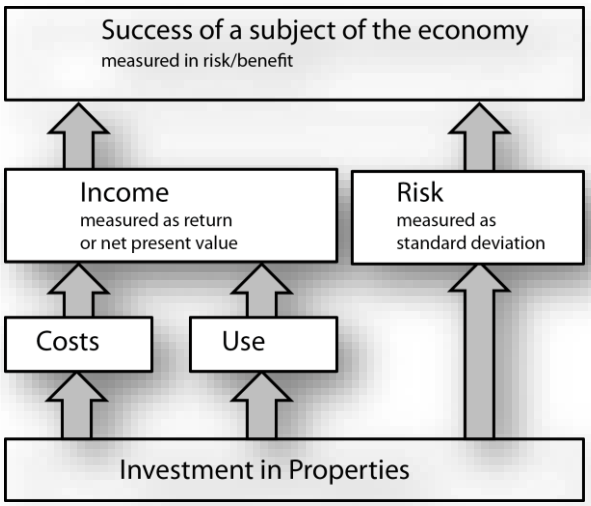

Figure 34: Dimensions of success of the investors, Pfnür 2011

Energy efficiency features have a measurable impact on property prices for both commercial and residential properties within many markets (Lützkendorf et al. 2011). Other sustainability issues (user comfort and health aspects of building materials) are likely to have an impact on property prices, but the empirical database available is insufficient to draw conclusions (Lützkendorf et al. 2011). Environmental impact, cultural quality and contribution to biodiversity preservation are not yet likely to have a direct impact on property prices; however, they can have an indirect price effect because they enhance the image and reputation of the building or of the building owner. However, largely this is an assumption that requires more detailed analyses and empirical proof (Lützkendorf et al. 2011).

Still, there is a market for ecological and social aspects amongst clients in the social upper class consumer behavior. Meins and Burkhard (2014) find five groups of value-related sustainability features, which contribute to the property value by minimizing the risk of loss in value: flexibility and polyvalence; energy and water dependency; accessibility and mobility; security; and health and comfort. Still, facts on value discussion in relation to sustainable development remain as these statements show:

- The extent to which sustainability issues are reflected in value estimates is strongly dependent on the regional and local market conditions (Lützkendorf et al. 2011);
- When deriving concrete sustainability features, it is therefore vital to recognize the long-term developments relevant to property and to derive the consequences for the property value from them (Meins and Burkhard 2014).

Furthermore, Meins and Burkhard (2014) differentiate between environment-society-economy versus a financial point of view and come to the result that – if return is taken into consideration as argument – non-sustainable real estate has a slightly higher return. Many decisions related to real estate are in the

core investment decisions, be it construction or renovation decisions or transactions. It is always about the use of funds in expectation of future returns. These depend largely on the long-term trends, the economic prosperity at the site, the standard of living and the composition of the population, natural hazards or energy prices. It is thus clear that there is a financial relationship between sustainability and property investment (Meins and Burkhard 2014).

Losing the tenants, growth potential for rent and value occupier costs, tenant retention and fluctuation, duration and costs of letting, and depreciation as well as refurbishment and maintenance costs are considered the most important risk variables influenced by sustainability issues and influence the composition and the modelling of the cash-flow of a property (Lützkendorf et al. 2011). It is explained here, why future risks can be considered lower for sustainable buildings, and conventional buildings should be assigned to a higher risk.

Figure 35 illustrates the interrelation of financial risk and sustainable buildings (Lützkendorf et al. 2011). Concerning risk perception, technical quality and facility management cannot be underestimated as contribution to on the one hand value, on the other financial risk. As soon as sustainability issues are involved, the focus of risk perception will also be on the selection of materials, on end-of-life aspects and on aspects, which are yet demanded in certification systems as a next step. Still, the question remains, what finally contributes to sustainable development, a hard to define moving target.

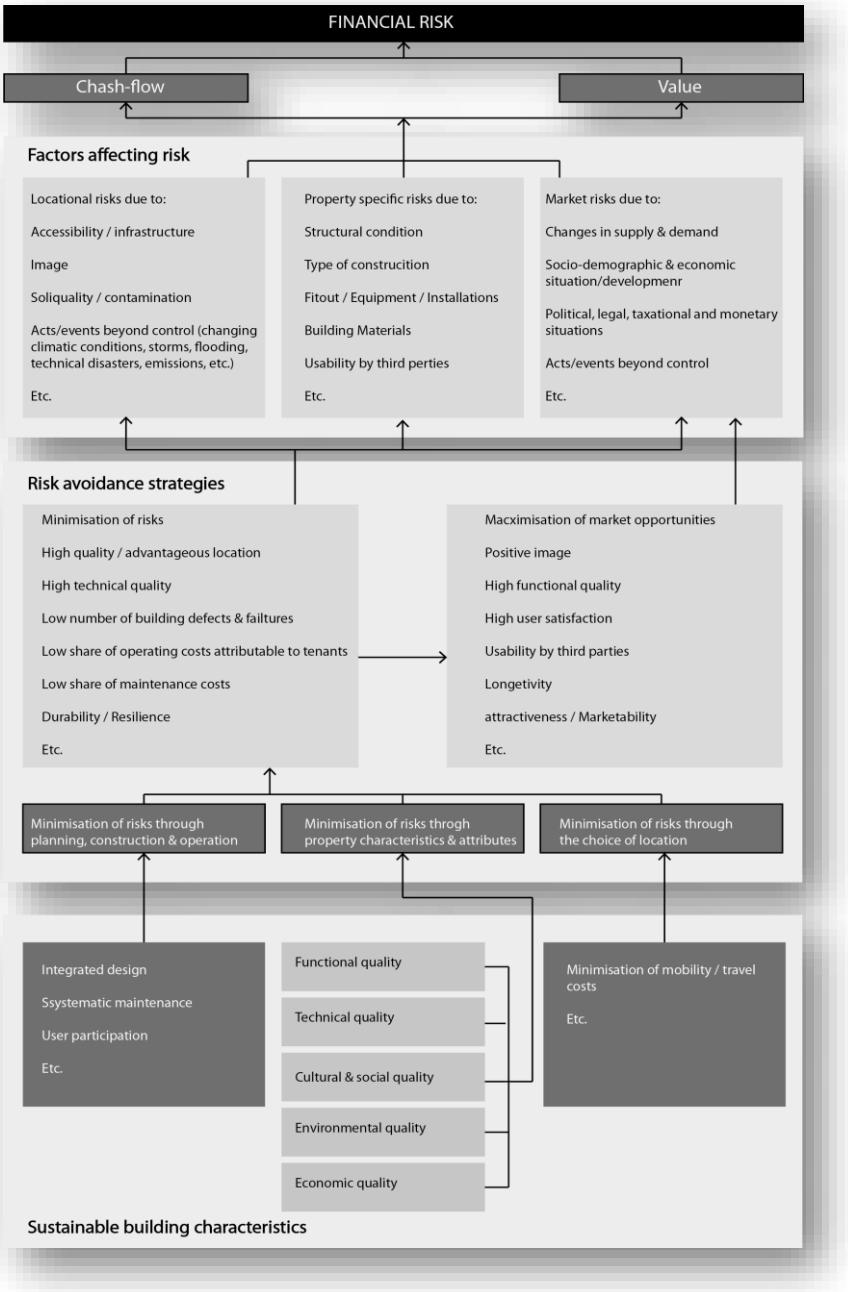

Figure 35: Financial risk, sustainable buildings, Lützkendorf et al. 2011

New values to be implemented in investment questions

According to the Brunsvician Lens, this chapter is amongst others, part of D, linking the perceptor to the synthesis, describing processes and objectives.

A	B	C	D	E
Problem	Decomposition	Perceptor	Synthesis	New composition

If one takes the circumstances of sustainable consumerism (Belz 2007) and links them to investment questions in the real estate context, new values can be identified and discussed. Not all consumerism turns out to be good. It depends, on what a given material object stands for[19]. Still, sufficiency seems no concept (Belz 2007). A compromise between sufficiency and though consumerism, which enables also the economic side of sustainable development has to be found.

A possibility to incorporate sustainability in property valuation consists of using hedonic pricing techniques, which have not been brought to operationalization yet (Meins and Burkhard 2014). In the end, it is a problem of gathering, processing and presenting property –related information. The challenges for property professionals also lie in the application and further development of methods for gathering, processing and presenting property-related information. The integration of sustainability into the valuation process is also an issue of increasing the transparency of property valuations. Value-influencing factors that have been considered implicitly (at least in part) in the past should now be made explicit to ensure the client understands the sustainability –related risks and opportunities of the subject property as well as the valuation professional´s thought process in deriving an opinion of value (Lützkendorf et al. 2011).

The guideline of sustainable construction (BMUB 2014) describes the following tasks as economic targets to be protected in the construction context:

- Minimization of life cycle costs;
- Improvement of economic efficiency;
- Preservation of capital;

These economic targets have to be kept in mind, in addition to the revenue. However, any investment asset design has the task return on investment/ risk as target. These are bearing the same decisions as portfolio decisions (Meins and Burkhard 2014). Due to the risk of investment decisions, an investor considers real estate to be sustainable if it is future-oriented, which means that it has a low risk of losing value on the long run (Meins and Burkhard 2014). Sustainability poses an additional and changing set of risks for property investors. Long-term developments or framework conditions, which will have an

[19] http://www.thebookoflife.org/good-materialism/, accessed on 09.09.2015: "An object can transubstantiate the very worst sides of human nature – greed, callousness, the desire to triumph – as much as it can the best. That's why we must be careful not to decry all material consumption: we simply have to ensure that the objects we invest in, and tire ourselves and the planet by making, are those that lend most encouragement to our higher, better natures."

effect on the value of property, are those scenarios[20] for the most industrialized countries (Meins and Burkhard 2014):

- Decline of people in the workforce and increase in the proportion of people of over 65 years of age;
- Due to rising fuel prices and the increasing proportion of older people, the demand for public transport will increase;
- Due to continually rising greenhouse gas emissions, climate change could accelerate and lead to (amongst other things) more frequent and longer heat waves in many areas as well as more frequent extreme weather events;
- The price of fossil fuels will rise, on the one hand, due to increased scarcity and, on the other hand, because of increasing costs of CO_2 emissions;
- As a result of increased demand (due in part to the substitution of crude oil by electricity), the price of electricity will also rise;
- From a global point of view, the emerging water shortage will lead to water becoming more expensive;
- Because of social trends, populations' requirement for security and general health awareness will continue to increase.

To integrate sustainability criteria into the portfolio strategy, the question of their financial relevance arises (Meins and Burkhard 2014). There is no absolute answer to this question, as the view of market and the view of investment differ. The market is about to price the sustainability criteria. This was assessed using historical data, which implies an orientation towards the past. The investment view is based on assessment of the future. So, which property features minimize an assessment of the future (Meins and Burkhard 2014) and insecure predictions? The focus lies on influences on rental prices and return on equity. Meins and Burkhard (2014) use indicators and 42 sub-indicators for the operationalization of sustainability and identify the most financial relevant sustainability criteria (Meins and Burkhard 2014).

Uncertainty remains, as estimating the value of a property is associated with a certain level of uncertainty and the emerging issue of sustainability and valuation is situated within the blurriness created by the

[20] Assuming a long-term perspective as the core component of sustainability, the question arises, which long-term developments or framework conditions will have an effect on the value of property. However, only those framework conditions whose developments – with a high probability – have a clear direction can be taken into account. Without this direction (trend), it is not possible to forecast the effects on the value of property (Meins and Burkhard 2014).

valuation lag (Meins and Burkhard 2014). Table 11 provides a short overview on financial relevant criteria which gain importance from the sustainability side.

Criterion	Effect on financial risk
Renewable energy utilization (heat and power)	Low
Location and public transport availability	High
Structural features (floor height)	High
Flexibility	Low
Resource consumption and greenhouse gas	High
Safety and comfort	High

Table 11: Financially relevant sustainability criteria, Meins and Burkhard 2014

The corporate responsibility performance of an organization has positive business effects, e.g. influence competitive advantage, workers´ commitment, the view of customers and financial community or owners, as well as the relationship with companies, media, suppliers and governments. Real estate as sustainable consumer product requires corporate responsibility of a real estate development company. In the past, the primary responsibility of a corporation was to provide an acceptable return on investment to its owners and stockholders. Starting in the 1960s a broader view of corporate responsibilities emerged that includes not only stockholders but other parties as well, including employees, suppliers, customers, the local community, local, state, and national governments, environmental groups, and other special interest groups its stakeholders. From this developed the concept of corporate social responsibility (CSR), the expectations that society has of a corporation or company. The underlying assumption is that companies have moral, ethical, and philanthropic responsibilities in addition to their responsibilities to earn a fair return for investors and to comply with the law. According to Gallardo-Vázquez (2014), the expectations are:

- *Economic:* Corporations will produce goods and services that are needed and desired by customers and sell those goods and services at a reasonable price. Organizations are expected to be efficient and profitable, and to act with the shareholder interests in mind;
- *Legal:* Corporations will comply with the laws that are in place to govern competition in the market. These include consumer protection and product laws, environmental laws, and employment laws;
- *Ethical:* Corporations will meet societal expectations that go beyond the law by conducting their affairs in a fair and just way. Organizations are expected to make proactive efforts to anticipate and meet the norms of society even if those norms are not formally enacted in law;
- *Discretionary:* Those corporations will meet society expectation to act as good citizens via philanthropic support of programs benefiting a community, or donating employee

expertise, time, and financial support to worthy causes. The larger the corporation the larger discretionary responsibility they carry.

In the context real estate corporations, advantages of sustainability are a better risk control, long-term value increase of the asset, and competitive advantage (Rottke and Landgraf 2010). Real estate developers prefer certifications, which leave space for own decisions. Too strict requirements lead to the fact that market leader cannot appreciate their full spectra of competitive advantage (Rottke and Landgraf 2010).

4.2.2. Selected concepts and standards for "sustainable construction"

In this part, several approaches for the assessment of sustainable development in real estate and construction are discussed. First, life cycle assessment is identified as an important methodology to quantify environmental impacts along the life cycle of products. Furthermore, the work of CEN TC 350 is introduced, which has elaborated a series of standards for the sustainability assessment of buildings for the European context. According to the Brunsvician Lens, this chapter is part of step B, and describes the decomposition of the case.

A	B	C	D	E
Problem	Decomposition	Perceptor	Synthesis	New composition

Environmental information and life cycle assessment data in construction

Yet mentioned the philosophy of life cycle thinking in environmental sciences is merging with life cycle thinking in engineering and the real estate approach. For this study, LCA is described important as tool to get access to sustainable development related information concerning environmental aspects. This information is based on the knowledge on material. Important for further discussion in this work is the product level. Via EPD, environmental product declarations, environmental information is provided on the level of construction products. Keeping in mind that sustainable development means integrating the trifold dimension of environmental, economic and environmental demands, this study discusses the possible homogenous implementation of information.

On normative level, the assessment on construction products is based on an LCA approach. More and more, this approach is being applied in the building assessment. This is being done not only concerning environmental aspects, but also concerning LCC life cycle costs.

Excursus IX On LCA Life Cycle Assessment in construction. LCA life cycle assessment is a decision support tool within environmental management, which has been developed to compile and assess the environmental implications of products. An LCA is based on an inventory of all material and energy requirements as well as emissions occurring over a product life cycle. These inputs and outputs are translated to a number of environmental impact categories. Climate change, air pollution and toxicity to humans are examples of environmental impacts addressed. Optionally, these impact categories can be weighted according to a defined importance and expressed in a common unit. LCA is one of the environmental instruments considered to be important in the context of product-related decision-making (EN ISO 14040, Werner and Scholz 2002). The main purpose of an LCA is to generate information on the environmental implications of products (Werner and Scholz 2002). LCA is a generic scientific method to assess the full environmental impacts of products. The stages in LCAs are described explicitly in the ISO 14040 series standards. The series of standards of CEN TC 350 provide guides for the execution of LCA for buildings. There is no objective way of defining a product system out of the complex system that is our world. As a consequence of the specific characteristics of LCA, consistency of the product system with the real world can only be by considering the attribution rules: The material and market characteristics of the materials involved and the management rules for the sustainable use of the materials involved on a case-specific basis. Only this way will decision-makers find their mental models of reality and their values incorporated in the product system and their action space properly depicted. Otherwise, the implementation might lead to environmentally inefficient solutions.

EN 15978 specifies a calculation method, based on LCA and other quantified environmental information, to assess the environmental performance of a building, and provides the means for the reporting and communication of the outcome of the assessment[21]. It is applicable to new and existing buildings and refurbishment projects. This approach to the assessment covers all stages of the building life cycle. It is based on data obtained from EPD, their "information modules" and other information necessary and relevant for carrying out the assessment. The assessment includes all building related construction products, processes and services, used over the life cycle of the building.

A scheme of the building life cycle according to CEN TC 350 is presented in Figure 36.

[21] http://www.beuth.de/en/standard/din-en- 5978/164252701;jsessionid=U8NOGFNGF11OFJEFK0ADHPCO.3, accessed on 27.08.2015

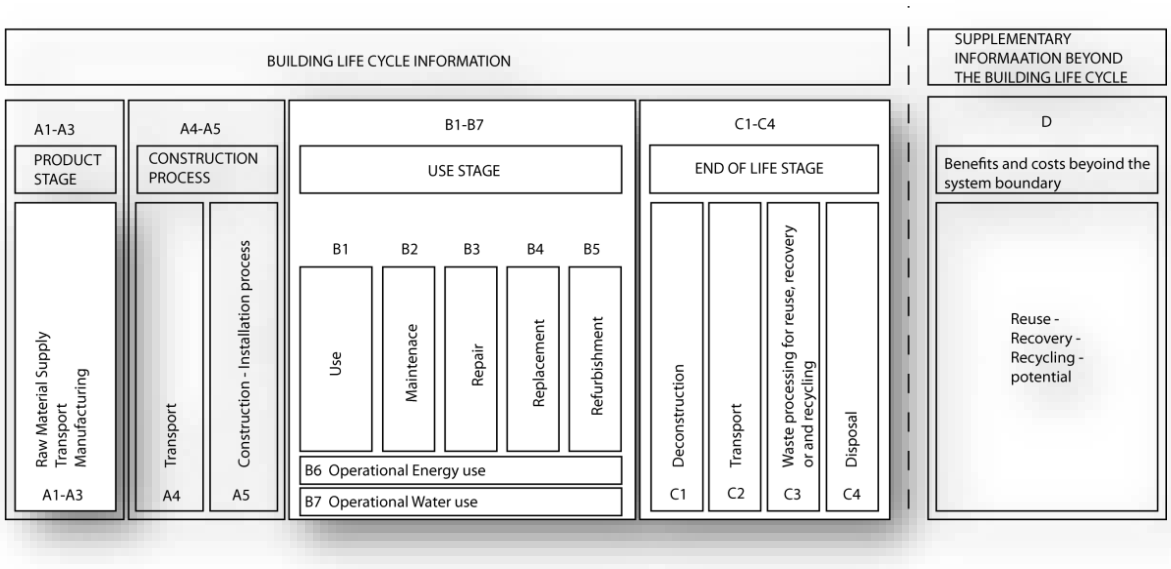

Figure 36: Modular structure of the building life cycle, CEN TC 350, EN 16627

Technical parameter which are applied to describe the use stage of a construction are listed in Table 12.

Task	Parameter	Unit
Use stage related to the building fabric	Maintenance cycle Ancillary materials for maintenance, e.g. cleaning agent, specify materials Waste material resulting from maintenance (specify materials) Energy input during maintenance (e.g. vacuum cleaning, energy carrier type, electricity and amount	Number/ RSL or year Kg/ cycle kg kWh
	Repair cycle	Number/ RSL or year
	Ancillary materials, e.g. lubricant, specify materials	kg or kg / cycle
	Waste material resulting from repair, (specify materials	kg
	Net fresh water consumption during repair	m^3
	Energy input during repair, e.g. crane activity, energy carrier type, e.g. electricity, and amount	kWh / RSL, kWh
	Replacement cycle	Number/ RSL or year
	Energy input during replacement e.g. crane activity, energy carrier type, e.g. electricity and amount if applicable and relevant	kWh
	Exchange of worn parts during the product's life cycle, e.g. zinc steel sheet, specify materials	kg
	Refurbishment cycle	Number /RSL or year
	Energy input during refurbishment e.g. crane activity, energy carrier type, e.g. electricity, and amount if applicable and relevant	kWh
	Material input for refurbishment, e.g. bricks, including ancillary materials for the refurbishment process e.g. lubricant, (specify materials)	kg or kg / cycle
	Waste material resulting from refurbishment (specify materials)	kg
	Further assumptions for scenario development, e.g. frequency and time period of use, number of occupants	Units as appropriate
	Reference service life Declared product properties (at the gate) and finishes, etc.; Design application parameters (if instructed by the manufacturer), including the references to the appropriate practices and application codes An assumed quality of work, when installed in accordance with the manufacturer's instructions Outdoor environment, (for outdoor applications), e.g. weathering, pollutants, UV and wind exposure, building orientation, shading, temperature Indoor environment (for indoor applications), e.g. temperature, moisture, chemical exposure Usage conditions, e.g. frequency of use, mechanical exposure Maintenance e.g. required frequency, type and quality and replacement of component	Units as appropriate
Energy and water use	Ancillary materials specified by material Net fresh water consumption Type of energy carrier, e.g. electricity, natural gas, district heating Power output of equipment Characteristic performance, e.g. energy efficiency, emissions, variation of performance with capacity etc. Further assumptions for scenario development, e.g. frequency and period of use, number of occupants	In kg, m^3, kWh, kW or unit as appropriate

Table 12: Technical parameter, EN 15804

The purpose of an EPD in the construction sector is to provide the basis for assessing buildings and other construction works, and identifying those, which cause less stress to the environment (EN 15804). It is possible to have an EPD for a substance or preparation (e.g. cement), for a product (e.g. a window), for a construction service (e.g. the cleaning service as part of maintenance) and for an assemblage of products and/or a construction element (e.g. a wall) for technical equipment (e.g. a lift). In principle the comparison of products based on their EPD is defined by the contribution they make to the environmen-

tal performance of the building. Consequently, comparison of the environmental performance of construction products using the EPD information shall be based on the product´s use in and its impacts on the building, and shall consider the complete life cycle (Koukkari et al. 2012). EN 15804 provides core product category rules for all construction products and services. It provides a structure to ensure that all EPD of construction products, construction services and construction processes are derived, verified and presented in a harmonized way. An EPD communicates verifiable, accurate, non-misleading environmental information for products and their applications, thereby supporting scientifically based, fair choices and stimulating the potential for market-driven continuous environmental improvement. EPD information is expressed in information modules, which allow easy organization and expression of data packages throughout the life cycle of the product. Furthermore, the structuring of the information in information modules allows the aggregation (addition) of environmental information on building level.

The end-of-life stage of the construction product starts when it is replaced, dismantled or deconstructed from the building or construction works and does not provide any further functionality. (…) During the end-of-life stage of the product or the building, all output from dismantling, deconstruction or demolition of the building, from maintenance, repair, replacement or refurbishing processes, all debris, all construction products, materials or construction elements, etc. leaving the building, are at first considered to be waste. This output however reaches the end-of-waste state when it complies with all the following criteria:

- The recovered material, product or construction element is commonly used for specific purposes;
- A market or demand, identified e.g. by a positive economic value, exists for such are covered material, product or construction element;
- The recovered material, product or construction element fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products;
- The use of the recovered material, product or construction element will not lead to overall adverse environmental or human health impacts.

Figure 37 illustrates an overview on the steps towards an EPD with IBU. EPD that are not in a building context are not tools to compare construction products and construction services. For the sustainability, assessment of buildings comparisons of the environmental aspects and impacts need to be undertaken in conjunction with the social and economic aspects and impacts related to the building. For the interpretation of a comparison, benchmarks or reference values are needed. This standard does not set benchmarks or reference values. Comparisons are possible at sub-building level, e.g. from assembled systems, components, products for one or more life cycle stages. The information provided for such comparison

shall be transparent to allow the purchaser or user to understand the limitations of comparability (EN 15804: 2012). Consequently, comparison of the environmental performance of construction products using the EPD information shall be based on the product's use in and its impacts on the building, and shall consider the complete life cycle (EN 15804: 2012). Comparisons are possible at the sub-building level, e.g. for assembled systems, components, products for one or more life cycle stages. The basis for comparison of the assessments is the entire building. It shall be ensured that the same functional requirements as defined by legislation or in the client's brief are met. The environmental performance and technical performance of any assembled systems, components, or products excluded are the same, and the amounts of any material excluded, and excluded processes or life cycle stages, and the influence of the product systems on the operational aspects and impacts of the building are the same, which are taken into account.

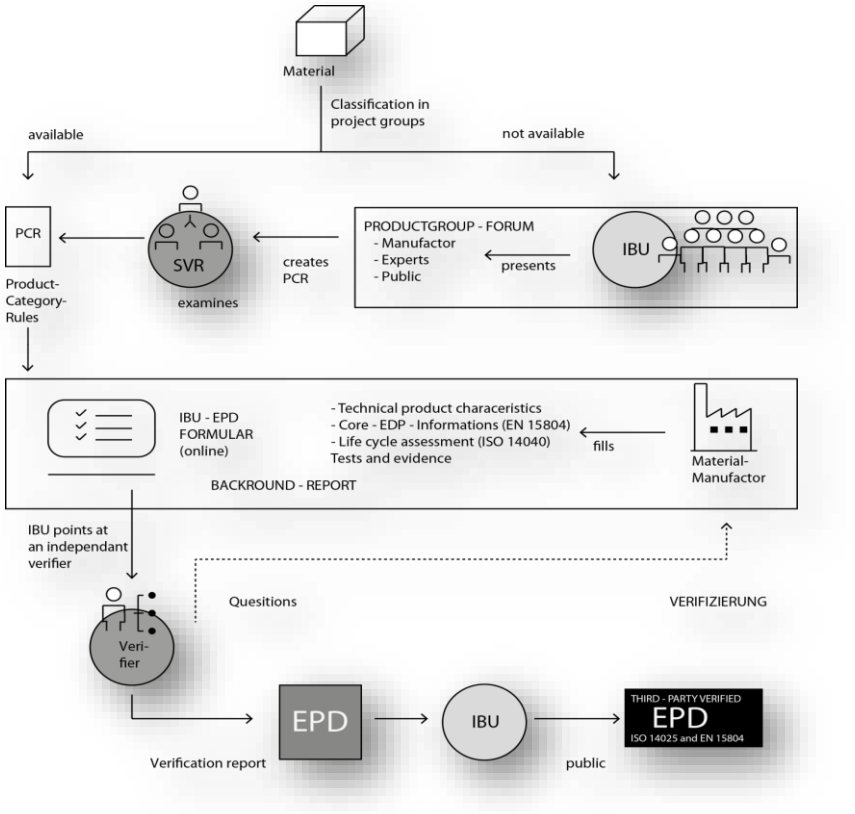

Figure 37: Overview of steps towards an EPD, IBU 2014

Table 13 summarizes parameters describing the environmental impact in an EPD on product level (IBU 2014).

Impact category	Parameter	Unit
Global Warming	Global warming potential, GWP;	kg CO_2 equiv.
Ozone depletion	Depletion potential of the stratospheric ozone layer, ODP;	kg CFC 11 equiv.
Acidification for soil and water	Acidification potential of soil and water, AP;	kg SO_2 equiv.
Eutrophication	Eutrophication potential, EP;	kg $(PO_4)^{3-}$equiv.
Photochemical ozone creation	potential of tropospheric ozone,	kg ethene equiv.
Depletion of abiotic resources-elements	Abiotic depletion potential (ADP-elements) for non-fossil resources	kg Sb equiv.
Depletion of abiotic resources-fossil fuels	Abiotic depletion potential (ADP-fossil) for fossil resources	MJ, net calorific value
LCI indicators	Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value
	Use of renewable primary energy resources used as raw materials	MJ, net calorific value
	Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials Use of non-renewable primary energy resources used as raw materials	MJ, net calorific value
	Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) Use of secondary material	kg
	Use of renewable secondary fuels	MJ, net calorific value
	Use of non-renewable secondary fuels	MJ, net calorific value
	Net use of fresh water	m^3
	Hazardous waste disposed	kg
	Non-hazardous waste disposed	kg
	Radioactive waste disposed	kg
	Components for re-use	kg
	Materials for recycling	kg
	Materials for energy recovery	kg
	Exported energy	MJ per energy carrier

Table 13: Parameters describing environmental information in EPD, IBU 2014

Still, it has to be mentioned that environmental tools can only provide hints on the way towards the environmental dimension of sustainability (Werner and Scholz 2002).

Sustainable construction described in CEN TC 350 standards

On European level, the commission assesses buildings via the product standards and CE marking. At European Union level, the Energy Performance of Buildings Directive (EPBD, 2002/91/EC) is perhaps one of the most ambitious programs ever created for the renovation of existing buildings (RICS 2013). A working group (CEN TC 350) elaborates basics for the assessment of social, environmental and economic quality of new and existing buildings. The work of CEN TC 350 intends to give a methodology for building assessment as voluntary opportunity for real estate and construction. Common principles and concepts for construction assessment according to CEN TC 350 methodology are presented in the following clauses.

Many regulations, standards and tools have been developed throughout Europe to address the different aspects of sustainability in construction. In this context, Räty et al. (2012) suggests that the standardization work sustainability of construction works of CEN TC 350 will play a focal role in the environmental evaluation of buildings and the materials used (Räty et al. 2012). According to the trifold dimension of sustainable development, CEN TC 350 describes economic, environmental and social categories of impacts and aspects for assessing demands of sustainable development. The standards do not set the rules for how building assessment schemes can provide valuation methods, nor do they prescribe levels, classes or benchmarks of performance. Valuation methods, levels, classes or benchmarks could be prescribed in the requirements for environmental, social and economic performance in the client's brief, building regulations, national standards, national codes of practice, building assessment and certification schemes, etc. The rules for the assessment of social aspects of organizations are not included within this standard. However, the consequences of decisions or actions that influence the social performance of the object of assessment are taken into account. These standards meet the calculations for all three dimensions of sustainable development. The suite of European standards intends to support the decision-making process and documentation of the assessment of the economic, environmental and social performance of a building. The general principles of the sustainability assessment of buildings are described in EN 15643-1 (the General Framework standard). CEN TC 350 seeks to achieve the following benefits:

- The avoidance of potential barriers to trade can be achieved by drafting these standards both in the European market area and in the global market area;
- The standards of TC 350 will provide the means for the quantification of the impacts in order to understand the effects of decisions taken in the construction sector;
- The standards will ensure the utilization of the salient features of all relevant ISO standards.

During its life cycle, from raw material supply of building products to the final disposal of building components, a building has environmental and economic impacts as well as impacts on the health & comfort of the users. To get an overall picture on the integrated performance of a building, these impacts have to be analyzed with the building as an object of the assessment of environmental performance, economic performance and health & comfort performance of building (CEN TC 350). These standards are compatible with the corresponding ISO standards, but they also provide additional guidelines for EPDs of construction materials. In the near future, these guidelines will contribute to any practical life cycle, footprint or green building measure to be used in the construction value chain, at least in Europe. "Even if the most immediate contribution of the standards is to improving pan-European EPDs, the main contribution of the Sustainability of Construction Works standard lies in providing overall rules for evaluating the performance of a building instead of building parts or materials. In this view, upstream producers should look further than the next phase of the value chain; they should set targets for how

their products contribute to the environmental performance of the whole building" (Räty et al. 2012). The assessment of a building is based on a functional equivalent in analogy to the functional unit for products. The „functional equivalent" is defined by requirements out of the client´s brief as well as technical and functional requirements, based on standards and norms.

The work program of CEN TC 350 has the trifold dimensional approach on concept level and a general framework. The building assessment methodology standards can be found on "building level". The product assessment standards set the rules on product level. This structured approach to link information on product level to the building context will be explored further in a different part of the study, particularly when it comes to the need to break down information from conceptual level to product related information flows.

The concept of the CEN TC 350 sustainability assessment is illustrated in Figure 38. Decision-making under multiple objectives is a problem also in existing certification schemes. The multiple objectives have to be brought into equivalence. Still, this system is under development.

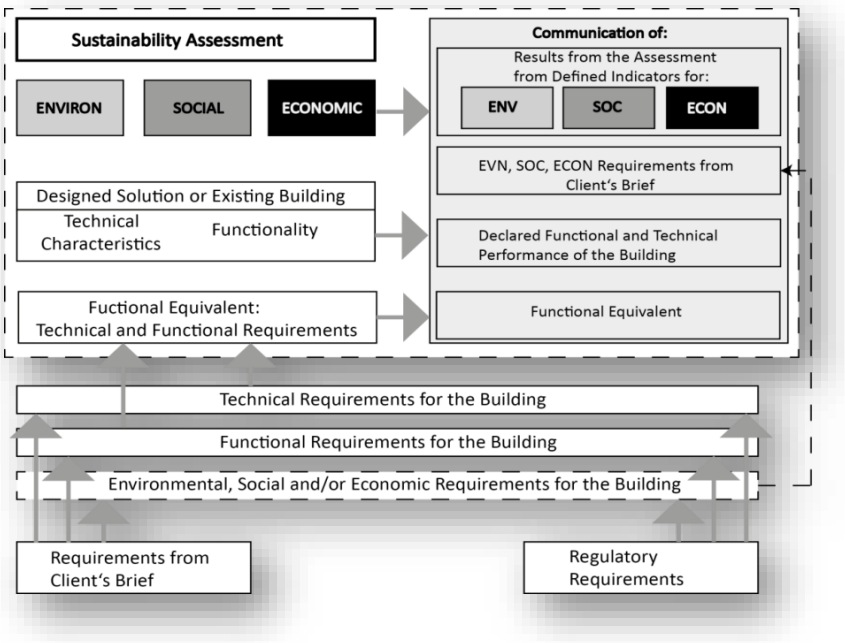

Figure 38: The concept of CEN TC 350 sustainability assessment, EN 15978

For an assessment, the following tasks are required, as shown in Table 14.

Requirements	Description
System boundary	- Impacts and aspects of the building-integrated technical system and building-related furniture, fixtures and fittings
Functional equivalent	- Building type and use - Pattern of use - Relevant technical and functional requirements (regulatory framework, client´s requirements) - Required service life
Assignment of data	- According to the building life cycle information modules

Table 14: Requirements for assessment, EN 15978

For the environmental assessment of a building, the calculations have to be performed according to the suggested process steps of EN 15978. In addition, a reference study period has to be chosen. The information modules indicate the different building life cycle phases including the production of the construction product (with own product life cycle), construction phase, transport, asset utilization and material disposal (EN 15978). Concerning life cycle thinking, concepts of standards follow the principles of life cycle assessment according to ISO 14044. The potential impacts from benefits and loads beyond the building life cycle from further reuse, recycling, energy recovery and other recovery operation potential can be included as supplement information. EPD is an information carrier for environmental information on construction product level. An EPD shows the same modular structure. In the following part, these aspects and impacts are discussed in more detail.

The modular presentation of information is a fundamental basic principle of CEN TC 350 standards for preserving an appropriate and transparent evaluation of construction. An assessment shall be established based on specified scenarios that represent the building life cycle. The applied scenarios shall be described and made available for communication together with the results of the assessment. The scenarios shall be realistic and representative and in accordance with the technical and functional requirements as given in the functional equivalent.

The economic performance assessment of a building addresses the life cycle costs and other economic aspects, all expressed through quantitative indicators. It excludes the economic risk assessment of a building and return on investment calculations. It includes economic aspects of a building relating to the built environment within the area of the building site – it does not include economic aspects beyond the area of the building site.

The standards developed under this framework do not set the rules for how the different assessment methodologies can provide valuation methods nor do they prescribe levels, benchmarks for measuring performance. The framework includes two indicators of economic performance (which is performance related to economic impacts and economic aspects according to EN 16627), cost and financial value. An economic aspect is defined as an aspect of construction works, part of works, processes or services

related to their life cycle that can cause change to economic conditions (EN 16627). Economic impact is defined as any change to the conditions, whether adverse or beneficial, wholly or resulting from economic aspects (EN 16627). Financial value describes the aggregation of and revenues of economic aspects expressed in monetary units (EN 16627). The economic impacts specific to a building life cycle excluding operational and water costs shall be organized according to the following groups of information for results from economic performance:

- From the pre-construction stage;
- From the product stage and construction stage;
- From the use stage;
- From the end-of-life stage.

EN 16627 describes two approaches to the calculation of economic performance at building level, which are summarized in Table 15.

Economic performance expressed in	**Representation**
Cost terms over the life cycle / Life cycle cost	- The lowest “life cycle cost” building over its life cycle is the most economic one. This implies that the building variants do not differ with respect to their functionality, or with any income streams produced by the building. This concept of economic performance does not include development on the real estate market, only the cost related to the building over the life cycle. Only cost data need to be gathered. - Economic performance expressed in cost terms over the life cycle, taking account of negative costs related to energy exports and from re-use and recycling of parts of the building during its life cycle and at the end-of-life. Calculation of this indicator is mandatory for compliance with the standard.
Terms of financial value over the life cycle / Life cycle economic balance	- In this concept, the best financial value building is the economic one, i.e. the building with the highest (discounted) revenue minus the cost over the life cycle. This concept is close to the income approach in property valuation and includes market-related revenue streams. Revenue data also need to be gathered. - Life cycle cost (see above) and in addition incomes over the life cycle and at the end-of-life. Calculation of this additional indicator is optional for compliance with the standard.

Table 15: Indication of economic performance, EN 16627

To assess the economic performance of some projects, it is essential to include revenues in the assessment. For example, a building integrated renewable energy installation cannot be justified on economic performance without taking into account revenue from the energy generated and any avoided energy costs arising from the renewable energy source. The information allocated to the relevant modules should be taken from appropriate sources, for example following the procedures in ISO 15686-5 or historical cost data.

For the economic assessment, some costs can be incurred before the construction stage commences. These are reported in information module A0, which is specific to the economic assessment. Modules A0 to C4 cover economic impacts and aspects that are directly linked to processes and operations taking place within the system boundary of the building, while module D reports the income relating to exported energy and secondary materials, secondary fuels or secondary products resulting from reuse, recycling and energy recovery that take place beyond the system boundary. Costs of waste disposal at the end-of-life are allocated to Module C, incomes from products or materials which are recycled, are included in Module D. To assess the economic performance of some projects, it is essential to include revenues in the assessment. Calculations for economic indicators are:

- Costs and incomes without discount (nominal value);
- Recurrent – non recurrent, year of reference;
- Determine cost effectiveness of options: net present value NPV according to LCC analyses;
- Investment options: AC annual costs total net cost of project taking into account the time value of money over the period.

Value stability and performance in a medium-to long-term perspective is the medium-to long-term value stability and performance will be influenced among others by specific market, location and building characteristics. The object under observation in a sustainability assessment of buildings is the building itself and its site. Therefore, only the building-related contribution to the value stability and performance can be assessed. This can be done using “consequential” indicators. These are among others (EN 16627):

- Flexibility and adaptability of the building to changing user needs to lower the risk of changes in the market;
- Energy performance of the building to reduce the risk of energy price changes and to lower the risk of depreciation if a high energy performance becomes the “standard” in the real estate market (and property rating);
- Environmental performance to reduce several risks (e.g. reputation risk) and to lower the risk of depreciation if a high energy performance becomes the “standard” in the real estate market (and property rating);
- Adaptability of the building to climate change;
- Durability.

Table 16 lists costs, incomes, and their expression according to the modules. These are classic life cycle costs in a broader sense.

Costs and income	Unit Indicator	Information Modules A Before use stage		Information Modules B Use stage			Information Modules C End of life stage	Information Module D Costs and incomes beyond the system boundary
Non-annual costs	€(or other currency) /occurrence Date of occurrence	Pre-construction (A0) and Construction (A1-A5)		Maintenance (B2) Repair, replacement and refurbishment (B3, 4 & 5)			Deconstruction, Transport, Waste processing and Disposal (C1-C4)	Re-use Re-cycling Recovery Potential
Non-annual Income	€/occurrence (or other currency) Date of occurrence			Use (B1) Energy related incentives (B6)				Re-use Re-cycling Recovery Potential Land sale
Annual recurrent costs	Ref. Year €/year			Use and maintenance B1 & B2	Operational energy use B6	Operational water use B7		
Annual recurrent income	Ref. Year €/year			Use (B1)	Exported energy (B6)			

Table 16: Expression of costs and incomes, EN 16627

Life cycle costs (LCC) is a common method to assess economic criteria concerning real estate and construction, as mentioned before. The classic approach, to avoid follow-up costs by a larger investment, is also part of this thinking.

After the economic part, the social performance is introduced. As clarifying function, terms are introduced which help to understand social aspects. EN 16309 defines the following terms related to social performance:

- *Social aspect*: aspect of construction works, part of works, processes or services related to their life cycle that can cause change to society or quality of life (according to ISO 15392);
- *Social impact:* any change to society or quality of life, whether adverse or beneficial, wholly or partially resulting from social aspects (according to ISO 15392);
- *Social performance*: performance related to social impacts and social aspects.

The standard on social performance of buildings EN 16627 is applicable to all types of buildings, both new and existing. This first generation of the standard is only applicable to the use-stage of a building. Future revisions of this standard will include the assessment of social performance for other stages of the building life cycle as appropriate methods for measurement are developed and become suitable for standardization. The goal of the assessment is to quantify the social performance of the object of assessment by means of the compilation and application of information relevant to a description of the social

quality of the object (EN 16309). The intention of the standard is the comparison of the social performance of different design options and the comparison of the social performance of refurbishment, reconstruction and/or new construction.

This indicator represents the resistance of the building against projected levels of solar radiation in terms of protection against adverse effects of UV- and infrared radiation (overheating). Examples for measures against the adverse effects of an increase in solar radiation can be:

- Solar control measures such as shading (e.g. shutters, overhangs, side fins, blinds) and/or type of window-pane;
- UV filters;
- Building orientation;
- Zoning, i.e. room arrangement (e.g. buffer spaces);
- Air conditioning, ventilation systems;
- Thermal mass.

Different aspects of the coverage of the social dimension according to EN 16309 are mentioned to support the understanding and prepare the further discussion. Personal safety and security against intruders and vandalism is one aspect. The following aspects shall be assessed in general:

- Building fabric related aspects of personal safety and security against intruders and vandalism;
- User and control system-related aspects of personal safety and security against intruders and vandalism.

Social performance demands the “sourcing of materials and services”. EN 16309 aims to use information relating to the building as a whole, including all relevant information related to design, construction products, processes (including all stages and processes of waste processing) and services for all stages of the lifecycle. This can be demonstrated by third party certification schemes, which meet the scope, and issues defined where they exist at a national/international level or through relevant information supplied by the manufacturer/supplier. For the assessment of sourcing of materials and services, the following two aspects should be assessed:

1) For the assessment of sourcing of services the following can be summarized:
    - Documented evidence of the license to provide the services applying to the workforce;
    - Documented subcontracting (when relevant);
    - Safety performance from start to finish of the service supplied: Documented implementation of health and management systems;

- Evidence of compliance with social responsibilities related to the human resources (documented evidence of the legal situation of own employees and subcontracted personnel; documented social conditions of the workplace and transportation to and from work as well as accommodation of workers);
- Traceability: documented management procedures ensuring the traceability of the services supplied;
- Quality management/control: documented implementation of quality management systems (e.g. according to EN ISO 9001 or equivalent) and factory production control;
- Environmental management/control: documented implementation of environmental management systems (e.g. according to EN ISO 14001 or equivalent).

2) For the assessment of sourcing and traceability of materials the following can be assessed:
    - Legal evidence of the materials` production: documented raw material origin (license and/or certification) from the point of extraction or harvest of the raw materials including processing and transport (trade routes);
    - Documented product installation and process authorization (licenses);
    - Safety performance from start to finish of the material production: documented implementation of health and management systems;
    - Evidence of compliance with social responsibilities e.g. ISO 26000 related to the human resources (documented evidence of the legal situation of own employees and subcontracted personnel);
    - Documented social conditions applying to the workplace;
    - Traceability: documented management procedures ensuring the traceability of materials supplied and respective characteristics;
    - Quality management/control: documented implementation of quality management systems (e.g. according to EN ISO 9001 or equivalent) and factory production control;
    - Environmental management/control: documented implementation of environmental management systems (e.g. according to EN ISO 14001 or equivalent);

Besides the information on building assessment according to the life cycle information, Figure 42 illustrates the product level, which is covered by EPD. Construction processes and building operation processes do have LCA/LCC impacts, which should not be underestimated. These are especially social ones. This topic is assessed later in the study. Figure 42 is structured on a logic coming from the material perspective. Still, impacts from the process side (production of construction products, construction process and operational processes) do have LCA/LCC impacts and have to be included in the assessment and also in the decision-making process far before any assessment or certification process, in order to be able to meet the demands of sustainable development in real estate and construction.

Figure 39 serves as structure for the understanding of life cycle orientation in construction, but still is lacking some aspects.

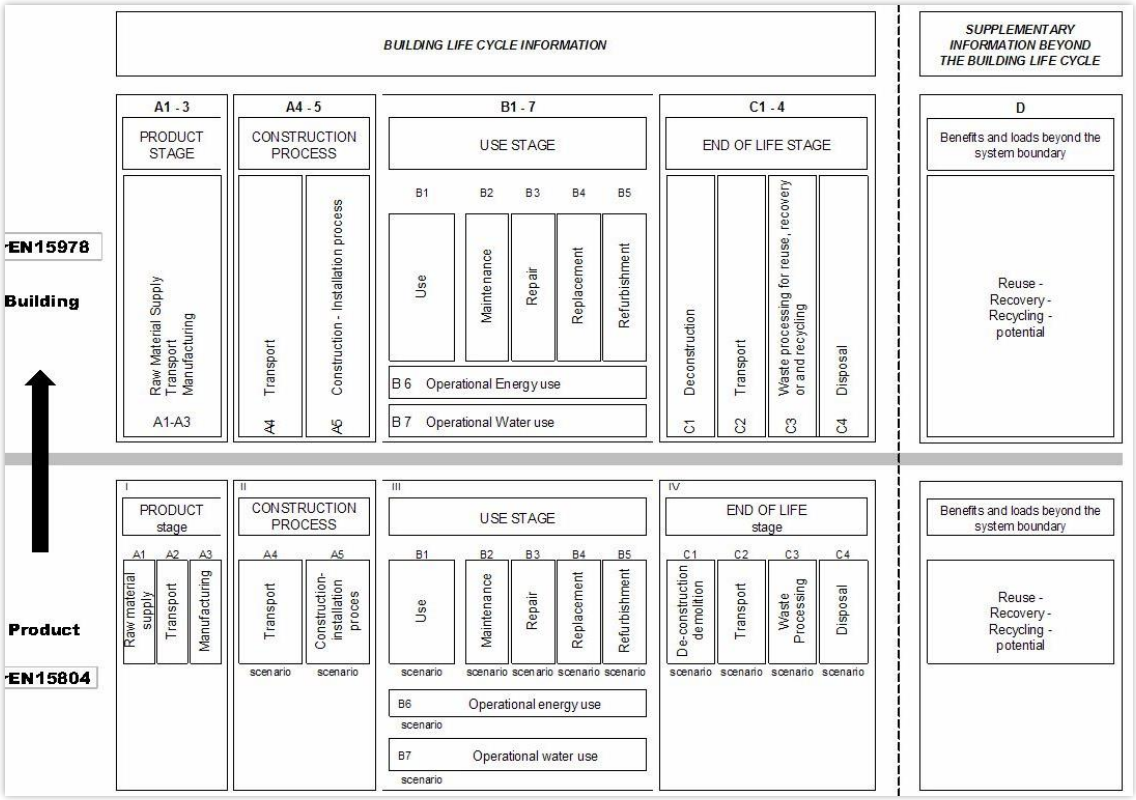

Figure 39: Information modules for construction assessment, EN 15643-1

Standards can be applied for the further development of benchmarks on country level. As there is not common property market on EU level existing, the base requirements and standards for constructions are set on construction product level. The applied stages of construction are mentioned in Table 17.

Stage	Task
Pre-construc-tion	The scenarios shall describe the assumptions made about the activities prior to the start of construction work. The scenario shall describe the key assumptions which will influence the costs of the project, for example: - Selection of a site or an existing building for retrofitting, - Site related taxes, subsidies and incentives, - Relevant professional fees.
Product and construction process stages	Scenarios for the product and construction process stage cover the manufacture or extraction of the different construction products through to the practical completion of the construction work. The scenario shall describe the key assumptions which will influence the costs of the project, for example: - Preliminary and/or temporary works, structures or facilities, including site clean-up and land remediation, - Client requirements relating to their corporate environmental objectives, - relevant professional fees, - Special arrangements for transport or supply of products, materials, equipment and waste to and from the building site, - Accessibility of the site during the construction stage, - Offsite construction activities, - Duration of the construction program and limits on working hours, - Assembly, installation, commissioning and waste management. (The costs of manufacture, transport and installation, might only be available in aggregated form and not as individual itemized costs)
End-of-life-stage	The end-of-life stage of a building starts when the building is decommissioned and is not intended to have any further use. At this point, the cost of the building's demolition/deconstruction can be considered as a multi-output process that provides a source of materials, products and building elements that are to be discarded, recovered, recycled or reused. The scenarios for these end-of-life options for the products and materials determine the system boundary (see 7.4.2, 8.4 and 8.7). These scenarios shall only model processes that have proven to be economically and technically viable. The building is deemed to have reached the end of its life when: - All components and materials that were to be clarified from the site have been removed; - The site is made ready for future re-use (i.e. clarified ready for new activity). The end-of-life stage includes the following modules: - C1 deconstruction, including dismantling or demolition, of the building, including initial on site sorting of the materials; - C2 transportation of the discarded materials as part of the waste processing, e.g. to a recycling site and transportation of waste e.g. to final disposal; - C4 waste disposal including physical pre-treatment and management of the disposal site. Waste processing is part of the building life cycle under study. In the case of materials leaving the system as secondary materials or fuels, such processes as collection and transport before the end-of-waste state are, as a rule, part of the waste processing of the building. However, after having reached the "end-of-waste" state further processing might also be necessary in order to replace primary material or energy from primary fuels in another product system. Such processes are considered to be beyond the system boundary.
Decon-struc-tion	The boundary of the deconstruction process includes on site operations and operations undertaken in temporary works located off site as necessary for the deconstruction processes after decommissioning up to and including on site deconstruction, dismantling and/or demolition.

Table 17: Stages of construction, EN 16627

Further tools to describe sustainable construction

Diverse description tools for sustainable development in the context of real estate and construction are on the market. Mainly certification processes are applied. The Swiss standard SIA 112/1 (2004) sustainable building – building construction is shown. This takes societal aspects in an architectural, design and comfort stressing way into consideration, highlights economic output in real estate management on investors side and adaption of building quality to the user demand like building substance and maintain-

ing costs. Ecological aspects show building materials, operational energy, infrastructure, soil and landscape aiming at the 2000-watt society. SIA 112/1 (2004) suggests a societal approach. Environmental issues are construction material (raw materials, environmental impact), operational energy and space efficiency as well as infrastructure. Suggested economic criteria by SIA 112/1 (2004) are construction substance (reach value stability), location (provide a long utilization) and flexibility. Further investment costs are mentioned as costs over the life cycle and long term assured finance along the building life cycle until demolition. In addition, social arguments are integration and community, design, comfort and functionality.

Beyond those regulative elements, certification systems gain influence in the real estate market as decision-support instrument and assessment tool. Some of these certification systems are based on regulative works. Still, regulative works are under development, and both approaches, certifications and regulations, grow parallel and gain influence as decision-support element. General points of view on systems are brought up here together with general assessment methods of the most known systems. This is important to be kept in mind in this study, to follow up the argumentation on sustainable construction versus sustainable development. Different building sustainability tools use different data source.

Excursus IX Environmental rating of buildings. The environmental rating of buildings has gained interest since the introduction of the first assessment system for sustainable buildings, BREEAM, in 1990. The most common certificates are LEED (USA), BREEAM (UK), DGNB (Germany), HQE (France), PromisE (Finland), Minergie (Switzerland), Green Star (Australia), Casbee (Japan) and Certificazione Protocollo SBC (Italy). The first two measures have gained wide international acceptance. These green building assessment tools vary in their scope from single to multiple-dimensional tools. Generally, they cover the energy efficiency of the building, although they extend to a number of other sustainability criteria including the sustainable sourcing of building materials. The fundamental problem with benchmarking tools is the selection of categories and their weights. The assessment tools usually cover the whole life cycle of the building by using typically fewer than ten evaluation categories, each one with its own set of indicators. Typically, the categories refer to health impact, energy use, water and transportation needs. However, buildings can also earn scores from management practices and innovativeness. The outcome of the benchmarking is typically expressed in three (DGNB), four (LEED) or five (BREEAM, PromisE) categories. None of these certificates specifies a benchmark for poor performance, but the categories start from “regular” or “certified” level. LEED (Leadership in Energy and Environment) and BREEAM (Building Research Establishment’s Environmental Assessment Method) have already established their position as international construction benchmarking tools. As the dominant voluntary program in the United States, LEED does not restrict the use of different forest certification programs, but offers credit only for FSC-certified materials. Other green building programs recognize additional third-party forest certification programs (UNECE/FAO 2011a). BREEAM has developed an extensive system called the “Green Guide” to rate materials and construction elements in the UK, but localized versions of BREEAM can use other established LCA tools or databases instead. A “newcomer” in green building standards is the German Green Building

Council's DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen). The standard is currently being developed for internationalization and has already been adopted in Austria. A catalogue of some 60 criteria constitutes the basis for evaluation: global warming potential, resource efficiency and the use of non-renewable energy are some principal evaluation criteria. The criteria are weighted in accordance with their importance for the particular occupancy profile. Currently nine profiles are in use. Unlike the main green building certificates (LEED and BREEAM), DGNB takes a holistic view of sustainability. It is possible to increase the weighting of each criterion as much as threefold, or to disregard it entirely, based on its societal or political relevance and its importance for the specific use profile. (Räty et al. 2012)

Life cycle costing (LCC) follows the idea of life cycle thinking. However, one of its shortcomings is that only costs but not revenues are accounted. Still, this study does not go deeper in the comparison of certification schemes, but points out that sustainable development is not addressed completely by certification of real estate and construction systems.

Summary of chapter 4.2:

Bridging the demands of the societal regulative target sustainable development and sustainable consumerism, and taking these approaches to real estate and construction circumstances, these points can be kept in mind for the future study:

- Sustainable development as regulative target cannot ultimately be quantified;
- Life cycle assessment is identified as one important approach to support product-oriented decision-making;
- Life cycle thinking as it is applied in environmental life cycle assessment can be linked to life cycle thinking in real estate and construction;
- In the context of real estate and construction, the main decision support information is coming currently from the environmental side of sustainable development. Hence, environmental information on construction products is comparably easy to find.

4.3. Towards the implementation of sustainable development for real estate decisions

This part details the proposed interrelation real estate-development, investment and contractor as responsible constellation for effects, which induce sustainable development. Evaluated expert interviews serve as validation for the identified gaps and overlaps.

4.3.1. Gaps: sustainable construction and sustainable development

This chapter describes aspects and resulting tasks to approach sustainable development in a broader sense than sustainable construction. In order to become relevant for decision-making, the difference between the two concepts sustainable development and sustainable construction needs to be operationalized for strategic management. According to the Brunsvician Lens, this chapter is amongst others, part of step D, which describes the synthesis.

A	B	C	D	E
Problem	Decomposition	Perceptor	Synthesis	New composition

Structural deficiencies and the induction of sustainable development

In Germany, real estate is seen primarily as living space and secondary as economic asset. Real estate are operating resources in the service creating process and capital investment asset and therefore need an active management (Pfnür 2011).

Deficiencies in coverage of sustainable construction in view of the general demands of sustainable development are described by Lützkendorf et al. (2011). They identify that social and economic issues largely remain unclear or unaddressed: there is a lack of a true understanding of what sustainable property really is. Relatively clear concepts exist only with regard to technical aspects such as energy efficiency and building ecology, whereas social aspects and economic issues remain vague and selective. In addition, they point out to the fact that sustainability is taken into consideration to an insufficient extent – if at all – when appraising a property financially. The Royal Institution of Charted Surveyors (RICS) has acknowledged this recently (Lützkendorf et al. 2011). Lützkendorf et al. (2011) support that a sustainable building is meant a building that contributes to sustainable development, including the minimization of life cycle costs and safety of workers, which is not yet fully provided by diverse certification systems. By safeguarding and maximizing functionality and serviceability as well as aesthetic quality, a sustainable building should contribute to the minimization of life cycle costs; the protection and/or increase of capital values; the reduction of land use, raw material and resource depletion; the

reduction of malicious impacts on the environment; the protection of health, comfort and safety of workers, occupants, users, visitors and neighbors and to the preservation of cultural values and heritage (Lützkendorf et al. 2011). This means, the context of sustainability methods and indicators needs to define protection goals first. The environmental dimension is developed, the social dimension is a challenge and the economic dimension is still unclear[22], Environmental impacts and environmental lifecycle thinking are often being implemented into decision-making. Lasvaux et al. (Lasvaux et al. 2014) demand adapted LCA tools for the different stages from design and construction phase, and LCA to include economic and social impacts. Rather abundant environmental information is accessible, but needs further development for applicability. A close co-operation between LCA methodologists and construction scientists can lead to appropriate methodological developments (Lasvaux et al. 2014).

Standards try to integrate the trifold dimension of sustainable development on product level, but still miss information input. Van Wezemael and Derron (2014) conclude that building standards are not focusing on the economic and social aspects, but are rather detailed in the ecological objectives. Social and economic aspects are underrepresented in the assessment. On the product level, the current work program of CEN TC 350 defines solely activities for environmental aspects whereas on building level, also social and economic performance are embraced. Sustainability measures are at the beginning to be used in practice. CEN TC 350 restricts the social dimension of sustainable development to the use phase for buildings and building products. The only connection on building product level are health and comfort, which are addressed partly in EPD. Until now, the coverage of social aspects is limited to the use phase on building level.

Now, an emphasis on solving the environmental part of the trifold dimension can be seen as regulative focus. Still, the analysis of sustainable development needs to integrate the partial sectors: raw materials extraction, construction materials production and construction creation. They have to be integrated for a holistic resource management. Here, reliable data is necessary, but official statistics do not preserve those (Weber-Blaschke et al. 2006). In addition, economic and societal aspects are taken into consideration, but definitions and descriptions of these challenges are not yet as elaborated as the environmental side.

To induce sustainable development (inter alia also by sustainable construction), the following lacking of understanding sustainable development can be summarized:

[22] https://www.dbu.de/708ibook76095_36293_705.html, accessed on 24.07.2015

- Understanding sustainable development is based on individual responsibility, rationality and trust;
- An ex-post certificate is no takeover of responsibility;
- The business model needs to be approached, to use existing control channels for the implementation of sustainable development into practice;
- Enlarge the coverage of social aspects of sustainable construction to the assessment of social demands happening along the production process (theory of sustainable consumerism). This leads to an enhancement of work opportunities;
- Intensify the economic focus and respect reality: existing economic tools can be applied to investigate the economic side of sustainable development, and developed further. Again, existing control channels can be applied and further developed;
- Regulative actions and standardization processes shall develop rules based on existing business and construction activities to supports an easy implementation and change management;
- Not only the building as a product, but also the production process, and construction products have to be taken into consideration, including their interrelations and effects.

Deficiencies in the target system sustainable development and sustainable construction are a lack of values and therein effects on decisions. The decisions of actors along the development process are interdependent; bear hidden causalities and structural deficiencies. Often, quantitative information is not sufficient. The decision-makers cannot be fully informed. Construction practice offers chances to address sustainable development beyond sustainable construction. Suggested are following topics in order to face the problem:

- Create new social aspects integrating the production process. This means, keeping an eye on the contractor;
- Integrate the sustainable development assessing the whole life cycle of construction;
- Real estate is an economic asset.

Following findings on sustainable development can be summarized to assess the problem of assignment and interlinking of ecology, social aspects and economic topics.

- Delegate individual responsibility;
- Regard corporate/ institutional responsibility;
- Initial decision phases and strategy development are responsible for inducing sustainable development;
- Create jobs;
- Create business opportunities;

- Provide attractive conditions for production;
- Create values in correlation to human living;
- Need of transparency;
- Own and community welfare opportunities;
- Structures of freedom, less regulation and regard real processes.

These findings have to be taken into consideration to induce sustainable development. The existing targets and objectives do not completely meet the requirements and demands of sustainable development. The study has shown the information flow in real estate development and construction on the one hand. On the other hand, the challenge was shown that information on product level is implemented on building level concerning the evaluation of sustainability. CEN TC 350 are taking the concept, building and product level into consideration and do have the same system boundary in all three areas. The standards on sustainable construction support information and answers concerning sustainable development in the end of the production process. This means that in practice an assessment can be made ex-post only, but for planning matters, standards of TC 350 do not work.

The following approach is suggested for an assessment that has the potential to induce sustainable development:

The production process of real estate as economic asset and the whole real estate life cycle can be seen as 3-dimensional frame for the induction of sustainable development. Figure 40 illustrates this approach.

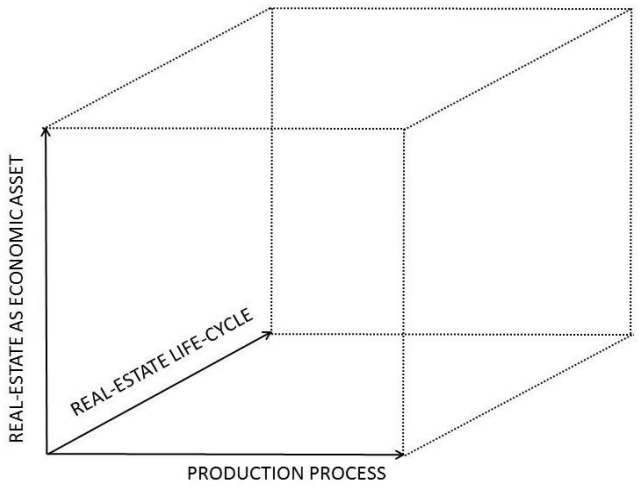

Figure 40: 3D-approach on real estate and sustainable development

Based on this concept, the gaps in the coverage of sustainable construction can be enlarged towards the general understanding of sustainable development. Therefore, this study focuses on real estate development (RED), investment and contractor and their connections, as shown in Figure 41. Here, SD stands for sustainable development. RED is directly connected to the contractor in the tendering processes and

project management and controlling. RED is also directly connected to the investor concerning budgets and the profile of the real estate project. All activities of RED, investor and contractor influence sustainable development. The three parties are connected each to further factors.

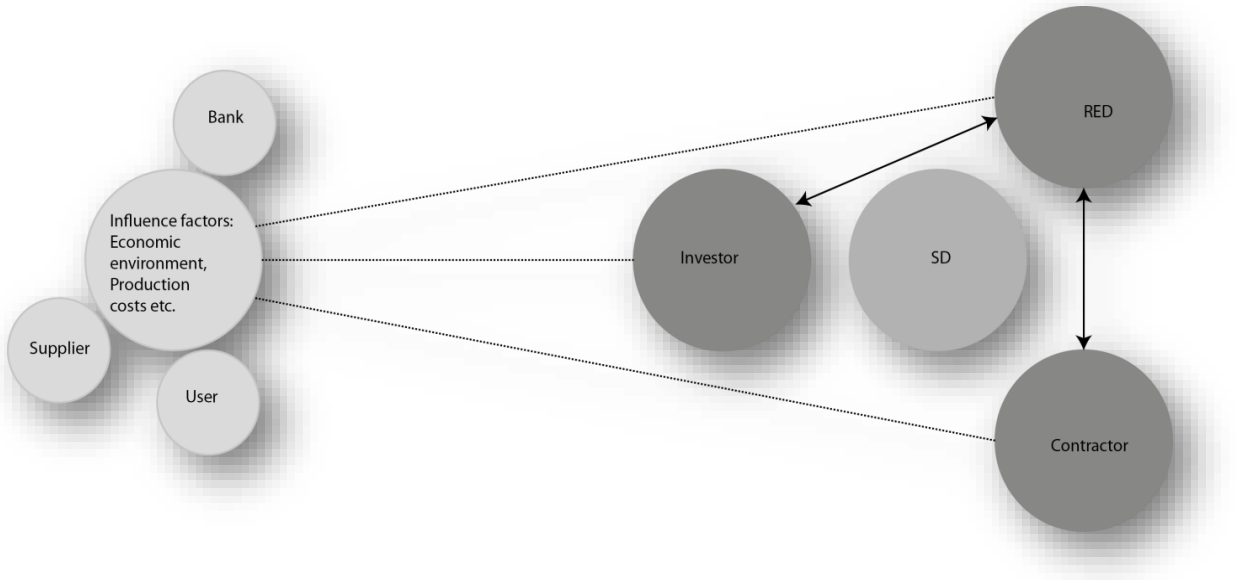

Figure 41: The RIC parties

The interrelations amongst investor, real estate development and contractor bear criteria, which are responsible for sustainable development. These criteria can be used to assess the potential for the induction of sustainable development. Furthermore, hints are given on a better understanding of real estate as an economic asset and as a product with a production process (with social impacts) at the same time in the context sustainable development.

Taking social aspects along the production process to the assessment

SCBA social cost benefit analysis (Damingos 2006) is used for large-scale infrastructure projects in the early planning phase e.g. in the Netherlands. The question here is, how does the work benefit others? In the application of the project management in the case study, social aspects are the “information on environmental compatibility and the attractiveness of the real estate object for the user (comfort, user-friendliness and health), emission of thermal, acoustic and visual comfort, functionality and space efficiency”. Social aspects describe the subjective attractiveness of the asset, which guarantee value stability and long-term marketability (Schwarz et al. 2013). At this point, the potential for social performance improvements is identified.

In "Vision 2050", the World Business Council for Sustainable development (WBCSD) presents a plan for the global population to live well, and for businesses to prosper within the limits of the planet. The council envisions markets that promote transparency, include externalities (such as ecosystem services

and environmental impact) within the marketplace, with the ability for the customer to choose products that provide overall value (Finkbeiner 2011).

A wide range of approaches regarding the methodology of SLCA exists. This field is still considered as immature[23] (Finkbeiner 2011). The product development process is regarded a crucial intervention point for sustainable development in society (Finkbeiner 2011). The social impact of a product is described as its influence on people´s well-being throughout its life cycle, and that this impact mainly depends on the conduct of companies involved in the life cycle towards their stakeholders and not on the production processes themselves (Finkbeiner 2011). A set of indicator was identified and narrowed down to 36 indicators and assigned to the most suitable of the stakeholder categories (Finkbeiner 2011):

- Employees;
- Local community (community development and social justice, respect of cultural heritage);
- Conflicts (neighbors and community);
- Society;
- Public commitments;
- Transparency;
- Contribution to economic/ technology development;
- Corruption and mitigation of crisis;
- Consumers;
- Value-chain actors.

As mentioned, one of the recommendations of the European Commission (UNEP 2014) are focusing on create growth and jobs beneath well-being of people. That means work and employment is in the focus of the European policy. Another important tendency is that, the change from industry to service society has large consequences for the construction sector and the construction project. The regional building industry will become the backbone of rural regions on the long run (Wallbaum et al. 2011). Furthermore, employment is in different systems seen as essential for social impacts. “Unemployment has important social impacts on the workers. Unemployment in general affects the physical and mental health and mortality of the individual to the extent that it is concluded that work (with all that it includes) on average improves physical and mental health in comparison to the unemployed situation (Jorgensen et al. 2010). It is widely known that work, respectively employment is the most important base for a self-determined

[23] However, there is a wide range of different approaches with the regard of the methodology of SLCA, which is s sign of the immaturity of the field. No standard or commonly accepted set of metrics or indicators exist for measuring the social sustainability of a product life cycle (Finkbeiner 2011).

life. The material and subjective dimensions (employment, salary, qualification, participation and health) determine the quality of life. Job creation as well as development of employment is a highly important topic for the European Commission.

The provision of employment is of high importance in the context sustainable development. A high employment rate is a political need. In an economic sense, below-capacity employment means a wastage of resources. For the ones who are not able to participate in working life or do have different societal recognized tasks, livelihood has to be safeguarded (Blazejczak und Edler 2004). This topic should be implemented in the discussion of the social demand of sustainable development next to health and comfort, as presented in Table 18.

Arguments for work as social demand
Job creation
Development of employment
Meet anticipating labor market needs
Social partners should ensure worker´s involvement in matters related to resource use
Health
Safety
Boosting GDP
Boosting jobs

Table 18: Aspects of work as social demand, EREP 2014

Aspects occurring whilst the production phase to contribute to a sustainable product and induce sustainable development as regulative societal goal to promote sustainable consumerism needs seeing employment and further described aspects as relevant ones. Still, the guidelines of sustainable construction (BMUB 2015) are missing this understanding. Sociocultural objects of protection are human health, user satisfaction, functionality and cultural value. Though, as targets of protection, securing of earning capacity and jobs, is mentioned as common understanding of sustainable development, it is not mentioned as objects of protection in the category sustainable construction amongst “protection of health, security and comfort, provision of functionality and design and urban design quality” (BMUB 2015).

Still, consumers have become increasingly interested in sustainability, creating opportunities for businesses to position their products using environmental or social responsibility related information (Finkbeiner 2011).

The construction sector can be seen as potential contribution to the argumentation in a constructive manner. Keeping in mind, production process of real estate and construction was suggested to move into focus of the assessment on sustainable development leads over to a closer look on social aspects as they are taken into consideration now. As mentioned in chapter 4.2.3, e.g. SIA 112/1 (2004) takes commu-

nity, design, transport and comfort into consideration for the assessment of social demands. Every societal change or change of quality of life, which are influenced or caused by the characteristics of buildings, construction parts, processes and services, determine social quality (EN 16627). Assessment of social performance of buildings focus at building level on diverse criteria, like e.g. accessibility, maintenance, flexibility, comfort, neighborhood, security. A social aspect is hereby defined as effects of construction works, assembled system, processes or services related to their life cycle that can cause change to society or quality of life (EN 16627). Ecologic or environment-related quality is measured within the change of environment, which is determined, by buildings, construction parts, processes and services. CEN TC 350 standards mention in the description of the determination of social aspects the organization of the construction works the influence on social aspects by construction, the design and of the construction works and the choice of products and materials as well as assembly, utilization and inspection/service/ cleaning and maintenance (EN 16309). Still, the phases A1 to A5 and C1 to C4, which bear life cycle related building information, are not integrated into the assessment of social demands. Furthermore, the assessment of the origin of materials requires the documentation of the installation of the construction product. In practice, this is easy to be avoided.

Excursus XI: SCLA. Corporate social responsibility (CSR) is among other things influenced by those criteria: Employment, work, respectively and unemployment are strongly indicating also social life cycle assessment (SLCA). The SLCA can in many regards be seen as a parallel to the environmental life cycle assessment (ELCA), but rather than focusing on environmental impacts, the SLCA[24] as decision support focuses on social impacts of products, processes, services or systems (here simply termed 'products') in principle throughout their life cycle (Jorgensen et al. 2010).

Excursus XII Definition of work and employment. Work means any target-oriented, scheduled and conscious physical and mental actions with certain targets. The result of the value-forming process is the work performance. The productivity and motivation is substantially determined of the right choice and allocation of staff, the working atmosphere and the appropriate payment. As key criteria of satisfaction, payment, social benefits, a safe employment, good advancement opportunities, working atmosphere and social recognition count. (Diederichs 1999)

[24] The ultimate objective for conducting an SLCA is to promote improvement of social conditions and of the overall socio-economic performance of a product throughout its life cycle for all of its stakeholders (Jorgensen et al. 2010).

As proposition, the coverage of social aspects of sustainable construction shall be enlarged. Regarding production as determining sustainable development, and sustainable consumerism theories, fair work is an essential argument for a sustainable product, which aims at supporting sustainable development. This means, social aspects of sustainable construction can be enlarged by qualitative employment as social dimension. Blazejczak and Edler (2004) stress the importance of gainful employment, which supports the argumentation that in an employment-centered society, sustainable development designs have to recognize the development tendencies of work in a stronger way.

In the case of construction, work is an important factor for construction quality and pricing (Diederichs 1999):

- For the stabilization of employment in the construction sector, diverse measures have been initiated (e.g. contractual agreement of time limited minimum wages);
- The costs of work as production factor in the German construction business are on international range on top;
- German non-wage costs are in international range on top (Social wages and social costs), which means a high pressure on contractors;
- The availability of local manpower is an upcoming problem due to mobile workers of different countries;
- Material/resource orientation can be observed in building products productions;
- Germany has compared to Europe high labor costs, a short annual working time and within this high labor unit costs; high unemployment due to structural labor market problems; a very high corporate and employee taxation; high bureaucratization as well as an antibusiness basic setting in society.

Still, those aspects can be implemented in criteria for social aspects along the life cycle of construction products and real estate. Social aspects are closely related to construction quality. Technical construction quality is an important argument for the life cycle of construction.

Integration of economic aspects in real estate and construction

What´s the financial return on your investment? The economic environment in the case of real estate includes both, space and money over time. From the point of view of an investor, mortgage lender or owner, a sustainable property within this approach corresponds to a property that maintains or increases in value in the long-term. In this definition, a sustainable property provides investors with a secured long-term profit. When considered from a dynamic financial point of view, property is sustainable if – ceteris paribus – it can deal easily with changes to the environmental, social, political and economic

framework conditions (adaptability) and, therefore, minimizes the risk of a reduction in value or increases the opportunity of an increase in value (Meins et al. 2010). For example, the main driver for the expansion of certified office space is the Corporate Sustainability Responsibility (CSR) agenda adopted in most international corporations. Based on CSR-guidelines the companies are committed to lease green office space – verified by a green building certificate. Therefore, property owners are seeking to certify their assets to fulfil the standards of international companies when acquiring them as tenants (RICS 2015). Pfnür (2011) and Lützkendorf et al. (2013) describe the actual situation and need for the development of economic criteria. In the case of sustainable construction, an understanding of what defines "green buildings" and drives demand in each context is essential, as local market conditions have a significant impact on the valuation of buildings. The question relating to areas and goals of protection in the field of economics arises. Yet, the importance of business economics in the real estate context has risen (Meins et al. 2010). On European level, the indicators *life cycle costs* as well as *value* are currently being developed (EN 15643-3).

Lützkendorf et al. (2013) debate economic performance aspects of buildings in the context of the contribution to sustainable development. They critically examine the current state of respective standardization activities, assessment practice as well as possible criteria and indicators and discuss open questions and problems, which are associated with the attempt of evaluating the economic performance of buildings within the context of sustainability assessments (Lützkendorf et al. 2013). Since financial assets and capital are resources, the goal of protecting financial resources can be implied in the first instance. Protecting financial resources also contributes to maintaining the actors'/market participants' (financial) capacity to act. However, it is problematic that besides for owner-occupiers, which can follow a total-cost-of-ownership approach, costs of buildings during their life cycle can and have to be assigned to specific actors. Consequently, the question of the appropriate perspective arises (Lützkendorf et al. 2013). Another possible goal of protection is the "affordability" of buildings. Without doubt, low construction and operating costs can contribute to the affordability of buildings in the sense of eased access to the rental housing market or to residential ownership. For example, for tenants but also for owner-occupiers operating costs are of particular interest as these costs are not only determined through user behavior but also though several building characteristics such as insulation, water-efficient taps, etc. However, in most cases and regarding other property market actors, the affordability of buildings is overlaid by a variety of other factors. For example, in the case of owner-occupiers, the "affordability of a building" is co-determined, amongst other issues, through household income and financial circumstances. As such, "affordability" is not a trait of buildings per se but a challenge to society (Lützkendorf et al. 2013).

The economic impact is reflected in the marketplace (RICS 2015). Studies dealing with real estate capital investment indicate that property does not only need an engineering differentiation, but time as dimension is an integral component of an economic real estate definition. Real estate does not have an intrinsic value, but the value arises with the use of property over a specific period of time (Pfnür 2011). Up until now and if at all, economic performance aspects[25] have been considered by focusing on the costs of buildings during their life cycle. The goal was to minimize these costs and to achieve a favorable trade-off between construction and operating costs (Lützkendorf et al. 2013). Space/ time units in money / time units via rentals, transfers real estate to a rewarding investment object (Pfnür 2011). Costs connected to the construction of real estate and the duty to care for contaminated sites have to be kept in mind (Pfnür 2011).

Questions on economic aspects do have to be seen under certain constraints (Lützkendorf et al. 2013). Besides certain exceptions, sustainability assessments of buildings usually do not involve valuations (in the sense of market valuations) or specific/ individual economic efficiency calculations. What can be described and assessed as part of a sustainability assessment is – in the sense of a partial (economic) indicator – the building-induced contribution to financial risk. Thereby, the actual property valuation – which considers several further aspects (such as overall market conditions) in addition to sustainability-related value relevant building features – still remains outside of sustainability assessments.

Economic targets in the real estate and construction context demand to connect technical aspects aims to minimize the expected total life cycle cost while maintain an allowable lifetime reliability for the construction. Deterioration, repair and time value of money are determining facts, connecting technical requirements to economic facts. The overall cost to be minimized includes the initial cost and the costs of preventive maintenance, inspection, repair and failure. LCC is a valuable financial approach for evaluating and comparing different building designs in terms of initial cost increases against operational cost benefits with a long-term perspective. The key incentive for applying an LCC analysis is to increase the possibility of cost reductions for the operational phase, even if an additional increase in the initial investment is necessary. By applying an LCC perspective in the early design phase, decision-makers are able to obtain a deeper understanding of costs during the life cycle for different design strategies. Economic lifetime is shorter than the technical (Haus 2012). Cost estimations of the construction phase, use phase and maintenance costs: in order to estimate net present costs of the different design options, indexation and discount rates can be chosen to reflect a stable macro-economic situation. Indexation rate

[25] "The goal is to protect/maintain and, as the case may be, to increase the buildings' economic value since this contributes to the stability of the economic system. Therefore, aspects like value stability, retainability and value development turn into assessment criteria. However, the problem here is that these aspects have not yet finally been transferred into manageable indicators and that appropriate measurement approaches and standards are still to be developed" (Lützkendorf et al. 2013).

can be tied to the European Central Bank inflation target and the discount rate can be tied to 10-year government bond. These rates can be applied to construction costs, energy costs, maintenance costs and life cycle costs.

Arising problems are upcoming conflicts of interest. First, two formerly distinct disciplines, sustainability assessment of buildings and property valuation, are converging and rely heavily on each other. On the one hand, sustainability assessments of buildings increasingly rely on concepts (market value) and methods (income/investment valuation method), originally developed by the valuation profession in order to be able to describe and asses the economic performance of buildings. On the other hand, the valuation profession increasingly relies on sustainability related information in order to be able to estimate the economic value of buildings (Lützkendorf et al. 2013). Next, the target minimizing life cycle cost interacts with tax strategies. "The calculation and assessment of life cycle costs is normally carried out by taking the perspective of planners which is usually identical with the perspective of owner-occupiers or public authorities. However, for all other market participants, individual or institutional perspectives dominate any assessment of cost-effectiveness. In addition, regarding the criterion life cycle costs there is a conflict of goals from a societal perspective. On the one hand, the input of financial resources during a building's life cycle shall be minimized; but on the other hand, this input of financial resources generates tax revenues and creates/maintains employment. With this background it becomes apparent that the application of life cycle costs as a criterion for assessing a building's economic performance has hitherto taken place without proper methodological deduction and theoretical reasoning" (Lützkendorf et al. 2013).

Figure 42 shows the economic performance criteria along the building life cycle. For an investment approach for trade, the regulative demanded approach is even harder, as the difference between core-and-shell and tenant fit-out does not allow provide information required for the economic assessment (Pfnür 2011).

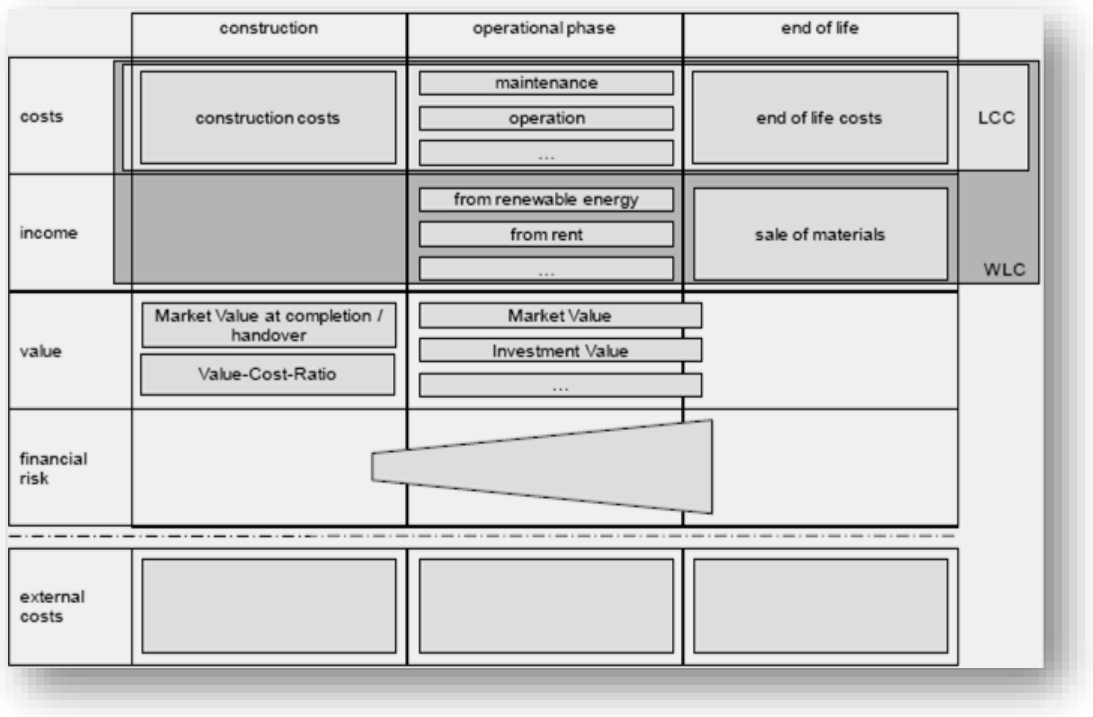

Figure 42: Economic performance in the building life cycle, Lützkendorf et al. 2013

The focus on financial and economic factors of real estate investors respectively owners of portfolios have different cost indicators and parameters (Lützkendorf et al. 2013). The following criteria for assessing the economic performance of construction inducing sustainable development are considered to be crucial. Table 19 shows the comparison of economic performance indicators.

A Construction/ investment cost	B LCC – selected cost	C Value-cost ratio	D Value stability/ development & risk
Considered construction costs	Type of included cost categories	Way of determining the investment cost	Integration of sustainability aspects into the valuation
Reference year of the costs	Scope of included cost categories	Methods of valuation	Development of methods to predict the development of value, considering also the sustainability aspects
Price level of the area	Time frame/ reference study period		Integration of sustainability aspects into the risk and property analysis
Treatment of planning costs	Applied discount rate		
Treatment of land costs	Assumed inflation rates		
Treatment of VAT			
Reference unit			

Table 19: Economic performance indicators checklist, Lützkendorf et al. 2013

Construction / investment costs cannot be recommended as an appropriate criterion for assessing the economic performance of buildings within the scope of sustainability assessments. Instead, it would be possible to consider maximum additional costs or demand compliance with a given budget as an additional requirement – e.g. within the scope of assessing life cycle costs.

An international standard for calculating life cycle costs is ISO 15686-5[26]. The results of a life cycle cost analysis are influenced, among other issues, through the following parameters: Type and scope of included cost categories: There are various forms of describing and structuring different cost categories, which could be included within a life cycle, cost analysis. A distinction has to be made between a life cycle cost analysis in a strict sense. A life cycle cost analysis in a wider sense (i.e. in addition to costs also income / payments-in are taken. The life cycle costs of a building are usually comprised of construction costs (DIN 276 for Germany) and operating costs (DIN 18960 for Germany). Up until now, usually not all costs / cost categories are considered within the scope of life cycle cost analyses in the context of sustainability assessments in Germany. Instead, a selection is made in order to consider building-induced costs only, since only these costs can directly be influenced through decisions made during the planning / design phase (e.g. energy costs, maintenance costs, cleaning costs). Measures and time frame under observation. From a methodological point of view, sustainability assessments of buildings favour taking an identical period (as well as an identical building model) for both, life cycle analysis (LCA) as well as life cycle cost analysis. In Germany, for example, the time frame (or reference study period) for both aspects of the assessment is 50 years. Choice of the discount rate for calculating net present value / net present cost (the choice of the applied discount rate significantly impacts on both, the resulting net present cost or net present value respectively as well as on the relationship between initial construction /investment costs and follow-up costs). In addition, the selection of the applied discounting model, e.g. exponential or hyperbolic discounting can be made from a number of different perspectives (assumed inflation rates, assumed scenarios for maintenance, modernization and end-of-life).

Cost value ratio means, investors as well as owner-occupiers have an interest in ensuring that the economic value of the building at point of completion is not less than the capital cost of it. The approach pursued by Lützkendorf et al. (2013) relates the total cost needed to bring a project to a commercially operable status (e.g. purchase of land, buildings, construction and equipment, an investor's profit margin, etc.) to the completed building's market value (estimated by applying the income/investment method of valuation) at the date of handover. This cost-value ratio at point of handover illustrates how worthwhile the investment into a project is at the point of completing the project since it reveals whether or not the capital costs are related appropriately to the current market situation. By introduction a cost-value ratio as an additional indicator into the sustainability assessment of buildings, the market valuation of properties (the traditional domain of the property valuation profession) becomes a basis for calculating this ratio. Moreover, this inevitably leads to further questions; notably the question whether or not non-valuation specialists are actually able to accurately assesses the market value of a building? Property

[26] However, the current structure of the standard is more or less a checklist to declare included cost categories. As such, the existing standard only partially answers currently unsolved questions (Lützkendorf et al. 2013)

valuation is a complex professional activity backed up by professional codes, extensive standards and guidelines and usually, carrying out valuations in practice requires extensive expertise and appropriate education and training. Advocates of a cost-value ratio might argue that a detailed property valuation is not really necessary in this context and that simplified valuation methods could be applied by laymen since finding out whether the capital costs are significantly higher (or lower) than the market value at the date of handover is sufficient. However, the counter argument here is that several past real estate and financial crises have painfully demonstrated that even experienced valuation professionals. This was due to the fact that they occasionally under- or overestimate a building's market value significantly. Consequently, it needs to be discussed whether external expertise (in the form of trained valuation professionals) is necessary whenever sustainability assessments of buildings aim to also assess the worthwhileness of an investment.

Long-term stability of value and value development / contribution to financial risk is a medium- to long-term perspective on the economic value of buildings is extremely difficult and associated with various uncertainties. This is due to various reasons: first, assessments of the economic value of buildings are snapshots in time they are usually valid only for the specified date of valuation. The concept of a long-term perspective on a building's economic value is termed mortgage lending value within the valuation profession; and this concept is controversially discussed since parts of the valuation profession simply deny (for good reasons) that a long-term assessment of economic value can even exist. Forecasting the future value development of buildings is hardly ever possible. In addition, the value development of buildings depends on many factors (e.g. market conditions) other than building-related characteristics, and attributes. Furthermore, integrating the long-term stability of value into sustainability assessments of buildings would mean taking the current Market Value as a starting point for the analysis; and this, in turn, would lead to the very same problems and open questions as discussed in the context of a cost-value ratio above. Lützkendorf et al. (2013) suggest assessing the medium- to long-term building induced contribution to financial risk. In practice, this could be done along the lines of so called property and market rating systems (the rating category "property" is of particular relevance in this context) which are applied by the valuation and financial industry since several years in order to measure and portray the financial risk of property investments and of loans secured by real estate assets (Lützkendorf et al. 2013).

The standardization process of CEN TC 350 yet considers the very early real estate development phase, and takes contracting, procurement of products, construction work as important stages for information

generation[27]. CEN suggests, taking information relating to the object of assessment from the client´s brief, regulatory requirements and project specification[28]. As system boundary for the assessment of economic performance, the beginning of the planning of the development is the start, whereas cost and financial value should be used to describe the economic performance of buildings over their life cycle[29]. This seems to be very similar to yet existing tools of value determination and real estate development. Indicators defined by CEN TC 350 are life cycle costing (economic performance expressed in cost terms over the life cycle) and financial value over the life cycle (economic performance expressed in terms of financial value over the life cycle). They are agreed on for future standardization. Stages of construction (EN 16627) require concerning the economic assessment to prepare a cost model of the building with full description of the technical and physical characteristics of the building, including the site and location. The purpose of the building cost model for economic assessment is to enable the costs associated the construction or refurbishment of the building to be quantified in a structured way.

Data, information sources and calculation methods are summarized in the discussion of assignment of data for on the assessment of the economic performance as state of art of standardization, see Table 20.

[27] For the assessment of the economic performance of a building, the life cycle starts with the decision whether to build, refurbish, renew, extend, retain or demolish. It proceeds through the contractual arrangements for design and specification, procurement of products, construction work, handover for fit-out and use, commissioning, actual use and finally at the end decommissioning, deconstruction or demolition. Information from these decisions and activities are needed to assess the economic impacts and aspects of the building (EN 16627).

[28] Information relating to the object of assessment and the functional and technical requirements shall be taken from the client´s brief, the regulatory requirements and from the project specification. In order to achieve compatible assessments between environmental, social and economic performance of a building, equivalent quantities and specifications for the assembly of products, and equivalent scenarios shall be used. The estimated service life of a building or assembled system (part of works) shall be established in accordance with European product standards and with ISO 15686-1, ISO 15686-7, ISO 15686-8 and ISO/TS 15686-9 (EN 16627).

[29] The system boundary for the assessment of economic performance of a building shall start from the beginning of the planning of the development, acquisition or refurbishment of a building or from the start of assessment of any existing building and include the life cycle of the building. The assessment report and communication shall include information on the main technical characteristics and functionality of the building that deviates from the technical and functional requirements given in the functional equivalent. Cost and financial value should be used to describe the economic performance of buildings over their life cycle (EN 16627).

Data	Information sources	Calculation method
Economic impacts and aspects incl. A0-A5, excluding B1-B5, incl. B6-B7, incl. C1-4, incl. D	- Site costs	- Rental and purchase
Decision to build, refurbish, renew, extend, retain, demolish	- Pre-construction costs, professional fees;	- (Design-fees), land value
Contractual arrangement for design and specification	- Taxes and other costs related to the permission to build; subsidies and incentives	- Fees for feasibility, planning and design;
Procurement of products	- Costs of products supplied at factory gate ready for construction, costs incurred between factory and site,	- ISO 15686-5, historical cost data;
Construction work	- Temporary and enabling works; landscaping;	- Activities to clear and prepare the building site for construction and to provide infrastructure and services (gas, electricity, water) within the site;
Handover for fit-out, commissioning and use	- Building related insurance costs, leases and rentals payable to third parties, taxes; regulatory costs	- Cyclical costs
Impacts excluding the building in operation at the use stage (Module B1-B5)	- Building relevant insurance costs; leases and rentals payable to third parties; - Cyclical regulatory costs; taxes; subsidies and incentives; - Revenue from sale of asset or elements, but not part of a final disposal; - Third party income during operation; repairs and replacement of minor components and small areas; - Replacement or refurbishment of major systems and components; - Adaption or subsequent fit out;	
Decommissioning		
Deconstruction-demolition		
Revenues (energy generated, avoided energy costs)		- Subsidies and incentives

Table 20: Assignment of data-economic performance, EN 16627

Still, most economic aspects can be determined after the tendering process. The following economic approach is suggested to address and induce sustainable development.

Originating from this conceptual approach, further benchmarks could be developed. Still, this study does not aim to develop benchmarks, as their weighting and development always has a political background (Werner and Scholz 2002).

Relevant economic aspects are summarized together with their operative approaches in Table 21. This stands as hint to break down economic aspects for the induction of sustainable development to an operative level.

Assessment criteria:	Manageable indication	Measurement approaches
Risk analysis	- Building-induced contribution to financial risk;	Property valuation in addition to sustainability-related value relevant building features
Returns analysis	- Short overview on ROI	*„Back-on-the-envelope" calculation*, revenues
Affordability	- Household income - Financial circumstances	Proof of sufficient capital reserves for maintenance, modernization and deconstruction Compare to 10 years of government bond
Value stability	- Value development	Profitability calculations (which are usually carried out within the context of investment or other decision-making processes)
- Construction cost - Operating cost - Tax revenues	- Clear, transparent and traceable depiction of construction / investment costs (in the sense of "additional information" accompanying an assessment)	Compliance with a given budget
Life cycle cost	- Assign to Life cycle cost the decrease in external costs	Avoidance of external costs within the scope of a subsequent deconstruction including disposal
Regional value creation of construction activities	- Regional employment - Regional service availability	Contract design

Table 21: Economic management indication

The economic-technical oriented structure of real estate economy results from specialization of professions and economic reasons. Within this structure, resources are bought and used almost exclusively under economic conditions. Real estate and construction can be understood as synergy of construction processes and construction products as well as space and money over time. The synergy of decisions and information generates economic, social and ecologic impacts.

Real estate is the result of a production process with an intermediate and final investor. If a building is regarded as the sum of construction products and construction processes, effects inducing sustainable development occur whilst the production processes of building products and the building– and do have to be taken into consideration when discussing the impact on sustainable development.

But still, individual stakeholder responsibility has been identified as one key element to meet the demands of sustainable development. Furthermore, the problem of an equitable consideration of the trifold demands has been identified to be challenging. Beyond that, production and consumption patterns have been identified and described as an important problem to solve on the way to sustainable development. Social and economic aspects need to be included into the decision process to meet the demands of sustainable development.

4.3.2. Structural deficiencies, hidden causalities and validation

Effects of real estate development, investment and contractor and their deficiencies regarding sustainable development have been identified in the previous chapter. Expert interviews with real estate developers, investors and contractors serve to validate these findings. According to the Brunsvician Lens, this chapter is part of step D, which links the perceptors to the synthesis.

A	B	C	D	E
Problem	Decomposition	Perceptor	Synthesis	New composition

Applying RIC to assess the induction of sustainable development

This study takes RIC (real estate development, investor and contractor) stakeholders, real estate development, investment and contractor as interrelation. Those are linked by further stakeholder (e.g. planning, engineering) in a second step. Figure 43 illustrates real estate development, investor and contractor interdependencies.

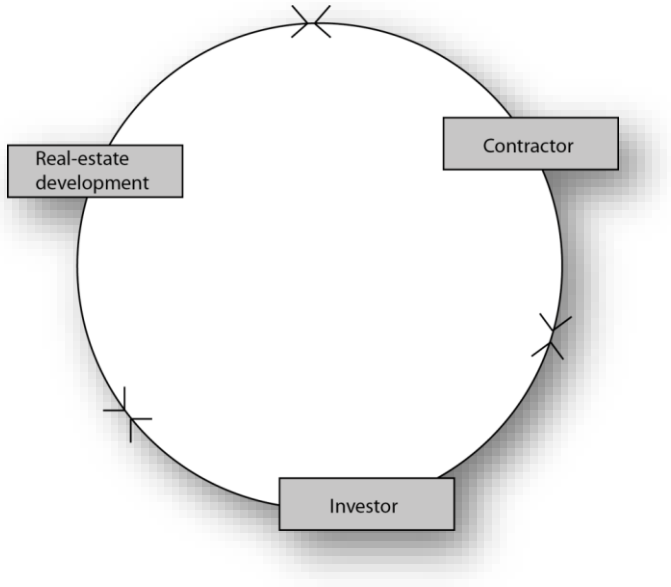

Figure 43: Real estate development, investment, contractor interrelation

Contractor activity. In search of structural deficiencies and hidden causalities concerning the induction of sustainable development, the contractor activity has been identified as determining element for quality and aspects along the construction phase. In addition, Hafner (2012) as well as Rottke and Landgraf (2010) identify the contractor as responsible for the construction phase and thereby for construction quality. Construction activity does not mean, seeming the final product "building" only, but taking into consideration different production phases and stakeholder. For construction quality, in the Swiss context (which in this case is similar to the German context), less diverse techniques and rising prices determine the decrease of building quality (Meins 2011). To enable informed decisions ex ante, a certification

process ex post does not mean taking responsibility. For the contractor, definitions by Diederichs shall be taken into consideration when describing construction operation entrepreneurship. Diederichs finds competitiveness as central task amongst entrepreneurial objectives that aim at market-oriented corporate development (Diederichs 1999). Furthermore, market participation has to be decided by the contractor to very different contract requirements, different origin, quality and extent without knowing potential competitors (Diederichs 1999). Gallardo-Vásques and Sanchez-Hernandez (2014) consider that "a firm has competitive success at regional level when it is able to attain a favorable position in the market and obtain superior results, while avoiding the need to have recourse to an extremely poor retribution of the factors of production". For the contractor, timeframes for consideration are construction time and warranty. Offer price is the critical element, which is determined by wage costs, other costs, equipment costs and external service costs. Extreme cases are competitors´ pricing. Contractors have problems of prognosis of the cash flow, as the construction market is very sensitive to cyclical fluctuations. Every building site is a new to-be-installed plant construction services are very staff intensive. In the case of underemployment, suddenly very high fixed costs arise which means extreme conditions for contractors (Diederichs 1999).

Investment decision-making. Hafner (2012) identifies the investor as very important stakeholder for the implementation of sustainability requirements and quality. In addition, the building life cycle perspective is stressed in this context. Hafner finds the investor as responsible as he has to specify the beginning of the construction project, the objectives to be achieved, he is the only responsible for the communication to those involved in planning. The investor has his early definition decisive influence on the further planning process and construction produced (Hafner 2012). The investor has support by assigned planners, engineers, consultants and advisory boards.

Real estate development activities. The investor as well as real estate development is interested in a very early integration of sustainable development relevant demands[30]. Derived from the target system sustainable development, quantitative and qualitative indication has to happen that supports the target system. In the early phase, it is not important to break down the target to final values but to enable the decision-maker to assure that decisions are directed into the right direction. The problem is that (especially environmental) information is available on product level. However, decisions are made on building level. Product information and real estate decision-makers and further stakeholders have different

[30] Investor must be aware that high demands on sustainability and construction quality only to a very early stage and with consistent implementation have minimal impact on the production costs. The investor should be clear cost savings must be calculated has to be done over the life cycle and do not necessarily lead to lower production costs. The influence of the client by, for example, indecision, delayed decision-making or has full confidence against the architect for the project success is of great importance. (Hafner 2012)

target systems. Ideas for this purpose how the different target system can be carried to match are developing criteria, not benchmarks. Furthermore, benchmarks are of political interest and their generation has to be questioned about timeframes. Creating benchmarks is insufficient due to the dynamic regulative perspective of sustainable development. It has to be kept in mind that the target system sustainable development cannot be fully operationalized. Better seeing it this way: targets[31] are essential for guiding action, for making sure that we are moving in the right direction, while indicators are needed to measure progress.

Interrelations and life cycle thinking. Moreover, Pietikäinen (2015) suggests sampling information on the whole life cycle of a building and postulates to change the building codes applied to all materials and parts of buildings and to develop a building passport based on the whole life cycle of a building. However, building products shall only be compared in the context of a specified application in the building, which is mostly difficult and a central problem when assessing the sustainability in the construction sector. In addition, the trifold demands have to be respected homogeneously[32].

Goal and scope of the expert interviews

The real estate development, the investor, and the contractor and their state of information determine the development processes. Real estate development, investor and contractor are identified as the relevant stakeholders for the initial phase as the first step of real estate development. Still, the end-of-life phase of real estate shall not be left out.

Goal of the expert interviews is, to clarify and confirm the interdependencies and hidden causal links amongst the stakeholder real estate development, investment, and contractor (RIC) in their activities. The question was which consensus does exist regarding the target sustainable development as mentioned? How does this target become decision-relevant? Which values do the stakeholders have and which information would they need in order to induce sustainable development?

Table 22 shows the concept for the questionnaire of the expert interview. The interviewed stakeholders are real estate development, contractors, construction tendering, construction project management, recycling association and company, architects, asset- and portfolio management, and real estate finance. Nineteen experts were interviewed between 05/2013- 05/2015 in a personal interview. Amongst those

[31] ”The EU should set ambitious, credible targets as soon as possible to improve the overall resource productivity of the EU economy, with a view to achieving the EU 2020 objective of overall decoupling of resource use and its environmental impacts from economic growth.” (Meins et al. 2012)

[32] For the sustainability assessment of buildings, comparisons of the environmental aspects and impacts need to be undertaken in conjunction with the social and economic aspects and impacts related to the building. (EN 15804:2012)

were five of the area real estate development, five in the role of the investor, four contractors and five consultants, managers and architects, which connect RIC. Topics covered in the interviews are listed in Table 22.

Topics of the questionnaire	
A) Contribution to sustainable development	A1) Risk perception
	A2) Economic evaluation
	A3) Ecologic evaluation
	A4) Social evaluation
	A5) Building quality
	A6) Long-term perspective
	A7) Value chain of materials
B) Effects on third parties and induction of sustainable development	B1) Social impact
	B2) Environmental impact
	B3) Economic impact
C) Resource efficiency	C1) Information needs
	C2) Technical functions
	C3) Documentation of deconstruction
	C4) Resource efficiency measures
D) Life cycle perspective	D5) Timeframe
	D8) Building quality
	D9) Portfolio strategy

Table 22: Scope of the interviews on RIC interdependencies

After the personal interview by help of the questionnaire, answers were documented. These results were coded and analyzed according to the following topics:

- RIC interdependencies, structural challenges and risk perception
- Assessment of RIC interdependencies in respect to sustainable development
- View of RIC on construction quality and long-term thinking
- Perception of the trifold demands of sustainable development

The results were summarized according to the suggested the 3-dimensional approach for the induction of sustainable development via real estate and construction.

The postulated approach as described in the study is:

- Regard real estate as an economic asset;
- Regard the whole life cycle from material extraction to the end-of-life phase of the building;
- Integrate the production process for constructions to assess impacts.

The results of expert interviews are presented in the following sections.

Key findings of interviews – identified interdependencies

Interview findings prove that RIC interdependencies (real estate development – investor – contractor) result in complex causal chains. It can be summarized that real estate investment decision-making is interdependent with real estate development performance. Table 23 lists criteria, critical elements and extreme cases for each of the RIC parties and interdependencies:

	Real estate development	Investor	Contractor
Criteria	- Return on investment (ROI) - Construction costs - Incidental building costs - Quality - Availability - Location	- Price - Return on investment (ROI) - Object availability - Cash flow stability - User satisfaction - Location	- Production cost - Negotiation - Offer price - Warranty - Rationality (location)
Critical elements	- Area development - Analysis of location and market - Development of requirement planning - Processing - Basic definition as guidelines for design planning - Definition of fit-out standards - Definition of technical standards and equipment - Early cost planning - Investment analysis - Quantity structure - Profitability calculation	- Quality; - Maintaining costs - Defining contract documents - Defining requirements - Fixing cost - Fixing Investment - Realization decision based on profitability calculation - Tenants want certified objects - Costs versus image - Direct purchase of real estate - Return/Risk ratio - Corporate investors (operating/ non-operating) - Foreseeable but insecure customer expectations - Contracts and their running time	- Quality - Requirement planning - Production planning - Responsible production - Subcontracting - Economically sensitive construction market - Uncertainties in cash flows - Construction services are personnel intensive - High fixed costs - Development of cost statement
Extreme cases	- Planning fees stick to transmission of costs for construction services - ROI - Market value of equity - Debt capital	- “sustainable” investment - “mainstream” investment - Willingness to pay (WTP) - Capital costs - ROI - Net present value - Does tenant pay more for certain criteria - Do certifications emphasize the right features?	- Competitiveness (doing the right things – doing things right) - Market-oriented corporate development - Human resources - Every building site is a new production plant - Production pricing - Material cost - Competitors´ pricing

Table 23: Interdependencies RIC

Real estate development is interdependent with contractor performance. A qualitative investment is only possible based on technical quality (of products and real estate as products), which is generated by qualitative contractor performance. The table 24 summarizes the interdependencies found by expert interviews. It can be stated that, regarding the investor, critical element is the price. Further criteria are quality, availability, and maintaining costs. The extreme cases are “sustainable” and “mainstream” investment and therein the willingness to pay (WTP). The real estate development is interdependent with

contractor and investor concerning life cycle cost, technical cost, capital cost, net present value and income. The production, pricing, availability, material cost, human capital, quality, regional value added. As result of interview statements, tasks mentioned in Table 24 influence real estate and construction decisions in the context RIC. The interdependencies, risk and management are mentioned cross-sectional for real estate development, investment, and contractor. Those risks perceived by the RIC parties are a point of interrelation of real estate development, investment and contractor.

After the general interdependencies, influencing challenges of RIC dependencies perceived by real estate development (RED) are presented. The meaning of the topics is elaborated by expert statements as follows. Table 24 shows the interdependencies between RIC parties from the perspective of real estate development. Three sub topics could be identified as main interdependencies. These are management challenges, market development as well as products and their availability.

RIC influences – the perspective of real estate development		
	Products and their availability	- Construction products availability and qualitative craftsmanship - Important arguments on materials are material qualities, limits of liabilities/ warranty, technological feasibility and construction quality (these are not mentioned in sustainability certification) - Construction products are needed on the market, which are traceable recyclable. There is no legal basis for handling this problem. The construction products regulation cares for EU regulated products - Recyclability is a question of technical possibilities - Design has to project the processes in an optimal way and save resources by a compact building and efficient structural design and construction - Design value and value of materials is defined by the market - Standards are defined by the market; costs of ten EUR more/ square meter convince the client to choose ETICS and no bricks - Ethos of architects is to design for eternity - Interest risks
	Market development	- Location and inherited burdens in contaminated sites and existing buildings - Flexibility to react on different markets - Difficulty to predict future purchase patterns - Vanity as motivation - BMUB 2015 booklet is influencing sustainable construction activity in Germany.
	Management challenge	- Interdependencies need to be managed. You cannot assume own perceptions, feelings and sense of tact - Laws and regulations are to be followed - Responsibility of planning: do not move away too far from HOAI - Design and planning should aim at space efficiency, optimized floor plan organization and reduce traffic areas - Budget development – budget allocation – budget definition (at least once a year) - Take responsibility, make decisions, use the common sense instead of certification - Ability to assess technical issues is lacking - Evaluation of funds by expert reports (asset value method and income method): only the income counts, not the asset value - Mass determination is based on the construction planning - Service specification (German LV) is qualified to place sustainable development. Planning activities to have to make up thoughts and this offers a good space to steer sustainable development

Table 24: RIC dependencies perceived by real estate developers

Investors are open and closed funds, private investors and institutional investors. The RIC interdependencies are considered as influencing factors and as a source of risk from the side of the investor.

Table 25 shows up these perceived influences. As main sources of risk and awareness can be identified:

- Products and their availability;
- Market development;
- Management challenges;
- Key value influencing criteria.

First, influences of real estate development, investment and contractor in the view of the investor are presented in the following tables. Table 25 shows the interrelations between the RIC parties, which are perceived by the investor concerning products and their availability.

Products and their availability – investors' perspective	- The user habits determine the sustainability of real estate - A sustainable user is determining sustainable development by use of the property; - Disposal determines product choice - Selection of contractors can implement sustainable development relevant tasks - Process of negotiation (which is possible in the private sector, not always in public awarding) – price reduction: does it make sense? The cheapest is never been chosen, the price is never pressed down to the end. The own budget is not the last aspect. Aspect: do I receive the service in time? Is the contractor motivated to perform? In case of warranty, you need somebody who really does it in the end; - Key points are legal requirements, demand of the real estate development and investment costs - Potential of an architect to steer qualities: offering a responsible product - Architect as advocate of the beauty and truth - Finance for investment trusts owner-managed SME, trust has been built up for years. Track record is well known

Table 25: RIC influences perceived by the investor/PRODUCTS

Table 26 shows the interrelations between the RIC parties, which are perceived by the investor concerning market development.

Market development – investors' perspective	- Risk assessment is based on marketability (space, utilization, market tolerance short time, long-time and location) - Risk assessment: existing buildings, contamination and future waste management - Construction based on life cycle- future clients in urban areas - Building physics standards (e.g. German EnEV) set standards, nobody pays for more - LOHAS do not buy in the top-price segment - Standardization and regulation should follow the processes of reality. This makes application and controlling a lot easier; - Sustainability certificates do influence the decision on finance and offers better conditions if a good brand is applied - Do certifications serve the tenant? - REITS aim at a maximum rate of return, and nothing else

Table 26: RIC influences perceived by the investor /MARKET

Table 27 shows interrelations amongst RIC parties, which are perceived by the investor concerning management challenges.

Management challenge – investors' perspective	- Tendering and awarding can implement sustainable development relevant tasks - Public awarding suggests to be economic efficient, but it is not. Still, the taxpayers pay additional payments - Suitability test of tendering: setting guidelines – testing – supervision – counter measures. In doubt: counter measures – alternatives until it matches the red line - Allocation of financial resources is in between technical aspects and building quality. The lifetime of a construction part shall be at the minimum 50 years. Decisions are based on the fact that the construction part shall perform with an acceptable effort - Management is, to select and advise directions following a strategy - The time in between planning and construction is essential for quality, time and costs - Investor and public planning authorities do have to get along and clarify tasks - The design process has to lever the timeline. HOAI prescribes calculations before having started work. Risks have to be calculated for a company to stay competitive. Problem: construction prices are fixed before the definition of frame conditions on building quality and design quality - Technical monitoring and budget monitoring as base for decisions on portfolio, prospective development, exit and sale - Portfolio management: economic data of real estate: rental space, number of tenants, branch, amount of rent - Risk of insolvent tenant, wrong mix of tenants, object damages - Construction cost rise with regulations. The regulations are often not reasonable. - Stable cash flows and long-term contract

Table 27: RIC influences perceived by the investor on management

Table 28 shows the interrelations amongst RIC parties, which are perceived by the investor concerning value.

Key value influencing criteria – investors' perspective	- Property rate (German: Liegenschaftszins) in valuation is determinant – all parameters can be adjusted; - The actual rent is the sustainable rent; - Tendering criteria have to be different ones; - VOB/ A § 16 aptitude of the tender within tender vetting (specialist knowledge, capability, reliability, technical means, economic means, education, references); - Private contracting authorities have to do it like this, but do it in advance by putting only those on the list. This is the first step to take responsibility and induce sustainable development. Price dumping is avoided by taking the second, not the cheapest; - The investor has to define the standard; - China has a new construction law that new building structure have to remain intact at least for 50 years; In China, property ownership only lasts for 70 years. Then, real estate owner is mostly the state or the property has to be sold; New construction laws are an unforeseeable risk factor in China concerning a long-term real estate investment; - Project management has to keep an eye on the application of materials and constructions. In reality, the short construction time is contradictory to this and Furthermore, the costs for higher material qualities are discussed; - For corporate investors the amortization of a building lies between 10-20 years. The investment costs are planned for this time. A further reaching use or longer lifetime is not wanted; - Location, object structure, object composition determines risks - Market value report does not dare to follow the market; - Real estate valuation is not objective; - Corporate real estate: certificates count; Rating for investor finance: economically competent client (credit rating) and object specific components as decision criteria; - Green lease is about to influence the contracts;

Table 28: RIC influences perceived by the investor on value

Contractors see the interdependencies of the RIC parties as risk and influencing. These main topics were identified the answers of experts:

- Products and their availability;
- Market development;
- Management challenges;
- Key value influencing criteria.

Table 29 shows the summary of topics and arguments of the expert statements, the view of contractors on the influences of the interdependencies of the RIC parties.

RIC influencing – contractors´ perspective		
	Products and their availability	- Technical risks are contradictory to natural hazards. DGNB certificate requires a water-based flat roof sealing which does not make sense - Target is warranty of 10 years - The design/execution planning is too weak. But construction planning is based on it as well as cost calculations - Risk of calculating masses out of a thin planning - Standard price risk - Price risk – market price risk - Quality standard risk: what do I want? Can I receive it? The product is not mentioned in the service specification, it is described only - Risk of appointed time: does the supplier provide the product in the desired quality? - Risk of processing - Risk of specialists of assembly - Risk of subcontractors - Risk of material sourcing and deficiencies
	Market development	- Economic structure: the building industry is decoupling of local and regional (supplying) markets
	Management challenges	- Timeline and finance planning leverage: calculations are made at a point, when tasks and to do´s are not defined. This risk has to be calculated. - Service specification is the point of information implementation possibility - Interest change risk - Calculation risk - Higher demand of supervisors and construction managers; - Risk of concept and time schedule
	Key value influencing criteria	- Durability, stability - Problem: construction prices are fixed before qualitative and design standards are set. This is an economic challenge and a challenge concerning construction quality

Table 29: Influences by RIC parties perceived by the contractor

In the interrelation amongst RIC parties, the topics, location, laws and regulation as well as budget allocation are recurring together with construction planning and service specification seen as influencing ones. These topics, which influence the correlation RIC, are inherited burdens on sites, rationality, different markets and purchase patterns, material qualities, resource efficiency by space efficiency as well

as budget development and controlling. The standards are considered to be defined by the market (consumer). Furthermore, construction products and craftsmanship availability as well as recyclability and technical possibilities and knowledge are important influences amongst RIC. As identified interdependencies, the answers of the expert interviews can be derived from the fact that valuation and technical risks are identified as challenging tasks. An important risk factor is budget allocation. This is because budget development and budget definition take place at a time, when the –"to do's" are not defined completely in the project. This provokes the problem of a timeline and finance planning advantage: calculations are made at a point, when tasks and "to do's" are not defined. Furthermore, the building industry is decoupling of local and regional (supplying) markets. Ethos of work and consumption are chances. This requires stakeholders to take responsibility, to really make decisions, and use common sense.

Structural challenges in the context RIC

The experts identified structural challenges regarding the interdependencies of RIC parties. Table 30 shows identified RIC structural challenges from the perspective of real estate development.

Structural RIC challenges – perspective of real estate development	- Stable, mandatory and clear decisions are essential - A clear, managed process is necessary. This means discipline and target orientation and a clear and strong management; - Intact structures and clear and explicate decision paths are necessary as well as clear decision competencies; - Consequent process management with personal responsibility - The process has to be clear before any decision is taken; - The spirit influences any motivation and commitment; - Early meetings and discussions; - Interaction technical expert investor optimizes quality; - Trade specific position does not allow cost estimations (DIN 276). The architect determines costs via each building part/trade. This means, investment should orientate towards trades; - Lack of translation DIN 276-trade wise; There is a lack of understanding and communication in cost allocation concerning CEEC/DIN 276. The investors do not speak this "language" of planners and engineers. - Bank cannot manage trade wise calculations. This is the dilemma amongst real estate development and contractor: costs are hard to be controlled; - Budget controlling amongst investor, real estate development and contractor as important discipline; - Return on investment or prestige via press as determining decision criteria; - The understanding of vacant property to used is lacking as sustainability criteria; - Qualities have to be described in detail and agreed on - Real estate projects are individual, but some standardization is helpful; - Bank-asks for sustainability related information and actively offers active and consultancy - Bank is aware of the „state of art" of sustainable construction

Table 30: Structural challenges –perspective of real estate development

Table 31 shows identified RIC structural challenges from the investors´ perspective.

Structural RIC challenges – investors'perspective	- In case of owned property; life cycle decisions and operating costs are considered; - Investor determines the qualities. The contractor produces what the investor wants to have - Certificates are understood as sustainable criteria - Investor and real estate development are not interested in recycling - Planning needs urgently clear advice from real estate development - Investor has to be competent and expert; - Regional contractors support quality; so, the warranty is more easy to fulfil - Risk of bad quality by bad tendering - Quality is defined by interest of the investor - The investor needs a good, coherent product; - As soon as funds come to a product, it is already built - Instruments of investor are good documents - Documents should focus on facts and figures - High optimization potential as well as concerning transparency of the financing process as communication - Insurance companies and certain funds do have CSR standards - Branches which are demanded recently (e.g. fair trade) determine financing business - Chance: transparent finance products and ethical correct products - Return/risk ration is the dominant topic - Blind-pool as funds with criteria only, the manager has to preserve qualification and instinct

Table 31: Structural challenges – investors' perspective

Table 32 shows the identified structural challenges in the RIC context from the contractors' perspective.

Structural RIC challenges – contractor perspective	- Generalists are the only ones to manage complexity; - Too many regulations in the construction businesses; There is no need for further regulations; - The chronological order in the construction process is too late. Contractors come on stage too late, but would have more innovative possibilities if they were involved earlier; - The people determine quality of work and trust. This is a qualitative assessment criterion; - Choice of contractor should be determined and seldom is, by the investor; - Contractor aims at fulfilling offers in best quality and less cost intensive; - Planners have to guide the contractor together with real estate development; - Quality arises from the interaction planning and contractor

Table 32: Structural challenges – contractor perspective

To sum up the results, most important aspects for all parties are:

- Stable decision-making and clear processes;
- Taking responsibility;
- Technical quality contributes to value development;
- Tendering can implement requirements concerning sustainable development;
- Investor is responsible to define qualities;
- Sustainable development for finance and investment is getting important;
- Regulation should stick to reality and orientate on existing processes;
- Qualitative documentation/planning as essential information source.

In detail, the structural challenges in the context RIC interrelations from the perspective of real estate development, investment and contractor:

- *Interaction technical expert* investor is necessary for construction quality; causalities have to be defined in detail, target life cycle has to be defined;
- *Documentation* should be clear, qualitative and focus on facts. Documentation as the basis for any communication between RIC parties. Transparent finance to avoid return/risk ratio;
- Need for personal instincts, responsibility and decision-making ability.

Interpretation of long-term thinking and construction quality

Results of real estate development, investor and contractor parties on long-term thinking and construction quality are shown in Table 33. The table shows detailed results for long-term thinking perceived by RIC parties.

- Warranty of ten years is the period. Not more;
- Rental contracts determine the demand to have a qualitative building
- Shell: 50 years; plants 10 to 15 years; facades 20 years;
- General contractor: warranty 5 years;
- Values, which remain as vision;
- Single family house 20 years;
- Money has to be spent on highly stressed components;
- The investor has to be made responsible: landfill tax;
- Avoid long distances for landfills;
- Avoid correct details but failing context;
- Portfolio differences: commercial property 15-20 years, portfolio 25 years, family house 100 years, residential property 50 years;
- Incidental acquisition cost should not be calculated too tightly;
- 10-20 years of technical requirements. User habits are changing:
- A blind pool hast investment criteria, yet now 20% should be invested in sustainable real estate. However, what are the criteria?
- Regarding user: no new tenancy without certification

Table 33: Description of long-term thinking according to RIC parties

The following points can be seen as long-term thinking relevant ones:

- Regulations set decision boundaries (warranty as timeframe);
- Investor decisions determine technical quality;
- Certification instead of common sense is applied;

Table 34 shows the perception of construction quality perceived by RIC parties.

- EnEV (D) is determining the standard and quality;
- Sustainability certificate should respect technical construction material qualities. Warranty and technical possibilities count;
- Technical controlling should be established all along the real estate development process:
- New construction materials are considered difficult technical situations by real estate development;
- Is the German construction quality too much?
- Real estate development, investment and contractor determine construction quality;
- Problem: construction activity is taking place before planning is finished in reality. One starting document should be agreed on;
- Harmony amongst RIC team is necessary for building quality;
- Human beings need a clear management;
- Clear description of qualities and standards by investor and real estate development;
- Question technical functions;
- Circular economy law and recycling before landfill (D) are contra productive;
- Tendering determines requirements;
- Investor sets standards;
- Contractor has to be able to fix the construction product. Cheap is not sustainable. Ability is important;
- Planner has to fix dates and standards;
- A low payment of the planner does not motivate;
- Be polite;
- Recycling laws are too strict, have too strict benchmarks (German: Ersatzbaustoffrecycling);
- Short term/ intermediate/ long term planning is always displaced. This causes technical problems;
- Contractor is responsible, investor needs to ask for education level;
- NIMBY rule provokes that construction waste is getting long distance logistics;
- Choice of contractors supports quality;
- Real estate development: quality of construction management and on-site management;
- Tendering according to VOB/A I s not guarantee for quality, as the cheapest has to be taken, no negotiation is allowed, this takes out competent contractors;
- Quality of planning is coherent with the motivation of the planner and time;
- The building site is conditioned by a good foreman;
- Qualified employees are responsible for construction quality;
- Short hierarchies and communication from the CEO of the contractor to the foreman are beneficial;
- Construction management is far more easy if you can work for the own portfolio of the investor;
- Take enough time for planning;
- Risk of planning deficiencies: data quality and CAD is too fast and lack of the process to rethinking the function of the building;
- The backfill of construction waste is equivalent to reuse;
- Construction product industry is influenced by heat and noise protection regulation;
- Ask for the reason, which regulations produce the waste for the next 20 years. Brick are filled with glass wool the gypsum industry does not take back the used sheetrock if high quality ash is available;
- A material passport does not work due to regulations and standards;
- Demolition has to be as cheap as possible, there is no prestige in that;
- Everything which can be separated by manpower, can be separated;
- There is a need for benchmarking the design according to space efficiency;
- Documentation of deficiencies, expert report, material certifications, fire protection approval count;
- Difficult documentation has a delay effect on purchase contracts;
- Value chain of materials is only for portfolio owned objects of importance and certification. Problem: there are no certificates existing (eastern countries), there is no such bureaucracy existing, but the quality is ok;
- No client wants any ecological certificate, corporate investors demand sustainability;
- Ethos of work and monument conservation: The architect has to mention non-ethical correct products;
- The definition of quality concerning sustainable development is proven only by certifications, though, investors doubt on the meaningfulness of those and costs.
- Investors ask, who is the driver for prices (e.g. insulation material)

Table 34: Construction quality described by RIC parties

As essential connections for construction quality perceived by RIC parties, the following aspects can be summarized, based on RIC interrelation:

- Quality: Standards and investor decisions define qualities. The lowest price does mostly not bring up quality. Tendering is identified as quality relevant process;
- Budget controlling amongst RIC is an important discipline. There is a lack of understanding and communication in cost allocation concerning CEEC or the series of standards DIN 276. The investors do not speak this "language" of planners and engineers;
- Contracts (warranty and rental contracts) determine qualities as well as the portfolio perspective;
- Trust, politeness is essential for confidence and supports any quality.

Perception of the trifold demands of sustainable development

RIC parties identified demands of sustainable development. The following Tables 35-37 list the detailed results.

Economic demands of sustainable development seen by RIC parties
- Difference in purchase of portfolio property (due diligence) or project development (building law establishment);
- Real estate development strategies: single tenant – client is responsible for decisions (rental price);
- Aiming at maximum return differs from aiming at portfolio property;
- Investors aiming at maximum return do not buy the real estate as technical construction, they buy rental contracts, they buy a cash-flow;
- China: rental contracts are made in the state of core and shell, the tenant is responsible for the fit-out, which provokes decontrol technical equipment;
- A speculative background aims at full rental at construction start;
- Quality of materials mean less operating costs and a long technical lifetime;
- Economic efficiency means to define the user in a specific way;
- Economic arguments for sale: space efficiency, operating cost efficiency, yield, rental revenues, return on sales, entry-level price;
- Building quality: fixed interest rate until point of sale;
- Investment and ROI of sales price;
- Portfolio property: investment costs include operating cost;
- BKI (D): speculative background, includes "pig cycle";
- Target: full occupancy: the product has to fit location, site and clientele;
- Does the chosen construction quality match marketing speed and location?
- Rental rates are chosen according to qualities: 1. Location, 2. Min-max rent, 3. Market value, 4. Quality of materials, life-time, less operating costs, serviceability;
- Low construction costs, low life cycle cost, high revenues;
- Funds are buying the development property calculates it "nicely" and sets targets. The object rating condenses in the price. The purchase price works with the nominal factor (annual rent)
- Costs of contaminated sites assumes a reduction of the ground value;
- By buying the rate of return and not the technical construction object results in a technical weakness: anything which is not budgeted is not accepted:
- Real estate valuation: the value does not work via benchmarks it works via pilot projects;
- Pilot projects can raise market awareness and test the market;

Table 35: Economic demands seen by RIC parties

Environmental demands of sustainable development, perceived by RIC parties
- Frequented streets are regarded as bad influence; - CSR determines finance strategies; - Standards of tenants are base for decisions; - Munich: catalogue of criteria for buying land: in the case of a passive house, the real estate development gets more floor space; - Concept tendering: land is sold with a fixed price – the one with the most points gets it; - Certifications are not in line with the market, standards should support the decisions; - Certifications in rental construction does only work via political pressure; - Environmental challenge: recycling is not a target for decisions on operative level yet. - Tendering is the medium for communication: - Choice of contractor, who works ethical and ecological correct; - Investor has to define the way of waste management and has to include that into financial management; - Today´s waste management will be a problem in 50 years; - Environmental topics are ok, but technical topics first; - A material passport is needed for answering, what to do with the construction at the end-of-life-time in connection with project management; - Waste management belongs to product choice; - Rules for construction recycling scenarios are EN 15978 - Industry should be forced by policies to take back construction products after use; - Energy standards are too high (EnEV), this does only serve the building products industry. ETICS are really bad, fires cannot be erased, not recyclable; - Toxic substances have to be declared: recyclability should be declared by industry; - In construction, environmental requirements are only understood by energy demand; - Environmental requirements are a theoretic wish; - For LEED certification, you have to have the certificate that anything will be recycled. What happens in the end and in reality, nobody cares; - Energy production on the roof is conflicting with tax aspects: central heat recovery – who has delivered the heat? - Energy saving in Germany has enough rules; - Environmentally conscious: use empty property instead of new construction; - Integrate waste disposal company into real estate development; - Environmental conscious materials will be cheaper if they are demanded more on the market - Long-term thinking of comfortable agglomerations and renaturation; - The sustainable construction industry in Germany is influenced by the BMUB 2015 booklet;

Table 36: Environmental demands seen by RIC parties

Social demands of sustainable development, perceived by RIC parties	- Frequented streets are regarded as bad influence; - CSR determines finance strategies; - Standards of tenants are base for decisions; - Munich: catalogue of criteria for buying land: in the case of a passive house, the real estate development gets more floor space; - Concept tendering: land is sold with a fixed price – the one with the most points gets it; - Certifications are not in line with the market, standards should support the decisions; - Certifications in rental construction does only work via political pressure; - Environmental challenge: recycling is not a target for decisions on operative level yet. - Tendering is the medium for communication: - Choice of contractor, who works ethical and ecological correct; - Investor has to define the way of waste management and has to include that into financial management; - Today´s waste management will be a problem in 50 years; - Environmental topics are ok, but technical topics first; - A material passport is needed for answering, what to do with the construction at the end-of-life-time in connection with project management; - Waste management belongs to product choice; - Rules for construction recycling scenarios are EN 15978; - Industry should be forced by policies to take back construction products after use; - Energy standards are too high (EnEV), this does only serve the building products industry. ETICS are really bad, fires cannot be erased, not recyclable; - Toxic substances have to be declared: recyclability should be declared by industry; - In construction, environmental requirements are only understood by energy demand; - Environmental requirements are a theoretic wish; - For LEED certification, you have to have the certificate that anything will be recycled. What happens in the end and in reality, nobody cares; - Energy production on the roof is conflicting with tax aspects: central heat recovery – who has delivered the heat? - Energy saving in Germany has enough rules; - Environmentally conscious: use empty property instead of new construction; - Integrate waste disposal company into real estate development; - Environmental conscious materials will be cheaper if they are consumed more; - Long-term thinking of comfortable agglomerations and renaturation; - The sustainable construction industry in Germany is influenced by the BMUB.

Table 37: Social demands seen by RIC

In general, the understanding of *sustainable development* by RIC parties can be condensed as shown here. The following points summarize the perception of the trifold demands by the RIC parties for each dimension of sustainable development.

These are:

Economic aspects:

- Quality of materials determine the technical life cycle;
- Less operating costs;
- Less life cycle costs;
- Yield;
- Rental revenues;
- Return on sales;
- Location;
- Valuation – market awareness (can be raised via pilot projects);
- Contamination and waste management.

Environmental aspects:

- Waste management;
- Standards of tenants define environmental aspects;
- Too high energy standards;
- Regulation should follow the existing processes;
- Too many regulations in construction;
- Industry should be forced by policies to take back construction products after use;
- Environmentally conscious: use empty property instead of new construction;
- Toxic substances have to be declared: recyclability should be declared by industry.

Social aspects:

- Reachability – local stakeholder, regional development;
- The EnEV is levering out brick construction and handicraft competencies;
- Sustainable tenant of the building;
- Management should set responsible supply chain as target;
- Employment is an essential factor. Employment for as many people as possible;
- Good skilled workers;
- Good payment.

In their general understanding of *sustainable construction* RIC parties are of the opinion, that sustainable construction implies:

- Space efficiency and questioning of need;
- Less energy consumption, less operating material;
- Long service life of products and buildings;
- Use recyclable, utilizable building products or reuse products;
- Short transportation ways in construction and operation;
- Easy deconstruction;
- By safeguarding and maximizing functionality and serviceability;
- Aesthetic quality;
- Contribute to the minimization of life cycle costs;
- Protection and/ or increase of capital values;
- Reduction of malicious impacts on the environment;
- Protection of health, comfort and safety of workers, occupants, users, visitors and neighbors;
- Preservation of cultural values and heritage.

Having in mind the expert statements and taking into consideration that EU aims at preserving work, the full life cycle of construction must be taken into consideration and the trifold dimension of sustainable development has to be considered in decision-making. For the synthesis, this means, different topics must be addressed. Responsibility should be shared and taken to create structures and processes. This leads to several conclusions. The points shown in Table 38 are considered urgent arguments on the way to induce sustainable development by real estate and construction. To meet the needs for induction of sustainable development, it is necessary to integrate points a), b), c) and d) in decision structures.

Fact		Short result
a	Integrate the production process of construction into the assessment on sustainable development.	Define social aspects in a broader sense
b	The life cycle perspective needs to be integrated in in the assessment on decisions concerning real estate and construction.	Include the life cycle perspective in real estate decision-making
c	Information carrier should implement the trifold demand homogeneously.	Balance the trifold dimension of sustainable development equitably
d	Consumer choices are responsible for offered products.	Facilitate sustainable consumerism for construction

Table 38: Basis for the induction of sustainable development

Summary of chapter 4.3:

Here, the synthesis was used to sketch an operative approach for real estate and construction decisions to broaden the view of sustainable development to assess the trifold demands in a homogenous way. Incentives to improve resource efficiency have to be considered. Sustainable development aims at the integration of the trifold task. Sustainable development as regulative target will be a central strategic competitive factor. Sustainable consumerism is identified as core approach for inducing sustainable development. As result, a model-based view is suggested as an approach. This should integrate the trifold demands along the life cycle of real estate. A linkage is made between the processes and decision support in real estate and construction. The linkage is elaborated in theory, derived from literature, case study company processes and expert interviews. For information gaps and overlaps, the feedback loop *real estate development, investment and contractor* was established. These interrelations are assessed with a view to optimize them concerning the induction of sustainable development. Based on these sources and findings, this part develops and presents a model-based view of information for operative process development. The postulate of Busse (2012) that – if the values and ideals of the previous decision-making and economic activity are obtained – the current management tools are essential to transform (not only in the real estate industry) and systematically to link is followed up herein.

5. LEADING THE SYNTHESIS TO AN OPERATIVE APPROACH

The Brunsvician lens as methodological approach requires closing the case study with a new composition of the case. This part suggests a solution based on theoretical findings and facts as well as expert interviews shown in chapter 4 of the study. To understand the interdependencies and knowledge integration between real estate and the construction phases in a life cycle approach, a model-based view is proposed in this part as a framework for information integration. This model serves as an integrative platform to support decision-making in real estate. The model builds on existing information structures on time, cost and qualities and allows the integration of complementary information on aspects of sustainable development as integral part of information commonly used in decision-making in real estate and construction. According to the Brunsvician Lens, this chapter is part of step E, new composition of the case.

A	B	C	D	E
Problem	Decomposition	Perceptor	Synthesis	New composition

5.1. The application of the analysis of structural challenges

Four key points are identified to be crucial for inducing sustainable development in the context of real estate and construction, as shown in chapter 4.3.2. This part explains how these key points can be brought from a theoretical approach to an operative level.

a) Define social aspects in a broader sense

In the building context, operative aspects such as comfort, use, health of inhabitants, neighborhood, etc. are considered social criteria. In case of other sectors such as the textile industry or agriculture, the scope of the social dimension is yet broader. If we want to enlarge the social aspects and provide a sustainable product according to the theory of sustainable consumerism, we have to look at the social aspects of the production processes – both of the building materials as well as of the building itself. Besides that, European Union strategies strongly aim at generating employment[33]. The availability of employment is

[33] „Empirical evidence suggests that decreases in labour demand leads to corresponding increases in unemployment in society if salaries are kept constant" (Jorgensen 2010).

an important target of EU policies, as it results in further job education, training, and quality of craftsmanship. Craftsmanship of high quality is one of the responsible elements for the quality of a construction.

Contractors are key stakeholders for regional employment, as the construction sector is important for regional and rural employment (Diederichs 1999). The contractor activities are mainly determining the production process as well as technical and qualitative aspects, but also social aspects. Therefore, the construction process bears the chance to orientate and further define the social aspect of sustainable development. The statements on employment respectively work is included e.g. in construction management tools. This includes, amongst others, the assessment of work performance for cost controlling. The work calculation is the specification for the controlling of the execution of a construction. The costs and the duration of work-related construction parts can be structured per existing structures (Ripberger 2003). This is one way to make qualitative and quantitative statements on work and employment about the construction project[34] (The productive function is the measure for the construction progress, the process costs and the production velocity; it could be interpreted as an indicator related to the induction of sustainable development related to social aspects.).

Besides contractor activities and existing operative social aspects, the production of construction products must be included together with the deconstruction of the building as part of the social dimension, linked to the working environment and related to sustainable consumerism and therein-sustainable development induced by real estate and construction. Beyond sustainable consumerism and the need of a real estate company to provide sustainable products, the CSR profile of a real estate company is determined by its products, the buildings.

b) Include the life cycle perspective in real estate decision-making

Product information and existing decision support in real estate can be enlarged to cover the whole life cycle of the construction and the construction products. The life cycle based information on product level should be linked to the building. The concept of life cycle thinking – a key concept in the context of environmental sustainability – can be transferred also to construction processes. Besides the devel-

[34] As one example, the productive function is one way to connect the factor work and the construction project; this function is the basis for service accounting (Ripberger 2003). Here, the effort W determines the quantity for employment. Process costs are calculated time-dependent device and human resource costs respectively material cost and saved as master data (Ripberger 2003).

opment and construction phase, the consideration of the end-of-life phase is important about environmental requirements and resource efficiency, and also to avoid future disposal costs and logistic difficulties.

For instance, regarding the economic dimension, it is suggested (Lützkendorf et al. 2013) to simplify the methods of life cycle costing and to make them more transparent and more suitable for decision-making. This simplified approach should be based on valuation approaches and include the contribution of the building to the financial risk of investors and users (Lützkendorf e al. 2013). Beyond this, cash flows for future maintenance, end-of-life costs due to technical end-of-life possibilities must be considered in the decision-making at the beginning of real estate development. This implies also that economic instruments must include the end-of-life phase.

Tendering is not object-orientated, but process-orientated. The life cycle aspects can be steered in tendering contracts and should be included in quality descriptions in addition to time and costs. A life cycle oriented planning processes requires a planning that is oriented towards the future facility management and a planning of the construction processes and property use (Reimoser 2013).

c) Balance the trifold dimension of sustainable development equitably

European and national environmental policies are driven by the goal to reduce the consumption of fossil fuels and related greenhouse gas emissions. This study suggests to enlarge the perception of sustainable development by economic and social aspects in an equitable quality as for environmental aspects. This means: if sustainable development shall be induced, it is not sufficient to consider the environmental aspects in a product assessment. Along the product production process, social and economic aspects need to be integrated with the same system boundary as the environmental ones.

Material qualities and properties are defined in the planning process at a point far before the choice of a construction product. As construction products interact when integrated into a building, sustainability related effects of construction products can be assessed only when considering the building context. Still, the whole life cycle of a construction product in the context of a specific building must be kept in mind.

Environmental product declarations can be used in construction processes. For environmental aspects, EPD serve as means to transfer environmental information on construction products to the building level. Any economic information on product level is currently limited to price. The social information on product level is available for emissions related to health and comfort – if at all. The system established

to develop an EPD can be taken as a basis to prepare decision support in the same dimension and information quality for social and economic aspects on product level.

The new aspect of this study is to include the broader defined trifold aspects and the life cycle perspective into a framework, which allows informed decision-making in advance.

d) Facilitate sustainable consumerism for construction

Consumers should make the right choices – this fact is forcing producers to develop and offer a product that is contributing to sustainable development (Belz 2007). This holds also for structural assets and buildings, which are products of e.g. real estate companies or other investors. For real estate as products, the construction process is equivalent to the production process of common products. The consumer choices require reliable information. For the construction process, this implies that information must be transferred from the concept to the construction product level.

To optimize an asset management strategy, expertise of several disciplines and sources need to be incorporated. Management and investment decisions must be supported by asset owners, asset managers and service providers, all based on one consistent set of data and knowledge (Den Heijer et al. 2014). For a real estate company, this means that products must be developed that facilitate sustainable consumerism. This means, arguments a), b), c) should be integrated in the real estate development process and communicated to the consumers, respectively the investors and users of real estate.

Entrepreneurship means taking responsibility for corporate activities. The companies can be motivated to invest in sustainability if they expect to increase their opportunity for profits and to avoid threats to profitable growth. Beyond the building concept and building technology in the context of energy efficiency, the aspects described in this study can serve as decision support to induce sustainable development by decision-making and corporate responsibility – this is explained in the following part.

Sustainable development bears risks and chances for real estate companies. The consumers but also the financing institutes and standardization processes are challenges for the market position of a real estate company. The aspects outlined above can support a real estate company to develop sustainable products and to develop corporate responsibility. This can be done by applying the conceptual model developed in this study as a framework for product and process development.

The regulative target sustainable development cannot be measured directly. In addition, the systematic assessment of sustainability in the construction process requires large amounts of information in a complex context. This requires a systematic approach for the information management in direct connection with the existing technical and financial information.

Therefore, structures, sources and information are linked within the concept for a model-based view. The information management offers the possibility to integrate structures and processes of different disciplines.

Excursus XIII: Current state of building information modelling (BIM) to link LCA. The parametric information databases of building assemblies, LCI data for building materials and their costs are the foundation of Integrated BIM-LCA application. The first results from a renovation project shows that the BIM-LCA methodology based on Autodesk Revit, energy simulation tools and excel program for LCA and LCC can support the optimization and evaluation of a construction project. The assembly database is the bridge that links BIM to LCA. The assembly category and material schedules derived from BIM can be imported in the integrated LCA model and be linked to LCI data and costs in such a way that the inventory analysis of building LCA can be largely simplified. Moreover, the information of life cycle impacts and costs of the assemblies can be reimported to the BIM database, which helps the designers to choose building elements with low environmental impacts in the early design stage. The BIM model can also carry information for operational energy calculation such as the U-values of building elements, window to wall ratio and space information. The results from energy simulation tools are linked to the integrated LCA and LCC model, too. There is a need for a BIM-LCA framework to enable an interactive optimization process (Yang and Wang 2013). A model-based view is suggested as an approach; it provides a parametric database including cost, material, and elements related to a visual interface during the whole process. BIM provides a platform integrating 3D geometrical model with various text and numerical data. The input data needed for LCA can be derived from BIM. BIM describes a method of optimized planning, execution of construction works and management by help of software. The software records the details of a building. BIM modeling is able to work object-oriented. This implies that impacts of processes are lacking. A central construction part oriented building model offers different cost evaluations based on the same element quality in an early phase (Reimoser 2013). A normative base and target system supports the process. For integrating information in different qualities and different process stages, a model-based view helps to access the complexity. Within a data model, knowledge management and integrated software has been applied in civil engineering and construction management since 1999 (Ripberger 2003). In construction operation modelling, concepts for cost allocation to cost

groups of constructions are yet existing (Engelhardt 2015). This concept can be used for any real estate, and enlarged by demands of sustainable development, which are described in this study.

5.2. A model-based framework for trifold information integration

Sustainable development as regulative target cannot be measured directly. In addition, any approach on sustainable development in the construction process requires large amounts of information in a complex context. This part shows elements of how information inducing sustainable development can be integrated into the processes of a real estate company for corporate development and strategic management.

Hence, the research question is addressed: How can the objective induction of sustainable development implemented into the economically oriented decision-making structure of real estate development? This requires a systematic approach towards the challenge.

For process development, this study concludes that it is essential to delegate individual responsibility. Per results of the interviews, for reaching high quality, it can be stated, that it is very important to enable responsibility to individual managers, guarantee excellent planning and construction processes, and provide management interfaces. Any benchmarks are considered as insufficient, but the organizational performance must be transparent and partial decisions shall be avoided. The empowerment, which means enabling individual responsibility, which means sharing and taking individual, defined responsibility. As first step, this can be preparing few high quality and efficient documentations. Construction specific tasks and typical structures for information carriers as well as sustainable development relevant knowledge and information carrier have been shown in the study.

Missing input has been identified for information management about yet existing technical, time-relevant and financial information. The structures and processes of different disciplines must be integrated, which is challenging in the construction sector, as this is a very discipline-orientated society. It is suggested to link structures, sources and information within the concept for a model-based view.

Figure 44 illustrates the concept of information integration to meet the demands of sustainable development in the context of real estate and construction. Within this model-based view, existing information channels can be used. This way, life cycle information, production processes, qualities and devices can be integrated to link systematically existing processes and tools. The user should be able to switch between different visualization modes, and identify critical elements and points in time. This means that functions must be implemented into the object model, which link environmental information and social information to processes. Real estate economic information must be integrated covering the whole life cycle of the building.

Now, building modelling and information (BIM) is broadening the types of data and information made available to the user of such tools. It is said to be able to reduce the effort for building description and to enable assessment results – e.g. from LCA or LCC – to be used as feedback to the design process (Yang and Wang 2013). To develop a methodology for environmental and economic assessment of construction and optimization from the early design stage, a framework that facilitates the integration of LCA and LCC as model-based view is proposed (Ripberger 2003).

A problem for the early design phase is that calculation and interpretation processes need specialized knowledge (Yang and Wang 2013). An optimal software support requires data to be structured and linked. The application of scheduled data allows a constant change (Ripberger 2003). Within project controlling, project documentation or cost management, database supported software is applied in construction management. In addition, database supported software is used in LCA. Buildings are described as assemblies with information of construction, material and cost, whereas in the LCA and LCC model, they are described as elements of different service life, which are linked to the life cycle inventory data of building materials (Yang and Wang 2013).

A practical application of tools needs steering and controlling functions. But: who does the controlling? What needs to be controlled? The question on the “who” is answered by corporate organization structures. “What” is to be controlled is determined by defined parameter. The corporate specific parameters are human resources, material, devices, subcontractor data, type of costs and performance range. These can be dynamic structures. The model is structured per classic structures as technical room schedule, service specifications and time schedule, higher-level ordering principles (e.g. the series of standards DIN 277; the series of standards DIN 276 and VOB) can be provided by existing regulations and structures.

A concept of an object model approach is presented and serves as the basis for the further development of the model and its implementation. In the following, the structure of the model, the functional range, framework conditions and necessary interfaces are sketched. Figure 44 shows the suggested model-based view of information integration, the SDI-model (sustainable development inducing model).

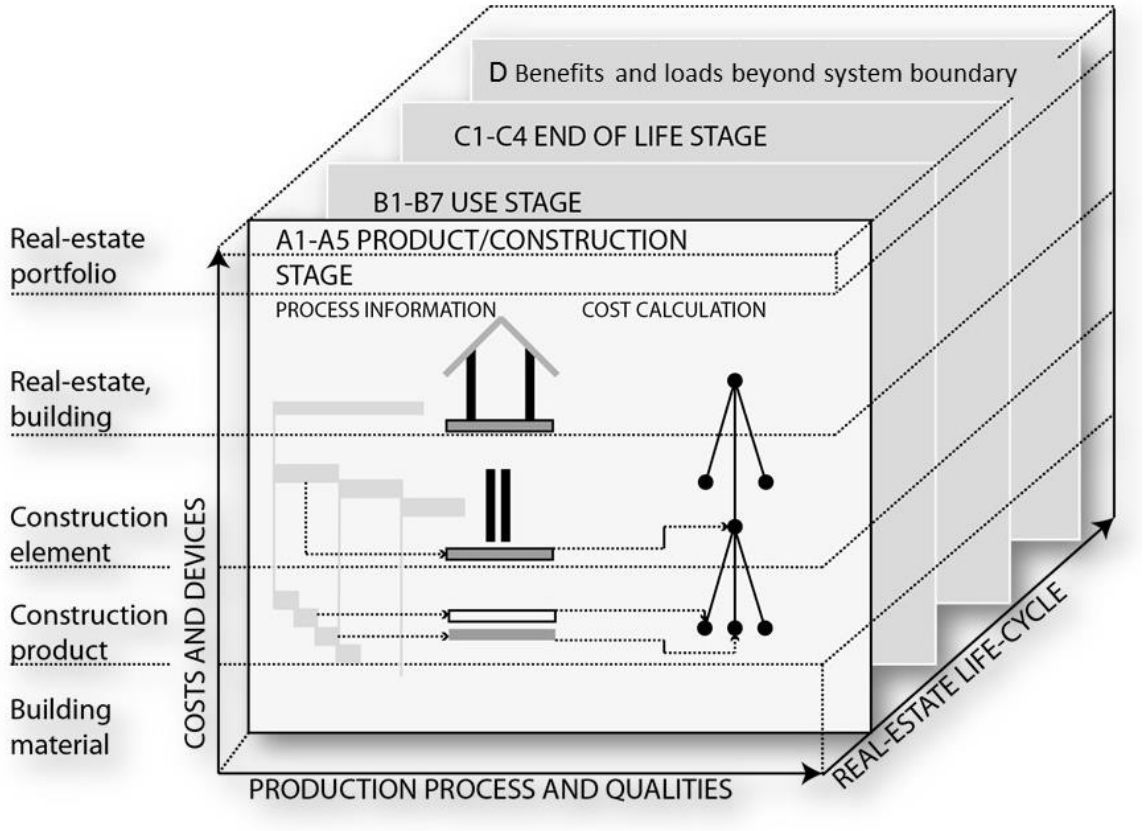

Figure 44: System of the SDI-model

The construction planning describes physical characteristics. Besides physical characteristics of the real estate or infrastructure asset, the SDI-model contains information on construction parts including construction products and materials. Furthermore, processes per construction parts are included as well as information on the operation of the assets.

The SDI-model is established by the following steps:

1. The time schedule of construction management and the actual construction workflow are requested from the object model (coming from a building operation oriented BIM model, including construction parts and time schedules).

2. Links must be established, which allocate construction parts to processes, and qualities.

3. Tools provide information editing.

4. Hereby, next to causal and temporal relationships, qualities can be allocated, also the lack of qualities.

5. Extreme points in the time schedule can be identified by visualizing the model as video version. These visualizations are used for decision-making, management operation or public relations work.

6. The amount of masses and information density are shown (assumed, intern benchmarks shall be developed). The problems and gaps can be identified in this way.

As the importance of standards and regulations is rising (Meins et al. 2012), structures proposed for the SDI model take the actual regulative approach as basis. But still, as critical point, for example, deposits from urban infrastructure and urban mining are a potential major source of secondary resources. However, reliable information concerning available volumes and qualities is lacking (Höglmeier et al. 2015). Considerable amounts of recovered wood for example, would be available in suitable condition for a resource-efficient use in cascades (Höglmeier et al. 2015). To utilize the existing potential of recovered material for reuse, recycling or cascade use, an overview of available resources and potential is necessary, to implement reuse and cascade use for application in planning, real estate questions and construction. This topic should be accessed via information generation.

Therefore, information should be made accessible first, where it is not available yet. To meet this need, Ott and Hausmann (2015) have analyzed this interdisciplinary information management problem in a project called STOFFPASS or *material passport – resource performance indicator* (Ott and Hausmann 2015). Concerning end-of-life and recycling strategies of a building, information is crucial on what construction is used, how was it put together and can be taken apart. For the engineering of dismantling of an existing building, an intelligent information source is not yet available. Only very few information on dismantling is yet ready to use. In this case, a material cadaster on building level such as a "material passport" for a building can serve as a concept and developed further for information generation and as basis for an operative approach to end-of-life processes and recycling in a BIM context.

For dismantling options[35], an expert model is necessary to describe the possibilities of construction material handling in the context of a specific building. At least some information on construction product level is available already as part of environmental product declarations and foreseen to be integrated in building assessments according to EN 15978: scenarios and related environmental impacts of dismantling and demolition, waste sorting, preparation processes for reuse, recycling possibilities, energy recovery, or decomposition are described in modules C1 to C3 (EN 15978); scenarios and related environmental impacts of waste treatment such as neutralization, combustion, and landfill are described in module C4. Last, in module D, processes are added which lead to a future resource replacement. The module D[36] cares for net environmental benefits or burdens, which arise from recycling and energy recovery as compared to the use of primary resources.

[35] What is separable by manpower can be separated (expert interview).
[36] Calculations for module D are defined in EN 15978

However, it is essential – due to the postulate of homogenous integration of information to induce sustainable development – to generate adequate homogenous information on economic and social aspects in the same quality as for the environmental dimension. A “material passport” on building level could be the starting point for the systematic integration of environmental, social and economic information on end-of-life processes into decision-making processes.

Beyond the explaining and analytic functions, the model bears also the potential as a vivid controlling tool because many elements can be linked to each construction part in a logic way. By clicking on a construction part, diverse information (including targets and debits) is available without the need to look up in diverse technical or environmental documents. To visualize 3D data, an Industry Foundation Classes (IFC) format is an established standard in commercial design software. It contains geometric data and can include further information.

On practical level, to integrate the framework into a model environment, the following obstacles must be solved when developing a prototype object model:

- Development of a programming interface using EPD information as add-in for databases (library);
- Development of a programming interface using social information as add-in for databases (library). Therefore, social information should be provided in a way comparable to environmental information in EPD;
- Extensions of the classic approach of costs and processes to include the life cycle stages A, B, C, D of CEN TC 350 to cover the full life cycle of a building;
- Development and integration of an expert model for the mechanical separability of construction parts for recycling options.

Regarding software interfaces and features, the model should be capable of a time-schedule import from Microsoft Project and a 3D model-import of IFC and Autodesk-software. Control elements are catalogues (time-schedule, models), tools (for editing component properties, model properties) and visualization modules, animation and selection.

This model-based view enables a user to address sustainable development without any certification process ex post, but tries to integrate demands of sustainable development into ex ante decision-making. Still, some steps must be taken, particularly regarding the generation and/or compilation of technical, social and economic information on products and processes. Some lacking information tasks are listed:

- For the management of construction waste: Separability, recycling and recovery options of construction and demolition waste including packaging, also regarding possible uses of a product in building context;
- For materials reuse: utilization of used, repaired and retrieved material;
- The recycled material content of the product;
- Concerning regional materials: indication of the distance to the production site, mass and material costs;
- Information on rapidly renewable materials.

For social aspects, a homogenous information quality has not been established yet. Based on the outcomes of the expert interviews and in view of the available information systems, it seems possible to establish an adequate support of information on social aspects. Per the demand to respect life cycle thinking and of fair value chains, the social aspects along the production processes as determined in the study should be elaborated and documented in an equivalent information carrier and quality as EPD. This information can complement any STOFFPASS ("material passport"); it can also be integrated into the SDI model. The establishment of the STOFFPASS as information carrier goes beyond the scope of this study, and can be part of a separate research project that should start from the available information in this study. It must be emphasized that the postulated information in this study differs in its character and quality from the current perception of real estate as space forming, society formative habitat. Indeed, employment as effect along the production process of real estate, constructions and construction parts be included as social aspects to enlarge the social aspects beyond health and comfort.

The SDI model-based view allows to integrate construction management aspects and therein the enlarged social aspects. Still, it should not be forgotten that the discussion on BIM models is diverse and BIM still in its infancy. For instance, more obvious elements such as operational energy use cannot be shown yet and there is still a considerable way to go in the development of BIM systems until an SDI model-based view will be integrated.

On this path, Table 39 lists further functions, descriptions and remarks that are needed, to implement the model-based view and establish the SDI model in a BIM context.

Steering elements		Functions	Description	Additional tasks for SD	How to do	Remarks	Further theory development necessary
Directly implementable	Modules	- Visualization module for 3D animation; - Visualization for selecting components; - Time-line for selecting points in time;	- Time-scheduling;	- Describe relevant points in time	- On cost basis (portfolio or trader-development)		Develop company relevant points in time;
	Catalogues	- Processes for assigning the time-schedule to different components; - models for different phases;	- Different time schedules as database;	- Add Life cycle time schedule	- Link stages A,B,C,D (CEN TC 350) to lifecycle times schedule	- Link components to A,B,C,D	Develop company specific frameworks;
	Tools	- edit global model properties; - edit component characteristics; - assign processes to components;	- Model characteristics editor;	- Add EPD information to components	- Link ökobau.dat	- order specific or new database	Develop company specific benchmarks;
Second step implementation	Modules	- Different model density (design level, construction documentation);	- BRI, BGF, GFZ; - m² WF and m² wall;	- Early decisions	- Use benchmarks	- Expert model	
	Catalogues	- Classification of recycling potential;	- Material is marked as one substance, which is least separable by hand;	- Add disposal criteria;	- Definition of disposal criteria;	- Expert model;	Expert model for criteria definition;

Table 39: Description of application of the information model

The SDI model was derived and elaborated for a development which aims at the implementation in BIM software. The main arguments for choosing this model-based view are:

- "Information modules" representing different life cycle stages of a product or building have been proposed in the series of standards by TC 350 and thus integrate life cycle thinking. Those information modules can be applied directly to the model;
- Device orientated information connects money orientated information in the model;
- The model integrates the construction product level to the building level and is enlargeable to the portfolio level;
- Some steps are to be developed first on scientific level. Existing IT concepts can be applied directly.
- The engineering of dismantling of constructions, construction products and materials is becoming important. Approaches such as STOFFPASS ("material passport") can support this development.

5.3. Corporate integration of sustainable development information

For corporate strategy building, information must be placed in structures, which helps to induce sustainable development. The potential of information integration for corporate process management is suggested.

Table 40 lists some suggestions for corporate activities to meet the demands of sustainable development. These processes, actors and interdependencies can be recorded and optimized. The model-based view can serve as information structure. Table 40 shows the integration of information about sustainable development on operative level and for process management.

Topic	Process steps	Documents	Operative approach/ tools
Finance	Draft of a codex for financing amongst bank and real estate development	Add on to contracting	Define requirements for material application and tendering
CSR	Annual report (financial) of a Real estate investment trust, within the Management compliance statement	Shareholder information	Show fields of action according to the model-based view
Vision	Define vision according to "serving a good life" and creating "fair values"(Ulrich 2004)	Shareholder information	- Annual reports - Yet existing in the case study company: Remaining values as mission statement
Mission	Create a mission (e.g. „Values, which remain")	- Shareholder information - Sales information	- Annual reports - Marketing documents
Strategy	To search to do the right things	Information for public stakeholders - Politics - Administration - Neighbors	- Respect end-of-life options - Communicate to the public - Influence politics regarding technical possibilities - Operative short term targets
Company culture	- Give/ take responsibility - Make decisions	- Clear responsibilities - Clear processes	- Personalized responsibility
Portfolio strategy	Take "remaining values" as mission statement	Integrate life cycle aspects as strategic approach	- Economic: integrate technical/ cost relevant recycling aspects - Environmental: integrate technical possibilities and future cost predictions of end-of-life options
Object strategy	- Avoid end-of-life problems - Good investment should be a cost effective investment - support material information	Tendering	- Specifications for products - Specifications for services/contracts - Communicate life cycle effects (environmental/economic) in a building passport[37]
Corporate Processes	Quality management process	Decision time schedule	- Demand a building passport including end-of-life information
	Reporting of real estate portfolios	- Reports - Calculations	Include end-of-life option - Dismantling - Recycling options - Disposal
	Quality standards	- Add on for description, tendering, typologies - Integration in guidelines of quality standards in cooperation with project development, project management and sales in the state of predesign/ Project initiation	- Use the model-based view - Use the model-based information - Define excluding criteria for the construction concept and construction operation

Table 40: Corporate potential to induce sustainable development

[37] A building passport can serve as information management tool on qualities, cost, time, life cycle and document transfer. A material passport can also be applied for asset management strategy is playing an important role.

For corporate processes, Table 41 summarises tasks and tools for the different corporate steps.

Topic	Process steps	Docu-ments	Tools
Project development	Area developent	Land use plan, Master plan	- Energy concept - Recycling concept (Infrastructure) - Recycling concept (Construction) - Dismantling concept
	Economic development and manage-ment	Competi-tion	- Dismantling concept - Recycling concept - Service lifetime concept of construction and life cycle s - Minimum service lives of determinant construction products - Indicate dominant materials - Indicate criteria for end-of-life scenarios - Life cycle concept (Materials and facility management)
		Planning	- Its constituent parts (all building elements, building components, building products, building materials); - Related processes such as transport, construction, maintenance, repair, re-placement, end-of-life processes; - Operational use including management inspection and insurance; - Operational energy and water use; - Patterns of use; - Required service life; - The reference study period used for the assessment: - Technical type of building (structural type); - Year of commissioning; - Year(s) of refurbishment; - Design number of building occupants; design occupancy schedule; - Heating, cooling and ventilation system - Hot water service system; - Lighting system; - Power and communication systems
		Project calculation	- Integrate life cycle (Operation and maintenance cost, replacement cost, dem-olition cost, etc.) - Integrate operating costs DIN 18960 service lifetime of construction and life cycle s ISO 15686-5
		Resolution proposal	Integrate life cycle scheme
Project management	Tendering	Assess-ment on contractor processes	- Transport distance - Regional employment, apprenticeships - Life cycle concept of construction products (technical/economic) - Quality of contractor performance - Integration of recycling options and disposal (disposal certificate) - Efficient planning/ use of interfaces - Include contractors in information generation
	Commission-ing	Interface manage-ment	- Life cycle concept of the building - Project realization competencies - Service life - Lifetime - Use material passport (chosen construction products, materials, EPD and disposal options) - Definition of maintenance cycles - Demand minimum service lives as standards
		Start of operating phase	Commissioning management documentation on materials (characteristics, handling, costs) and processes

Topic	Process steps	Documents	Tools
Operational phase	Building operation	Facility Management decisions	Material inventory data source - Building material passport (lifetime, maintenance cycles, etc.) - Room book - Inventory plans - Recycling data for building products on materials components, material, hints on separability; with information technological applicability, demanding a recycling relevant information according to recycling pass for electronic devices) - Data on reuse of materials
	Maintenance	Investment decision support	- Scenarios of changes of building management - Conversion investment - Follow up costs
	Tender management	Contract management	
Recovery phase	Scenarios for different exit strategies: Demolition Decommissioning Conversion	End-of-life decision support	Documentation - Material inventory data source: building material passport (lifetime, maintenance cycles, etc.) - Overview on future disposal regulations
	Start of a new building life cycle (Continue Phase C)	Choice of material life cycles	
	Sale	Provide documentation	

Table 41: Corporate levels and processes to apply SDI information

6. CONCLUSIONS AND EVALUATION

This section summarizes the key findings of the study. Furthermore, it evaluates the methodological approach, the practicability of the research results and assesses the need for further research.

6.1. Key findings

This study follows the postulate of the European policy. The EU wants to promote sustainable consumption and production models (European Commission 2014). For instance, the European Parliament stresses the need to establish a more coherent legal framework for sustainable production and consumption, covering the complete production cycle from sustainable sourcing until to end-of-life recovery (European Commission 2014). The conclusions of this study are coherent with these EU targets[38,39] The study has a business ethic part, a real estate economic part and an information management part. An interdisciplinary research approach links different scientific disciplines of real estate economy and environmental science. The study has two main findings that will be discussed in more detail below. First, the production process of real estate must be taken into consideration whilst assessing the demands of sustainable development. Second, a suitable platform is suggested that integrates information of different stakeholders and management processes for operation management, end-of-life options and further business drivers.

The following detailed conclusions can be drawn regarding the two initial research questions[40]:

(1) SOCIAL ASPECTS ALONG THE PRODUCTION PROCESS AND END-OF-LIFE. The real estate as "space and money over time" stands in correlation with the view of seeing structural assets and constructions as space forming, society formative habitat. To enlarge the coverage of social aspects to an integral understanding of the social demands of sustainable development besides health and comfort, employment and further effects along the production process, must

[38] It is important to place SMEs at the core of the EU resource-efficiency strategy as they account for 99 % of EU enterprises and employ two thirds of the workforce. (European Commission 2014)

[39] A transition towards a sustainable and circular economy should combine ambitious environmental goals with strong social requirements, including the promotion of decent work, healthy and safe working conditions (i.e. ensuring that workers are not exposed to harmful substances in the workplace (European Commission 2014)

[40] Research questions of this study: How can the objective induction of sustainable development be implemented into the economically oriented decision-making structure of real estate development? (1) How to develop the holistic framework for analysis of the three dimensions of sustainable development by means of real estate and construction? (2)

be included as social aspects. The inclusion of this aspect can also support regional development. In such a view, buildings are considered as more than the sum of construction products: building processes, building services and building products build up the entity of construction as real estate. A model-based view allows to integrate construction management aspects and therein the enlarged social aspects of sustainable development together with economic and environmental ones. The material relevant information presented in KG 300 can be enlarged by social aspects along the production process.

(2) HOMOGENOUS INTEGRATION. Any real estate investment respectively consumerism strategies have to be looked at in a holistic approach for them to meet the demands of sustainable development. Real estate and construction offer good prerequisites to integrate aspects that can induce sustainable development. Any responsible investment means to maximize positive effects and minimize negative effects on society while protecting the environment and capital as resources. This applies also to real estate management and development as well as to corporate activities and responsibilities. The integration of environmental information in construction needs to integrate construction management processes as well. The social and economic criteria need to be developed and integrated into the decision-making in real estate and construction to support a homogenous integration of the trifold demand of sustainable development.

(3) SHARE/TAKE RESPONSIBILITY. For corporate sustainability as well as for a sustainable product development, the trifold dimension has to be taken into consideration. Thinking on “sustainable development” enlarges the view on real estate decisions and construction from “sustainable construction” to “sustainable development as a societal goal”. To understand sustainable development as societal goal and regulative idea requires responsibility and a corresponding action field – as an individual or as an institution. The individual and the institutional responsibilities must be allocated and decisions have to be taken in view of these responsibilities. This can be done via process development in the context of management systems (e.g., per EN ISO 9001 or EN ISO 14001). Regulations and standards should be established and developed in the context of real estate and construction with the daily business processes as a background.

(4) ECONOMIC ASPECTS NEED TO GO FURTHER. In addition to enlarging the social aspects, for economic aspects, existing concepts can be transferred to the model-based information support. The complete building life cycle must be taken into consideration. Especially, end-of-life options and costs should be pointed out in investment decisions. The KG 400 support economic information.

(5) KEEP AN EYE ON TECHNICAL QUALITY. The available environmental criteria for real estate and construction are quite elaborated. However, the approach of building quality and life cycle phases can still enlarge the trifold dimension of sustainable development by implementing an improved technical background. Furthermore, existing economic instruments can optimize the coverage of these techno-economic requirements.

(6) ORIENTATE REGULATION ON EXISTING PROCESSES. This study found that standards on sustainable construction, e.g. from TC 350, could not serve directly as a tool for real estate development decisions yet. Although, they provide a methodological structure, standardization should follow the construction business reality to be effective. On the other hand, standards have to be made applicable for practice. The real estate development must develop the existing processes in recognition to the development of standards and regulations.

(7) DEVELOPMENT OF FAIR AND EFFICIENT INTERDISCIPLINARY PROCESSES. The existing processes should be transformed or in the case of new establishment towards regulation activity. High quality products require a fair treatment of all partners. Closer and efficient collaboration can be to the advantage of all stakeholders in real estate and construction. The proposed model-based view needs multi-project contracts for the information exchange between planner and contractor. The construction processes and production processes carry information on material and further effects. The life cycle costs (LCC) are follow-up costs due to technical quality, and can herein be assigned to material and construction products and result in the SDI model-based view.

(8) MODEL-BASED INFORMATION FOR INFORMED MATERIAL DECISION-MAKING. A modern interdisciplinary data management of construction projects using the model-based view goes beyond the classic structures of real estate and construction management. The integration of processes requires developing documentation to be able to integrate the information and make it available for processes. The SDI-model-based view for a homogenous information integration on effects, which induce sustainable development, integrates the whole life cycle and relevant material information. However, this model needs further scientific development in some aspects. A first step on the way to the implementation of the SDI model in a BIM context would be to work on an expert model for construction separability and create a database and to define relevant scarcities in the context of resource efficiency. A material passport supports the information management by providing relevant material information combined with every construction part, including the life cycle perspective. All material information can be presented as information in a material passport.

(9) ENGINEERING OF DISMANTLING. Building life cycle aspects can be implemented in real estate development. The planning allows calculating material masses and material diversity. However, construction details are critical. Still, the understanding of life cycle thinking in environmental sciences can merge with the life cycle thinking in engineering and real estate. For end-of-life scenarios, material separability is required. Currently, the engineering of dismantling is underrepresented.

The system approaches resulting from this study have good chances to be implemented, but they have still some limitations for their direct implementation. Therefore, some developments still must be made for their practical implementation, for example, the development of internal standards and the development of an expert model for the separability of construction materials in different building contexts. Further research needs are listed below.

6.2. Methodological evaluation

The Brunsvician lens (Scholz and Tietje 2002) was chosen as method for knowledge integration in case study research. This method allowed to work on a practical case study and allowed to structure the context of the case study, to analyze it and to draw conclusions for the research questions in the synthesis. This case study approach also supports the postulate of Busse (2005). She postulates that existing channels of information and control need to be linked systematically to find ways to induce sustainable development. Furthermore, this method allows to assess and develop relevant practical boundary conditions of the case study in the research setting. These practical framework boundary conditions consisted of (amongst others) the conditions for production and consumerism patterns, which are determined amongst others by the interrelations of real estate development, investment and contractor.

The structuring and analysis (decomposition) of the case was supported by a set of expert interviews covering diverse decision-makers, which are stakeholders along the process chain from real estate development to investment. Those stakeholders included investors, real estate developers, planners, contractors and disposal companies. To validate the structuring and analysis of the case, the expert interviews were first coded and then structured according to the research question. The coded results were integrated directly into the description of the case study context, in view of answering the research question in the context of the case study (synthesis). The methodology concludes with a new composition of the case per the Brunsvician Lens (Scholz and Tietje 2002). In this study, the new composition of the case proposes the model-based view of information integration. Real estate decision-making and construction management can apply this model. It is applicable for further branches.

Concluding, the method allowed working with an interdisciplinary approach, to structure the context and answer the practical research problems.

6.3. Recommendations for further research

This study concludes with the identification of further research needs. These needs can be divided into two groups, scientific topics and practical research problems.

First, scientific knowledge is still lacking in the field of construction sciences, environmental sciences and sustainability approaches to operationalize the induction of sustainable development in investment, real estate development and construction. The generation and the communication of social information on construction products and building level should be aligned with the methodology for the assessment of the environmental dimension as proposed by CEN TC 350. Here, the proposed model-based view can be used to structure the relevant information and data. For economic information, the existing processes in real estate and construction bear information, which can be developed for the application in the assessment of sustainable development. Regulation activities such as the development of standards, guidelines and recommendations should recognize the existing processes.

Strategies for the end-of-life of constructions need to be developed to include the life cycle perspective into decision-making to face future problems related to the disposal of construction waste. To find solutions for regulation and management concerning the end-of-life phase, the separability of constructions and construction products as well as to the disposal possibilities must be integrated into decision-making. To this end, an expert model has to be developed to link information on dismantling to information on material choice. Furthermore, a building passport needs to be developed and institutionalized as an information carrier along the building life cycle.

Research also needs to assess problems in the practical context of corporate partners in real estate and construction. Those problems include strategic process development, business development management and product innovation. These needs for further research are identified in the context of the development of processes, internal standards and benchmarks for investment, real estate decision-making as well as for construction and end-of-life activities of structural assets and buildings.

In the context of a real estate company, current decision-making misses several aspects of sustainable development, which would contain the potential to perform sustainable investments and to orientate the portfolio per the demands of sustainable development. This would allow a real estate company to

achieve a portfolio of higher value or at least to justify a high-valued portfolio. The information management in a real estate company can be optimized concerning information flows and decisions that have an influence on the induction of sustainable development by the activities of the real estate company. To optimize the information management, information processes amongst the decision-makers from construction to portfolio level in the company should be consolidated for management purposes and for the application of existing tools. For decision-making in a real estate company, information is lacking on the impacts of corporate activities on the induction of sustainable development. Hence, there is a lack of data for comparison and generation of internal benchmarks for information that is relevant for the induction of sustainable development via the activities of the company. Existing standard constructions should be assessed in a feasibility study to develop information approaches based on the suggested model-based view. This will allow the development of benchmarks and standard processes. Besides the concept and knowledge of the model-based view, this feasibility study should include experts in the field of software development, sustainable development and construction management.

Current products in real estate do not enable sustainable consumerism. For product innovation, recycling and end-of-life tasks should be included together with social requirements. This means for a real estate company to develop such a product portfolio together with scientific support and relevant real estate development, investment and contractor interdependencies. Beyond that, the properties of the product concerning their impacts on sustainable development should be disseminated to the public. In the context of real estate investment companies, the structuring of the portfolio per the demands of sustainable development is not yet possible in an operative sense. Portfolio benchmarks should be developed based on the model-based view of information management. Chosen benchmarks and categories should integrate the trifold demands homogenously and be developed based on the scientific findings outlined above. These facts can be applied also for sustainable investment.

Investment decisions have been identified to be responsible for effects on sustainable development. Yet, sustainable development inducing information for portfolio strategies and management are lacking for real estate investors. The identified information management and suggested approaches should be used to develop portfolio management strategies for investment questions, and zoomed onto fund level. This is one way to support sustainable consumerism. Last, sustainable consumerism needs to be promoted. For real estate, ethically correct and transparent real estate funds bear a chance to establish a product for this consumption pattern. Therefore, CSR and demands of sustainable development should be linked with the description of the real estate portfolio/ real estate investment funds. Indeed, the construction process should be integrated into the assessment on impacts on sustainable development. Technical aspects such as technical service life and life cycle aspects should not be underestimated in the management of funds. In the context of a construction company (contractor group), sustainable consumerism opportunities are generated by characteristics of products. Therefore, sustainable consumerism needs

products that induce sustainable development. This information should be integrated into an operative process of product development. The information on social values and qualities in the production processes which meet the demands of sustainable development are not disseminated yet in an adequate way. These achievements of contractors should be made accessible for investors, users and regulative activities.

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