Nordic and Baltic Case Studies and Assessments in Enterprises

CREDIT Report 2

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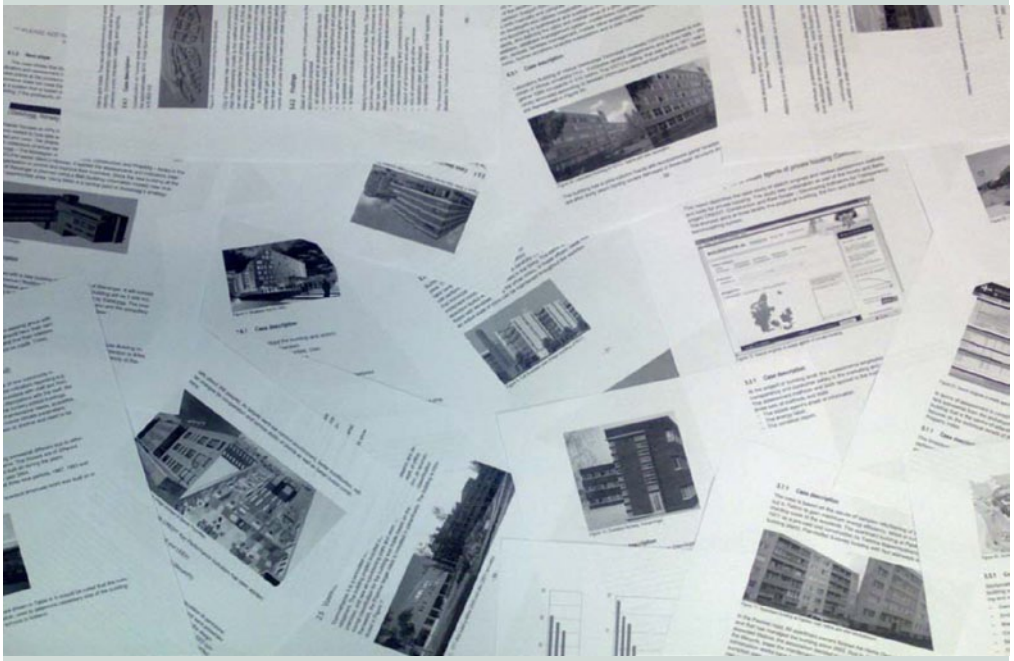

Danish Building Research Institute
AALBORG UNIVERSITY

CREDIT©

Construction and Real Estate -
Developing Indicators for Transparency

Nordic and Baltic Case Studies and Assessments in Enterprises

CREDIT Report 2

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Contents

Preface

This report summarises the results from the work undertaken in fifth work package on "National Case Studies" as part of the Nordic project *CREDIT: Construction and Real Estate – Developing Indicators for Transparency*. Altogether, these cases represent an interesting cross-section from building types - offices, housing, schools and nursery, shopping centres and hospitals - in Denmark, Finland, Norway, Sweden, Iceland, Estonia and Lithuania. Further, we also compare cases and find the trends in the building stock.

CREDIT includes the most prominent research institutes within benchmarking and performance indicators in construction and real estate, namely SBi/AAU (Denmark), VTT (Finland), SINTEF (Norway) and Lund University (Sweden). Moreover, three associated partners joined CREDIT for the Norwegian part of the project. The three associated partners are The Icelandic Center for Innovation (Iceland), Tallinn University of Technology (Estonia) and Vilnius Gediminas Technical University (Lithuania).

The project has been managed by a steering committee consisting of the following persons representing the four main partners:
– Kim Haugbølle, SBi/AAU (project owner), Denmark.
– Niels Haldor Bertelsen, SBi/AAU (project coordinator), Denmark.
– Pekka Huovila, VTT, Finland.
– Päivi Hietanen, Senate Properties, Finland.
– Ole Jørgen Karud, SINTEF, Norway.
– Magnus Hvam, SKANSKA, Norway.
– Bengt Hansson, Lund University, Sweden.
– Kristian Widén, Lund University, Sweden.

The steering committee wishes to thank our industrial partners and all the contributors to the CREDIT project. In particular, the steering committee wishes to thank the four Nordic funding agencies that sponsored the project as part of the ERABUILD collaborative research funding scheme: The Danish Enterprise and Construction Authority (Erhvervs- og Byggestyrelsen) in Denmark (funding SBi), TEKES in Finland (funding VTT), The Nordic Innovation Centre (NICe) (funding SINTEF) and FORMAS in Sweden (funding Lund University).

Danish Building Research Institute, Aalborg University
Department of Construction and Health
August 2010

Niels-Jørgen Aagaard
Research director

Summary

This report summarizes 28 case studies addressing the common interest for indicators in case studies in Nordic and Baltic countries and is distributed to different building types

- Benchmarking systems and indicators (4 case studies)
- Offices (7 case studies)
- Housing (8 case studies)
- School and nursery (5 case studies)
- Shopping centres (3 case studies)
- Hospital (1 case studies)

There are some good practices for benchmarking in large scale. At the moment, those are addressing mostly process and investment indicators, and do not yet cover performance indicators. Front-runner enterprises are already recognizing the potential of benchmarking, rating to highest class may increase interest from investors and building owners. Otherwise, some national and international rating systems are available in the market.

Few frontline owners are already using cost and performance indicators in daily operations, such as Senate Properties in Finland and Statsbygg in Norway. Their focus is mostly directed to investment, costs, and energy efficiency. Altogether, it seems that systematic procedures are needed in the industry for evaluating performance and compliance to end result to needs.

There is no commonly agreed or standardized global or European Key Performance Indicator system, but some national and international rating schemes are available. During the past five years a number of rated buildings has grown greatly, and motivation for using those is increasing.

Market signals are also showing paradigm shift towards end user involvement, and standardized methods for involving end users and making continuous monitoring of satisfaction should be agreed. When committing end users, they need help in order to be able to contribute in value adding way. Workplace management in office buildings is used for tailoring spaces better to end user needs. Senate Properties in Finland develops services where spaces are a strategic asset that can help to contribute an organizational change.

National and international indicator systems do not cover all important business matters and companies are developing their own systems. Some contractors have been developing national systems for process performance monitoring. Indoor environment is important in shopping centres, and performance level for spaces is an opportunity to owner to enhance cash flow through rental agreements. In the future, building automation systems could provide real-time monitoring of performance indicators continuously contributing changes automatically to reach desired performance.

Organizations are looking for an indicator system that could help them to measure and enhance performance of buildings. Apparently some indicators are more important than others; regulations for accessibility have become tighter, location is still the core driver, common interest towards operations and reducing annual energy consumptions is growing. There is potential to improve energy efficiency of buildings. Indicator systems should be implemented in tools to encourage usage in projects; those processes are now rather manual. Building Information Models (BIMs) may be suitable tool for managing those more automated way. Based on findings in CREDIT project, offices and shopping centres are most attracting building types in terms of benchmarking.

Enterprises are benchmarking indicators to some extent but systematic process has not yet been developed and a uniform indicator system considering also building performance and value creation is missing. CREDIT pro-

ject has increased understanding on indicators and transparency and industry needs more research on this matter.

1 Introduction and objective

This chapter describes the objectives, organisation and work packages of the CREDIT project as well as the deliverables including the reports published by CREDIT. The chapter is an introduction to the following chapters where an improved understanding of end user needs, performance indicators and user satisfaction in Nordic and Baltic countries is given. The report is based on collaboration that gives a solid and evidence-based transparent ground for communicating results in order to improve the competitiveness of construction and real estate business.

1.1 The objectives and the project programme of CREDIT

Sir Winston Churchill once said, “We shape our buildings, afterwards our buildings shape us” (28 October 1943). This quotation underlines how strongly a building can influence its occupier or user. It is not without complications to provide complex public facilities for example for hospitals, schools, universities and libraries able to meet both the internal and external stakeholders’ needs and experience. The aims and demands of different stakeholders within a project may sometimes conflict with other stakeholders’ interest. Understanding the needs and experience of the stakeholders is essential to stay competitive in today’s market. A client who pays attention to the needs of the end-users will be rewarded with a high-performance property. Concurrently, this shift seeks to solve many ills associated with inadequate building conditions that result in poor building function.

The amount of both public and private money that are invested in delivering public and private facilities calls for decisive measures to be adopted. Collaboration with the relevant stakeholders helps building owners to identify performance indicators required for creating high-performance facilities. The project aims to define a model for the implementation of performance requirements that ensures fulfilment of various types of users’ and stakeholders’ needs and demands. The model should also allow for the continuous measurement of the effectiveness of the applied requirements and the model as such, so that it can be improved as more knowledge and experience of it is gained.

Adhering closely to the themes laid down in Erabuild, the aim of CREDIT is to improve transparency of value creation in construction and real estate. Thus, the objectives of CREDIT are:

– To capture end-user needs and experience in order to identify and quantify – where possible – value creation in the constructions and real estate sectors,
– To develop compliance assessment and verification methods,
– To define and develop benchmarking methods and building performance indicators for the construction and real estate,
– To propose recommendations for international benchmarking of key performance indicators of buildings.

Consequently, the deliverables of CREDIT are:

1. The establishment of a network of Nordic and Baltic researchers of benchmarking and performance indicators by frequent interaction in workshops across the Nordic and Baltic countries.
2. A State-of-the-Art report to identify and critically examine a number of existing tools, databases, mandatory reports, approaches and benchmarking schemes to capture and measure end-user needs, client demands and public requirements to performance and value creation.
3. A strategic management and decision-making tool to guide the definition and development of benchmarking methods and building performance indicators in different business cases.
4. A comprehensive performance assessment and management tool with associated key performance indicators to capture end-user needs and experience and to continuously measure and verify the compliance of performance throughout the life cycle of an actual building project linked to building information models.
5. Recommendations of how sector and national indices of performance indicators can be designed in order to promote international benchmarking of construction and real estate.
6. Dissemination of the lessons learned and tools developed through news articles, press releases and workshops with actors from the construction and real estate sector.

The expected impact of CREDIT on the construction and real estate sector at national and European levels are as follows:
– Improved understanding of end-user needs and client's demands to performance requirements and level of satisfaction.
– New and improved tools to make the costs/value ratio of products and services more transparent throughout their life cycles.
– A more solid and evidence-based background for launching new public policies to improve the competitiveness of construction and real estate business.
– Improved opportunities for more accurate comparisons with neighbouring countries via improved methods.

More information about the background is given in the CREDIT project programme (CREDIT, 2007).

1.2 Main partners in the CREDIT project

The CREDIT project was a cooperative research project including four Nordic research institutes:
– Danish Building Research Institute (SBi), Aalborg University, Denmark – funded by The Danish Enterprise and Construction Authority (DECA) (Erhvervs- og Byggestyrelsen).
– VTT, Technical Research Centre of Finland, Finland – funded by TEKES
– SINTEF Byggforsk, Norway – funded by The Nordic Innovation Centre (NICe)
– Lund University, Construction Management, Sweden – funded by FORMAS.

Another three associated partners joined CREDIT for the Norwegian part of the project:
– The Icelandic Center for Innovation, Iceland.
– Tallinn University of Technology, Estonia.
– Vilnius Gediminas Technical University, Lithuania.

The Danish Building Research Institute (SBi) was project owner and project coordinator of the project as well as legally responsible according to ERABUILD on behalf of the four main partners. SBi, VTT, SINTEF and Lund University were the national coordinators for the project in Denmark, Finland, Norway and Sweden respectively, and moreover SINTEF was responsible for the coordination with the three associated partners.

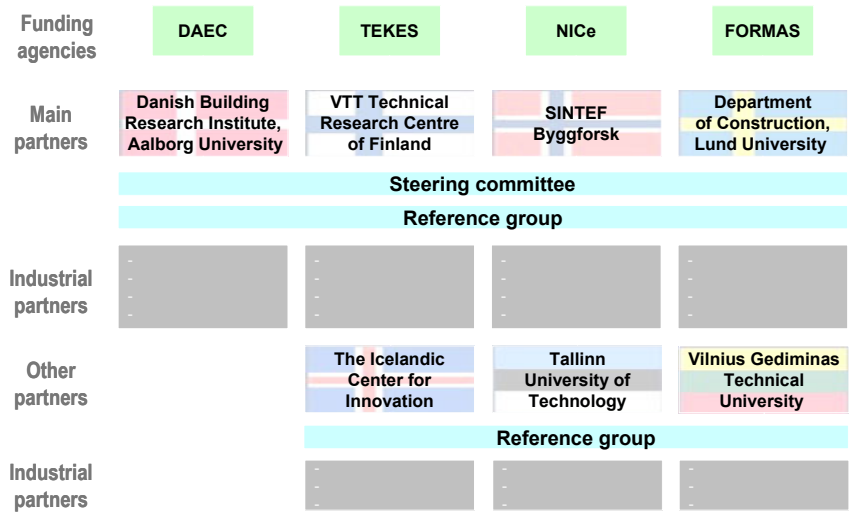
The project was managed by a steering committee chaired by the project owner, the project coordinator was secretary and each of the four main partners had two seats. The steering committee saw to the overall coordination and operation of the project, and was responsible for making the decisions necessary in this regard. The following persons represented the four main partners in the steering committee:

– Kim Haugbølle, SBi (project owner), Denmark.
– Niels Haldor Bertelsen, SBi (project coordinator and DK project manager), Denmark.
– Pekka Huovila, VTT (FI project manager), Finland.
– Päivi Hietanen, Senate Properties, Finland.
– Ole Jørgen Karud, SINTEF (NO, IC, ES and LT project manager), Norway.
– Magnus Hvam, SKANSKA, Norway.
– Bengt Hansson, Lund University (SE project manager), Sweden.
– Kristian Widén, Lund University, Sweden.

In relation to national activities, different partners from the construction and real estate sectors were involved in the case studies and the discussions of the findings. All these national contacts and cooperative partners were referred to as national reference group members. They represented different users of performance data and benchmarking systems in the Nordic and Baltic countries and are therefore the target group for the CREDIT results. Together with policy makers, funding agencies and researchers they constituted the Nordic Baltic Reference Group.

More information about the organisation is given in the CREDIT cooperation agreement (CREDIT, 2008).

Figure 1. The main partners and funding agencies in CREDIT



1.3 CREDIT work packages and meetings

Through seven work packages (WPs), the national research groups studied international experiences and examined a number of existing and new methods, tools and systems for performance assessment and international benchmarking. WP1 and WP7 dealt with the general project management and dissemination of results from CREDIT. WP2, WP3, WP4, WP5 and WP6 represented different steps of the research activities from a general study of the state-of-the-art in WP3 through the performance model in WP2, project assessment in WP4, national case studies in WP5 and international benchmarking in WP6 and returning with the final conclusions and recommendations to WP2. Coordination of the specific research in WP4, WP5 and WP6 were also handled by WP2, and WP2 therefore had the following three tasks:

1. To formulate the research model and coordinate the research in CREDIT.
2. To classify performance indicators in the CREDIT benchmarking model.
3. To summarise the CREDIT reports including national recommendations.

WP3 studied literature and general national practice as background for the specific research in WP2, WP4, WP5 and WP6, and this resulted in a formulation of more specific tasks and objectives for the four other WPs. WP4 studied different project assessment methods and tools and how the different enterprises worked with indicators, assessment and benchmarking. WP5 studied 28 different case studies in the Nordic and Baltic countries, which were grouped and compared within different building segments. WP6 surveyed sector, national and international benchmarking systems of key performance indicators and experience from front–runners in the construction and real estate sector.

According to the CREDIT project programme (CREDIT, 2007), a number of deliverables (D) were agreed for each of the seven WPs. A final list of the specific deliverables (D) is given in Appendix A, and an overview is given below of each of the seven WPs:

– WP1: CREDIT project management. (Responsible: SBi/DK)
  Deliverables: Steering committee (SC) and SC Meetings (D1), CREDIT project meetings (D2) and Progress reports and accounts (D3).

– WP2: Performance models. (Responsible: SBi/DK)
  Deliverables: Stimulus paper, draft report and final report (D4a) on performance indicator and a draft and final summary report (D4b). D4b is an extra deliverable according to the project programme. CREDIT Report 3 and 6.

– WP3: State-of-the-Art. (Responsible: SINTEF/NO)
  Deliverables: Stimulus paper, draft report and final report (D5) on State-of-the-Art. CREDIT Report 1.

– WP4: Project assessments and tools. (Responsible: Lund University/SE)
  Deliverables: Stimulus paper, draft report and final report (D6) on project assessments and enterprises. CREDIT Report 4.

– WP5: National case studies. (Responsible: VTT/FI)
  Deliverables: Stimulus paper, draft report and final report (D7) on case studies and buildings. CREDIT Report 2.

– WP6: International benchmarking. (Responsible: VTT/FI)
  Deliverables: Stimulus paper, draft report and final report (D8) on sector, national and international benchmarking. CREDIT Report 5.

– WP7: CREDIT dissemination. (Responsible: SBi/DK)
  Deliverables: CREDIT project web (SINTEF eRoom) (D9), reference group and user workshops (D10), press releases (D11), news articles in trade journals (D11) and research articles (D12).

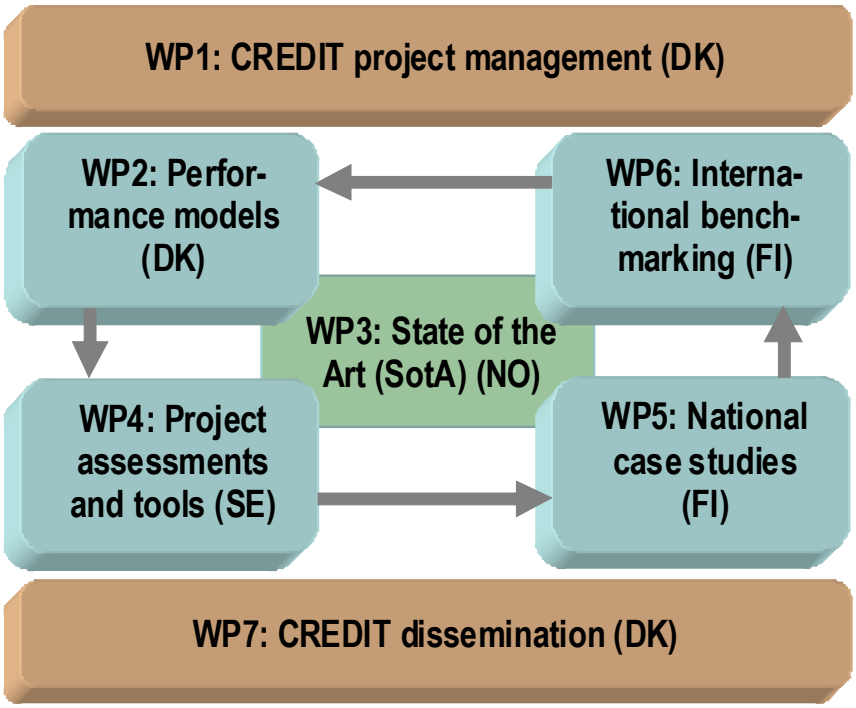
Seven two-day meeting packages (MPs) were held in 2008, 2009 and 2010 in the different countries to strengthen the innovative cooperation between the researchers and the national reference groups comprising the main players in planning, construction, real estate, benchmarking and the responsible authorities. Each meeting package (MP) focused on a specific work package (WP) and consisted of a one-day project meeting, a half-day user workshop, a reference group meeting and a steering committee meeting.

The seven CREDIT meeting packages alternated between the participating countries:

1 Helsinki, Finland, 24-25 January 2008: Kick off and end-user values.
2 Oslo, Norway, 29-30 May 2008: WP2 Performance models and WP3 State-of-the-Art.
3 Lund, Sweden. 8-9 October 2008: WP4 Project assessment methods and tools.
4 Vilnius, Lithuania, 19-20 January 2009: WP5 National case studies.
5 Reykjavik, Iceland, 8-9 June 2009: WP6 International benchmarking.
6 Tallinn, Estonia, 26-27 October 2009: Discussing the final CREDIT Reports 1, 2, 3, 4, 5 and 6. An extra meeting according to the project programme.
7 Copenhagen, Denmark, 25-26 January 2010: Final reports and closing of CREDIT.

The CREDIT project plan (CREDIT, 2007) outlines the relations between work packages (WPs), meeting packages (MPs) and deliverables (D). Every six months a project status was prepared and a progress report sent to Erabuild at the Danish Enterprise and Construction Authority, and in February 2009 it was extended to a 'CREDIT Progress and Mid-term Report' of 36 pages (CREDIT, 2009). A final version of the project and meeting plan is given in Appendix A.

Figure 2. The seven work packages (WPs) in CREDIT with the responsible countries (DK, FI, NO or SE) in bracket. WP2-WP6 are the main research WPs, and WP1 and WP7 include the project management and dissemination of results of CREDIT respectively.



1.4 CREDIT reports, deliverables and eRoom

The work of each of the main work packages (WP3, WP5, WP2, WP4 and WP6) were documented in five reports - CREDIT Reports 1, 2, 3, 4 and 5 - and in various scientific articles and news articles. For example Report 1 describes the state-of-the-art as a result of the work of 'WP3 State-of-the-Art'.

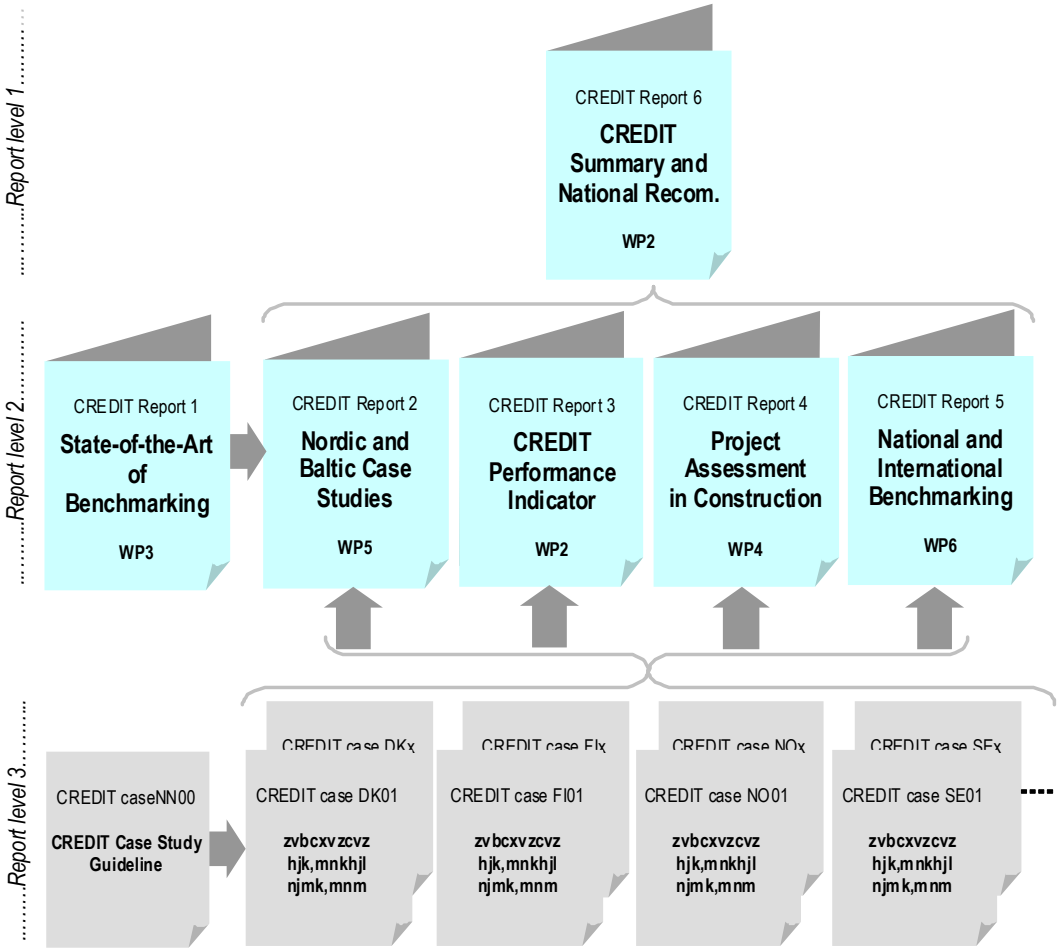
The work of 'WP5 National case studies' resulted in 28 Nordic and Baltic case studies with focus on performance indicators, assessment tools and benchmarking in front-runner building projects, enterprises and benchmarking organisation and reported in CREDIT Report 2. Each case study is described in accordance with a common guideline and together with results from the state-of-the-art report they form the background for the research and proposals for future improvements presented in CREDIT Reports 3, 4 and 5.

CREDIT Report 3 describes the CREDIT performance indicator framework as a result of 'WP2 Performance models', and the indicators are relation to national regulations; international standards and research; and:
– Report 4: Project Assessment in Construction and Real Estate.
– Report 5: Internal, National and International Benchmarking.

The results of the five CREDIT reports are summarised in this CREDIT Report 6 together with recommendations on how to implement the results nationally in the Nordic and Baltic countries.

In Figure 3 a graphical illustration is given of the three levels of the hierarchy of CREDIT reports, and after Chapter 8 all CREDIT reports are listed. Through the research all deliverables were filed in the common CREDIT project web in eRoom in SINTEF, Norway, and a complete list can be seen in the minutes of the CREDIT Steering Committee Meeting 8 (CREDIT, 2010).

Figure 3. Graphical illustration of the hierarchy of CREDIT reports.



2 Existing benchmarking systems and indicators

This chapter introduces four existing benchmarking systems. First, we have two Danish cases explaining how key performance indicators are implemented to practice for contractor work, and get to know commercial facility Investment Property Index that is being use in over 20 countries. Then, we go through Swedish system for evaluating the construction process, and finally close with enhancing competitiveness of the civil engineering.

2.1 The Danish Benchmarking Centre (Denmark)

Indicators applied in the construction process are described in this case study. These indicators form the basis for a systematic calculation of Key Performance Indicators (KPIs) by an independent organization, the Benchmark Centre for the Danish Construction Sector (BEC).

The actual building, building parts and processes

The actual building, training centre ("Søværnets Taktikkursus") for the Danish Navy employees, is situated to Frederikshavn in the northern part of Jutland. It has been designed and constructed between the years 2006 to 2008. In the case, the client Forsvarets Bygnings- og Etablissementstjeneste had a focus on different aspects of the building process. Further, the case has also been used as a starting point for a description of the benchmark system and the indicators in Denmark.

The applied assessments and tools in the processes

The necessary data for calculation of the KPI's is collected by the client and the companies during construction, and delivered to the Danish Benchmark Centre (BEC). Currently, the indicators are mainly calculated after the construction phase and used for two purposes; first to evaluate work on the site, and second give information to actors. Up to now only some of the companies use indicators for development of procedures and methods. It is compulsory for clients responsible for state and non profit housing projects to ask for KPIs in new buildings, and in practice the demand usually is in the contract.

The resulting KPIs are used to get an impression of quality and effectiveness of the executed work in post analysis. They also give clients a possibility to evaluate qualifications at potential contractors looking for a new job. In this way the collected data and the calculated KPI's were primarily for the companies and for the client. The costs for an evaluation depend on the size of the project.

Cost and performance indicators applied in the processes

The indicators address the building as a whole (for example construction time), the process on the site (for example accidents) and the different parts of the building (for example defects).

KPIs delivered to the client after execution:

- Actual construction time in relation to planned construction time
- Actual construction time incl. remediation of defects in relation to planned construction time
- Remediation of defects during the first year after handing over
- Number of defects recorded in the handing-over protocol, classified according to degree of severity
- Accident frequency per billion DKK
- Work intensity, man hours per m2
- Labor productivity
- Changes in project price during the construction phase
- Square meter price
- Customer satisfaction with the construction process

KPIs delivered after construction to the contractor:

- Actual construction time in relation to planned construction time
- Actual construction time incl. remediation of defects in relation to planned construction time
- Remediation of defects during the first year after handing over
- Number of defects recorded in the handing-over protocol, classified according to degree of severity
- Accident frequency per billion DKK
- Customer satisfaction with the construction proces

Relation to different enterprises and national benchmarking

The system and the indicators are used for different types of buildings – from offices and museums to all sorts of housing projects. Up to now BEC has executed 1460 evaluations, and 640 contractors are in process of getting KPIs. From the evaluations, about 30% of the evaluations are executed due to state demand, while 70 % are made for private clients or local authorities.

This case shows that it is possible to evaluate the process on the building site after the final delivery, and give the client and the companies an insight and information about the executed work. BEC also informs how the obtained KPI's are ranked in comparison with the average values. The results can be used for altering and evaluating the contractor procedures. These calculated Key Performance Indicators (KPI's) also form a basis for the individual company grade book that is published in 2010. For the government, politicians and the building industry the KPI's give the possibility for an overview of development in the industry concerning the evaluated topics.

Visions and innovation for future improvements

The main focus in this case is a system of evaluating the building process. The evaluation is based on defined KPI’s and is executed by an independent organization. The necessary data is collected during the work on the building site and at handing over. Until now it has been up to the contractor and subcontractor to report the main amount of data.

Meanwhile the findings of the system have shown that the companies had complaints about the scope of the work and wanted a reduction. The main part of the work has been digitalization the new system simplifies the work and simplifies the data collection in companies. The results have also caused changes to the KPI's.

2.2 Benchmarking commercial property (Denmark)

This chapter focuses on the systemic qualities of the Investment Property Databank's 'IPD Denmark Annual Property Index.' The present IPD case differs from the typical CREDIT case, and describes on a very general level how a building is established as an economic entity in the public sphere.

The actual benchmarking organisation and its purpose

IPD is the world’s leading provider of real estate performance analysis for funds, investors, managers and occupiers. Among the business services that IPD provides are market research, reporting, benchmarking, conferences and indices. It operates in more than 20 countries including most of

Europe, the US, Canada, South Africa, Australia, New Zealand and Japan. It publishes IPD's indices, which form the basis for developing commercial property derivatives market, and operates under a set of articles and shareholder agreements to preserve the company's operating principles and independence. Shareholders must approve aims of company including open access to data (www.ipd.com).

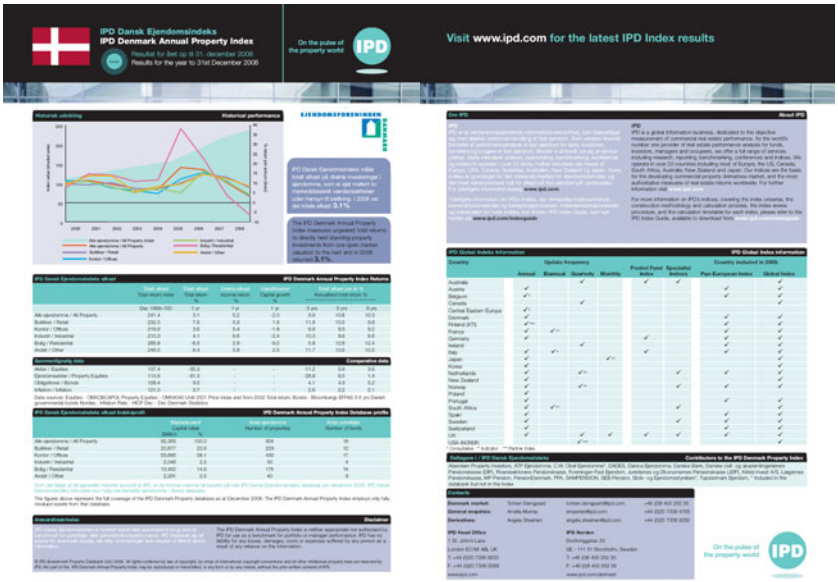


Figure 4. Format of the IPD Denmark Annual Property Index (IPD, 2009).

Assessment applied in the benchmarking organisation

From its databases the IPD constructs indices relating to the total returns to directly held standing property investments from one open market valuation to the next. The IPD databases hold records of properties owned by investors and managed by portfolio managers. The cornerstone of the system is direct data input and the databases contain financial and descriptive information on individual buildings belonging to investment portfolios.

The role of the IPD is to collect information, to ensure that this data is consistent, and compare this data across different portfolios and countries. The raw building level data is taken directly from the systems of property investors and occupiers for complete investor portfolios. The main part of the input comes from auditing reports, tax authorities, external valuators and external accountants, and IPD validates these data. Automated validation routines check for completeness, identify internal inconsistencies, and highlight any numbers that look implausibly large or small. If problems are identified, these are raised with participant investors as queries.

Cost and performance indicators applied in benchmarking

IPD records all types of property investments that are contained in their participants' portfolios. Each directly held asset (building) that attracts a separate open market capital valuation is individually recorded in the IPD database according to following indicators:

Table 1: Data on properties recorded in the IPD database (IPD, 2008: 10-11).

Indicator	Description
Location	Address, postcode, type of location.
Investment interest:	Type of investment, owner occupied status, tenure, ownership share.
Direct property type	Predominant current use, percentage use mix.
Physical/historical data	Building condition, listed building or conservation area status, construction date.
Purchase data	Method of acquisition, purchase date, gross and net purchase price, purchase costs: stamp duty, legal fees, agents fees, other fees.
Sale data	Sale date, gross and net sale price, sale costs: legal fees, agents fees, other fees. Sales are dated to the end of the month.
Valuation data	Valuation date, managing agent, valuer (company name), open market capital value, open market rental value, rent passing, net lettable area, current gross, net, equivalent yields and cap rates, method of valuation.
Lease and headlease details	Tenant name, tenant use, lease start and expiry dates, rent review dates, whether upward only, step dates and amount, rent review frequency, lease status, gearing information, net lettable floor space, date and type of break clause, rent passing, open market rental value.
Vacancies	Start and end dates of last vacancy, days vacant, anticipated letting date.
Capital expenditure and receipts	Development expenditure, on-going capital expenditure, transaction costs, part purchases and sales, other capital receipts.
Revenue expenditure	Ground or head rents, property management costs (base management fees, rent review fees, lease renewal fees), other irrecoverable revenue costs including expenditure on vacancies and bad debt write-offs.
Rents and income	Rent passing, contracted rent, rent receivable, other income, net income receivable. Income is recorded in daily amounts.

Relation to enterprises, building project and real estate

IPD measures total returns to property investments and thus covers the process of building operation. It is important to note that the IPD indices are used by companies in investment decisions and also in the pre-briefing phase. At enterprise level, the IPD system is used strategically by a property investor for supporting a managerial decision of selling certain properties.

The databank profile in Denmark reveals that IPD coverage is up to 48 % of the total market, distributed on 21 enterprises and funds at the end of 2007. These 21 funds own 1,036 properties with a capital value of € 13.6 bn. (IPD, 2007: 6). Properties are distributed into one of five different categories; retail properties, offices, industrial properties, residential properties, and other. For each of these property types, the total return, income return and capital growth, as discussed previously, can be seen. Furthermore, a total return index is provided as well. For each property category the current years return rates are presented, as is the annualised total return percentage in a three, five, and nine yeas period.

Visions and innovation for future improvements

At the most general level of observation, the system can be seen as a means to create transparency to domestic and international property markets. Enterprises adopt the system in order to compare their investments to ones from its competitors and hereby benchmark the performance of investments.

It is shown how the system is institutionally anchored at an umbrella organisation that collects data and coordinates the different users of the system. It is argued that this particular type of institutionalisation, where a mediating association promotes the benchmark system only as a part of its larger 'package' of paid member services, seems to constitute an important ele-

ment in the operation of the system, and hence for the fulfilment of the purposes of creating transparency in the market.

During the recent years, several specific issues have been addressed within the Danish IPD system when dealing with possible changes. Most notably concerning the frequency of data reporting, but also indicators for sustainability has been considered for inclusion in the system (e.g. pertaining to energy consumption and the like). According to the Danish Property Federation, these indicators have not yet been implemented, however, IPD will be able to provide these indicators and question is are members willing to pay the cost. With inspiration from the UK debate concerning the IPD indices, there have been talks about converting the index towards considering geared investments, i.e. include debt situations.

2.3 System for evaluating the construction process (Sweden)

This case study presents a system for measuring, steering and developing within a project and between projects. Data is collected by a company specialised on reviews.

The actual building, building parts and processes

The system is supposed to work in all kinds of construction projects (houses, roads, railways, hospitals etc.) and for new built, renovation and conversion projects. The main idea on a project level is to continued improvement by a learning spiral of preparations, data collection, results from the questionnaire, feedback, dialogue and interventions.

The applied assessments and tools in the processes

The software uses Gantt charts to offer a structured support for planning the measurement and knowledge exchange. The project is divided in four main phases: briefing, designing, construction and occupancy. The system provides a volunteer pre-study (strategic briefing phase). Measuring/following up is made before starting and ending a new phase as well as during that particular phase.

The system has a focus on two perspective; how and what. The “how” perspective is focused on leadership, co-workers, organisation and processes. The construction phase is the main focus in measuring. The tool advocates the use of a SWOT (strength, weakness, opportunities and threats) analysis and risk analysis as well as systematic evaluations. The “what” perspective on effect/operation goals and project goals and brings value both to the client and the user. The main thought with all evaluations is to force project members to evaluate and analyse how results meets original goals. Every evaluation consists of around 20 questions that the respondent have to rate their experience on a scale with the possibility to make a remark.

The great benefit with the tool is that the tool confirms that you understand the prerequisites, to create an awareness of the conditions and force people to take one’s stand. The cost for using the tool is estimated to be around 0.2-1% of the total project cost. The tool enables a systematic evaluation of the process. Every new actor that is participating gets the chance to evaluate the previous work and their experience of the work.

Cost and performance indicators applied in the processes

The two perspectives are working in parallel but are to be considered individual, and the system uses different kinds of measuring/following ups for management;

– time and cost follow-up

- goal fulfilment
    - project
    - effect
- different kinds of evaluation processes
    - self-evaluation
    - temp – measuring
    - performance evaluation
- feedback and meetings
    - experience from the temp- measuring
    - workshops (when starting up a new phase)
- interventions
    - activities

The cost and time aspects are lifted out as independent evaluation parameters though they are important for project success. The performance evaluation is validated by the fact that first is the leadership rating their performance and then is the participants rate the performance.

Relation to different enterprises and national benchmarking

All information collected during the evaluations is stored in a database. Both within the enterprise as well as between enterprises are different “best practices” possible to compare. The information is made visible to other enterprises by the creation of a “client-index” in the software for every specific project. The information shared is though made anonymous but provides information about project kind, size, collaboration form etc. The parameters that will be compared are leadership, self-evaluation, temp-measuring, how the way we manage our projects experienced and cost registration.

Visions and innovation for future improvements

Interviews revealed that changing goals and needs should be considered more thoroughly when developing the system. The supplier concludes to offer an open tool that does not lock aspects to much to enable project work in different conditions; such as rail ways and housing. Further, system should also confirm that every involved participant is aware of the changes made during the project.

The tool is delimited to focus on internal relations. It focuses on the client perspective from a project and construction efficiency perspective. Because the system is not in use, it is hard to evaluate its benefits in use. Altogether, it is very ambitious and it is interesting to see feedback from the participants through workshops and meetings.

2.4 FIA (Sweden)

Different initiatives to improve the construction industries competitiveness have been introduced in a number of European countries. In Sweden, a focused program to improve the competitiveness of the civil engineering part of construction in FIA (Renewal within the civil engineering sector) was launched in December 2003.

The actual benchmarking organisation and its purpose

The aim of FIA is that the year 2010 their vision should be fulfilled. To achieve this five aims have been defined to increase efficiency, to improve cooperation, develop competences through R&D, to disseminate knowledge efficiently, and to ease recruitment by reforming the image of the industry.

Assessment applied in the benchmarking organisation

The Division of Construction Management in Lund University was commissioned by FIA to develop the survey, manage the data gathering and to do the analysis of results. The survey consists of factual project questions and assertions about the project. The assertions and how they relate to the five goals are presented table 2 (very strong, strong, weak or none). Besides, there was also an open question for key factors in the outcome of the project.

Cost and performance indicators applied in benchmarking

The main focus in this assessment was on efficiency. However, for a civil engineering project it is better to measure the output in terms of the project value. In this survey the project value is measured both as the contract sum and as actual cost. The total length of the project is also measured through both the planned timescale and real length of the project. If the final outcome is different from the budgeted or planned outcome, the respondents are asked to answer why this deviation occurred. The input is measured as number of days (man days). In addition, a number of soft parameters exist. From these measures it is possible to evaluate the efficiency from following relations:

- Actual cost (SEK) / The total number of man days (days)
- (Actual cost (SEK) – Contract sum (SEK)) / Contact sum (SEK)
- The final length of the project (days) / the total number of man days (days)
- (The final length of the project (days) – Contracted length of the project (days)) / Contracted length of the project (days)

Relation to enterprises, building project and real estate

Depending on what form cooperation have been adopted it can be graded on scale from 0-5, where 0 is conventional practice and 5 is a long term strategic cooperation between for example client and contractor. However, the correlation between questions can give insights of how different levels and forms of cooperation interact.

The main question that relates to R&D is if any new production methods or products have been used that have not been used before by client or main contractor. In the survey there are no direct factual questions relating to knowledge transfer. In the questionnaire design the formulation of one clear question that could not be misinterpreted was almost impossible. However, nearly all other questions in the questionnaire can indirectly be related to this topic, which gives ample opportunity to indirectly evaluate the consequence of an existing, or non-existing, transfer of knowledge. The main questions that relates to this topic are the following:

- Have systematic cooperation been adopted beyond conventional practice?
- Have common goal been established between the actors in the project?
- Amount of changes in the contracted works during construction on site
- Amount of errors at final inspection.

Visions and innovation for future improvements

There has been an interest in the development of indicators on productivity. The issue has not been solved yet, as it has been found to be rather difficult

to find comparable measure across the infrastructure sector. It is now leaning towards the use of a number of indicators, indirectly measuring productivity and those measures used together as indication on the trend of productivity in the sector.

3 Office case studies

Chapter ahead introduces to us seven office case studies. First, the Danish case explains how to manage operation period benchmarking. Then, we have a closer look on performance indicators in four Finnish projects; one new construction and three renovation projects. Finally, we demonstrate indicator systems to capture process indicators, and owner perspective in two Norwegian projects.

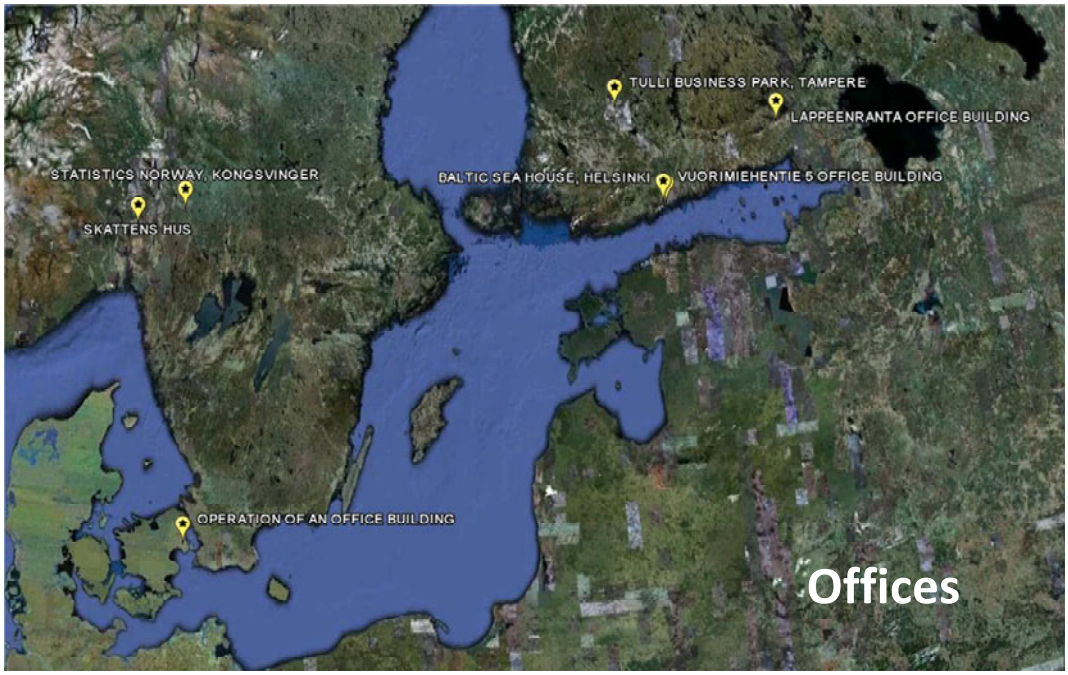


Figure 5. Office case studies in CREDIT project.

3.1 Operation of an office building (DFM benchmarking, Denmark)

This case describes how to collect information during the operation phase in order to get an impression of the development year for year of costs for operation and compare different operational activities with similar activities in other buildings. And on the basis of the findings reduce the costs or increase the quality.

Case description

The building is situated at Ørnevej in Copenhagen and owned by the municipality of Copenhagen and used for offices for administrative tasks, day care institutions and educational facilities. It is operated by Copenhagen Properties which is an administrative organization within Copenhagen authority. The collection of KPIs is part of annual registration of economical data and consumptions of resources as energy, water and electricity.

The applied assessments and tools in the processes

The method is based on written and standardised instructions for gathering of data and calculations of KPIs. The costs are calculated as DKK per square meter. Services are furthermore calculated as costs per number of people – employees or users. Data are mainly taken from different yearly accounts with information about registered costs and use of heating, water, electricity and costs for maintenance. Every activity has a requisition number

which has to be used. Renovation of the building is viewed on as building work – and not a part of the operational activities - and is not a part of the registration.

Cost and performance indicators applied in the processes

The indicators are calculated and used for assessments during the operation of the concrete building. Data belongs mainly to CREDIT indicators concerning group 5. Facility performance in operation and use" but they are also of interest for the groups 3 and 7. They are on levels two and three. Most important data are the yearly costs for

- maintenance,
- supplies (water, electricity, heating),
- cleaning,
- common operation,
- services and
- regular expenses as tax.

Services comprises canteen, network for data, post services, reception and security. In the work with exchange of experiences the KPIs are divided in accordance with different building types as for example schools, offices and hotels.

Relation to different enterprises and national benchmarking

Copenhagen Properties gets the resulting KPIs from Danish Facility Management networks, and uses the data to compare operation of the current period with former periods and budgeting the coming periods. Furthermore, the resulting KPI's are used as the basis for seminars and workshops within the network to exchange experiences and get information to reduce costs or increase the quality of the operation.

Some of the information go to the press or are used in connection with general statistics concerning costs of the operation of a building. An example is political discussions in connection with budgeting next year's expenses to operation of a single building or a group of buildings. The KPIs are also used in talks with the companies who are doing the actual work and the service providers.

Visions and innovation for future improvements

The chosen indicators give a comprehensive picture of the operation of a building and some important "lighthouses" for the daily operational activities at client and company level. They form the basis for systematically voluntary comparisons and exchange of experiences at workshops and yearly reports. It has been considered to extend the number of data to other services and parts of renovation works but there are no plans for the moment to alterations. It is recommended to reduce the number of indicators at least in the first phase of introducing a benchmark system.

3.2 Tulli business park (NCC, Finland)

This case study shows how performance indicators are collected and analysed in order to find performance improvement possibilities. The case explains how a short site evaluation in indoor climate and mechanical systems are used to recognize improvement possibilities to thermal comfort and automation system reporting.

Case description

Tulli Building is located right in the centre of Tampere. The design takes people to centre stage and enhances job satisfaction by minimizing negative

stimuli in the working environment. The design concept is flexible to built open, cell or mixed office solutions. Four buildings were built in stages; first was completed in 2008 and last in 2009.

– Location: South-West Finland, Centre of Tampere city next to railway station
– Total floor area: 34.900 m2, about 1.200 jobs
– Rentable floor area: 22.000 m2, leased office spaces 150 - 4.500 m2
– Commercial spaces 50 - 700 m2

Figure 6. Tulli Business park (Image courtesy of NCC).

The applied assessment methods and tools in the processes

NCC's third generation Business Park highlights role of the office environment as a strategic business tool. The objective of environment is to offer prime locations, high-standard architecture, flexible facilities, the latest technology, versatile services and higher job satisfaction for tenants and their clients. The approach is described in design guidelines and goals have been written into NCC's business park concept book. In order to get customer feedback information, an internet questionnaire has been sent to users. Results are used for corrective actions in control systems and also possibilities to improve Business Park concept for future projects.

Cost and performance indicators applied in the assessments

Localised indicators to Finland have been used in this case study.

1. Cost, price and life cycle economy (LCE)

11 Capital investment, construction and commissioning costs
- Site costs total and €/m2
- Programming and planning costs total and €/m2
- Design and engineering costs total and €/m2
- Construction costs total and €/m2
- Space cots/m2
- Work place costs €/unit

12 Building service related to operation and maintenance
- Administration costs €/m2
- Maintenance and repair costs €/m2
- Energy costs, water consumption costs €/m2
- Cleaning costs €/m2

13 Business services related activities in the building
- User service costs
- Catering
- Lobby
- Office services
- Conference and meeting room reservation
- Office maintenance and operating services, management services
- Wellness services
- Security services
- ICT services
- Parking 0,32 car parks/employer

2. Location, site, plot, region and country

21 Location and address

22 Plot opportunities
- Size of the plot
- Bearing capacity
- Building efficiency and density
- The plot is brown field area

23 Spatial solution and property aesthetics
- Modifiability of spaces
- Modern head office architecture style

24 Surrounding services
- All kind of services are available within 500 m
- Distance to railway station 150 m, bus station 300 m, bus stops 150 m and 300 m
- Distance to Tampere – Pirkkala airport 17 km
- Distance to bicycle route 200 m, footway: 50 m
- Distance to Pyynikki park 2 km, Sorsapuisto park 300 m
- Distance from Tulli Shopping Centre 100 m

25 Social values
- Community acceptance

3. Building performance and indoor environment

31 Category of building, quantity, size and areas
- Office building
- Number of storeys 6
- Build up area
- Gross floor area 8942 m2
- Net floor area 5715 m2

32 Safety and security of burglary
- Report of an offence system
- Automated fire alarm system
- Sprinkler system in all spaces
- Access control system

33 Usability and adjustability
- Adaptability and compliance with needs
- Accessibility
- Workplace quality and usability
- Easy modification possibility, movable electric and network towers

34 Thermal comfort
- Allowed temperature range: 23-26 summer, 21- 22 C winter

35 Air quality and health
- Indoor climate class S2/S1 requirements

36 Visual climate
- Atractivity of workplaces
- Work place characteristics

37 Acoustic climate
- Indoor climate class S2/S1

38 Aesthetic of building and indoor spaces
- Stress free zones
- Open, mixed and room offices

4. Building part and product performance

44 Thermal quality
- Envelope, doors and windows comply 2006/2007 standard in Finland

45 Impact on air quality
- Indoor climate class S2/S1 requirements

46 Lightning quality
- Low energy fluorescent lightning
- In work places 400 lx luminous intensity
- In corridors and stores 300 lx

47 Acoustic quality
- Partition walls 35 dB, acoustic ceilings

5. Facility performance in operation and use

51 Category of tenancy and operation and area of space
- Spaces to different size customers
- Rentable area/total area > 0,85 (the whole building)

52 Applicability of the facility
- Flexible concept: open, mixed and room offices
- Easy access by public transport

54 Services
- Maintenance services
- Cleaning, catering, lobby services, office rooms, moving services

6. Process performance in design and construction

64. Quality management
- QM system complies with ISO 9001 standard.

65 User involvement and cooperation
- Requirements from users for final space design

7. Environmental impact

71 Resource use
- Electricity kWh/year
- Heating energy kWh/year
- Water consumption m3/year

72 Emissions
- Fixed waste amount

Relation to different enterprises and national benchmarking

Tulli Business Park was designed according to Finish 2006 – 2007 regulations and any national rating system was not used. Tulli Business park facility has been sold to UBS United Bank of Switzerland and NCC take's care of minor services and contractual liabilities after handing it over 2009.

Visions and innovation for future improvements

NCC is uses experiences from project into the development of the Business Park concept. The implemented user inquiry gave data and information in order to improve control activities related to building automation, heating and ventilation systems. The design goals are based on national 2006/2007 regulations, and therefore, high energy efficiency was not yet one of the main topics but will be. NCC's wants to be a leader in energy-efficient construction, and develop CO2-neutral products and services (NCC, 2009). Customer oriented workplace planning and usability are important aspects in office spaces.

Implemented short performance audit highlighted some improvement possibilities in design solutions. Implemented mechanical systems need as

well some extra control activities. General national rating system has not been used in the project. However, a number of indicators have been addressed during the project and in internal benchmarking the Tulli Business Park got the best project status.

Enterprises and organisations can use different indicator systems and assessment methods. Participation to Credit project gave possibilities to discuss on real estate indicator needs and to collect data and get valuable comments. Indicator tables should be opened so much that it's possible to see what means e.g. "social performance" or "resource use" in indicator level. Nowadays and in the future performance, usability, ecological and energy aspects will be much more highlighted in national benchmarking.

3.3 Baltic Sea House (Sponda/Ovenia, Finland)

Baltic Sea House reveals how performance indicators are gathered and used in reports to the owner and the manager of the building as daily, weekly, monthly and yearly routine. Study also includes occupier interviews of three tenants on perofmance indicator importance, and considers new measures useful during the operation period of the building.

The actual building, building parts and processes

The Baltic Sea House was designed by professor Teräsvirta and built in 1971. The building comprises three underground and five above ground floors and its foundations are about 10 m below the adjacent sea level. Besides, the Baltic Sea House was the first open-plan office building in Finland. It is owned by Sponda Oyj and managed by Ovenia Oyj, and thoroughly renovated in 2002.

– Region: Helsinki metropolitan area, Ruoholahti (3.5 km from Helsinki City Centre)
– Gross floor area:22 117 m2, net floor area: 14 602 m2 and rentable floor area: 11 171 m2
– Number of employees: 400
– Wide scope of additional services are available in the immediate vicinity for example in the Ruoholahti Shopping Centre.

Figure 7. Baltic Sea House, Main entrance (Image courtesy Sponda Oyj)

The applied assessment methods and tools in the processes

The following reports were studied when collecting indicators and measures utilized by the owner and manager of the Baltic Sea House:

- continuous/monthly energy and water consumption monitoring
- yearly customer satisfaction survey (KTI Kiinteistötieto Oy)
- yearly FM cost and energy consumption benchmarking (KTI Kiinteistötieto Oy)
- customer's service requests, web based service request system (FIMX)
- failure statistics produced by the building automation and control system
- condition surveys done by Ovenia Oy twice a year

New indicator needs were gathered during discussions (interview study) with the representatives of the owner, manager and three tenant organizations of the Baltic Sea House.

Cost and performance indicators applied in the assessments

This case study follows nationally agreed Finnish indicators on cost and performance because the CREDIT indicator framework was not finished when this case study has been implemented.

LOCATION AND ARCHITECTURE (L)

PLOT OPPORTUNITIES

Site characteristics

L2 Sea level

- About 1 1/2 underground floors (cellars) under the sea level

L3 Proximity of sea or lake

- Class 1: (< 1km), sited on the sea bank

L7 Proximity of infrastructure

- Class 1: (At site border, short connection distance)

ACCESS TO SURROUNDING SERVICES

L15 Distance to public transport

– Distance to Helsinki-Vantaa international airport: 21 km

– Distance to Helsinki railway station: 3.5 km

– Distance to tram stop: 400 m, interval of trams 10 min

– Distances to bus stops: 500 m, 600 m, 1000 m, interval of busses 22 min

– Distance to subway: 900 m, interval of trains 5-10 minutes

L16 Distance to pedestrian and bicycle

– Distance to bicycle path: 100 m

– Distance to footway: 20 m

L17 Extent of services in the vicinity

– Distance to growing neighbourhood: 800 m to Ruoholahti Shopping Centre

– Many canteens and restaurants in the neighbourhood

– Car wash

L18 Distance to green and open spaces

– Distance to Ruoholahti Park: 1.1 k

BUILDING PERFORMANCE (P)

INDOOR ENVIRONMENT AND HEALTH

Thermal quality

P1 Thermal comfort

- S1 (Finnish Society of Indoor Air Quality and Climate FiSIAQ: 2001) / Category I (EN 15251:2007)

Air quality

P3 Air quality

- Category I (EN 15251:2007)

SAFETY

P17 Meeting present needs and regulations

- The building was thoroughly renovated to fulfil present-day requirements in 2002.

P18 Human security

- Access control system in the building
- Private security company, mobile patrolling

P19 Material security

- Access control system in the building
- Private security company, mobile patrolling
- Condition assessment every 5th year

REAL ESTATE BUSINESS (B)

APPLICABILITY OF THE FACILITY

B1 Branding and rating certificates

- Finnish Energy Certificate

B3 Workplace management

- Space use: 36.5 Net Floor-m2 per employee that is a bit above the median value of office buildings in Finland (KTI Kiinteistötieto Oy)

OPERATION AND MAINTENANCE

B4 Failures

- Overall condition class 4 (1 to 5 scale)
- Windows & wastewater system is partly old
- Building automation system reports failures
- Internet based feedback system for tenants

B5 Frequency and significance of failures

- Number of feedback (complaints) from tenants during one year 151
- Distribution of complaints during one year (Electricity 34%, Construction 22%, Cleanliness 16%, HVAC 11%, Thermal comfort 9%, Appliances 3%, Courtyard 3%, Lifts 1%
- Priority class (normal 53%, urgent 35%, duty work 12%

B6 O&M manual with short and long term measures

- Yes (condition assessment and budgeting ever 5th year)

B7 Systematic procedure for updating the manual

- Yes (Manager company, Ovenia Oy, is responsible)

B8 Training of personnel organized: Yes

SERVICES

B9 Availability of facility services

- Catering: 55 seats that is 0.14 seats per employee
- Catering services (Sodexho)
- Conference and meeting rooms; net-based booking system (Sponda)
- Lobby and office services
- Operation and maintenance services
- Security services
- Waste disposal (extra waste)
- ICT-services

B10 Service to find a proper space

- Yes

B11 Spectrum of services

- Wide range of services in Ruoholahti area.

PARKING

B12 Number of parking places

- 99 car parks: 0.25 car parks per employee.

B13 Quality of parking places

- In the garage 74 car parks and outside uncovered with plug box 25

SUMMARY SET (S)

S2 User satisfaction questionnaire and S3 Overall user satisfaction

- Yearly user satisfaction study by KTI Kiinteistötieto

S4 Return on Investment

S5 Development potential, upside

IMPACTS (I)

ENVIRONMENTAL IMPACTS

I1 Carbon footprint

- Energy performance rating: 193
- Heating consumption: 2.46 kWh/heated m3/month (below median value in Finland (KTI)
- Electricity consumption: 55.5 kWh/m3/year, it is well above of the median value of office buildings in Finland (KTI Kiinteistötieto Oy)

COSTS

I3 Operation and maintenance costs

- Operation and maintenance cost deviation and rank are shown in the case study.

Cost and energy consumption indicators applied by Sponda Oyj are listed in the case study report. Sponda Oyj utilizes various key performance indicators, mostly Euros per square meter per month, produced by FIMX maintenance system and condition surveys and assessments. These indicators include administration, operation & maintenance, maintenance of outdoor areas, cleaning, heating & cooling, water & waste water, electricity & gas, waste management, insurances, site lease, taxes, other running costs, and repairs. Besides consumptions for heating, water and electricity are monitored.

Relation to different enterprises and national benchmarking

Sponda Oyj (including Baltic Sea House) takes part in the national FM cost and customer satisfaction benchmarking surveys of the office buildings that are run by KTI Kiinteistötieto Oy. Example of FM cost benchmarking results is shown in the case study.

Visions and innovation for future improvements

Sponda Oyj uses wide range of cost and performance indicators in its daily operations. These indicators are a result of many different actions, systems and partners.

Based on three occupier organization interviews, the overall customer satisfaction of the tenants in Baltic Sea House is on the good level. The interviewees rated the importance of each indicator on 1-5 scale and how they found the actual performance. All indicators were important (lowest average value 4,0).

According to the interviews the tenants want more information on performance indicators, especially about the indoor air quality. There is a need for some kind of new indoor climate verification system that shows clearly if the indoor air quality is good or poor. Another point that came up was some

kind of “easy to understand”- classification system of the greenness of the building and the premises.

For benchmarking purposes it is essential that indicators are exactly defined, uniform and easy to generate. This requires better and deeper co-operation from the actors. Sophisticated management systems of today produce huge amount of data. However this data is not fully utilized in practice and refining data could give a lot of added value to building owners, managers and occupiers.

3.4 Lappeenranta tax office (Senate Properties, Finland)

Senate Properties is one of the largest real estate managers in the Finnish industry that uses performance indicators and workplace management in the projects. Lappeenranta project shows how multiple indicator systems can be tested, bringing successfully closer building and facility management concepts.

The actual building, building parts and processes

Lappeenranta tax office (12 150 brm2) was constructed 1980 and under a thorough renovation from 2003 to 2005 including renovation of moisture damages, structural reparations, renewal of HVAC technology and 300 workplaces of taxation department, highlighted in Figure below. In the renovation, the targets were set to comfortable environment through modification and co-operation to improve clients service ability.

The applied assessment methods and tools in the processes

The building owner, Senate Properties, has studied multiple indicator systems. Project included total renovation and simultaneous workplace efficiency improvement. For the CREDIT project, the most interesting indicator systems are investment decision support and benchmarking (SeneKPI), performance classification VTTProP®, environmental rating systems (PromisE and LEED), end user opinions (POE), work place management, and Building Information Modelling.

Figure 8. Lappeenranta tax office (Image courtesy of Senate Properties).

Cost and performance indicators applied in the assessments

The first indicator approach used in the case is SeneKPI that helps management of both new and renovation investments and gives information for resale value estimations. Senate Properties is interested in to increase pro-

ductivity of clients but doesn't use other indicators than working environment. More detailed content is available at Table 2.

The second approach on indicator frameworks tested in Lappeenranta is performance based VTT ProP® building properties classification. It is used for setting the objectives in order to meet client needs, following systematic structure that in this case included 9 indicators for conformity, performance, life cycle costs and environmental pressure.

Third approach tried was an environmental assessment system in Finland - PromisE. It is available for varied types of buildings. PromisE rating in A-E scale for Lappeenranta Tax Office after renovation is C, more information in Figure 9..

Table 2: SeneKPI summary from Lappeenranta Tax Office.

PROJECT	**Project type:** Renovation **Business area:** Offices **Client:** Central Finland, Offices	**Project name and descriptions:** **Lappeenranta Tax Office** is constructed 1980 and was an object of a thorough renovation 2003…2005 including renovation of moisture damages, structural reparations, renewal of HVAC technology and workplace of taxation department. As targets were set comfort environment, better modification, better changes for co-operation and service ability of clients as well as better indoor conditions. 7 500 htm2 | 12 150 brm2 | 35 000 brm3 | 300 workplaces
FUNCTIONALITY AND VALUES	CLIENTSHIP AND AGGREEMENTS	Permanent client ship. Aggreement time 15 years. Profit target 8,9 %. ***
	LOCATION	Centre of Lappeenranta ***
	ARCHITECTURE AND CULTURAL VALUES	Minor **
	WORKING ENVIRONMENT	The spaces are modifiable, colourful and light. They ensure good possibilities to co-operation. The services of clients have been separated from other spaces. **
	CONDITION AND BUILDING LIFE	After the renovation condition good and building life over 80 years ***
	HEATING ENERGY EFFICIENCY	E → D **
	ELECTRIC ENERGY EFFICIENCY	C → D **
	INNER CLIMATE	S3 → S2/S1 ***
	ENVIRONMENTAL CLASSIFICATION	B **

		Unit	Basis 020105	Project targets 020105	Realized 020107	Use 020108	Use 020111
EFFECTIVINESS	INVESTMENT COST	mill. €		11,3			
	SPACECOST	€/v	0,80	1,10	1,15	1,18	
	RENTS	mill. €/y	1,10	1,50	1,55	1,60	
	PRESENT RESIDUAL VALUE	mill. €	12	21	23	22	
	PROFIT RATE	%	7,2	8,9	8,6	8,8	
	HEATING ENERGY CONSUMPTION	kWh/m2/y	32	25	27	24	
	ELECTRIC ENERGY CONSUMPTION	kWh/m2/y	10	12	13	12	
	CLIMATE CHANGE - emissions CO2 - primary energy	 tn/m2/y kWh/m2/y	 740 25	 725 22	 760 23	 690 22	
	USE OF WORK PLACES	%	93	98	96	94	
	M2/workplace	m2/wp	32	27	26	26	
	USER SATISFACTION	%	60	75	69	72	
RISKS	RISKS AND POSSIBILITIES	Potential risks concern permanence of client, growth of maintenance costs and possible structural damages.					

LEED (Leadership in Energy and Environmental Design) was the forth indicator system tested in case. Main principle of it is to provide a sustainability report for a building, calculated with total points. Regarding points, the highest value is Platinum (64-85 points), followed by Gold (48-63 points),

Silver (40-47 points) and Certified (32-39 points). Lappeenranta reached LEED Silver rating (Figure 10.).

Organisational culture has changed, and end-user feedback was collected because changes involved also workplaces. Post Occupancy Evaluation (POE) revealed that spaces in renovated property are more comfortable and light spaces, supporting effective cooperation. Unfortunately layout changes from cell to open office did not please everyone, but organization is currently renting 400 Square meters less space.

PromisE – Lappeenranta tax office

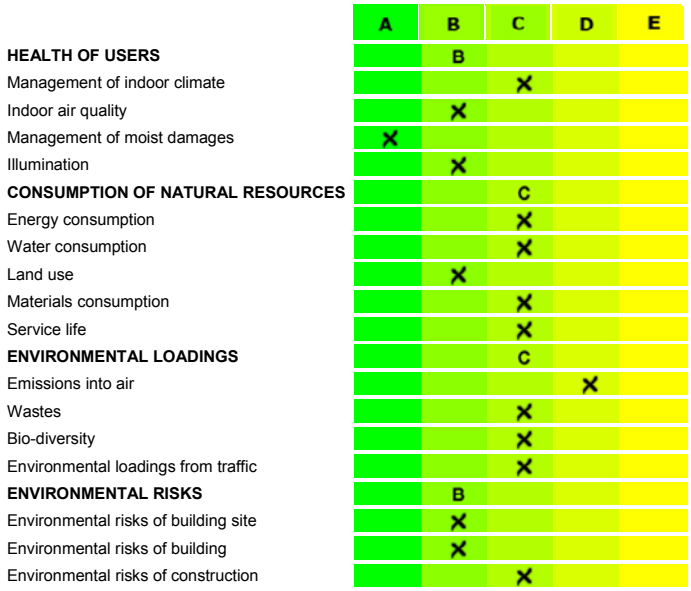


Figure 9. PromisE environmental rating from Lappeenranta tax office renovation.

LEED for Existing Buildings v2.0 (year 2008)
Registered Building Checklist

Lappeenranta Tax Office

Yes	?	No			
5			**Sustainable Sites**		**14** Points
Y			Prereq 1	**Erosion & Sedimentation Control**	Required
Y			Prereq 2	**Age of Building**	Required
1			Credit 1.1	**Plan for Green Site & Building Exterior Management -** 4 specific actions	1
			Credit 1.2	**Plan for Green Site & Building Exterior Management -** 8 specific actions	1
1			Credit 2	**High Development Density Building & Area**	1
1			Credit 3.1	**Alternative Transportation -** Public Transportation Access	1
1			Credit 3.2	**Alternative Transportation -** Bicycle Storage & Changing Rooms	1
			Credit 3.3	**Alternative Transportation -** Alternative Fuel Vehicles	1
			Credit 3.4	**Alternative Transportation -** Car Pooling & Telecommuting	1
1			Credit 4.1	**Reduced Site Disturbance -** Protect or Restore Open Space (50% of site area)	1
			Credit 4.2	**Reduced Site Disturbance -** Protect or Restore Open Space (75% of site area)	1
			Credit 5.1	**Stormwater Management -** 25% Rate and Quantity Reduction	1
			Credit 5.2	**Stormwater Management -** 50% Rate and Quantity Reduction	1
			Credit 6.1	**Heat Island Reduction -** Non-Roof	1
			Credit 6.2	**Heat Island Reduction -** Roof	1
			Credit 7	**Light Pollution Reduction**	1

Yes	?	No			
3			**Water Efficiency**		**5** Points
Y			Prereq 1	**Minimum Water Efficiency**	Required
Y			Prereq 2	**Discharge Water Compliance**	Required
1			Credit 1.1	**Water Efficient Landscaping -** Reduce Potable Water Use by 50%	1
			Credit 1.2	**Water Efficient Landscaping** - Reduce Potable Water Use by 95%	1
			Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction -** 10% Reduction	1
1			Credit 3.2	**Water Use Reduction -** 20% Reduction	1

Yes	?	No			
13			**Energy & Atmosphere**		**23** Points
Y			Prereq 1	**Existing Building Commissioning**	Required
Y			Prereq 2	**Minimum Energy Performance** - Energy Star 60	Required
Y			Prereq 3	**Ozone Protection**	Required
6			Credit 1	**Optimize Energy Performance**	1 to 10
				Energy Star Rating - 63	1
				Energy Star Rating - 67	2
				Energy Star Rating - 71	3
				Energy Star Rating - 75	4
				Energy Star Rating - 79	5
			x	Energy Star Rating - 83	6
				Energy Star Rating - 87	7
				Energy Star Rating - 91	8
				Energy Star Rating - 95	9

Figure 10. LEED sustainability report from Lappeenranta tax office renovation.

Relation to different enterprises and national benchmarking

The workplace development process depends strongly on user-organisations strategies aiming at that kind of mixture of spaces that will satisfy targets of all interest groups. Currently big facility owners and users are interested in to bring closer building and facility management concepts. Solutions are influenced by the state productivity programme and increasing use of e-business and mobile solutions. Senate Properties is a member facility development networks, such as PureNeT, Workplace Network, and New Ways of Working Network (NewWOW).

There are no commonly agreed or standardized global or European Key Performance Indicators. Currently Senate Properties is looking for indicator system that could help them to develop performance of the work spaces. However, there is not such an indicator system and existing national indicator systems, such as PromisE, LEED and BREEAM, have been designed from different viewpoint to consider mostly environmental values, sustainability and life-cycle economy. In addition, Senate Properties focuses on work place management in order to increase customer satisfaction and create more strategic relationships (partnership agreements). An important integrative approach for Senate Properties is also Building Information Modelling (BIM), and they are very determined to support new paradigm of design and currently modelling is used for both new construction and renovation projects with budget over 2 million Euros.

Visions and innovation for future improvements

The client, taxation administration, wanted to renovate the facilities and carried out also space efficiency improvement in the work environment. Project was successful and underlines the importance of bringing closer building and facility management concepts. However, it is hard to evaluate the trade-off between building performance, developed process and work spaces while organizational changes have been made. It is also challenging to develop better indoor conditions while reducing energy consumption because working conditions are typically produced with electrical energy.

Senate Properties has long traditions among workplace process being the leading service provider in Finland. They have partnership agreements with 10 workplace consultancies, and has recently started to develop 3 levels for workplace management services; Level 1. Improving space efficiency, Level 2. Alignment, and Level 3. Transformation.

Senate Properties has tested multiple indicator systems, and has an objective to harmonize the use of multiple indicator systems in projects. The existing national indicator systems, such as PromisE and LEED, have been designed to consider mostly environmental values, sustainability and life-cycle economy but issues like work places and performance are not included.

3.5 Vuorimiehentie 5 office building (Senate properties, Finland)

The second case from Senate Properties describes multiple indicator systems and implemented indicators for small renovation for spaces rented by VTT in Southern Finland.

The actual building, building parts and processes

The building represents office style from 1970's and pictures before and after the renovation are introduced in Figure 11.. The renovation has major impacts on work place management and space efficiency because cell offices were transformed into open office.

General information on Vuorimiehentie 5:

- Region: Southern Finland
- Location: Espoo, less than ten kilometres to Helsinki city centre
- Gross area: 10.835 m2,
- Office floor area: 8.930 m2,
- Volume: 37.300 m3
- About 500 jobs, About 300 car parks
- Constructed 1975, renovated 2007

Figure 11. VTT office building before (2005) and after (2007) renovation.

The applied assessment methods and tools in the processes

The building owner has implemented multiple indicator systems. First national indicators are presented, and then we continue with environmental classification PromisE ratings. Senate Properties uses Building Information Models (BIMs) in all projects that ate over two million Euros, and has since 2007 provided BIM guidelines. Modelling has been mainly prepared by using the completed final 3-dimensional as-built drawings and plans, some interior perspective pictures to support the decisions, and simulation of lightning conditions. The model was prepared from final drawings for facility management use.

End user of Vuorimiehentie 5 office building was interested to examine employee satisfaction on office spaces. For this purpose, a new open source based application to map user perceptions to office spaces was developed in order to provide feedback to top management. The method draws from answering first to ten questions and then addressing ten different space types by selecting the image that user prefers most from set of images collected from similar spaces in organizations building portfolio.

Cost and performance indicators applied in the assessments

This case study follows nationally agreed Finnish indicators on cost and performance because the CREDIT indicator framework was not finished when implementing case study.

Location and architecture (L)

L1 – L7 Site characteristics

– The plot is rock-bottom area.

L 11 Architectural quality

– Old 70's office style

L12 Growing neighbourhood

– Distance from Otaniemi Shopping Centre, post office, bank and library 100 m
– Located to Aalto university area

L13 Public transport

– Distance to railway station 5 km, bus station 3 km, bus stops 100 m
– Distance to Helsinki - Vantaa airport 20 km

L14 Pedestrian and bicycle access

– Distance to bicycle route 50 m, footway: 50 m

L15 Access to services

– All kind of services are available within 300 m

L16 Access to green open spaces

– Distance to Otaniemi park 200 m

Building performance (P)

P1 – P2 Thermal comfort

– Indoor air quality standard: 23-26 summer, 21- 22 C winter

P3 – P4 Air quality

– Indoor condition levels S2

P5 – P7 Lightning

– Low energy fluorescent lightning

P8 – P11 Noise

– Partition walls 35 dB, acoustic ceilings

P12 Design flexibility

– Open offices
– Easy modification possibility, movable electric and network towers

P16 Meeting current safety regulations

– Fire safety system

Real estate business (B)

B1 Branding

– Entrance and courtyard area have been developed

B6 – B8 Maintenance

– Maintenance services

B9 Facility services

– FM organization

B10 Range of user services

– Restaurant, lobby and office services, conference and meeting room reservation

– Office maintenance and operating services, management services

– ICT services

B11 – B12 Parking

– 300 car parks: 0,6 car parks/employer

PromisE environmental rating is described more in detail in actual case study report. Altogether, building was rated C in total PromisE class.

Descriptive indicators

– Location: suburban

– Services in the neighbourhood: shopping mall, post office, bank, library, university campus (Promise class B)

– Service life: no target lifetime (Promise class E)

– Public transportation: (Promise class A)

– Bicycle and pedestrian traffic: (Promise class C)

User oriented indicators/satisfaction

– Indoor condition levels for temperature and relative humidity: S2 as a general level, S1 for meeting rooms, and S3 for storage rooms (the Finnish classification of indoor climate). Indoor climate rated values for chilled beams and fan coil units: temperature 24 C, relative humidity 45 %.

– Modifiability of spaces: highly flexible office spaces (Promise class B)

– ICT services: VTT's ICT support process

– Acoustics: 33 / 38 dB(A) in office spaces (C1 Sound insulation and noise abatement in building Regulations and guidelines)

– Lighting: working space lighting level 500 lx (Promise class C)

Eco/energy indicators, annual consumptions described in.

– Heating energy consumption kWh/year: calculated estimate after renovation 88,8 kWh/htm2 (before renovation 140 kWh/htm2) (Promise class D)

– Electricity consumption kWh/year: calculated estimate after renovation 58,2 kWh/htm2 (before renovation 140 kWh/htm2) (Promise class D)

– Fresh water consumption m3/year: water consumption level corresponds to typical office building usage (Promise class E)

– Recycling level %: the building has target levels for recycling (Promise class D)

– Waste amount /year: separation of wastes (Promise class D)

Energy indicators are becoming more and more important in Finland. From the 1990s Finland has employed a voluntary agreement scheme to promote energy efficiency. Practical means have been energy audits, analyses and certain energy efficiency investments subsidised by the government.

The main interest in the space preferences survey was to understand better the work place satisfaction and preferences that users have in their individual and collaborative work at VTT's facilitiesconcerning the current work place. The spaces that were evaluated included entrance to building, lobby, corridors, work place, meeting rooms, teamwork spaces, printing and support rooms, coffee rooms, outdoor relaxation area, and temporary work places. Screenshots from the space preference application are shown below in Figure 9. During the CREDIT project, small sample of employees answered to survey. This kind of studies may reveal patterns in answers between age groups and genders. In our survey, one of the trends remaining was valuation to cosiness and richness of colours

Figure 12. Screenshots from space preferences survey carried out to end users at Vuorimiehentie 5 office building.

Relation to different enterprises and national benchmarking

Senate Properties is the largest building owner in Finland and uses internal investment indicators (SeneKPI) in all facility projects. Further, they have applied multiple approaches in CREDIT project, such as Finnish environmental rating (PromisE). As an owner and user of spaces Senate emphasizes sustainability. Since 2001, Senate Properties has carried out a number of pilot projects to develop and study the use of BIMs. Based on feedback, they have assessed technology to be sufficiently ready for ordinary project work, and decided to require IFC BIMs in their projects since 1st October 2007.

Visions and innovation for future improvements

The building has been in use for year and half, and therefore, longer operation period is required for reliable conclusions. Currently annual heating energy consumption has risen, while it consumes less electricity. Apart from earlier, use of building has changed. Current regulations are also tighter, and it a challenge to estimate the payback time efficient space use solutions and indoor environment changes such as extra ventilation periods.

The issues described earlier could be studied in e.g. an energy audit or in an inspection for energy performance certification In long run, it is important to understand energy consumption behaviour. In the future, Senate Properties plans to take in use more LCA based indicator systems that create value to end user. At the moment the interest is to find an internationally implemented indicator classification adoptable to local conditions.

Kuva 1

3.6 Skattens Hus (Skanska, Norway)

This case study describes usage of key indicators in Skattens hus Oslo. The analysis aims at three levels: project or building, firm and national benchmarking system.

The actual building, building parts and processes

Skattens Hus in Figure 13. is located in the centre of Oslo and is the new head quarter for the Tax authorities in Oslo.

Some facts about the building and actors:

- Owner: ROM Eiendom,
- End user: Tax authorities, Oslo
- Main contractor: Skanska
- Contract Value: 366 MNOK,
- Gross area: 25 000 m2,
- Schedule: February 2007 – October 2008

Figure 13. Skattens hus in Oslo.

Office Building is a distinctive office building with eight floors. The three blocks are developed with good flexibility from prefabricated elements. The biggest challenge in this part of the town was the ground conditions; there is 70 meter of soft clay before solid rock.

The applied assessment methods and tools in the processes

All Skanska projects use the same Falk management system that is a very useful internal tool for collecting data and making continuous assessments. Different kinds of information are reported with different frequencies:

- Economic progress is reported per month.
- Health, Environment and safety incidents are continuously reported.
- The client fills out a standardised template form when the project is finalized.
- The final project report is used as a guideline for new projects, but is not meant to be used as something to be carbon copied.
- The Falk system uses filters that information can be shown according to context/perspective (enterprise, project management, type of building).
- Falk is used by management, geographical regions, and country.
- However, information to the project management is provided from the accounting system.
- Benchmarking is done in relation to progress and quantitative measures of technical drawings.

Cost and performance indicators applied in the assessments

Skanska has supplied information in a separate questionnaire. In Skattens hus following indicators have been used for measuring the building process:

- Category of building parts, quantity size, area
- Category of process, supplier and organisation
- Health, safety and work environment

Measures when project is finalized are:

- Safety
- Thermal quality
- Impact on air quality
- Lightning quality
- Acoustic quality
- Resource control and project management
- Health, safety and work environment
- Environmental impact (emissions).

Final internal project report:

- Short project description
- Project organisation
- Goal achievement (economy, quality, health/environment/safety, waste)
- Subcontractors and important suppliers
- Changes, Deviations
- Important observations
- Experience figures from the production
- Building owners evaluation

The most important indicators for clients are related to accidents and environment. The calculation department in Skanska is more concerned with hours used per square meter and uses those for cost calculations in future projects. Skanska uses several human resource indicators; such as TPI (Team Performance Index) and GBI (Great Boss Index).

Relation to different enterprises and national benchmarking

The Falk system is used to simplify communication and reporting of large data samples delivered to governmental databases. Earlier Skanska's main contribution to national benchmarking was participation to the residential housing project "Benchmarking in Construction 2". To conclude, the Falk system is a great example of the benefits large enterprise can get when using common data gathering system for its internal (benchmarking, analysis) and external (reporting) needs.

Visions and innovation for future improvements

Skanska Norway uses Falk as its Information Management system. The cost of data gathering has decreased, and the information is more readily available. The benefits of system are significantly fewer manual operations and formats used, which give huge savings in time and motivation and full control over important aspects in the company. Moreover, they see the same data in real-time and have possibility to execute corrective actions based on deviations and trends. It is easy to just drill down in the system, to benchmark regions/districts, and share knowledge between parts of Skanska.

Today, the advantages with the Falk system are mostly for the management level. It is expected that the clients in the future will demand more detailed and frequent information when it comes to safety and environmental aspects. Some information is still not reported in Falk, but the ambition is that over time almost everything is reported in the system.

3.7 Statistics Norway, Kongsvinger (Statsbygg, Norway)

This case represents the usage of key indicators in Statistics Norway Kongsvinger. Building owner, Statsbygg, offers governmental organisation premises and collects data for reporting upward in the system, such as benchmarking against similar buildings, and to improve work processes. Energy consumption has a special attention.

The actual building, building parts and processes

The Statistics Norway (SSB) office building is located at Kongsvinger. Building was constructed in 1987, and has gross floor area of 12 700 square meters. New part construction was concluded on December 2005.

An important goal for project was to design the new building so that it complements the existing one. The original main entrance was upgraded with a new and modern reception. The new part has three storeys, and includes a canteen and open areas in a centre building.

Figure 14. Statistics Norway, Kongsvinger

The applied assessment methods and tools in the processes

A standardized data gathering following NFN's (Norwegian Facility Management Network) specifications has been used to collect key indicators. The owner, Statsbygg, has reported data to NFN since 2003 and has its own energy consumption and cleaning cost statistics. The motivation for collecting the data in Statsbygg is:

- Local assessment of the effect of local measures
- Planning of activities
- Reporting upwards in the system: Property, region, headquarters, Ministry of Government Administration and Reform.
- Basis for Statsbygg analysis and reporting
- Benchmarking against similar buildings
- Improving work processes
- A basis for condition assessment
- Energy consumption has special attention

Cost and performance indicators applied in the assessments

Statsbygg owns 2 300 buildings, but creates only about 20 -30 new ones each year. Statsbygg collects a large amount of data for each building. Energy indicators are used to compare buildings within categories (office, education, etc.). The other numbers are compared independent of building category. The area where largest progress has been made is energy performance. In addition the indicators are used when creating cost budgets and calculating rent. Statsbygg has created its own LCC-calculator ("LC-profit") that is used for life cycle costing.

The real estate indicators are used to manage the existing buildings in a more efficient way. The transfer of knowledge from existing buildings to new buildings is not taking place in a large degree.

Relation to different enterprises and national benchmarking

Statsbygg compares buildings in their facility portfolio. Table 3 shows how indicators are compared between different buildings within and between different building categories and regions. Previous year values are used for positioning trends. Statsbygg reports on its energy consumption to the Ministry of Government Administration and Reform and has an overall target of 210 kWh / m^2 energy consumption decided by the Ministry in 2009. In 2008 Statsbygg reported 206 kWh / m^2 energy consumption. In NFB different types of buildings are characterized by the standard NS 3457 and cost data follows NS 3454 standard.

Statsbygg believes that their buildings have a relatively equal level of maintenance. However, there are substantial differences in level of mainte-

nance between properties. Another problem is that different definitions seem to be used between value preserving maintenance and value increasing development.

Table 3: Comparing some important indicators between different buildings. Statistics Norway is on the second to last row.

Reg	E.nr.	Eiendomsnavn	Areal i m2	Fastkraft kWh	Oppvarming kWh	Vann m3	Totalt kWh	Totalt gdk. kWh	Spes.gdk. kWh/m2	Driftstid tim/uke	Spes.dtn. kWh/m2
EØ	60/101	Regjeringskvartalet G-Blokk	17 100	2 571 197	64 246	14 716	2 635 443	2 826 527	165,3	70 (58)	151,1
EØ	00074	Regjeringskvartalet Grubbegate 1	8 000	603 794	596 819	1 695	1 200 613	1 287 664	161,0	58 (58)	161,0
EØ	60/102	Regjeringskvartalet H-Blokk	19 222	2 847 494	1 770 107	7 132	4 617 602	4 952 403	257,6	70 (58)	235,6
EØ	60/105	Regjeringskvartalet Møllergate 19	3 962	615 142	0	1 030	615 142	659 743	166,5	58 (58)	166,5
EØ	60/107	Regjeringskvartalet R4 og M17	25 898	2 402 537	1 314 199	15 339	3 716 735	3 986 219	153,9	58 (58)	153,9
EØ	60/108	Regjeringskvartalet R5	48 774	5 378 226	2 782 600	11 926	8 160 826	8 752 530	179,5	70 (58)	164,1
EØ	60/104	Regjeringskvartalet S-Blokk	14 796	2 432 357	55 391	3 817	2 487 748	2 668 123	180,3	58 (58)	180,3
EØ	60/109	Regjeringskvartalet Utendørsanlegg*	0	0	0	0	0	0	0,0	(58)	0,0
EØ	60/103	Regjeringskvartalet Y-Blokk	21 805	1 297 417	1 562 599	3 289	2 860 016	3 067 383	140,7	70 (58)	128,6
EØ	00602	Statistisk sentralbyrå	12 755	2 354 447	0	3 568	2 354 447	2 517 770	197,4	58 (58)	197,4
EØ	00061	Victoria terasse	40 703	3 234 169	1 904 927	8 265	5 139 096	5 511 709	135,4	52 (58)	143,2
		51 eiendommer i denne kategorien.	479 491	MWh	MWh	m3	MWh	MWh	kWh/m2	Snitt tim	kWh/m2
		46 er med i statistikken.	468 287	49 648	30 880	171 009	82 879	88 374	189	78	169,4

Visions and innovation for future improvements

Property managers are reporting key performance indicators and regarded costs, that are crucial in planning the facility management of the building. Regarding energy consumption, benchmarking enables Statsbygg to compare their building portfolio. Therefore, the numbers collected are a good starting point for improving the facility management in the building. However, collection of indicators requires work, and standardized definitions and instructions are needed in practice to guide project managers.

For Statsbygg as a company the key performance indicators are a necessity, both for its planning and budgetary work, but also for its reporting to the Ministry of Government Administration and Reform. The numbers are also a good starting point for analyses and learning from best-practices within the company. However the activity of collecting and assessing the data is not cost effective.

Statsbygg participates in national benchmarking networks (NBEF and NFN) as a result of a policy decision, and uses internal data as comparison points. One reason why Statsbygg chooses to rely on its own data is comparability. Some might have different ambitions for level of maintenance in long term.

4 Housing case studies

This chapter of seven housing case studies draws from two Danish, three Swedish, and one Icelandic and Estonian case studies. First, two Danish cases explain the deficiencies in housing projects and introduce search engines used in private housing in Denmark. Then, the Swedish cases consider developing new products, management of tenants, and managing joint ambition. Third, the Icelandic case discusses on housing preferences of inhabitants in the capital area. Finally, we close with a refurbishment project of apartment building in Estonia.

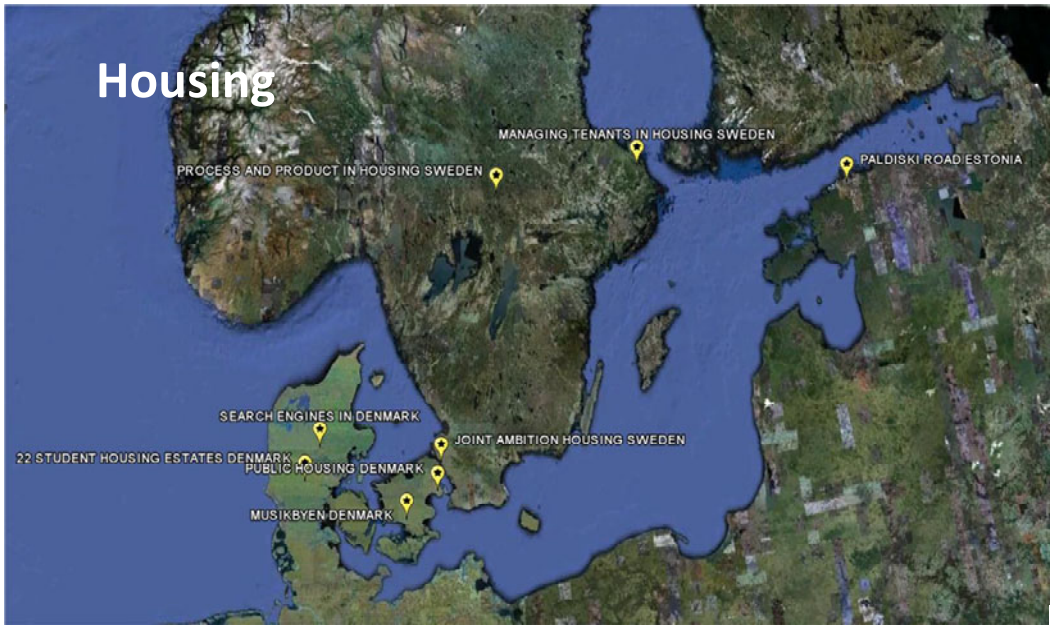


Figure 15. Housing case studies in CREDIT project.

4.1 Defects in housing (Danish Building Defects Fund, Denmark)

The Fund is an independent organization that inspects new housing quality. Each new housing project with public financial support registers at the Fund and pays 1% of the building and site costs to the Fund. Defects Fund makes inspections to buildings one and five years after handing over. The results concerning the indicators are published and thereby used in coming new housing projects.

The actual building, building parts and processes

The project consists of 25 dwellings and was designed and constructed in 2003-2004 with handing over in April 2004. The client was a non profit housing organization Boligselskabet. The inspections are in general executed by a number of private companies, who are chosen after a prequalification. They have to take part in different meetings arranged by the Fund in order to disseminate experiences from inspections.

The applied assessments and tools in the processes

The independent companies are chosen by the Fund. They look after deficiencies and building damages which are registered in accordance with a classification of the different parts of a building and the seriousness. The starting point are the documents for the execution and quality assurance

work. Then, buildings are visually inspected and if necessary some parts of the building are inspected in more detail. Only a certain number of apartments and building parts will be inspected.

Cost and performance indicators applied in the processes

The inspections are executed in accordance with a general classification of the different parts of a building. When a deficiency or a building damage is observed it is therefore also marked at the concrete part. The Fund has furthermore established a classification for the seriousness of a deficiency or a building damage.

The general classification covers - except from for example indoor equipment - construction parts from the whole building, which are essential for lifetime of the building - especially the climate protection - and comprises

- the foundation and the cellar,
- the structural elements (bearing and stabilizing parts of the building),
- the outer walls,
- the roof,
- the bathroom,
- drainage and sanitary facilities,
- concrete in complicated environment (as concrete in outer balconies) and other building parts (for example outer staircases).

The mentioned parts of the building are each divided in minor parts – from three to nine. So the total number of indicators sums up to about 50. A *deficiency* means that the building materials, structures or building elements are in absence of properties, which should have been present. A *building damage* means a deficiency, which leads to breakage, leakage, deformations, impairment or deterioration in the building. Both deficiencies and damages must be caused by the design or the execution of the house in order to be recognized by the fund as covered by the fund.

The inspection firm will use this division of the building in the inspection and make notes in accordance with the indicators. And later the notes will be channelled into the data bank. All communication between the Fund and the inspection firms are digitalized, as well as the internal procedures in the Fund including data transmission to the public accessible homepage, www.byggeskadefonden.dk

The indicators are the starting point to show whether there are or will be problems with indicators at higher levels in CREDIT classification as indoor environment (as safety and indoor climate) and product performance (as constructions and installations).

Relation to different enterprises and national benchmarking

The indicators are used, when an independent company executes an inspection after hand over. In this way they are not used in the planning or construction of the actual project. But they are used in eventually repair work and in the operation of the building. And due to the dissemination of information and the obligatory rules for quality assurance they are part of the planning and execution of coming projects.

Visions and innovation for future improvements

The client, Boligselskabet, is satisfied with the way the inspections are executed and uses the results in the operation of the estate. The Fund has some considerations concerning the future work. The main vision is to strengthen the implementation of the experiences by a stronger use of them in connection with the planning and design of new estates.

The experiences from one year and five year inspections give the Fund, the client and the companies some valuable lessons about good and bad practice in the actual building project. The Fund's dissemination of the les-

sons gives at the same time the whole industry not only knowledge about defects but also the possibility to learn and develop methods, components and materials. Furthermore the results are used to considerations about remediation and liability in the actual project.

The mentioned parts of the building are each divided in minor parts – from three to nine. So the total number of indicators sums up to about 50. They have been chosen in accordance with experiences from analysis of defects and earlier inspections. They represent topics where there is a risk for defect. The Fund has furthermore established a classification for the seriousness of a deficiency or a building damage.

The indicators are the starting point to show whether there are or will be problems with indicators at higher levels in CREDITS classification as safety, indoor climate and product performance (as constructions and installations). In some cases detected deficiencies and damages have appeared to be sign of structural or other more general problems. An example is that deficiencies in roofs have been caused by problems with the stability of the building. It is recommended to choose indicators which can signal possible defects, are well defined and easy to implement in benchmarking and dissemination of experiences as done in the BSF system.

4.2 Private housing – search engines at estate agents (Denmark)

This case study describes search engines and related assessment methods and tools for private housing. It addresses questions related to how data and information about the sales process and the building is collected, managed, evaluated and used. Further, the chapter deals with which assessments and indicators are applied in the sales process.

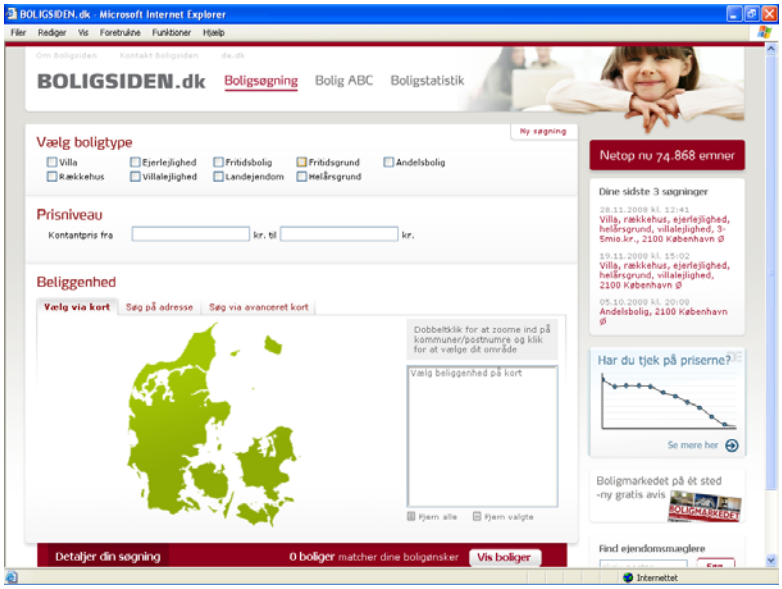


Figure 16. Search engines at estate agents of private housing.

The actual building, building parts and processes

The search engines cover the whole country. Principally, there are no restrictions but sales require up-to-date information. The search engines include existing buildings as well as new buildings (typically project development). The types of buildings covered are:

– Single-family house/(small) detached house.
– Owner/occupier dwelling.
– Summer cottage.

– Vacant building site for summer cottage.
– Tenants-owner housing.
– Terrace house/Non-detached town house.
– Dwelling in detached house (in Danish: Villalejlighed).
– Farm house.
– Vacant building site for permanent housing.

The applied assessments and tools in the processes

The assessment methods and tools applied in the marketing and sales process include three sets of methods and tools: The estate agent's sheet of information, an energy label, and a condition report.

The sheet of information is a presentation of the building for sale includes also governmental requirements. The sheet contains description of property, the cash price, gross/net costs, loans and land registry data. Sheet is not mandatory for private sellers, but part of the purchasing contract.

The second type of assessment is the energy label. The energy label scheme was established in 2006 as part of the EU directive on buildings' energy performance. The objective is to save energy, and it is mandatory for all new and existing buildings with a few exclusions like industrial and agricultural buildings. The energy label is calculated using various types of calculation tools.

The house inspection system ensures consumer protection and information in conjunction with purchase and sale of single-family houses. The purpose is to secure seller’s 10-year responsibility for hidden faults and defects towards buyer. Although the house inspection system is voluntary, some 60-80,000 reports are produced each year and majority of all sales of single-family homes involve the house inspection system.

Cost and performance indicators applied in the assessments

The sheet of information typically comprises 6-10 pages, and includes following:
– 1) The cash price.
– 2) Information on mortgages and bank loans as well as a standard financing scheme.
– 3) Gross/net expenses.
– 4) Utilisation costs.
– 5) Cash payment required to finance and finalise the purchase.
– 6) Latest property value and land value according to public valuation.
– 7) Plot, building and built-up area (BBR registry) possibly including distributional keys for heating etc.
– 8) Land registry number, location, present use and previous use if different from present use.
– 9) Present insurance including special conditions e.g. non-insurable against dry-rot and insect.
– 10) Burdens and liabilities of the property or seller, which the buyer must take on outside the purchase amount.
– 11) Energy performance.
– 12) Special or extensive limitations of use due to district plans, servitudes etc.
– 13) Pollution mapped according to knowledge level 1 or 2, or information on light polluted soil.
– 14) Economic or personal circumstances, including:
  – a) any economic or personal interest that the estate agent may have in closing a deal or in the buyer's choice of finance, insurance or other services in relation to the purchase of property, or
  – b) that the estate agent do not have the interests mentioned in 14a).
– 15) Other items of significance.

The energy label operates with predefined energy categories ranging from A to G. The energy consumption is calculated in two ways; energy costs per

year, and energy consumption per year in kWh/m^3. Report typically comprises 6-10 pages, and includes:
– Basic information on the property and the assessor.
– Calculated heat consumption.
– Energy label (category A to G).
– Proposals for energy saving measures.
– Savings and financing.
– Free text comments describing the analysis of energy performance.
– Detailed building inspection by energy consultant.
– Detailed basic information on property.
– Assumptions used in calculation.
– General information on energy labelling.

The condition report uses the following 6 scale grading for the assessment. The building divided in to 11 main building parts; Foundations/basis, Cellar/crawl space/ground deck, Outer and inner walls, Windows and doors, Ceilings/floor structure (horizontal division), Floors, Internal stairs, Roof structure, Bath/toilet and utility room, Plumbing (heating/ water/ sewage), HVAC, and Electrical installations.

The condition includes also:
– Basic information on the property and the assessor.
– General information on the house inspection system, grading scales etc.
– Detailed observations on each of the 11 building parts summarised in the above table.
– Questionnaire to be answered by the seller.
– Summary information to the insurance company from the assessor on the results of the inspection.

Relation to different enterprises and national benchmarking

The assessments serve two purposes; transparency and consumer safety in the marketing and sales process of homes. Transparency is enforced in search engines to all groups of users – estate agents, sellers and buyers – having access to an excessive amount of data on properties that include sheet of information, energy label and condition report. In relation to earlier, the increased market transparency also helps to set a 'fair' price for property and monitor the market or benchmark similar properties. The sheets of information are primarily a *marketing device* for sellers and estate agents, but they also serve as a *selection mechanism* to find the most appropriate purchase when filtering the content according to building type, location, price, size etc. The other main purpose is consumer safety, and house inspection system has been created for liability reasons. Close to 1 million condition reports has been issued since 1997, but yet no official statistics or benchmarks on the performance of homes has been provided.

Visions and innovation for future improvements

Currently there are no immediate plans to change the three assessment methods and tools.One of the main lessons to be learned is that a wide range of information is already available, and covers also a number of the key performance indicators discussed in CREDIT like price, size, location, energy performance and building performance most notable considering visible defects or damages. It seems also that there is a need for performance indicators focused on the services provided by the actors.

Interestingly, none of the interviewees pointed out a need to include new performance indicators on e.g. building performance. Instead they argued that performance is something that can be changed whereas the location remains fixed. However, the foundation Realdania has recently published a study end user satisfaction to building inspection and condition report. It seems that 90 % of the home owners find it valuable, and majority also has confidence to it. Despite the confidence of the consumers, there is a huge

gab between the way the consumers *perceive* the scheme and the way the scheme actually works. There is also a wish to improve consumer protection by expanding the coverage of the condition report, and some of these areas are linked to performance indicators such as indoor climate, service life values, and state of maintenance.

4.3 22 student housing estates - Stakeholder evaluation (Denmark)

This case has an initiative to increase the number of dwellings in private housing for students. The evaluation is focused on the following four themes: quality in the finished buildings, the building process, economy for the society, client and user together with user satisfaction.

The actual building, building parts and processes

The case is based on the whole evaluation of 22 estates – 15 private estates with 1113 dwellings and 7 non profit estates with 627 dwellings. Focus in the case is in other words an evaluation of a group of buildings and compared with normal traditional buildings of the same functions. Five of the 15 buildings/estates are renovated buildings, and apartments vary from 27 to 50 square meters. 13 of the buildings have common room and kitchen facilities, and all apartments have small or big kitchen.

The applied assessments and tools in the processes

The evaluation is primarily based on registration of the quality of the finished buildings, questionnaires and interviews with all clients and persons responsible for economics in the execution of the estates, interviews with local authorities, questionnaires to students, questionnaires and interviews with persons responsible for the operation of the estates and interviews with members of the judging committee.

The indicators were tailored to this evaluation. The theme quality contained three main topics: architecture, standard and fulfilment of the demand from the ministry. The evaluation was divided into "levels" and started from appearance and individual apartments, continuing to rooms and components. The theme building process focused on general level to the interplay between the main actors: the ministry, the client, the companies and the local authority. The theme economics looked at the costs for construction, operation and life cycle use. The theme user satisfaction focused on the users own evaluation of their apartment. They also rated common areas and social interaction. Furthermore, student movements and the use of the estate were evaluated.

Cost and performance indicators applied in the assessments

The ministry decided that the evaluation should concentrate on indicators within the following four themes: quality, building process, economics and user satisfaction. The same themes were used for all estates.

Relation to different enterprises and national benchmarking

There is no national benchmarking system in this area, and used system was tailored to the situation used in evaluation. After the evaluation, none of the clients and companies have initiated specific assessments of their building and the process. For the private student housing there were three groups of clients: self-governing institutions (4), turn key contractors (7) and property owners (4).

Visions and innovation for future improvements

The evaluated themes and indicators reflected the political intensions with the initiative. A broad spectrum of tools was used. The indicators and the chosen tools yielded a good insight in the results of the political initiative. The results aimed primarily at the agreed overall framework and not at the individual case under planning and construction. But in the case a new initiative is taken there are conclusions which also will influence the single building quality, process, economics and user satisfaction. Some data turned out to be difficult to evaluate, especially some indicators concerning economics. Also the short period for evaluation caused problems concerning the operation of finished buildings.

4.4 Public housing - User needs and economy (Denmark)

Public housing case study is a renovation project in Copenhagen. The main objective in U2 project was involving end users and capturing their needs. The study also looks at how architects end-user needs in their work, and considers also a national system BOSSINF.

The actual building, building parts and processes

The U2 project is a located to Amager -Urban Planen - near the centre of Copenhagen, where planning started in 2003 and site is expected to finish in 2010. It includes renovation of façades, gables, new windows, balconies, roofing, and a new layout for the exterior areas. Renovation project also developed four elements: 1) A model for value creation in the building industry, 2) Optimization of product and process on the level of building parts, 3) Education on the building site, and 4) Value creation and optimization in all phases of the building process. The client for the project was a cooperating team (partnership) with members from the housing organisation and local municipalities.

Figure 17. Drawing of the planned changes in the out door area in Urbanplanen.

The applied assessments and tools in the processes

A number of tools and methods has been used in order to involve dwellers in the area and get insight to their wishes, opinions and knowledge about the area. Tools include *surveys, workshops*, and *events*, and results were documented and communicated through exhibitions, catalogue of ideas, newspaper and web forum.

Survey of the end users in the housing area included questionnaires via telephone, distributed to all households and semi structured interviews within different focus groups. This was a preliminary process of briefing in 2004 in order to gain views, wishes and opinions from representative part of

the end users and assess benchmarks for process. The survey was done by a third party, and corresponding survey is planned after project is finished.

3 *workshops* were held as a part of the strategic planning in the initial phase. First, a long workshop was chaired to challenge end users to innovate on recreational space, buildings, common functions, and the identity of the area. Second, a short workshop was held about the playgrounds, where kids had possibility to express their needs. Third, one workshop considered also the pathway through the area. Results from the workshops were documented in exhibitions and later to an idea catalogue. These ideas were also discussed and different departments of the public housing voted decisions. In relation to earlier, children were able to vote between the different playground solutions.

However, the involvement of the end users to the whole planning and construction process was evaluated by a third party. This evaluation was based on interviews with key players, registrations, questionnaires and the evaluator's judgement of the goal achievement with the different events.

Cost and performance indicators applied in the assessments

Focus group meetings considered:
- The design of the flat
- The location
- Access to public transportation
- Vicinity to family and friends
- What kind of place is it to live?
- The service from the caretaker's office
- The rent
- The quality of the playground for children
- The reputation of the area
- The shopping possibilities
- The demography of residents in the area
- The outdoor spaces
- The maintenance
- Identity of the area
- Social contact in the area
- Sense of security in the immediate environment and in the other areas.

The list of objectives in U2 project concerning cooperation included:
- More dwellers at the meetings
- Good publicity in the media
- Few complaints
- Content residents
- All residents are informed about the changes
- Less damages
- The vital connection is realised
- The result of the renovation becomes a reference for other renovation projects.
- More people are visible in the area
- Proud tradesmen
- Proud residents
- Increased possibilities for each resident to have influence on his/her dwelling
- Project will stay within the budget
- The quality of the new facade and outdoor are

Relation to different enterprises and national benchmarking

U2 is a demonstration project for the innovation network for public housing organisations and the local authority in Copenhagen. The assessment methods developed by process consultant WITRAZ Architects were targeted to involving and capturing the users' knowledge, opinions and wishes.

Experiences and knowledge gained in this project will be used by other housing organisations in Almennet. Further, experiences are also relevant for enterprises such as process consultants, architects in future projects, and have been distributed to public through publications on user driven innovation with architects as the target group.

Visions and innovation for future improvements

The objective with Almennet is this to further learning processes in public housing, and to develop methods and processes that will improve the user's satisfaction with their dwelling and housing area. The innovation strategy is user driven innovation.

This renovation project in Copenhagen shows that there are available methods and tools at hand for user involvement and capturing user needs as

well as experience with the employment of these methods in the public housing sector. Methods are primarily suitable for the strategic pre-analysis and briefing in the CREDIT Carpenter model. The assessment of total project success includes both statistical data and softer feelings and sensations based personal judgements.

The assessment of process and end result relate to indicators in the CREDIT Indicator framework, mostly to Location and address (2.1), Plot opportunities (2.2), Spatial solution and property aesthetics (2.3), Surrounding services (2.4), Social value (2.5), Category of building, quantity, size and area (3.1), Safety and security of burglary (3.2), Usability and adjustability (3.3), Feelings and sensations (3.9), User involvement (6.5).

4.5 Developing process and product in housing company (Sweden)

This case study shows a franchise housing company and how it continuously develops product and project in environment where end users are not known from the beginning.

The actual enterprise, company and firm

The company is selling building concepts for new build villas, apartments and terrace houses to licentiate takers in Sweden, Denmark, Norway, Finland and Great Brittan. Several public real-estate owners providing rental houses constitute 40% of its turnover. The purpose of the assessments for better understanding their customers is mainly to develop the products and the project.

Though the customers are not known from the start the housing company is using a system of surveying and evaluating methods to improve and develop product and project process to better meet the needs of the customers. The company has learned lessons from the evaluations and changes have been made in order to make the system more efficient. Besides, the company is continuously comparing their work with competitors but not in a systematic benchmarking procedure.

Applied assessments and tools in the enterprise

The housing company is working continuous with improving both process and product from a customer perspective. The development of the project is initiated with a market survey and is followed by a positive customer index (PKI) survey, both performed by consultants and analysed by the company.

Costs and performance indicators applied in the enterprise

Company has used surveys in multitude of projects. They make market analysis to ensure that location matches the target customers. A two store terrace house has also been developed and investigated interviewing 300 hundred younger children families (how they lived today, living customs, opinions of their living, like to change, possible solutions). Results show commonalities between Nordic countries. In general people living in terrace houses like to have good storage areas, a proper kitchen and a sensible solution for the laundry. Open plan solutions are more common in Denmark, and big glass facades towards garden but not to street are liked. Bed rooms should be on the upper floor, and toilets in both floors.

Then, the company uses deep interviews (90 min) when the product in use to get input to product development. These interviews included following areas; company and area, external environmental aspects, internal aspects of living such as systems, spaces, materials, functionality, and usability. Respondents are also answering to questions concerning various living situations.

Positive customer index (PKI) is performed by a consultancy with telephone interviews. The importance of the requirements was graded by the customer on a five graded scale, and output included three main areas: before moving in, at occupancy, and for the residence. The results are used in two ways; first to improve the production, and second to use the result as an inspiration for future projects.

The company is surveying the quality of living in their two year or older residents. For example the telephone survey addressed to apartments, 2004, included totally 200 respondents (5 respondents per project). The survey includes background variables, quality of living in spaces, change needs, changes made, image, economy, development, recommendations, moving plans and customer loyalty.

The most obvious indicator in use is of course PKI. The parts of the building being asked for in the evaluation are: ventilation, sound insulation, functionality of rooms, equipment in bathrooms, technical equipment and energy consumption. It is concerned quite difficult to know what technical aspects bring added value to the customers. If we take one finish detail away to save money will the customer notice it and be less happy with their products? It is hard to know.

Relation to building cases and national benchmarking

The company do not use a structured benchmarking system. They are though keeping track on the competitors and analysing how their products succeed. Thus, it is important to use different evaluations as inputs to the developing process. For example, once they developed a product for the people born in the 1940s. When following up who actually lived in the houses, it was a mixture of varied customer segments and company decided to make changes.

When evaluating the project the result is sent to the licentiate takers. The company interferes if the brand is hurt, an minor faults are the company relying on the licentiate takers. The improvements from the PKI are mainly addressed through adapting the outcome to local conditions.

Visions and innovation for future improvements

The company is using a system of survey and evaluation methods to improve and develop product and project process to better meet the needs of the customers. The development of the product initiates and ends with different kinds of surveys; typically initiated with a market survey and followed by PKI survey. Besides customer surveys are done to all projects that are two years or older. The company has learned some lessons, and develops the system more efficient.

The company finds it difficult to know what brings value to the customers and how needs are changing. They also feel that it is hard to exploit information from the different surveys organisation wide and show best practice examples. One problem with the PKI system is that sometimes one not satisfied customer gets too much attention.

The company gives customers a guide when moving in. The guide includes also inspirations material on how to furnish but also guaranties, drawings, user’s guide, and worth knowing section.

The list of CREDIT indicators were shown to the interviewed person. For the company Location and Building Performance indicators would have been interesting to measure. The remaining indicators were not seen that interesting in a franchise company. The respondents were missing indicator determining general trends. When a trend is so important/ interesting that you should pay attention to it?

4.6 Managing tenants in housing company (Sweden)

This chapter describes how the housing company is using a number of methods to better understand and manage their tenants in occupancy and in different construction projects

The actual enterprise, company and firm

The housing company is a public real-estate concern owned by the city. They supply 20 000 habitants with 8500 dwellings and 100 000 square meter premises for shopping, offices, cinemas and geriatric care. The functions the company offers is building of new houses, refurbishment and operation and maintenance.

The company is monitoring the buildings and the customer satisfaction in occupancy. The company is prevailing under the tenant's law, which affects the management of the existing tenants when rebuilding or raising of development density.

Applied assessments and tools in the enterprise

The methods used in the company, for managing and monitoring the tenants satisfaction, are different key performance indicators (KPI), meetings, databases, questionnaires, surveys and the experience and knowledge among the employees. The company measures satisfied customer index (SCI) once a year from all dwellings. The purpose with the measuring is to improve their work and receive a picture of the customer satisfaction. The SCI measurement has lead to improvements and their customers are nowadays feeling safer, like the dwelling better and are more pleased staff in the housing company. The questionnaire consists of eleven main questions which are broken down in a number of statements that respondents scale;

1. Age of respondent
2. How long the respondent have been living in the apartment
3. Number of persons living in the apartment
4. Service
    a. Easy to contact, well treated by the employees, reliable company etc.
5. How they contact the housing company
6. Maintenance
7. The laundry
8. The quality of living
9. Safety
10. New customers/tenants
11. Remaining
    a. Value for money, information, internet, television, the attraction of the apartment/estate etc.

The company has two systems for collecting information about the customers and their living preferences. One is a questionnaire in homepage where anyone can fill their wishes for qualities of their future living. The other system is a queue for dwellings. When signing in the application the company receives information about living wishes.

The company has a number of tenants' associations where tenant represents give important feedback to the company. The strength turned out to be the service how promises are kept and the competence among employees. On the other hand, tenants did not put much interest in environmental work the company is performing. The knowledge within the company is not shared in a data bank or similar. The demand for a central living is highest among young and elderly people. Households with children prefer more living in the outskirts of the town. These prerequisites affect the designing of apartments.

The tenants have to be involved, according to the tenant's law, when renovating existing buildings. An example of a working procedure when involving tenants is:

- meet all the tenants in a meeting
- send out a questionnaire about their opinions of the renovation
- meet the tenants again and present the result
- perform a number of reference meetings with the tenants

The company makes tenants reference meeting that link together representatives from the company and tenants. During the meetings, issues like space analysis, development density and affects to tenants are discussed. When a rebuild is made, discussions about the equipment, colors, material etc. are held, though the changes will influence the tenants rent. Tenant's possibility to affect is quite high.

When developing new housing concepts, like co-operative association, the company is hiring external consults to make surveys. The surveys for a co-operation project in a village outside the city existed of two surveys. One survey of the opinion about co-operating concept among the habitants in the village and another survey of how much they were willing to invest in that kind of living. The housing company felt that they had benefits from the surveys.

Costs and performance indicators applied in the enterprise

The company is monitoring following indicators:

- **Satisfied Customer Index**
- **Resource use** (use of energy, material, electricity and water)
- **Economical parameters** (almost every post in the statement of income).
- **Accessibility** (In the existing housing accommodation are surveying of accessibility for elderly people performed in collaboration with researchers).

The company is considering at almost every parameter in CREDIT indicator framework, and parameters are measured as goals. The market manager considers that short list of indicators should be used for monitoring. Besides, some of the indicators are not of particular interest, such as Green House Gas emissions. The risk indicator could be interesting on the habitats but the company has so long queue to apartments that this matter is not of particular interest. The manager also points out social indicators being maybe hard to compare with other companies.

Relation to building cases and national benchmarking

The housing company has been participating in a national benchmarking system for couple of years - SABO (Sweden of public utility housing companies). The measuring is focusing on economic and resource use aspects. The purpose is to use the system for comparing towards the competitors to see how well they perform. They have always been in the top section, but does not consider it easy to learn from the benchmarking system.

Visions and innovation for future improvements

The company is working in a number of procedures to understand the needs of existing and future tenants. The voice of existing tenants is expressed in SCI measuring, tenants associations and in renovation projects. Perceptions of future tenants are collected in website. Unfortunately, much of the collected information is not yet used in an efficient way and more knowledge exists in the heads of employees.

The real estate company is participating in a national benchmarking system provided by SABO that focuses on economical parameters. They plan to

introduce a SCI questionnaire for their habitat customers as well. The marketing manager wants to perform a study of future living preferences to understand better where the development will go and what the tenants of tomorrow want and require. The construction manager is concerned about communication technology issues.

4.7 Joint ambition housing project (Sweden)

This case study gives an example of how to work together in the building process in a joint ambition. It is necessary to test new ways of working together in the building sector. The end-user is not always satisfied with the product considering quality and costs.

The actual building, building parts and processes

This case study explains details on a housing area with 200 apartments near Helsingborg Sweden. The project that was started in 2004 and finished in 2008 offers a variety of dwellings and apartments in multi-storey houses and detached houses. It had a special focus on end-user perspective.

The applied assessments and tools in the processes

The involved actors, local authorities, architects, caretaker, construction firm and representatives for future tenants, worked together in the early stages at workshops and meetings to share knowledge and experience from each part in favour for the planning process.

In this project all handling of data were made on a web-based portal. Several meetings and visits at housing areas with all actors involved gave possibility to discuss experiences and formulate the goal for the new project Maria Sofia. Target of the meetings was to create a common understanding for the end-users needs and requirements. All actors involved were requested to read information concerning also the other actors. Information and discussions about prejudices towards the roles and responsibilities gave an interesting picture of the culture and tradition in construction management.

Cost and performance indicators applied in the processes

The actors involved started up the process with several meetings and a precise goal concerning the costs per square meter. Economical frames bring challenge also to the collaborative work. More time and efforts in the early stages can be an investment with good results, such as using the knowledge from the group.

The winners are the actors involved, the end-users and future tenants because of the possibilities to lower the rent. The project was delayed because of the infrastructural planning from the municipal planning office. The result is very good for the quality and low cost production. The most important positive result is that when the tenants move in to their apartment there are no problems or faults. This can be an effect due to a collaborative way of working.

Relation to different enterprises and national benchmarking

This case study clearly showed the positive effect of working with a joint ambition. All parts involved are content with the result and knowledge from this project will be transferred to coming projects.

Visions and innovation for future improvements

This case study indicates the positive effects of working together with a joint ambition in the building process. Each party has different interests and it is

necessary to draft what goals can be shared. There are discussions about how to improve this way of working together. The experiences from this case study indicate that when you focus on the end-users requirements and work with a joint ambition positive effects can be achieved. The result is good concerning the product, the time-schedule and the economy. These are also heavy arguments for developing collaborative team work and learning organisations.

Every actor and individual involvement is important when working together in a project. Using each others competence in a safe and encouraging atmosphere can give positive effects on the process and on the product. The ambition and good experiences of working in a more cooperative climate can be traced in the official description of every actor involved. Their policies and codes of conduct can be meaningless if the will to work in this climate does no exist. The architect should initiate the dialogue and maintain good communication between the users and the professional team. If the appropriate role is given to the architect and if the architect's attitude towards the task is appropriate, user involvement in the design process is positive.

Different working methods can be used to support communication. Both full-scale models and 3D modelling at the computer are valuable when describing designs to end users. The architects challenge in this case study clearly was producing houses with a fixed cost. Hopefully more customer driven processes give a smart and elastic working- model that can change prevailing conditions. The winners in changing towards a better organizational development are both the companies and the individuals.

4.8 Paldiski road (Tallinna Majaehituskombinaat, Estonia)

This case describes details from complex refurbishment project in Tallinn Estonia. The main interest in the project has been to reduce heating energy consumption.

The actual building, building parts and processes

The case is based on the results of complex refurbishing of an apartment building carried out in Tallinn to gain maximum energy efficiency, which in turn affects significantly the monthly costs of the residents. The apartment building at Paldiski Road 171 was built in 1977 as a pre-cast unit construction by Tallinna Majaehituskombinaat (Tallinn House-building plant). Flat-roofed 5-storey building with four stairways is situated in Õismäe.

The applied assessment methods and tools in the processes

In the Paldiski road, 60 apartment owners formed the Home Owners' Association in 2001 and that has managed the building since 2002. Due to 25 years of use, that is half of its expected lifetime, the association decided to refurbish the building in order to lengthen the lifecycle, lower the maintenance costs and raise the quality of life. Currently the reconstruction works have been finished, but maintenance related data and energy consumption data are still monitored. Further, surveys of resident satisfaction have been carried out.

Figure 18. Apartment building at Paldiski road, before and after refurbishment.

Cost and performance indicators applied in the assessments

As a result of the reconstruction project, the apartment building has a modern look, it is well insulated and has a heating system with individual calculation of heating expenses, where the estimated 40% energy saving can be expected. The general payment burden of the residents (housing expenses) increased, but thanks to the energy saving the residents will be able to fulfil their obligations.

Opinions of the residents concerning the results of the renovation are mainly positive, especially those concerning the aesthetics, living comfort (warm rooms) and expenses that correspond to the increase in living standards. The apartment owners appreciate highly the changes in the outer look of their building and the significantly improved heating system: adjustability according to the individual needs; it is hoped that the new system would be efficient and economical. Considering all the changes that were rated positively, it is presumed that also the market value of the apartments has increased. This understanding has not increased the residents' housing mobility.

Relation to different enterprises and national benchmarking

The national housing stock of Estonia consists of dwellings inherited from different eras; the largest of which as for influence has been the Soviet period. Though the publicly built stock of this period was developed according to strict rules and standards, it was performed and maintained on low level of quality. According to current statistics on January 2007, there are 638 200 dwelling units in Estonia, mostly in private owner-ship. Therefore, surveys on housing stock emphasize multi-storey houses.

Visions and innovation for future improvements

Using this example, it is possible to refer in the future to a specific apartment building and the energy efficiency that resulted from the refurbishing, which in turn affects significantly the monthly costs of the residents, mostly reducing the heating expenses.

Based on this example as the case study we expect to assess the performance criteria for different other buildings/dwellings being currently technically surveyed for future strategic activities.

5 School and nursery case studies

School and nursery case chapter includes five very interesting case studies; one from following countries respectively: Denmark, Norway, Sweden, Iceland and Lithuania. First, the Danish case promotes energy efficiency in university buildings. Then, the Norwegian case demonstrates project management benefits from using building information models. Third, we have a possibility read from efficient end-user perspective recognition in the Swedish case. Next we get an overview to comparing nursery schools in Iceland, and finally we conclude with a laboratory building from Lithuania utilising decision support system that is based on computer simulation.

Figure 19. School and nursery case studies in CREDIT project.

5.1 University buildings and Energy labelling system (Denmark)

This case describes how energy efficiency is furthered by directions in the University and Property Agency (UBST) and public mandatory energy label system EMO for buildings in Denmark. It explains The Danish directions for energy efficient building.

The actual building, building parts and processes

The competition about the University building in Kolding, a part of the University of Southern Denmark, started in July 2008 and the winning project was published in October 2008. The building is planned to be finished by the summer 2013.

The building in question is a university building for teaching, project meetings for the students, offices for researchers and teachers, administration, café, library, auditoriums. To minimize the energy consumption of the building is a special concern is paid to calculations and evaluations of the estimated energy consumption.


Figure 20. Façade of the planned university building in Kolding.

The applied assessments and tools in the processes

The UBST has since 2008 had new directions for the planning of energy efficient buildings and Kolding project was the first project where these directions were used. It consists of two parts; a calculation programme for energy demand of planned building, and parameter explanations in order to make the calculations.

In the case a set of measurable requirements concerning the energy efficiency of the building was defined by the client in cooperation with consultants and other stakeholders. The building reached energy class 1, which means that the resource consumption is (50 + 1100 kWh/m² that is 50 % of the Danish building regulations.

The evaluations include the calculation of energy demand, a calculation of the profitability of the planned solutions and alternative solutions that comply with the requirements in the brief and indicators of the directions.

The indicators in the energy efficiency labelling system EMO concern:
- Contributions to the energy demand (heating, electricity for running the building, temperatures that exceed the limit for the temperature)
- The net energy demand (heating the space, warm water, cooling)
- Selected electricity demands (lighting, heating the space, heating warm water, heating pump, ventilators, pumps, cooling)
- Loss of heating in the installation (heating the space, warm water)
- Output from special sources (solar heat, heat pump, solar cells)

The data that is entered in calculation programme includes:
- The building type (detached house, row houses, blocks) as well as the function it houses (offices, schools or teaching, day-care, hospitals and so on).
- Heated floor area
- Heat capacity
- Hours of use per day.
- Type of energy supply
- The building envelope (exterior walls, roof, floors, and other surfaces, foundations and joints by the windows, windows and doors including the orientation, grade and glass area of the window)
- The transmission area
- The transmission coefficient
- The factor of temperature

These indicators are summed up in a label expressing the energy demand for the specific building. A building can get a label on a scale from A to G. Though it is mandatory for all buildings with an area that exceed 60 m², more than half of the buildings that ought to be labelled are not. There are no sanctions for not labelling one's building.

Relation to different enterprises and national benchmarking

The UBST has a large portfolio of teaching and university buildings both as owner and facility manager. The operation of these buildings gives access to information about the energy demand and consumption. This information is mandatory to collect and deliver to the national energy monitoring system (EIS) for all buildings run or owned by the state. The knowledge gained by monitoring energy consumption and having the buildings energy labelled, makes it possible to know how functions of building affect the energy consumption. This knowledge is used in the briefing process making and decisions about what level of energy efficiency in new buildings should reach.

Both the estimated and the actual costs of the new university building to have a energy demand of 50 kWh per square meter will be used as a guidance for the expenses for increased energy efficiency in building.

Visions and innovation for future improvements

The objective with the Directions for energy efficient building is to establish an experience with different solutions for energy efficient building and gain knowledge about whether the level of ambition is reachable and if it raises the costs. Such a knowledge is valuable for the UBST themselves as well as for other public authorities in charge of public buildings.
according to Jens Rømer Olsen, UBST directions are too detailed and elaborated by themselves, and are probably going to be replaced by new directions (Energy Strategy of the Danish University and Property Agency 2009 - 2028). The assessment tool, method and calculations are the same in the new energy strategy as it was in the directions for energy efficient buildings.

The case shows that there in relation to energy consumption is a developed set of indicators and assessment methods available, that relates to the indicators of CREDIT. The case points out a problem in having a mandatory system without sanctions when someone does not meet their obligations. Furthermore, it shows the weaknesses in having a system that is based on the owner incentives from the energy labelling.

5.2 University of Stavanger (Statsbygg, Norway)

This case study describes the usage of key indicators in relation to University of Stavanger Norway. Statsbygg as building owner has a focus on use of Building Information Model (BIM), and therefore KPIs are considered from BIM perspective, and questions addressed related to how data and information about the building is collected, managed, evaluated and used.

The actual building, building parts and processes

The University of Stavanger is located to Ullandshaug and contain premises for faculty of social science. Basic information:

- Size: 3 600 m2, rooms for 100 employees and 140 students
- Owner: Statsbygg
- Architect: Link Signatur
- Consulting engineer: Multiconsult
- Schedule
- Programming phase: 2008 - 2009
- Construction: 2009 - 2010
- Handover: 2010 / 2011

Figure 21. University of Stavanger.

The applied assessment methods and tools in the processes

One of the criteria of the competition was that a Building Information Model (BIM) should be delivered. Currently (Summer 2009) the project is in the programming phase. A digital room and building program are being designed. Requirements that the building has to meet are being defined. It will be important to keep track of the original requirements and the final product as built. In principal everything will be stored in the BIM.

Cost and performance indicators applied in the assessments

An important example of relevant indicators is gross/net area efficiency. Information about the building from the BIM can be analyzed together with cost information from other sources. In the current phase of the building project the main focus is on the performance of the building. The approach is to compare with the original requirements. The motivation for collecting the data in Statsbygg is high. Energy indicators are used to compare buildings within similar buildings, while other numbers are compared independently. The real estate indicators are used to manage the existing buildings in a more efficient way, but as of today they are not used in the designing new buildings. The transfer of knowledge from existing buildings to new buildings is not taking place in a large degree. The area where largest progress has been made is energy performance.

In addition the indicators are used when creating cost budgets and calculating rent. Statsbygg has created its own Life Cycle Cost -calculator. Due to owning 2 300 buildings, Statsbygg currently has main focus in better management of existing buildings. It has about 20 -30 new building projects each year.

Relation to different enterprises and national benchmarking

Statsbygg's facility managers benchmark their buildings against other buildings in company portfolio. In each geographical region the managers meet twice a year, and key indicators are used as "discussion points".

Statsbygg participates in both the national benchmarking networks (NBEF and NfN) as a result of a policy decision. When it comes to using data for benchmarking purposes, Statsbygg uses its own internal data as comparison points. One reason why Statsbygg chooses to rely on its own data is that some of the data from other participants in the networks might not be comparable. Some have for example different ambitions for the long term level of maintenance. They believe that their buildings have a relatively equal level of maintenance, but if attention is not paid to this matter benchmarking can result in misguiding recommendations. Buildings with too low historical maintenance expenses can become best practice when mainte-

nance level is not taken into account. Another problem is different understandings of value preserving maintenance and value increasing development.

Visions and innovation for future improvements

Statsbygg has made the strategic decision to require usage of BIM for the University of Stavanger. One of the interesting aspects in this project is to examine how the data inserted into the BIM can be used for benchmarking. One key indicator that will be studied is net / gross area in different phases of the building process. Today there are some parallel processes that can be eliminated, and idea is not to create a data warehouse but a system that collects data as needed from subsystems.

From 2010 Statsbygg will require the use of BIM in all their building projects. This is an important signal to the building industry both in Norway and abroad. Information stored in the BIM is important as basic information. It can potentially be used when calculating rents, for the maintenance strategy, and for internal analysis. The information can also be used as input for changes in work processes for Facility Management.

At the firm level, the analysis focuses on Statsbygg's usage of the indicators. In order to perform Life Cycle Costing analysis, Statsbygg's collects data on a number of cost and performance indicators. The data from individual buildings are processed and compared with different building categories and between different types of costs.

Statsbygg believes that it is important to keep focus on the physical usage of energy rather than energy costs. The reason is that fluctuating energy prices might distort the benchmarking.

The new building at the University of Stavanger is not completed, and lessons are still being learned. On interesting aspect is how simple it will be to use information stored in the BIM to semi-automatically generate the information required to report to the national benchmarking networks.

5.3 Creation of new university centre (Sweden)

This case study explores how end users are managed in a construction project, and what methods and tools are used when capturing and managing their requirements.

The actual building, building parts and processes

The project is located to southern Sweden, and is a re- and new build for a faculty in a university. The building contains offices, lecture halls, a cafeteria, a dry laboratory and a library. First people moved in the summer 2004. The study covers needs analysis, briefing, design, construction and FM and occupancy. The evaluation is performed by user, investor (university), local planner, project leader and architect.

The applied assessment methods and tools in the processes

In the early phases was the main purpose to create a common reference frame and a common language among end users, architects and technicians but also to show the possibilities of a new centre. This was performed with study tours, meetings and workshops. The end users participated to different working groups focusing on different aspects of the building. They received checklists from the local planner as a help in their work. The end users had an own project leader and a reference group with represents from teacher, researchers, students and administrative personnel. During the process, opinions were asked from students and staff. Every drawing or program was circulated to different departments for commenting. When the building was

finished about 15 following up meetings were held. No specific measuring of the fulfilment of requirements has been done after finishing.

Cost and performance indicators applied in the assessments

The company uses satisfied customer index (SCI) questionnaire for randomly chosen end users, and perform limited number of interviews. They send out indoor climate questionnaires. The project arranged a parallel sketch competition for the design and they used two earlier university projects as a reference for formulating and evaluating competition documents. In this evaluation work they as well used a checklist from a KBS report. When the building was completed a meeting was arranged to feed forward lessons learned into a new project.

Relation to different enterprises and national benchmarking

The project lasted for a decade and not many people remember the whole process. The project had three project leaders from the real estate company, four local planners and two project leaders from end user organisation. The president of the university changed and also the chairman of the district. All most every person on every professional position changed during the project. This was both a bad and a good thing; knowledge and information was lost and contact persons were changing but the changes brought in new motivated persons to the project and kept it alive and moving.

Visions and innovation for future improvements

The study tours were seen as very fruitful from all perspectives; end users tend to relate to what they have and therefore it is a need to increase their perspectives to be able to create more innovating and better suited buildings.

One of the real estate company represents believes that it would have been good if the company always were involved in an early phase of the project. It is also very important that briefing includes visions of the future, but those are seldom clearly stated as goals in the briefs. The end users should have an organisation with a steering group that has rights to make decisions. Every department involved in the project should also have their own represent in the project group otherwise there is a risk for distrust.

5.4 Nursery schools (Reykjanes municipality, Iceland)

This case study describes key indicators from five nursery schools in the municipality Reykjanesbær Iceland. The cases create an interesting comparison between different schools from different times, but all in the same municipality.

The actual building, building parts and processes

The buildings are one-storied with different plans, but the main characteristics are same. The houses are of different ages; and all three have been partly refurbished.

Holt (590 m2) was built in 1979 and renovated in year 2004 (see Figure below). *Tjarnarsel* (602 m2) was built at three time periods; 1967, 1983 and 1999. *Garðasel* (821 m2) was built in 1974 and extended with employee room in 2007. It should be noted that number of kids per square meter is a fixed ratio, used to determine necessary size of the building in planning and design of nursery schools in Iceland.

Figure 22. Holt nursery school building.

The applied assessment methods and tools in the processes

Technical information regarding the buildings, the operation of the buildings and the core business were collected from the municipality. The municipality does not have a description of what they require, and it is up to municipality and consultants to decide this in each case. In this case, some indicators stand out as important for the municipality, while others are mainly of interest to the users.

- The building and operation (Net floor area per child, energy use, operational cost)
- The user (Type of materials, acoustics, spatial arrangement of the building)

Cost and performance indicators applied in the assessments

The case study included consideration of building and material performance, mainly as condition assessment and materials suitability. An overview of the answers shows that it was impossible to consider spatial functionality of the buildings. To conclude, the staff is mainly interested in surfaces that need frequent cleaning or are easily damaged (floorings and walls up to about 1.2 m height) but no so much in e.g. ceiling materials. They had no interest towards performance. *Garðasel* scored higher than the other two schools, possibly because personal room has been added that clearly is very important to the staff.

Costs for daily operation (except wages) and maintenance were gathered for the last two years, 2006 and 2007. Table 4 includes average costs for two years in euro/m2.

Table 4: Average costs (euro/m2) and energy consumptions (kWh/m2) from 2006-2007 in nursery schools.

	Holt	Tjarnarsel	Garðasel
Size m2	590	602	746
Garbage collection	1.8	2.2	2.5
Energy	17.3	11.7	13.3
Cleaning	47.3	45.4	44.0
Maintenance	19.0	25.1	24.9
total	85.4	84.5	84.7

	Tjarnarsel	Garðasel
Energy for heating (kWh/m2 floor)	414	417
Energy for lighting (kWh/m2 floor)	55	65
Energy use total (kWh/m2 floor)	469	485

Distribution on and sizes of the different costs vary. Cleaning constitutes 50-54% of the total costs, followed by maintenance with 22-32%. The total costs

are related to the building size. Apparently, energy use varies considerably between the buildings, even though that the climate is similar at all locations. It is quite clear that the result also shows considerable potential for better energy efficiency. In Iceland energy indicators are used to compare buildings within categories, but this is only done in limited cases. The facility owner discussed has not made such comparisons.

Relation to different enterprises and national benchmarking

This is the first study of its kind in Iceland. Benchmarking is not done to evaluate building qualities and performance in Iceland but the methodology used in the case study should be valuable for such evaluation. Benchmarking in Iceland is so far very limited and mostly used in comparison of energy use and facility management, and then only in a very limited number. National statistics are also limited.

Visions and innovation for future improvements

It has been very interesting to compare the results from discussion with the staff of three nursery homes, which mostly agree on what the important factors are. Many of the important additional aspects, such as thermal comfort and humidity, must be addressed at another time.

The case study shows also that there seems to be systematic faults in panning and designing nursery schools; some of the rooms are generally considered to small and material choices for flooring and walls are often inappropriate. As for now only the important aspects, which may be used as performance indicators, have been mapped but how to classify results or measure the performance as such has not been clarified so far.

Facility owners are beginning to show interest in comparison between cases, and the market is starting to understand the value of applying performance indicators in planning and design. So far only the first steps have been taken, but this work is expected to grow in importance in near future.

5.5 VGTU Laboratory Building (VGTU, Lithuania)

This case study introduces a knowledge-based decision support system in a renovation project. It explains also evaluation of energy efficiency and quality of life after renovation has been completed. The results can be used in new housing projects.

The actual building, building parts and processes

The case is located to Vilnius Lithuania, containing a refurbishment of Laboratory Building in Vilnius Gediminas Technical University (VGTU) (see Figure 23). The site is in suburban and surrounded by VGTU university, residential housings and forest. The building was built up in 1971, and has several departments and lecture halls. It has 1084 occupants and 219 rooms. The renovation was finished in 2004.

Figure 23. Laboratory Building of VGTU – before and after renovation.

The applied assessments and tools in the processes

The building has a pillar-column frame with concrete panel facades, that have severe damages in three-layer structure and junctures. The windows and entrance doors do not correspond to modern requirements, and both are replaced. Roofs are flat, and new coverings are added. Since the building is long, a new automated thermal unit was added to central heating system. After renovation the heating adjusts to outside temperature and operation at varied time of day; heating system works according to the diminished temperature schedule when building is not occupied. Hence old mechanical air supply/removal systems were noisy and not energy efficient, new ventilation system was installed. Additionally, electrical installations were renewed and new lines for computers were built. Additionally, illumination is also out-of-date and has to be reconstructed.

The energy saving and quality of life indicators are used in eventually repair work and in the operation of the building. And due to the dissemination of information they can be a part of the planning and execution in coming projects. Multiple criteria and quality of life analysis methods have been developed.

Cost and performance indicators applied in the processes

The refurbishment efficiency indicators and database for walls, windows, roof, etc. have been developed by VGTU experts. Based on those, Web-based Building's Refurbishment Knowledge and Devices Based Decision Support System (BR-KD-DSS) was developed. When using BR-KD-DSS, up to 100 000 alternative building refurbishments may be obtained. Following indicators have been used before renovation and in an inspection after hand over; energy saving (U-value (W/m²K), heating energy consumption (kWh/m²), quality of life (particle pollution, electromagnetic pollution, illumination, volume flow, air velocity, air temperature, relative humidity, dew point temperature, vibration impulse amplitudes) and refurbishment efficiency (price of refurbishment, etc.).

The assessed indicators are documented and reported, and used in later phases of the construction and real estate processes. The indicators are the starting point to show whether there are or will be problems with indicators at higher levels.

Relation to different enterprises and national benchmarking

The end result of renovation in Table 5 comprises structural unit and energy efficiency improvements. Different CREDIT information model indicators (1.2.2. Operation, 1.1.5. Construction of building, 3.4. Thermal comfort, 3.5. Air quality and health, 3.7. Acoustic climate, 4.4. Thermal quality, 4.5. Impact on air quality, 4.6. Lighting quality, 4.7. Acoustic quality) have been used in the national case study. Refurbishment efficiency indicators are used in the

design stage, and energy saving and quality of life indicators are used during the operational stage. The developed indicators and obtained experience can be used in other projects.

Table 5: Renovation outcomes of the laboratory VGTU building.

Structural unit U-value [W/m2K]		
	Before renovation	*After renovation*
Windows	2,5	1,16
Walls	1,07	0,26
Roof	0,8	0,3
Doors	2,3	1,5
Heating energy consumption [kWh/m²a]		
Before renovation 2002	*After renovation 2005/06*	*After renovation 2006/07*
178	157	88

Visions and innovation for future improvements

European citizens spend over 90 % of their time in closed space, and therefore, health and comfort are important issues. It is also important to ensure quality of life in premises in order to improve productivity and reduce health care expenditures. We have plans for improvement the e-assessment methods and e-tools (this includes all step in an e-assessment process such as collecting and processing data and giving recommendations) for analysis of particle and electromagnetic pollution. We are under development of intelligent systems designed to perform a few dedicated functions with real-time computing constraints, such as measure and analyse particle pollution and give concrete recommendation how decrease particle pollution in premises.

It is the opinion of VGTU that the experiences concerning design, multi criteria analysis and selection of most effective alternative of the projects should be spread to other clients in construction and real estate industry. By using digital alternative versions analysis VGTU contributes to the digital construction and real estate process.

On the other hand, CREDIT indicators give the client as well as the companies' possibility to learn more about the effectiveness and quality of the executed work. And use the results in new projects. The indicators can stimulate thinking about all the phases in the building process – from the idea and the first discussions to details in the project and further to work on the building site. Furthermore, the results can be used in connection with education and post education at the level of the individual companies and in workshops and conferences for several companies.

6 Shopping centre case studies

This chapter describes two Finish case studies, that are focused indoor conditions, and then Norwegian shopping centre case study targeted to performance monitoring. The first two Finnish cases demonstrate how an active owner may pursue better indoor conditions through indoor air and energy efficiency-related measurements. Finally, the Norwegian case explains how to use performance management system for benchmarking.

Figure 24. Shopping centre case studies in CREDIT project.

6.1 Shopping Centre 1 (Citycon, Finland)

Shopping Centre 1 is owned by Citycon, an active owner and long-term developer of shopping centres. As a whole they own 33 shopping centres and 50 other retail properties with property portfolio of 2,094.4 M€ (2008). They are accounted to 72.5% share in Finland, 22.2% in Sweden and 5.3% in the Baltic countries.

The actual building, building parts and processes

Shopping centre 1 in Figure 25 is located to Helsinki metropolitan area.

- Location: Helsinki Metropolitan area.
- Car parks: 700 totally, 580 indoors
- People living in the area: 103 000
- Yearly buying power: 1,6 billion €
- Year of construction: 1993
- Number of visitors per year: 3 000 000
- Sales per year: 53 000 000 €
- Leasable retail premises: 15 200 m2
- Gross leasable area (GLA): 17 600 m2

Figure 25. Outdoors from Shopping Centre 1.

In the centre, sales per visitor are 18,25 € that is above the median in upper quartile in national scale. Annual sales per leasable area embrace 4 322 €/m2. Heat load varies because of the spotlights and other type of lighting. Additional cooling system has been installed on the customer's expenses including to the electricity bill. Tree shops; stationery shop, cosmetics and liquor shop of one service area in the ventilation system were selected for near examination.

The applied assessment methods and tools in the processes

The study was carried out in two shopping centres, both located to Helsinki metropolitan area and focusing on indoor air conditions. The objective of the analysis was to verify the active heat loads. Results from other case study, Shopping Centre 2, are described in next section. The indoor environment studies were focused to the business spaces. The term indoor environment includes thermal conditions, indoor air quality, acoustic conditions and lighting conditions.

Cost and performance indicators applied in the assessments

Continuous measurements for a week in one service area (three shops) were performed three times (autumn 2008, spring 2009 and summer 2009). Measurements included:

- Indoor air temperatures, CO2-concentration, relative humidity
- Air supply and exhaust air temperatures, air flows in terminal devices
- Electricity power monitoring
- Single measurements, carried out during one monitoring day
- Control of air flow rates
- Lighting level, illumination
- Interviews of shop managers

The main topic in this study was to find correlations between the cooling need, indoor air quality and thermal comfort and electricity consumption – the results showed that further studies are needed to show the possible connection because of the problems in ventilation and cooling system. The measured air flow rates were lower than designed in every shop. This means that the ventilation system and balancing must be checked. Also the consumption of electricity showed some unexpected figures, which also means that the electricity consumption should be checked by more detailed way.

The measurements showed that one can not find all the crucial information from building automation system, and the reporting concept should be improved. This is not any single finding; it can be generalized concerning many similar facilities. The use of building automation system must be improved to include the positioning and installation of sensors and meters, and also owner's requirements should be set more detailed than now. Business space owners (shops) should also list better their requirements, and for example on-line reading should be available for electricity consumption. Spaces should be classified to certain categories according to indoor conditions.

Business space specific KPIs

- Indoor temperature and the stability of temperatures
- Lighting
- Temperature of supply air
- Cooling temperature and cooling power
- Air flow rates
- Electricity consumption, heating energy consumption, water consumption (in general: utilities consumption)
- Air quality, CO2

Facility specific KPIs

- Electricity consumption, heating energy consumption, water consumption (in general: utilities consumption)
- Maintenance costs
- Cleaning costs
- Investment costs
- Taxes, insurances etc

Relation to different enterprises and national benchmarking

Citycon's contribution in CREDIT project involves indoor air and energy efficiency-related measurements in two shopping malls. The company has its own facility management and energy management system, yet not detailed enough to find out deviations, malfunctions or operation errors online. The main interest is to find relevant indicators that help to manage and control technical performance of real estates and share costs in proper way between customer shops. The level and type of existing building automation system varies depending on the target. The third goal was to analyze changes needed (sensors etc) in order to improve the facility management and reporting.

There are no general information dealing with shopping malls available, and also the generally accepted performance level classification and indoor conditions ranking are missing. Therefore, various retail chains and shopping mall owners have own not public procedures. The building codes and indoor air classification determine the general requirements.

Visions and innovation for future improvements

The background of the case study was the owner's interest to direct electricity costs by righteous way between the customer shops and to create incentives in optimizing indoor conditions and energy costs. The main topic was to find correlations between the cooling need, indoor air quality and thermal comfort and electricity consumption – the results showed that further studies are needed to show the possible connection because of the problems in ventilation and cooling system. The essential Key Performance Indicators for indoor conditions have been suggested.

In the enterprise level it is obvious that existing building automation system should generate information real-time information with reports (indoor conditions, energy consumption). The enterprises should also create KPI`s which relevant to be used in internal benchmarking.

In national level there is lack of public data, which partially is caused by competition related things. To determine the key performance indicators in the level of single spaces is not any unambiguous task in the shopping centres. The needs of the shops are different and performance of the systems must be mirrored against the required values. According to results, key issue for the owner is to optimize the cooling and share the costs in proper way.

Based on the results a procedure can be created for monitoring and increasing the shops activity control for their utility consumption. In the future, also reflections to key performance indicators (KPI`s) and the validity of these KPI`s should be discussed. The results showed need for adjustments for ventilation system and cooling convectors. The systems should be balanced in order to operate correct way. Probably same type of problems occurs in other shopping centres. Also the "owner's requirements" should be set more detailed than at the moment. In shopping centres the building commissioning (Cx) procedure could be beneficial if it would be used.

6.2 Shopping Centre 2 (Citycon, Finland)

This and earlier case study are both owned by Citycon, an active owner and long-term developer of shopping centres. The company takes into account environmental interests and the wellbeing in the areas surrounding its retail properties, and is currently the market leader in the Finnish shopping centre business. It has 22 shopping centres in Finland, eight in Sweden, two in Estonia and one in Lithuania.

The actual building, building parts and processes

General characteristics in shopping centre 2 are (Figure 26.):

- Location: Helsinki Metropolitan area
- Car parks: 1 400 totally, 1 100 indoors
- People living in the area of influence: 93 000
- Yearly buying power in the area of influence: 1,3 billion €
- Year of construction: 1994
- Number of visitors per year: 6 900 000
- Sales per year: 157 200 000 €
- Leasable retail premises: 33 000 m2
- Gross leasable area (GLA): 42 000 m2

In the shopping centre 2, sales per visitor are 22,78 €, that is above the median value in upper quartile in national scale. When annual sales are compared to leasable area those embrace 4 764 €/m2.

Three shops were chosen to measurements in the same service area of ventilation system; clothing store for men, shoe shop, and clothing store for women. Two shops have an additional cooling system (including to the electricity bill), and heat load varies because of various lighting power.

Figure 26. Shopping centre 2 in Helsinki metropolitan area.

The applied assessment methods and tools in the processes

The indoor environment studies will be focused to the business spaces of shopping centres. The term indoor environment includes thermal conditions, the quality of indoor air, acoustic conditions and lighting conditions. The measurements will be mirrored by performance key indicators.

The aim is to manage and control the heat load and energy use is business areas. The correlation between the active heat load and electric power will be determined, and the passive part of heat load by certain measurements, as ventilation measurements.

The study has been carried out in two shopping centres, both located to Helsinki metropolitan area. The objective of the analysis of results is to verify the active heat loads. The main goal was same in both cases, to find the possible connection between cooling load electricity and other factors.

Cost and performance indicators applied in the assessments

Three sets of continuous measurements in one service area for a week were carried out on following indicators (autumn 2008, March 2009, June 2009):

- Indoor air temperatures, CO2-concentration, relative humidity
- Supply and exhaust air temperatures, air flows in terminal devices
- Single measurements, carried out during one monitoring day
- Control of air flow rates
- Lighting level, illumination
- Interviews of shop managers

After the first measurement period some preliminary evaluation based on results was done. First period results show how the indoor air conditions depend on internal loads and type of the shop. The women's clothing shop had a weaker lighting than other clothing shops. However, the indoor temperatures were higher than in other shops. The general lighting is from 1995.

Hence, the number of customers and their average staying time in shop is also influenced by indoor conditions and shop type. The second set of

measurements followed the previous, and third period was carried out in the summer conditions. Consumption of electricity did not vary significantly between the periods. Interestingly, the night consumptions vary for example in the shoe shop the night consumption in summer is triple compared with the spring. Overalls, the building services and ventilation systems performed well, but for instance the insufficient function of cooling convectors might cause the temperature increase during the rush hours. In some cases the actual costs distribution depends also on the booking system – how to organize the maintenance costs, investment costs etc.

Business space specific KPIs
- Indoor temperature and the stability of temperatures
- Lighting
- Temperature of supplied air
- Cooling temperature and cooling power
- Air flow rates
- Electricity consumption, heating energy consumption, water consumption (in general: utilities consumption)
- Air quality, CO2

Facility specific KPIs
- Electricity consumption, heating energy consumption, water consumption (in general: utilities consumption)
- Maintenance costs
- Cleaning costs
- Investment costs
- Taxes, insurances etc

Relation to different enterprises and national benchmarking

Citycon's contribution in CREDIT project involves indoor air and energy efficiency-related measurements carried out during the autumn season 2008 and winter/spring season 2009 in two shopping malls. The company has its own facility management and energy management system, yet not detailed enough to find out some deviations, malfunctions or operation errors online. The main interest of the participant is to find relevant indicators to manage and control technical performance of real estates and also share the costs by proper way between the customer shops in both centres.

There are no general information dealing with shopping malls available – also the generally accepted performance level classification and indoor conditions ranking is missing, but various retail chains and shopping mall owners have their own procedures and concepts, but in most of the cases these concepts are not public. The building codes and indoor air classification determine the general requirements, but e.g. the overall commissioning (Cx) (Pietiläinen et al 2007) procedures are not in use at the moment.

Visions and innovation for future improvements

The background of the case study was the owner's interest to direct electricity costs by righteous way between the customer shops and to create incentives in optimizing indoor conditions and energy costs. The main topic was to find correlations between the cooling need, indoor air quality and thermal comfort and electricity consumption – the results showed that further studies are needed to show the possible connection because of the problems in ventilation and cooling system and similar defects also occurred at other Citycon's shopping centre. The essential Key Performance Indicators for indoor conditions have been suggested.

In the enterprise level it is obvious that existing building automation system should generate information real-time information with reports (indoor conditions, energy consumption). The enterprises should also create KPI`s which relevant to be used in internal benchmarking.

In national level there is lack of public data, which partially is caused by competition related things. To determine the key performance indicators in the level of single spaces is not any unambiguous task in the shopping centres. The needs of the shops are different and performance of the sys-

tems must be mirrored against the required values. According to results, key issue for the owner is to optimize the cooling and share the costs in proper way.

Based on the results a procedure can be created for monitoring and increasing the shops activity control for their utility consumption. In the future, also reflections to key performance indicators (KPI`s) and the validity of these KPI`s should be discussed. The results showed need for adjustments for ventilation system and cooling convectors. The systems should be balanced in order to operate correct way. Probably same type of problems occurs in other shopping centres. Also the “owner’s requirements” should be set more detailed than at the moment. In shopping centres the building commissioning (Cx) procedure could be beneficial if it would be used.

6.3 Stortovet shopping centre (Skanska, Norway)

This case study describes the usage of key indicators in Stortorvet kjøpesenter in Kongsberg, an addition designed to the existing shopping centre. It focuses on the KPIs relevant for FM. and addresses questions how data and information is collected, managed, evaluated and used.

The actual building, building parts and processes

Stortorvet Shopping Centre (Figure 27) has 75 different shops. Facts about the building and actors:

- Owner: Kongsberg Utvikling AS
- End user: Kongsberg Utvikling AS
- Main contractor: Skanska
- Contract Value: 185 MNOK
- Size: 10 000 m2 shopping area
- Type of contract: Design build
- Procurement method: Negotiated
- Schedule: February 2006 – October 2007

Figure 27. Stortovet shopping centre, drawing.

The applied assessment methods and tools in the processes

All main contractors (Skanska) projects use Falk management system. This is a very useful tool, both for collecting data and continuous assessments. In addition to the Falk, project always makes final project report which describes its process, experiences and special conditions. Falk is an internal system, and includes information reported with different frequencies:

- Economic progress is reported per month.
- Health, Environment and safety incidents are continuously reported.
- The client fills out a standardised template form when the project is finalized. .
- The final project report is used as a guideline for new projects, but is not meant to be used as something to be carbon copied.
- The Falk system uses filters that information can be shown according to context/perspective (enterprise, project management, type of building).
- Falk is used by management, geographical regions, and country.
- However, information to the project management is provided from the accounting system.
- Benchmarking is done in relation to progress and quantitative measures of technical drawings.
- The client wants to measure Skanska based on physical aspects of the building actually delivered (for instance air flow through ventilation channels).

Cost and performance indicators applied in the assessments

Skanska has supplied information in a separate questionnaire. Looking at the information provided for “Stortorvet” the following main indicators are recognized:

- Capital investment, construction and commissioning cost
- Location and address
- Usability and adjustability
- Safety
- Durability
- Thermal quality
- Impact on air quality
- Lightning quality
- Acoustic quality.

Skanska has objectives and key numbers at both a company level and a project level.

The company level key indicators are:

- Economy
  - EBIT
  - Not paid receivables
  - Cash flow situation
  - Profitability
  - Order reserve (12 months)
- Market
  - Customer satisfaction
- Organisation and employees
  - Total sick leave
  - Internal HR-survey
- Operation effectiveness and health / environment / safety
  - Injuries with absence (two different categories)
  - Waste sorting (%)
- Production and services

The project level key indicators are:

- Economy
  - Final prediction
  - Unforeseen / not paid receivables
  - Balance
- Staff
  - Total absence
  - Numbers of administrative staff
  - Number of workers / craftsmen
- Health / environment / safety
  - Injuries with absence
  - Injuries without absence
  - Reports about unwanted incidents
  - Safe job analysis
  - Waste sorting (%)
- Production and services
  - Loyalty using Startbank (supplier register in the construction industry)
  - Zero defects
- Customers
  - Customer satisfactionRelation to different enterprises and national benchmarking

Skanska Norway is mostly acting as a large contractor, but sometimes it also has the role of being a client (Skanska Residential Development Nordic). It has contributed in the Credit project with filling out two forms describing which indicators they see as most important – depending on the role taken as a contractor or a client.

Falk is built to gather and report all information that Skanska Norway is required to deliver in relation to its construction projects. The traditional approach has been to communicate directly with other project managers, for instance when they have been in contact with the same client earlier. It can be difficult to compare projects at a national level because of heterogeneity in building types, performance requirements and external demands.

One of Skanska's main contributions to national benchmarking has been participation to the Norwegian research project "Benchmarking in Construction 2". However, data gathering in this research project took place before the Falk system was operational (2001-2006) and had its main concern with blocks-of-flats.

Visions and innovation for future improvements

All projects in Skanska use the Falk management system. Today, the advantages with the Falk system are mostly for the management level. The project manager contributes a lot of data to the system, but does not yet use it for his/her own needs. It is expected that the clients in the future will demand

more detailed and frequent information when it comes to safety and environmental aspects.

The Falk system would be ideal for internal and external benchmarking of Skanska at different levels. As a large organisation, Skanska could get valuable results purely based on internal data and cross-project/region benchmarking.

In the near future the project part will be further developed, and the KPI's will be compared within project types (today the comparison is independent of project type). Adding more historic information into the system is desirable. It could be beneficial to measure customer satisfaction more than one time during the project. Skanska Norway wants better measuring of team processes, sub-contractors (not measured today) and more information relevant for early warnings.

7 Hospital case study

Hospital case study chapter introduces to us a case from Sweden; representing outstanding results what happened when more responsibility in the building development was given to users.

7.1 End-user participation in new and rebuild of hospital (Sweden)

This case study presents an end user driven project for creation of a new centre in hospital environment. In general, hospital projects are highly interdependent and challenging environment, and therefore, more cooperation is called from the professionals and the end users. In this case, the end user project leader had to take a bigger responsibility than usually, and study highlights difficulties in managing the end users, organisational changes and creating a working communication in construction project.

The actual building, building parts and processes

This case illustrates a building project where the end users had to take a bigger responsibility than normal. The operation in the hospital was ongoing during the whole project, which makes the circumstances complicated. The study covers needs analysis, briefing, design and construction. Description of the building and project:

- The project is located in the south of Sweden.
    - New build 7 000 m2, construction start August 2005
    - Rebuild 11 700 m2, construction start March 2007
- The building is a hospital with the following functions
    - Casualty department, care institutional rooms, research centre, operation theatre, sampling rooms, offices
- The first thoughts of the project were born in the mid 1980s but was delayed, due to political prioritizing and started first in 1997.
- Opening ceremony will be in September, 2009
- Project cost 350 MSEK

The applied assessments and tools in the processes

The project was organised in the early phases by manager of users and end user leader. In the later phases the end user project leader had to manage without a manager of end users. In the briefing and design, the first goal for the manager of end user was to make people believe in the project, to enthusiasm them and make them understand that their contribution matters.

The end user project leader holds everything. Along the space related questions were moving related questions discussed. A lot of time was spent on making the end users see the bigger picture of their situation. The working groups were supported by the end user project leader and the architect and when needed experts were contacted to give advices and opinions. The end user project leader found it very helpful to have the architect connected in an early phase.

Multiple method were used in the case study. Study tours (nine performed) were adapted to the phase; first tour gave a broader view of the organisation, and later in the process tours considered details like interior solutions. Study tours were experienced positively among all participants; end users saw that the organisation was investing in them. During the whole project, the end user project leader has written weekly letters to the end user organisation. A showroom was built up so that the end users could try and

evaluate its functionality in a questionnaire. Patients and visitors were not involved or consulted in the project.

The end user project leader participated in construction site meetings during the whole process. He experienced that barriers had to be crossed to understand the social and cultural nature of the meetings. Changes within the hospital organisation affected the project as well, and in 2007 divisions started working with lean production. In this case, exchange of knowledge was done in monthly project meetings during the project. During the meetings were end user changed requirements and operation management questions discussed. This can be seen as a form of knowledge sharing among the participants.

Cost and performance indicators applied in the processes

The company does not measure the proposed items like indicators. A real estate manager have studied the list and pointed out indicators of interest.

- For calculating building performance and indoor environment the company is involved in a national hospital program called “Teknisk standard”.
- Facility performance and performance in use: considered in the early phase (pre-study).
- Resource control and project management: The company follows-up, when needed, how much time the project manager is putting on the projects.
- User involvement and cooperation: The end users are always involved in steering comities, reference groups and trade union.
- Resource use: they are mainly concerned about the media consumption. They use an “Excel media” tool for every building in use. The data is used both in property management and when designing new buildings.

The real estate manager is missing one post that they are very concerned about - project account of economical issues. The company can analyse the projects on a monthly basis and four time a year are forecasts performed of the project budget. This is very important for the company though the process to initiate a project is quite long and involves a number of stakeholders.

The company is following up costs at project closure and after 6 month of occupancy they make a customer evaluation where softer issues are discussed. Currently they need new questionnaire for this, because existing ones are considered inappropriate for both new building and renovation.

Relation to different enterprises and national benchmarking

The company is a real estate company for hospitals in the south of Sweden. It is a part of a larger cooperation with the assignment of being a strategic partner in building related questions.

Visions and innovation for future improvements

Hospital projects are highly complicated, and success may depend on social skills in the decision making process. When involving end users it is important that the prerequisites are known. Organisational questions have to be clear also to the end users. They prefer having one contact person instead of many during the whole project. Otherwise, it is one of the crucial characteristics that person with good social and communication skills manages the end users that represent different parts of the organisation. When communicating with end users, it was found important to try being a half step before the end users, especially when considering and describing functional space solutions. In relation to earlier, all parties should understand the needs of each other and be willing to collaborate. During the project it was noted that when end users were met with negative attitude, they also responded in the same way.

Methods used when involving end users were; study tours, working groups, weekly letters, different meetings, a strong vision to follow and show rooms. Many development ideas were gathered and for example parties wished for a knowledge transfer system. Lots of knowledge exists in the heads of the people, explains the manager of end users.

8 Discussion and conclusion

The purpose of work package 5 has been to test the assessment tools and key performance indicators in case studies in Nordic and Baltic countries. However, the focus of the case studies in Denmark, Norway, Sweden, Finland, Iceland, Estonia and Lithuania turned out to be slightly different. Finnish cases concentrated to measuring key performance indicators in enterprises and testing multiple rating systems. Swedish cases emphasized methods for capturing end-user needs. Benchmarking systems have been the focus in Danish cases, and enterprise level tool implementations in Norwegian case studies. This report summarizes 28 case studies addressing the common interest in indicators. Figure 28. shows their distribution to different building types

- Benchmarking systems and indicators (4 case studies)
- Offices (7 case studies)
- Housing (8 case studies)
- School and nursery (5 case studies)
- Shopping centres (3 case studies)
- Hospital (1 case study)

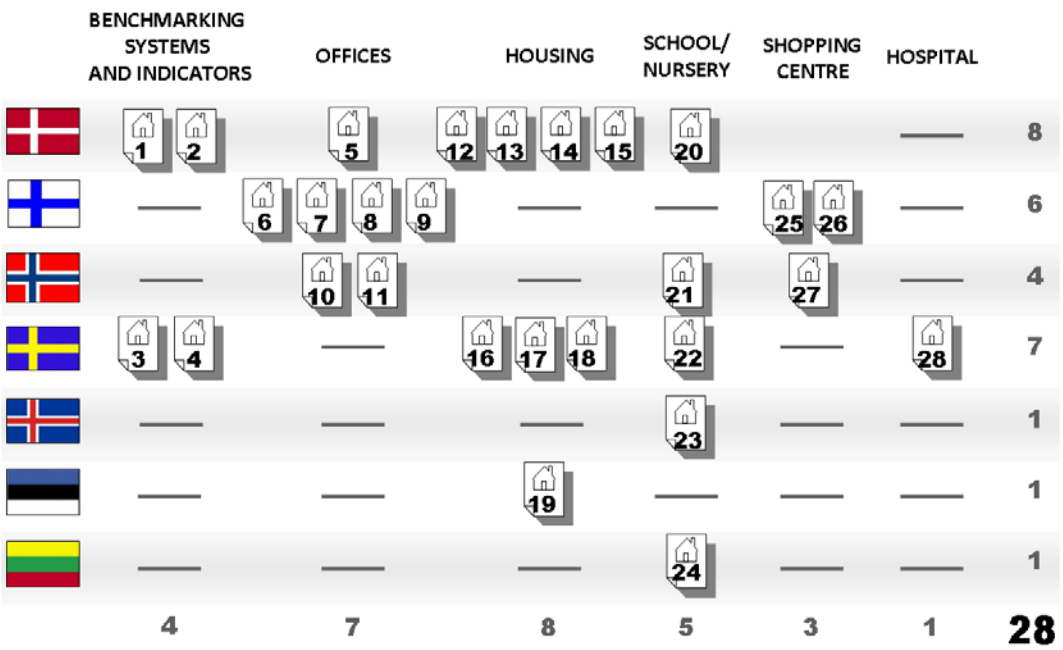


Figure 28. Cases included to Report 3 structured according to countries and building types.

There are already some good practices for benchmarking in large scale. Danish Benchmarking Centre (BEC) provides a web tool for addressing process indicators, such as time, accidents, productivity, and customer satisfaction to process. On the other hand, Investment Property Databank (IPD) publishes annual indices focused to investments and use of building collected from thousands of buildings, but yet building performance indicators are not included.

At the moment, front-runner enterprises are recognizing the potential of benchmarking for business purposes. If the building is rated to the best class, also the interest increases from investor and building owner perspective. There are also national and international environmental rating systems in the market, for example PromisE classification is used by large building owners in Finland.

Some of the frontline owners have already interest to use range of cost and performance indicators in daily operations. Senate Properties in Finland

and Statsbygg in Norway are addressing costs, energy efficiency and investment process with indicators through all their projects. Interestingly indicators offer a way to improve property portfolio management. Altogether, it seems that systematic procedures are needed for evaluating performance and compliance to end result to needs. When doing so, the set of indicators collected should not be too large.

There is no commonly agreed or standardized global or European Key Performance Indicator system, but some national and international rating schemes are available. During the past five years the number of rated buildings has grown greatly, and is seems that LEED and BREEAM are strong candidates to international investors. These systems are typically developed for certain market, and are highlighting certain perspectives such as environmental values and sustainability. The prominent solutions for benchmarking are now getting stronger than ever and motivation for using those is also increasing. One of the case enterprises, NCC, one of the largest contractors in Nordic Countries, has chosen BREEAM as their rating scheme.

Signals from the market are showing paradigm shift towards more active end user involvement to projects. For example public housing in Denmark involves tenants more actively to project development. Good experiences show that it is important to hear the voice of tenants, but we should agree on systematic methods for involving end users and making continuous monitoring of their satisfaction. Post Occupancy Evaluation (POE) helps to capture user perceptions in existing buildings. In Sweden, one promising method used for collecting annual tenant satisfaction monitoring is Satisfied Customer Index (SCI). When committing end users, they need help in order to be able to contribute in value adding way thought the project implementation. Few cases have built bridges between designer and end user with study tours and changes the way how site meetings are organized. Experiences from joint ambition development are also very promising.

The results from testing user friendly application developed in CREDIT project to map user preferences in office spaces are very interesting. The application presented a unique combination of textual survey and visual approach. The results from small scale testing were very promising. There seems to be strong need for this kind of new tools, and therefore, it has potential for further development.

Workplace management enhances office design through tailoring spaces better to end user needs. The basic question here is how to develop spaces to meet organizational needs. This may often culminate to the question whether the space layout follows cell offices or open layout, or is it using a mixture of both. Senate Properties in Finland is developing services for customers who want to develop their space use; for example if they need to improve space efficiency, or make organizational change and they wish to do it strategically where spaces are as an important asset. Promising results from this were shown in Lappeenranta office building.

National and international indicator systems do not cover all important business matters, and therefore, companies are developing their own systems. Skanska, one of largest construction companies in Norway, has been developing FALK system to help them to see progress with measuring e.g. safety, resource use, quality and environmental impacts. Citycon is a market leading shopping centre owner in Finland and operating in Nordic and Baltic countries. They have strong interest monitor indoor conditions and provide better indoor environment. Yet this monitoring information for indoor environment is not available. In the future, building automation systems could provide real-time possibility for monitoring performance indicators and parameters continuously throughout the lifecycle a real estate and contribute performance changes automatically. Indoor environment is important in shopping centres, and performance level for spaces is an opportunity to owner to enhance cash flow through rental agreements.

According to findings, organizations are looking for an indicator system that could help them to measure and enhance performance of buildings. Apparently some indicators are more important than others. In many countries regulations for accessibility have also become tighter. Location is still the core driver for offices and shopping centres, but common interest with owners is growing also towards operations and reducing annual consumptions, like heating, water, electricity, maintenance costs. However, based on findings in CREDIT case studies, it is hard to balance the trade-off between building performance, process development, and better usability. In relation to earlier, better indoor conditions require better automation system that in turn increases the electricity consumption. There is lot potential to improve energy efficiency of buildings, especially in renovation, and schools and nurseries. In Denmark this is furthered by directions with currently mandatory energy label for university buildings.

Indicator systems should be implemented in tools to encourage their use in projects. At the moment, the process of assessing indicator is rather manual. This problem is addressed in Norwegian and Finnish cases, emphasizing the use Building Information Models (BIMs) as a tool for managing in more automated way indicators along with the building data. For example building gross floor areas of spaces may be used as a baseline for indicators utilizing that information.

Based on findings in CREDIT project, offices and shopping centres are most attracting building types in terms of benchmarking. The larger and complicated the case is, the more potential there is for benchmarking. However, the growing size and increasing complexity also bring challenges. Enterprises are at the moment benchmarking indicators to some extent but systematic process has not yet been developed. Industry needs also a uniform indicator system that considers also building performance and value creation. CREDIT project has made a contribution to this and increased understanding on indicators and transparency through testing performance and value driven CREDIT indicator framework. Now the first steps towards cross-border benchmarking have been taken, and industry needs more research on this matter.

CREDIT reports

CREDIT reports and CREDIT case study reports are published by Danish Building Research Institute (SBi), Aalborg University, Copenhagen, and all reports are available free of charge in http://www.sbi.dk/byggeprocessen/evaluering/credit-construction-and-real-estate-developing-indicators-for-transparency-1/.

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Construction and Real Estate -
Developing Indicators for Transparency

This report summarises the results from work in fifth work package on ”National Case Studies” as part of the Nordic project Construction and Real Estate – Developing Indicators for Transparency (CREDIT). It represents a sectional view to case studies from varied building types: offices, housing, schools and nursery, shopping centres and hospitals. These impressive results have been reached in active cooperation between the most prominent research institutes within benchmarking and performance indicators in construction and real estate, namely SBi (Denmark), VTT (Finland), SINTEF (Norway) and Lund University (Sweden), and partners from Icelandic Center for Innovation (Iceland), Tallinn University of Technology (Estonia) and Vilnius Gediminas Technical University (Lithuania). To conclude, these results are also described in order to compare and find trends from the existing building stock.

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