FINAL REPORT

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Elios2

'Facilitating access to insurance by self-employed builders and small building firms so as to stimulate innovation and the promotion of eco-technologies in the European Union'

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Foreword

Liability and insurance law in the construction sector in Europe is still a juxtaposition of various and sundry laws. In fact, each legal system has, over the years, developed its own set of rules, without taking into account, given the immovable nature of the future building, either legislation in other countries or the possible international nature of the contracts. Construction rules and law remain thus the work of each of the national legal orders and reflect their peculiarities.

Following the first Elios1 pilot project, whose objective was to study the measures that would allow *"facilitat[ing] access to insurance by building contractors, especially self-employed contractors and small firms, in order to stimulate innovation and the promotion of eco-technologies in the European Union"* and which, in 2010, formulated various recommendations, the European Parliament adopted a new budget line in 2011 in order to proceed to a more in-depth study of some of its recommendations.

The European Commission thus launched a call for tenders for Elios2 whose mission has been defined more particularly as: *"(i) provid[ing] objective and reliable information on the opportunities and threats of quality/conformity marks and building pathology that could support risk appraisal by (re)insurance; and (ii) identify[ing] possibilities for greater convergence of mutual recognition of construction insurance regimes in the EU-28 with view of the Internal Market and the cover of building sustainability performances."*

What you, the reader, hold in your hands today is the result of research carried out by the Elios2 consortium, which was made up of top European actors in the construction insurance industry and in quality control in the construction sector, with a leader role played by CEA (Centre d'Etudes d'Assurances), a brokerage company specialised in construction insurance.

Not only recognising the ever-increasing discrepancy in the regulation of insurance and quality control activities but also being aware that the climate does not currently favour attempts to harmonise rules that apply to construction contracts and to insurance covering the works and builders' activities[1], the authors of the Elios2 report wisely proposed implementing a pragmatic system, with some modest ambitions, but directly applicable.

Of the recommendations formulated by the Elios2 group, two are of particular interest.

[1] See, amongst others, on this question our studies: B. Kohl, *Droit de la construction et de la promotion immobilière en Europe. Vers une harmonisation de la protection du consommateur en droit de la construction ?* (preface by H. Périnet-Marquet), Brussels and Paris, Bruylant and L.G.D.J., 2008; B. Kohl, "Towards a European Consumer Construction Law?", *I.C.L.R. (International Construction Law Review)*, 2010 (vol. 27, part 2), pp. 211-241.

The first stems from the suggestion to implement an *"Eco-technologies Quality European Observatory"* (EQEO), the aim of which would be to pool qualitative data related to certain pathologies of buildings, in the specific field of eco-technologies. The data used to build this database could be gathered by certain public or private stakeholders who are nationally active in supervising the building sector. The success of this initiative will again clearly depend on the willingness of these stakeholders to share the databases patiently created throughout years or even decades of experience.

The second recommendation appears to us to present more serious opportunities to obtain tangible results in the short term. It means to set up a *"European Facilitator for Access to Construction Insurance"* (EFACI).

This recommendation, justified by a detailed analysis of some key trends of the current situation, is the measure that the authors favour in order to address the concern that the freedom to provide construction insurance services is, at the moment, little more than wishful thinking, in particular because of the national differences between the various obligations imposed in terms of construction insurance.

In fact, the Elios2 report identifies several ways to respond to this concern. For example, it suggests establishing a system of equivalence of insurance issued in different Member States (liability insurance for builders provided in a Member State being presumed recognised as equivalent and accepted as such to cover builder's liability on work sites in other Member States). Nonetheless, this solution faces the obstacle of the existing differences between the national regimes in terms of builder's liability. Based on this last observation, an alternative solution would consist in an attempt of reducing the diversity of national regulations in the field of builder's liability insurance. By the authors' own admission, this option remains nevertheless currently still essentially theoretical, which we personally regret. Another proposal is to increase, for the benefit of SMEs and consumers, information exchange concerning each of the existing legal systems' requirements as well as on opportunities to access national construction insurance and guarantee markets.

This last solution may nevertheless appear to be insufficient in the light of existing experience as regards the *"Points of Single Contact"* (PSC), intended to inform the service providers about the regulations, authorisations, licences, permits and so on required for them to carry out their activity in a specific Member State, the implementation of which has not led to a substantial reduction in difficulties encountered by cross-border service providers.

For these reasons, the Elios2 consortium proposed setting up an independent authority, appointed by the European Commission, which would be aided by a Liaison Committee made up of representatives from both the construction and insurance industries and of experts and representatives from the European Commission. This authority would be responsible for advising and assisting service providers in the real estate construction sector with a view to entering the cross-border activity insurance market. This "Facilitator" would accompany the providers, essentially SMEs, in collecting information and would direct them to recognised insurance organisations. Its role, however, would include neither forcing an insurer to cover a specific risk nor managing the contractual process of buying insurance in the service provider's place. The "Facilitator" could also be asked to *"monitor"* access to the European insurance market and advise the European Commission as to the actions to take if specific difficulties are observed.

This pragmatic proposal deserves consideration. If it may admittedly not remove all obstacles that currently prevent seeing little more in the freedom to provide insurance services in the construction industry than an essentially theoretical concept, it would nonetheless allow, on an individual and tailored basis, providing assistance to the service providers to cover risks that are inherent to construction, especially when there is a cross-border element involved. However modest, this initiative will facilitate access to insurance for SMEs in the construction industry. Through this concrete proposal, the Elios2 report thus responds positively and visibly to one of the main objectives assigned to it by the European Parliament and the European Commission.

Jean MONNET used to say *"what's important is neither being optimistic nor being pessimistic but rather being determined"*. That, without doubt, is the desire that we can formulate for the decision-makers for whom this Elios2 report is intended.

The recommendations in the Elios2 report are common sense and justified by a pertinent analysis of the existing systems: not revolutionary, but ad hoc measures aimed at improving the daily lives of the players in the construction industry, which we know represents a significant portion of the Gross Domestic Product of the European Union Member States. It is thus possible to see the interest of the proposals formulated in the report whose authors are found to be excellent practitioners of the principles of both reason and subsidiarity.

Prof. Dr. Benoît KOHL

Chairman of the Elios2 Scientific Committee
Professor at the University of Liège and of Paris 2
Lawyer at the Brussels Bar

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N. B.: The name Elios was adopted by the project team in charge of undertaking the first Pilot Project (CEA and CSTB). Since 2008, it has been used by the Commission and by the various stakeholders to refer to the two successive Pilot Projects, Elios1 and Elios2.

The acronym Elios stands for European Liability Insurance Organisation Schemes in reference to the scope of the two Pilot Projects defined by the European Commission.

INTRODUCTION

Sustainable development is one of the main pillars in the policy of the European Institutions.

In the construction sector, it appeared very early on that the actions taken to promote activities that were more environmentally friendly should take into account the role played by insurance. It is in fact fundamental that the evolution in this sector be accompanied, even stimulated, by the implementation of suitable guarantees.

On the occasion of the previous Pilot Project that formed a feasibility study, Elios1, a number of trends in the Single Market were highlighted. These trends fully justified the need for measures to be taken to move towards a Single European Market that would facilitate access to insurance by self-employed builders and small enterprises so as to stimulate innovation and the promotion of eco-technologies in the European Union.

This Pilot Project falls within this perspective.

Its objective is to provide a certain number of deliverables, allowing for improved exchange and improved dissemination of information between the different actors involved by sustainable construction and access to insurance within the Single Market.

These deliverables also form pilot tools because it is of course necessary to consider going further and extending the actions to be taken in this regard. It is for this reason that this Pilot Project also focuses on researching and proposing methods for improvement for the future through several recommendations.

Background of Elios2

In 2008, MEP Guy-Quint brought to the attention of the European Parliament the difficulties of access to insurance faced by craftsmen and small construction companies. This resulted in the adoption of a first Pilot project entitled *"To facilitate access to insurance by building contractors, especially the self-employed and small firms, in order to stimulate innovation and the promotion of eco-technologies in the European Union"*.

In order to examine the feasibility of this Pilot project, the European Commission launched in 2008 a call for tenders for a study on the subject of *"Liability and Insurance Regimes in the Construction Sector, National Schemes and Guidelines to Stimulate Innovation and Sustainability"*.

A consortium composed of Centre d'Etudes d'Assurances (CEA) and of Centre Scientifique et Technique du Bâtiment (CSTB) was selected in November 2008 to carry out this research project which is now better known as ELIOS: European Liability Insurance Organisation Schemes.

The recommendations were published in the Elios final report on 30 April 2010 (see http://www.elios-ec.eu/report.html). They are summarized as follows by the DG Enterprise and Industry:

- Construction projects generally involve large investments and the financial implications of the technical failures are often significant. Moreover, the risk of insolvency is generally high in the construction sector. For these reasons, the client of a construction project is often exposed to high risks and the coverage of these risks by a contractual warranty alone could be insufficient in many cases.
- Traditionally, the contract governing a construction project focused on the delivery of a physical asset that responded to a number of technical and functional characteristics. The market will require more and more guarantees on building performances, in particular for energy efficiency and the production of energy from renewable energy sources.
- Today, these performances are often not covered by insurance. As (re)insurers do not have enough feedback experience on some materials, construction processes and eco-technologies, they tend to adopt a prudential attitude when assessing the risks. The growing number of quality/conformity marks for construction products/services and eco-technologies doesn't necessarily provide clear and reliable indicators for the risk assessment and furthermore could raise issues regarding their compatibility with the objectives of the Internal Market.
- The diversity of existing national liability and insurance regimes could raise difficulties of interpretation of the market conditions in case of cross-border services, in particular for small enterprises. The "points of single contact" for businesses, which have been put in place within the context of the Services' Directive, should provide at some point targeted and impartial information in a wide range of {areas/domains}, including on construction insurance.
- The creation of an insurance guarantee fund, as originally planned by the European Parliament, requires beforehand a greater convergence of the national liability and insurance regimes and of the risk assessment methods. This convergence process would require a more solid technical basis for risk appraisal and better policy learning between Member States.

On 15 December 2010, the European Parliament adopted the 2011 EU budget at its plenary session in Strasbourg. In the Multiannual Financial Framework (MAFF), budget lines have been allocated for Sustainable Growth.

The Elios recommendations were discussed during a meeting with the stakeholders organised by the European Commission and the MEP Estelle Grelier on 23 March 2011 to take stock of the work undertaken to date and to discuss the main orientations for the proposed follow-up pilot project based on Elios2 recommendations.

The birth of Elios2

As a continuation of the ELIOS feasibility project, the European Commission, in a new call for tenders, decided to express its wish to analyse in greater depth some of the recommendations of the first pilot project (Prior information notice in OJ: 2011/ S 70-113046 of 9.4.2011).

This new call for tenders N°116/PP/ENT/ASS/11/611 published in the Official Journal of the EU on 26 July 2011 was entitled*: "Facilitating access to insurance by self-employed builders and small building firms so as to stimulate innovation and the promotion of eco-technologies in the European Union"*. It was developed within the framework of the Lead Market Initiative for Europe adopted by the European Commission in order to support certain market sectors of strategic interest within the EU, including sectors of sustainable construction and renewable energies.

The bid for the new Pilot project named Elios2 was submitted on 15 September 2011 by a consortium composed of the two partners of the ELIOS study (Centre d'Etudes d'Assurances (CEA) and Centre Scientifique et Technique du Bâtiment (CSTB)), and of the Danish Building Research Institute – Aalborg University (SBi), Hannover Rückersicherung AG and Arcadis Nederland B.V.

In addition, the joint partners have been reinforced by the following subcontractors: Allianz (DE), Alten (FR), Apave (FR), Belgian Building Research Institute (BBRI), National House Building Council (NHBC), Technical and Test Institute for Construction (TZUS). This new team largely embodies the different European cultures and gathers a wide range of skills and expertise.

On 20 December 2011, the contract, based on the Elios2 team's bid was officially signed with the DG Enterprise and Industry.

Objectives and work program of Elios2

The main objectives of the pilot project are summarized as follows:

a) Provide objective and reliable information on the opportunities and threats of quality/conformity marks and building pathology that could support risk appraisal by (re) insurance.

b) Identify possibilities for a greater convergence or mutual recognition of construction insurance regimes in the EU-28 with the view of the Internal Market and the cover of building sustainability performances.

The work programme included at least the following elements:

- Development of an EU directory on quality/conformity marks (labels, certificates, technical assessment, etc.) for construction products, processes, works, technical equipment and professional qualifications.
- Development of indicators and monitoring of the evolution of quality in construction and of the pathology related to construction design and techniques and the integration of eco-technologies.

- Analysis of the conditions for a greater convergence or mutual recognition of the construction insurance regimes and identification of the criteria and the modalities for the development of insurance schemes that could support cross-border services and the {coverage/cover} of building sustainability performances.
- Assistance for the setting up and functioning of a forum composed of representatives from the construction and the (re) insurance sector, Member States and Commission services for the implementation of the pilot project.

Methodology

In order to organise the work programme between the Elios2 partners, five Work Packages were put in place and for each of them a leader was appointed:

- Work Package 1: Directory on quality/conformity marks with CSTB as WP leader;
- Work Package 2: Indicators and quality monitoring of quality and pathology with Arcadis as WP leader;
- Work Package 3: Re(Insurance) with Hannover Re as WP leader;
- Work Package 4: Organisation of a Forum and dissemination of data with Sbi-AAU as WP leader;
- Work Package 5: Project Management with CEA as WP leader.

The leaders have been in charge of the execution of all working activities, decisions, management of tasks and communication with the members of their work packages.

A steering committee, which met at regular intervals (+-/ every 2-3 months), was established within the consortium, consisting of the project coordinator and the work package leaders. This steering committee was responsible for monitoring the work execution, delegating work packages, motivating the team, encouraging creativity, correct problems-solving procedures and corrective actions.

The project co-ordinator CEA has acted as moderator and mediator, having the responsibility of ensuring that correct procedures are carried out and all deadlines and project obligations were met.

The Elios2 team also integrated a Scientific Committee chaired by Prof. Benoit Kohl and composed of Mr. Bønnelycke, Prof. Cerini, Prof. Kullmann, Mr. Merlet and Mr. Sougné.

The Scientific Committee's role consisted in giving general orientations to the project and resulted in a report focussing on the following items which the Elios2 project team considered as key issues to be addressed (Appendix Intro.1):

1. The exercise of the freedom to provide services (FPS) in the field of construction insurance;
2. Eco-technologies Quality European Observatory, the EQEO.

Consultations through a European forum

The Elios2 project team assisted the European Commission in organising and executing a consultation process throughout the entire project period. The consultation has taken place via the setting up and functioning of a forum composed of representatives from the construction and the (re)insurance sectors, Member States and Commission services to ensure guidance of the pilot project and a dialogue with stakeholders.

Seven forum meetings were held every six months or so during the three years of the project. The meetings were organised as half-day meetings except for the second meeting which was a full-day meeting.

The overall schedule and themes for each forum meeting is shown below (Table 1):

Table 1 : proposed themes for debate for the seven forum meetings

Forum N°	Date	Themes for debate
1	20 March 2012	Strategy and detailed work plan
2	13 June 2012	Directory on the directory on quality/conformity marks (draft version)
3	24 January 2013	Database for indicators on quality and pathology (draft version)
4	11 June 2013	Analysis of insurance schemes (draft version)
5	21 January 2014	Cross-cutting debate on directory on marks, indicators and schemes
6	11 June 2014	Preliminary conclusions
7	12 November 2014	Final report and recommendations

The project team prepared each meeting in close collaboration with the European Commission.

In advance of each forum meeting various types of material were prepared and circulated among the forum members. The material included a proposal for the agenda, presentations for each item on the agenda and background material such as draft reports on the relevant deliverables.

Dissemination

A number of dissemination activities were carried out by the project team. As part of the ELIOS pre-project a dedicated website was created (http://www.elios-ec.eu). This website was redesigned early in the pilot project and has frequently been updated with news and documents like Progress Reports, technical reports and presentations. Further, access to an operational version of the web-based directory of quality signs and a test version of the pathology database was made available through the website.

Every six months the project team issued a four-page newsletter. The newsletters were circulated directly among some +250 persons on a distribution list maintained by the technical secretariat of the pilot project in close relation with the EC project officer. Further, each team member has to varying degrees either circulated the newsletter within their own contact network or made it available through their websites.

Towards the end of the project it was decided to substitute the planned seventh newsletter with a pamphlet to summarise the main conclusions of the pilot project.

In addition to the different encounters the team members had in the course of the project with stakeholders and other interested bodies, the dissemination activities have also included news articles (Le Moniteur, etc.), publications on different professional websites (www.ectp.org, www.construction21.org) as well as on partners websites and presentations of the pilot project (UPSI-BVS, IHHWA, AFDC, etc.).

Finally, every 6 months, a progress report was distributed showing the progress of all the work. The final component of the dissemination activities is the present final report of some 150 pages plus extensive appendices with technical reports, detailed data and analysis etc. The conclusions of the pilot project have been summarised in three 20-page executive summaries in English, German and French.

Actions taken to meet encountered challenges

Obviously different difficulties and obstacles, or let's say challenges, were encountered in the course of the study. Some of them were related to one specific Work Package as others concerned different Work Packages (Table 2).

Table 2 actions taken as regard to encountered challenges

Challenges	Concerned WP(s)	Actions
Different concepts of construction insurance throughout Europe	WP 3 (with consequences for WP 1 and WP 2)	Systematic search for tools to promote the exchange of information and mutual recognition
Scepticism of some national actors about an European initiative in construction insurance	WP 1	Creation of the "Elios 2-test" status which permits the description of corresponding QS by Elios 2 partners. The QS providers are invited to validate recorded information. PR actions through European and local networks and advertisement on professional websites.
	WP 2	Stimulate exchange of information between selected key national actors holding information on building pathology

Conformity/complementarity of national Quality Signs in relation to the CE marking	WP 1	Interaction with representatives of the EC and several stakeholders of the construction and insurance sectors, especially sign providers, in order to focus the debate on the access to insurance. Attempt to better understand the underwriting process.
Confidentiality of data on pathology and reluctance to disseminate this data	WP 2	Emphasize qualitative data rather than quantitative data. Focus on some eco-technologies based on predetermined criteria.
Lack of guarantees in terms of energetic performances	WP 3	Comprehensive state of the art of existing guarantees and exchange with major actors in insurance in order to understand their point of view.

CHAPTER I – WORK PACKAGE 1

1.1 Introduction

1.1.1 Expectations and objectives

Work Package 1 of the Elios2 project mainly deals with one of the objectives of the call for tender: *"Development of an EU directory on quality/conformity marks (labels, certificates, technical assessment, etc.) for construction products, processes, works, technical equipment and professional qualifications.*

This development includes:

- *An inventory of quality/conformity marks in all EU-27[2] countries used in construction markets for products, processes, works, technical equipment and professional qualifications together with an appraisal of the level of impartiality of the procedures that are used to deliver the quality marks;*
- *A critical analysis of the rationale and of the relevance of the information provided by the quality marks to the operators of the construction value chain and to investors, including the compatibility and complementary issues with the CE marking;*
- *An appraisal of the conditions and of modalities to be followed by construction operators in order to access to the quality/conformity marks, including those related to the mutual recognition of the marks by Member States;*
- *An assessment of the possible impact of the quality/conformity marks on the competitiveness of construction businesses and the functioning of the Internal Market;*
- *Evidence and assessment of the extent to which the quality/conformity marks are used in practice by the insurance sector, including in the context of cross-border services. The assessment will consider possible constraints on the Internal Market resulting from common practice in insurance".*

The development of the directory is a way to address the following issue: *"The growing number of quality/conformity marks for construction products/services and eco-technologies does not necessarily provide clear and reliable indicators and information for the risk assessment* (by insurers) *and furthermore could raise issues regarding their compatibility with the objectives of the Internal Market."*

[2] Call for tender launched in 07-2011, now EU-28

1.1.2 Methodology

Methodology was adapted to carry out activities necessary to meet these objectives (Table 3).

Table 3 : activities and methodology of WP1

Activities	Methodology applied
Collection of information on quality signs on construction products, construction systems, competences and works	• Literature • Definition of reference terms • Team discussions • Presentation of directory structure to quality signs providers and subsequent amendments
Critical analysis on the relevance of the information provided by quality signs	• Desk study • Exchange with quality signs providers • Exchange with quality signs users, including insurers
Appraisal of modalities to follow to access to quality signs	• Desk study • Exchange with quality signs users, including insurers
Assessment of the impact of the quality signs on the competitiveness of construction businesses	• Desk study • Preparation of an electronic survey targeting construction clients, architects/technical designers, providers and insurers
Assessment of the use of quality signs by the insurance sector	• Analysis of directory records • Analysis of responses to the electronic survey • Phone interviews
Specification of characteristics of an internet platform for diffusion of the directory	• Translation of the directory structure specifications into IT specifications • Validation of IT options with the IT department of the EC
Development of a EU directory on quality signs accessible on Internet	• IT development by ALTEN (subcontractor) • Tests by partners and quality signs providers • Promotion of the directory through meetings and web pages • Personal contact with 120 QS providers

The work carried out to address the above listed tasks is reported in four chapters of this report:

- State of the art
- Design of the structure of the directory
- Development of a web-based directory
- Contextual framework of QS

Work progress was presented every six months during Elios2 forums. Feedback from forum members on progress reports and comments received from the Commission on draft deliverable reports were taken into account during the course of the project.

1.2 State of the art

The directory aims to collect and provide access to information on "*quality/conformity marks (labels, certificates, technical assessment, etc.) for construction products, processes, works, technical equipment and professional qualifications".* During the first months of the project, exchanges with construction actors and insurers took place to define the terms contained in this quotation of the call for tender.

1.2.1 Product, system, competence, building work

Basic requirements for construction works, as defined in the Annex I of the CPR (EU 2011), reflect performances of construction works expected by clients and users/occupants. Depending on the location of a construction operation in any of EU-28 countries, there is a multitude of design and technical solutions to meet clients/users expectations for any type of construction (e.g. housing, school, hospital, shop, factory). Generally, there is no one best solution, but available budgets of course restrict choices.

Local factors do influence the use of local predominant solutions (e.g. wood, metal, concrete or brick/concrete blocks masonry structures, type of windows and shutters). This variety reflects local climate, culture, architecture, tradition, know-how, access to resources.

Though construction is undoubtedly a traditional production sector, it is at the same time very innovative. Drivers for innovation may for instance be demands of clients for specific performances or regulations that convert requirements of the society to new construction challenges (e.g. low energy consumption buildings, high acoustic performances, ground vibration isolation).

In order to answer the demand of the call for tender to address information issues concerning "*quality/conformity marks (labels, certificates, technical assessment, etc.) for construction products, processes, works, technical equipment and professional qualifications*", the proposal to select **four subjects** that echo the items of this list was accepted during the course of the project:

1. construction **products**,
2. construction **systems**
3. individual/company **competences**
4. building **works** performances.

Processes are not addressed as such. Construction process is implicit in the subject "building works performances" as performances are the outcome of this process. Manufacturing process is also implicit in the subject "construction products" and "construction systems" as corresponding products and systems are the outcome of production processes. Products (e.g. bricks) and technical equipment (e.g. boiler) have been merged in the same subject as they both result from manufacturing processes.

The definition of each of these subjects is supported by Figure 1 that presents a view of the construction process. This presentation acknowledges the importance of traditional and innovative technical solutions used to erect buildings in each specific local context.

During the main phases of any construction project (i.e. programme, project, erection), decisions are taken by a temporary construction team to build a building that meets expected performances.

Whilst these three phases last a few years, the building life lasts decades after hand over by client/users/occupants. Both for new buildings and for refurbishment projects, technical solutions may be fully traditional or be a mix of tradition and innovation.

Traditional technical solutions benefit from experience of previous projects over long periods. Concerned construction products have been locally known for long; their characteristics are stable enough to be standardised. Associated design and implementation rules are precise enough to be codified. Products and associated rules form a coherent and stable reference for construction actors. Such a stable context is likely to limit construction defects as long as construction actors have adequate competences. The stability of this context does not hamper evolutions, e.g. codified rules may be revised in order to incorporate observed modifications of practices or evolutions of products. As most of building pathologies are located at interfaces (e.g. junction between walls and window frames) design/implementation rules and product design pay a specific attention to these interfaces.

Innovative technical solutions do not benefit from such experience. They are by definition new for construction actors so that traditional references concerning products and design/implementation rules have to be reconsidered together. This is necessary in order to ensure expected performances are met when innovative solutions are incorporated in building works. Design/implementation rules have to be defined by experts in relation with interested parties, e.g. architects and technical designers, manufacturers of concerned constructions products, contractors. Specific competences may happen to be necessary to adequately incorporate innovative technical solutions in building works according to local contexts. Interfaces between innovative and traditional building parts are of the utmost importance in order to limit building defects. Strong evolutions of traditional technical solutions can be assimilated to innovative technical solutions (e.g. evolution from traditional masonry to adhesive mortar masonry introduced new design rules, new tools (trowel replaced by a roll), new performances of walls).

After some years, products characteristics, design and implementation rules of innovative solution become stable. Many innovative solutions are mature enough to become “traditional”. The distinction between “traditional” and “innovative” solutions is essential for the core issue of Elios2, i.e. the access to insurance in the construction sector.

The four subjects considered by Elios2 according to the call for tender can now receive a definition (Figure 1):

- **Construction products** (e.g. bricks, roof tiles, cement, tubes) defined as *“any product or kit which is produced and placed on the market for incorporation in a permanent manner in construction works or parts thereof and the performance of which has an effect on the performance of the construction works with respect to the basic requirements for construction works”* (article 2 of the CPR)

- **Construction systems** (e.g. external thermal insulation systems, ground heat pump systems, building integrated photovoltaic systems) defined as a set of products, accessories and specific design, implementation and maintenance rules to fulfil and maintain functions awaited from buildings or building parts. Interfaces of systems with other building systems/parts are a key issue as they have to ensure the continuity of crucial functions (e.g. water tightness, acoustic isolation, thermal insulation).

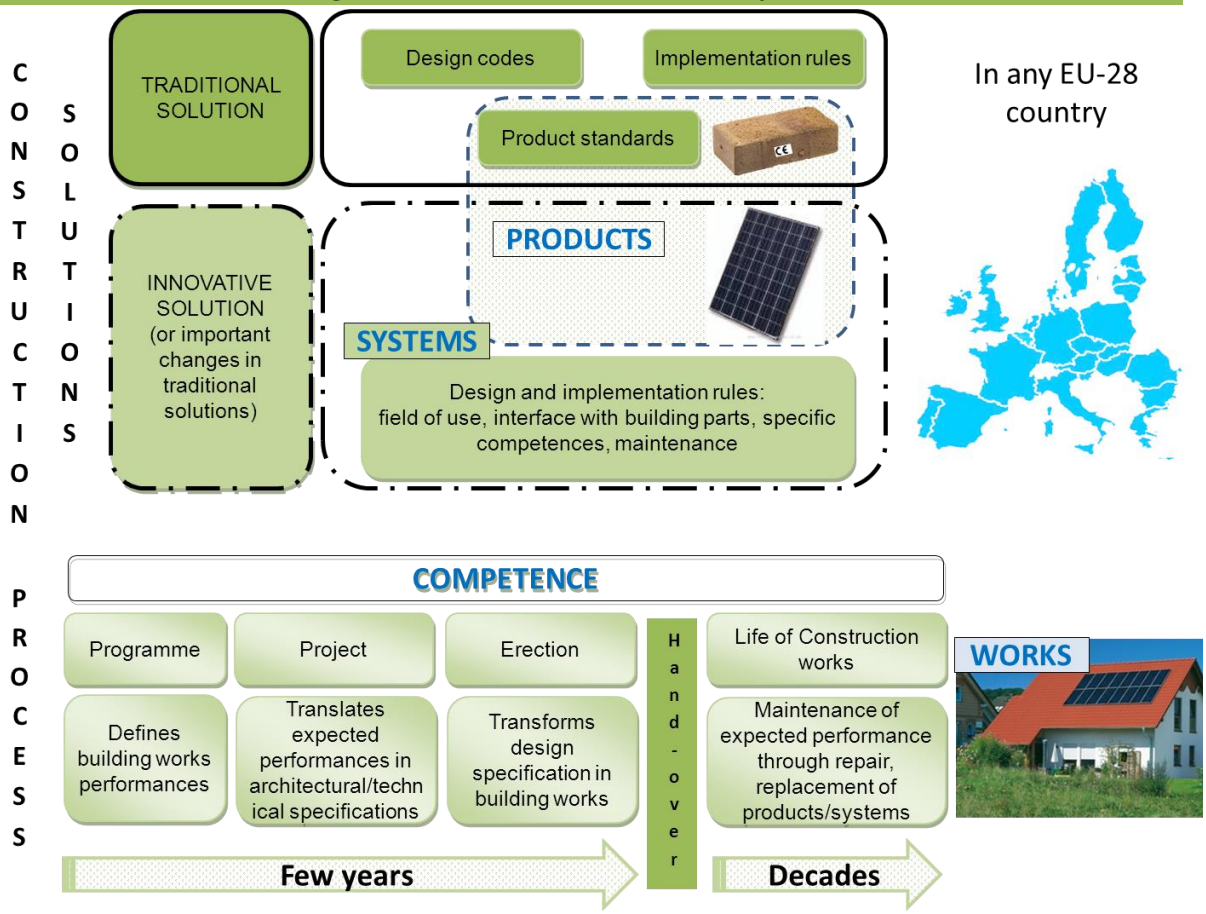
- **Competence (of individual or company)**: necessary skill of construction actors through the different phases of a project, according to the technical complexity of projects.

- **Performances of works** (i.e. building works) to be met and sustained when buildings are operated, according to the expectations of the client.

Of course, these four subjects do not cover all relevant subjects to be addressed during any construction project. Information needed for any project goes far beyond in terms of subjects (e.g. safety and health instructions, finance). Depending on their role in a project, one of the challenges for involved construction actors is to access up-to-date information. This information may be printed, electronic or oral. "**Quality Signs**" (referred to as **QS** in this report) carry such information.

Building works are the outcome of the process presented on Figure 1. **What matters first for clients/insurers are the performances of the delivered building works.** They result from the integration of products and systems by means of (design/implementation) competences of actors. Records of building defects by insurers and clients (see chapter II) show that competences of actors are of the utmost importance to get expected performances of works. This fact is reflected in the outcome of investigations concerning the use of QS by insurers (see chapter 1.5.3).

Figure 1 : a view on the construction process



1.2.2 Information: a core issue

On a daily basis, everyone needs and uses information to choose goods, select commercial offers or assess the adequacy of products or services for a specific purpose. This generic concern goes far beyond the Elios2 specific focus on four subjects in the construction sector.

This information may be objective or subjective, oral or written. In this latter case, information is carried by published (hard copy or electronic) documents. The publisher of these documents is clearly identified. Documents may or may not be associated with logos.

The importance of oral transmission of information in the construction activity must be emphasised (e.g. formal/informal meetings, telephone) (Geren 2012). Oral reports on good experiences or counter performances participate in the flow of information used during a construction project. This aspect is nevertheless out of the scope of Elios2 that focuses on published information.

Generally speaking, this information is meant to bring elements concerning some elements to user's attention. It may concern the reputation (of a distributor, of a product, of a contractor/architect, etc). It may confirm the robustness of a product or a tool in certain circumstances.

It may also warn the user about the field of use of this product or tool. This list is far from being exhaustive but long enough to illustrate the variety of situations where information is crucial to make adequate choices in situations that are always constrained (e.g. by budget, by time availability).

What the society and the construction markets in particular are looking for is **confidence**. Creating and maintaining confidence between many stakeholders involved in a construction operation is a crucial challenge.

In their seminal article, D.M Gann and A.J Salter (Gann and Salter 2000) view construction *"as a process rather than an industry. (…) It includes designing, maintaining and adapting the built environment, involving many organisations from a range of industrial sectors, temporarily working together on project-specific tasks."* In this project-based activity one of the key issues is the management of activities with complex interfaces. Most problems in construction originate at the interfaces of different functions (Figure 2).

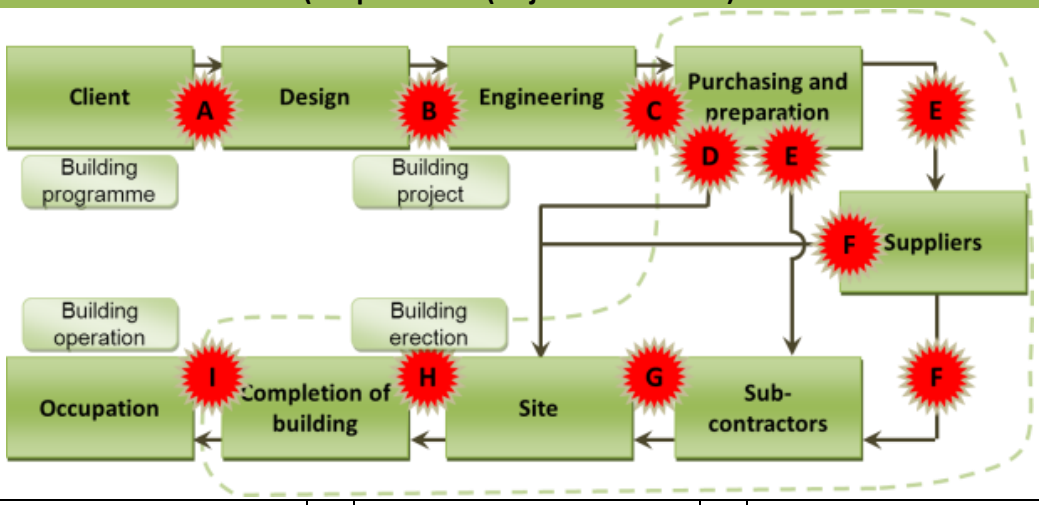
Indeed, many actors of the supply chain never worked together before being involved in a particular construction operation and most of them are unlikely to work again together for other construction projects. This context objectively creates conditions for many kinds of disruptions in the exchange of information. Therefore, all actors involved in a project need access to reliable information in order to hire the right competences, select the most suitable products/systems or understand the conditions that are necessary to properly install/incorporate and use/maintain these products/systems, especially if these are innovative.

Once a building is completed and transferred to the client/occupant, reliable information on expected performances and conditions to keep them constant over time (e.g. external/internal noise protection level, safety, energy consumptions) is also essential. Some of the actors know what others should not ignore.

These situations illustrate the problems of markets with asymmetric information which was put forward by Akerlof (1970). Since one party has relevant information whereas the other(s) do not, it favours opportunistic behaviours and impede the functioning of markets by leading to adverse selection.

Depending on the context of each construction project, the client hires a project manager (e.g. architect, engineering office). Asymmetric information occurs between these two actors who are not equally knowledgeable. But it also concerns contractors, sub-contractors, designers, consultants, and so forth (Ceric, 2013). The relationship becomes increasingly complex as the number of project parties grows. Moreover, asymmetric information evolves during the project. In project management, the client does not have all the information about the contractor before the contractor is hired. This causes adverse selection problems. The client cannot be sure that contractors, once hired, will respect his interest. For example, contractors can use inferior materials and reduce design standards (Xiang and al., 2015). This leads to moral hazard risks.

Figure 2 : Location of some information issues along the construction process (adapted from (Vrijhoef et al. 2001)



A	- Difficulties finding out client's wishes - Changes of clients wishes - Long procedures to discuss changes	D	- Inaccurate data - Information needs are not met - Unrealistic planning	G	- Subcontracted work not delivered according to main design, contract and planning
B	- Incorrect documents - Design changes - Extended wait for architect's approval of design changes	E	- Inaccurate data - Information needs are not met - Adversarial bargaining - Order changes	H	- Problematic completion due to quality problems
C	- Inaccurate data - Engineering drawings not fit for use	F	- Deliveries not according to planning - Wrong and defective deliveries - Long storage period - Awkward packing	I	- Unresolved quality problems - Delayed occupation due to late completion

To minimize risks that arise from adverse selection and moral hazard screening and monitoring are two options (Schieg, 2008).

The "*screening theory*" refers to the strategy used by the uninformed party to extract private information from another (Stiglitz 2001). The aim for the principal is to learn more about the agent's qualifications For example license (meant as a permission to practice) can be considered as a screening process to identify the applicants who have attained the required degree of competency. As a consequence, it is a way to regulate a profession.

The purpose of monitoring is to ascertain that parties are behaving in accordance with the contract. It helps reduce moral hazard and hold-up risks.

Signals appear to be another possible solution to the aforementioned problems. Spence argued that the person holding the information can signal to the other party the "quality" of the good/service he/she is selling. "*It should be noted that the information carried by the signal can be productive itself. This will occur if there is a decision that is made better or with greater efficiency, with better information"* (Spence 2001).

Minimum quality standards which *"provide signals that a given product conforms to the content and level of certain defined characteristics*" (David et Greenstein, 1990, p.4) reduce transaction costs and search costs (the buyer does need to spend time to evaluate the quality of the product). They provide adequate information and help actors to evaluate the risk that they bear. They contribute to the reduction of asymmetries of information between suppliers and between suppliers and customers. Swann (2000) considers that "*the existence and use of standards makes it easier to produce, sell and buy products and services. Standards enable a market. They are part of the infrastructure for innovation-led growth*". To be sure that the actors conform with standards, certification procedures became more widespread.

However, standards and certification procedures are ineffective without an enforcement mechanism (Hatanaka et al., 2005). This is why third-party certification is the backbone of a quality process aiming at enforcing public and private standards. The certification body is usually independent.

"*Third-party certifiers also appeal to technoscientific values such as independence, objectivity, and transparency in an attempt to increase trust and legitimacy among their customers and to limit liability*" (Hatanaka et al., p.355, 2005).

Third party certifiers play the role of an independent authority that guaranties companies are following certain standards.

Thus it appears that procedures aiming to produce such signals are examples of means to reduce information asymmetry. They help identifying the actors of the construction supply chain who have better experiences and records, and the quality of products / systems / competences / works.

The example of the market for Renewable Energy Systems (RES) illustrates how the reduction of information asymmetries (concerning operators of the construction value chain and products, qualification schemes) can improve the quality of installations and reinforce the confidence of the consumers/users (QualiCert 2011). According to the Qualicert Manual, the impact of qualification is expected to be twofold:

- *"To enable the development of installation standards and best practices, while increasing the craftsmanship of professionals, and improving the general quality of RES installations;*
- *To increase consumer confidence in RES products and give them easy access to a network of qualified installers"* (p.9).

1.2.3 QS in construction

As it is the case on any market, actors of the construction value chain also need to send signals to the market in order to circumvent the asymmetry information problem they have to face: **Certificates**, **labels**, **qualification**, **technical approvals**, etc, are examples of such signals.

For example suppliers may indicate to the market that their products, equipment, materials are conform to the requirements of the clients. Similarly contractors may demonstrate a certain level of knowledge, competence and skills within the relevant field of practice.

For these operators of the construction value chain it is also a way to differentiate themselves from their competitors. Such signals carry information concerning a specific subject (products, systems, competences or works). This information is said to reflect properties of the subject which are of interest for the client/user (e.g. qualification, performance levels, field of use, design rules, etc).

Early in the project, the ELIOS 2 team proposed to use the expression "**Quality Sign**" (referred to as **QS** in this report) to name *"quality/conformity marks"* as worded in the call for tender. The following definition was proposed:

> QS designates "any kind of sign on the basis of which (construction) stakeholders rely on or give credit to when decisions or choices have to be made."

This definition highlights different aspects of QS:

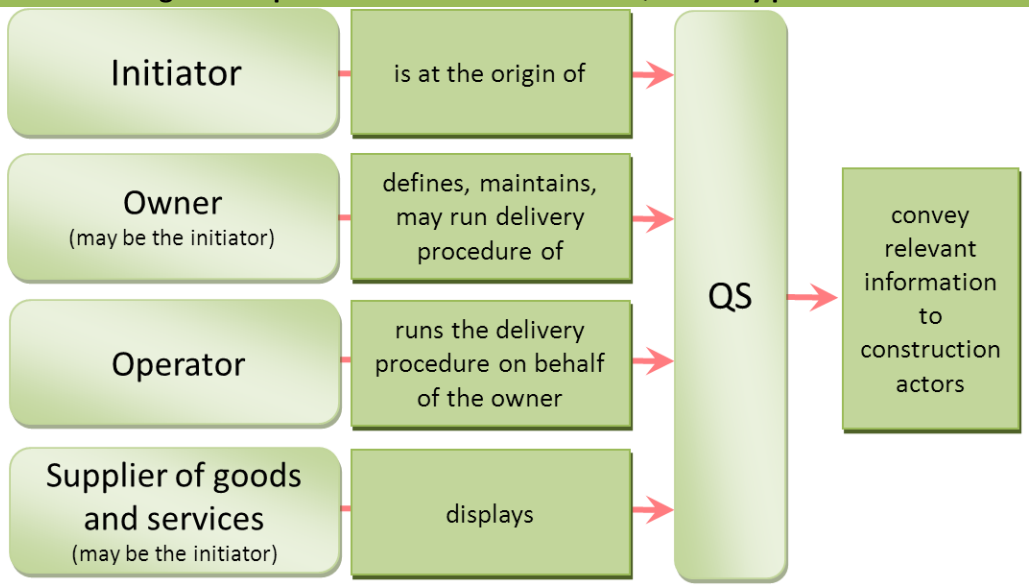
- QS aim to create trust/confidence between the transmitter and the receiver of the information;
- QS is one element among many others to make a decision;
- The existence of QS is not information in itself. It is essential for the receiver/user to access full description of the content, the scope, the delivery process and the limits of the information carried by a QS;
- The usefulness of QS may be different between construction actors: they do not all look for the same kind of information concerning a subject they are interested in;
- The comparison between QS concerning a same subject requires a thorough analysis of the content, the scope, the delivery process and the limits of the information.

Construction is a complex compromise between several influential parameters: e.g. budget, context (regulations, environment …), culture, products, competences, know-how, resources availability. QS are then generally designed to bring information to construction actors according to specific local contexts.

For instance, information needed to adequately install PV panels over an (existing or new) roof are different from information needed to integrate PV panels in the envelope of the building. In this latter case, PV system (embedding PV panels) has to be designed to ensure basic functions of the envelope (e.g. rain proofing).

The potential interest of a directory on QS in construction is to easily share information and compare QS concerning a given subject. Such a comparison may be useful when addressing mutual recognition of different QS on similar subjects. Figure 3 proposes a representation of main actors concerned by QS issues: from initiator to final user.

Figure 3 : upstream and downstream of QS delivery procedure



As it is the case for any information, accessing to relevant QS costs time and money. Information has to be collected, processed, disseminated, up-dated. The best interest of construction professionals is to strike a balance between relevance and cost to access QS.

This balance takes answers to the following questions into account:

- why and by whom are QS needed/used?
- who initiates QS?
- what is the exact scope of QS?
- who provides information carried by QS?
- how is the information carried by QS elaborated, up-dated, traced and accessible?

1.2.4 Types of QS

QS associated to the four subjects (construction products, construction systems, individual/company competences, performances of works) address two types of delivery schemes:

- **certification scheme:** that brings factual and reliable information on subjects for which reference specifications are available and against which characteristics of the subjects can be checked,

- **technical approval scheme** : that answers the need to bring construction actors relevant and reliable information, usually on innovative, customised or complex technical systems,

The former may concern any subject (as soon as relevant reference specifications are available) the latter mainly concerns construction systems (as defined in chapter 1.2.1).

There is no overlap between these two concepts. They may even be complementary: some characteristics of construction products being part of a construction systems or competences being essential for the installation of such systems may be certified.

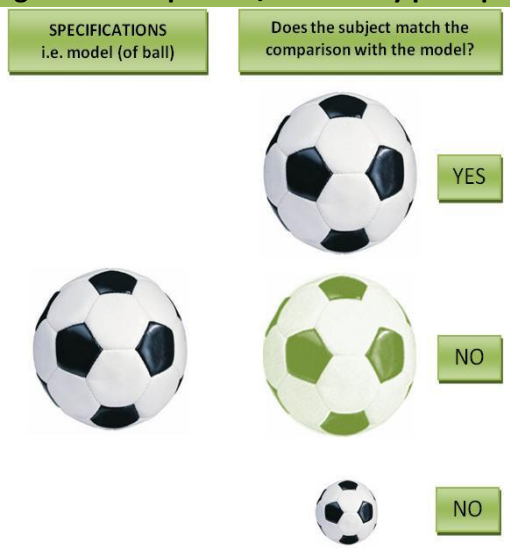
Certification and technical approval aim to provide information construction actors (client, designers, contractors, facility managers) are looking for to select, design, install and maintain elements that are needed for a project. **These QS do not explicitly aim to provide information for insurers to assess their risks but part of the information may nevertheless be relevant for such assessment**. This latter point is very important for the Elios2 study and is further discussed in this report.

1.2.4.1 Certification

According to ISO 17000 standards (ISO2008), certification is defined as a *"(third-party) attestation related to products, processes, systems or persons*". Attestation being an "*issue of a statement, based on a decision following review, that fulfilment of specified requirements has been demonstrated*".

A general principle to elaborate and deliver QS following a certification procedure is to compare some subject's characteristics to specifications. The existence of such specifications is a prerequisite for certification. This general principle is illustrated in Figure 4.

Figure 4 : Comparison/conformity principle



Specifications can refer to inherent characteristics or to other characteristics:

- Inherent characteristics of products are generally defined in standards or codes of practice (e.g. tensile resistance of steel). Inherent characteristics of required professional competences can be defined in a training frame of reference.
- Other characteristics of products that are important according to the local context of the construction project (e.g. impact of weather local conditions on aging of characteristics when not defined in standards, local experience and safety strategy on the assessment of fire behaviour)

When defining specifications related to a particular subject, the owner of the certification scheme (or QS provider) selects characteristics of the subjects and defines procedures (possibly associated to quality management procedures) to collect, process and up-date information. Of course, these specifications depend on the subject as illustrated by the following examples:

- The features of a construction product are compared to inherent characteristics defined in standards or to other characteristics defined in other documents;
- The characteristics of a construction system (filed of use, design, implementation, exploitation, maintenance) are compared to demands that reflect legal or client-specific requirements which may concern safety, energy or other matters;
- The knowledge/competences/capacity of a person or company are compared to specifications reflecting knowledge/competences/capacity required to practice a specific activity;
- The as-built characteristics of a building are compared to specifications that reflect regulatory aspects or expectation of clients which may concern safety, energy performance energy or other matters.

It is important to understand that certification concerns two linked aspects:

1. Information specific to the subject (e.g. the way a product is manufactured from raw material to packaging, the way persons are trained for a particular activity (prerequisite, content of the course, examination),
2. Quality management procedures that are (almost) independent of the subject concerned due to their generic aspect. (Refer to ISO 9000:2005 (ISO 2009)). The existence of such quality management procedures is important for the reliability of information carried by QS.

1.2.4.2 Technical approval

Construction projects do require products and competences for which QS resulting from a certification procedure are of the utmost importance for the market.

Nevertheless, when prerequisites for certification are not met, i.e. when there are no available specifications against which conformity can be assessed, the delivery of a QS has to follow other procedures. Situations for which a certification scheme cannot be used are not anecdotal.

The construction sector constantly incorporates innovative systems (strongly modified traditional construction systems are sometimes considered as innovations) for which published specifications cannot exist due to the novelty of the subject. This is for instance the case for eco-technologies.

The absence of published specifications does not prevent the delivery of QS. There exist a lot of such procedures which are recognised by the market as QS provide relevant and reliable information on technical innovative subjects. Though QS do not directly target insurers to assess their risks, pieces of information carried by QS may be relevant for insurers.

A non-exhaustive list of such technical approval procedures includes:

- ATG in Belgium, (www.ubatc.be)
- Avis Technique, Appréciation Technique d'expérimentation, Pass-innovation (http://evaluation.cstb.fr) or rapport de contrôle technique, in France,
- Agrément certificate in UK (www.bbacerts.co.uk)
- Documento de Idoneidad Técnica (DIT) in Spain (www.ietcc.csic.es)
- TUVdotCOM in Germany (www.tuv.com)
- Evaluation reports issued by the International Code Council Evaluation service (US) (www.icc-es.org)
- Evaluation certificates in Japan. (www.bcj.or.jp/en/)

Such procedures leading to the elaboration of QS when a certification procedure cannot be directly implemented are named "**technical approval**" (referred as **TA** in the rest of the report).

The European Union of Agrément (UEAtc) defines TA: *"The Approval, regardless of the members that issue it, is the result of a favourable technical assessment of the fitness for purpose of materials, products, equipment or processes, such assessment being made taking into consideration safety, health, the use and sustainability of the works and any other matter related to works in which they are to be used. The Approval states the scope of application, conditions and possibly limitations."*

Some of the above mentioned technical approval schemes are linked to certification schemes. A subject concerned by a TA procedure (e.g. a construction system) can include products or competences for which the certification of some characteristics (e.g. characteristics of products, competences of persons or company) is needed. This association of TA and certification is decided by the owner of the scheme on a case-to-case basis in relation with local markets.

It is important to note and understand that TA generally includes guidance on design, execution, maintenance and repair. This is necessary because TA covers, almost by definition, subjects that are not standardised, thus for which no design rules, no codes of practice (e.g. DTU, NIT, …) do exist.

Due to their importance on the internal construction market, QS resulting from TA procedures associated or not to certification procedures have to be referenced in the Elios2 directory.

When innovative solutions become more mature, characteristics of concerned products and design/implementation/maintenance rules become more robust and stable. When experience is gained through several construction operations, many systems covered by a TA shift from innovative technical solutions to traditional technical solutions. Products characteristics can become standardised, rules can be codified. In this perspective, TA can be considered as a first step for an innovative solution towards more traditional and widespread solutions adapted to local conditions.

1.2.5 CE marking of construction products

As a matter of fact, the previously described QS are used in the construction activities. When observing this phenomenon within the European single market, it is of course necessary to refer to the CE Marking and to define the respective roles of CE Marking and the different national QS, since the Construction Product Regulation of the 9 March 2011 (EU, 2011) "*lays down conditions for the placing or making available on the market of construction products by establishing harmonised rules on how to express the performance of construction products in relation to their essential characteristics*".

Thus, this regulation aims at ensuring reliable information on **construction products** in relation to their performances and this is to be achieved by providing a *"common technical language*", based on uniform assessment methods of the performances of construction products.

Furthermore "*for any construction product covered by a harmonised standard, or for which a European Technical Assessment has been issued, the CE marking shall be the only marking which attests conformity of the construction product with the declared performance in relation to the essential characteristics, covered by that harmonised standard or by the European Technical Assessment. In this respect, Member States shall not introduce any references or shall withdraw any references in national measures to a marking attesting conformity with the declared performance in relation to the essential characteristics covered by a harmonised standard other than the CE marking.*
A Member State shall not prohibit or impede, within its territory or under its responsibility, the making available on the market or the use of construction products bearing the CE marking, when the declared performances correspond to the requirements for such use in that Member State.

A Member State shall ensure that the use of construction products bearing the CE marking shall not be impeded by rules or conditions imposed by public bodies or private bodies acting as a public undertaking, or acting as a public body on the basis of a monopoly position or under a public mandate, when the declared performances correspond to the requirements for such use in that Member State".

Recital 33 and article 9.3 of the CPR introduce possibilities, in accurate circumstances, for additional information to be delivered to construction actors for CE-marked construction products:

- Recital 33: *The CE marking should be the only marking of conformity of the construction product with the declared performance and compliance with applicable requirements relating to Union harmonisation legislation. However, other markings may be used, provided that they help to improve the protection of users of construction products and are not covered by existing Union harmonisation legislation.*
- Article 9.3: *The CE marking shall be affixed before the construction product is placed on the market. It may be followed by a pictogram or any other mark notably indicating a special risk or use.*

This raises the question of compatibility and complementarity between CE Marking and the other QS used in this sector of activities, according namely to the ECJ rulings (EC, 2014, see also the FAQ ref). This issue will be further developed in the conclusive chapter (1.6.1) of this section.

1.3 Design of the directory structure

This chapter presents the main steps of the design of the directory structure. A full deliverable was written that provides more details (Appendix 1.1)

1.3.1 Specifications

The directory aims to reflect the variety of situations concerning the ownership, the scope, the delivery procedure of QS for the four selected subjects (products, systems, competences and works (performances)). It also aims to highlight the use of QS by construction actors including insurers.

The structure of the directory was designed taking two opposite constraints into account:

- provide detailed information for the web-user to fully describe QS and allow comparison between QS concerning similar subjects. This may mean a lot of information to collect.
- limit time and efforts for people entering description data concerning QS.

It was then proposed to develop a structure where users could access the following information for each QS:

- identification of the QS (name, logo, type of subject, ...)
- characteristics of the subject that are covered,
- who is "behind" the QS?(e.g. the legislator, a private or private/public stakeholder, related to or independent from the supplier)
- who elaborates and maintains the QS specifications (e.g. certification rules) and the delivery procedure ?

- if relevant, how, where and by whom subject samples are selected ?
- if relevant, how is conformity to specifications checked (audit, inspections, tests in internal or external labs, …) ?
- how frequently the conformity to specifications is checked after QS delivery: never, every x months, ... ?
- what is the validity period of the QS?
- by whom and for what purpose are QS used?
- Indication on the number of valid QS

In order to avoid inaccurate information record, it was stated that QS description would be made by a duly mandated representative of the (certification/TA) scheme owner. Some trials quickly showed that the record of such information by somebody (e.g. an Elios2 partner) who is not involved on a daily basis in the delivery procedure of particular QS could not efficiently address all the points of the above list.

In addition to language barrier, relevant information may not be available on line. Inaccurate, if not wrong, information was likely to result from such a filling-in procedure. This principle nevertheless had to be reconsidered (chapter 1.4.2)

1.3.2 Overview of the structure of the directory

Though they are different by nature, certification and TA schemes can nevertheless be described using similar information packages. Figure 5 illustrates this situation: identification, scope and 'other key information' sections contain comparable types of information for certification and TA.

The section 'Identification' is a record of the name of the scheme, of the concerned type of subject (construction product, construction systems, individual/company competence, works), of the owner and country of the scheme, of the operators in charge of the QS delivery procedure (if the owner delegates to one or more such operators).

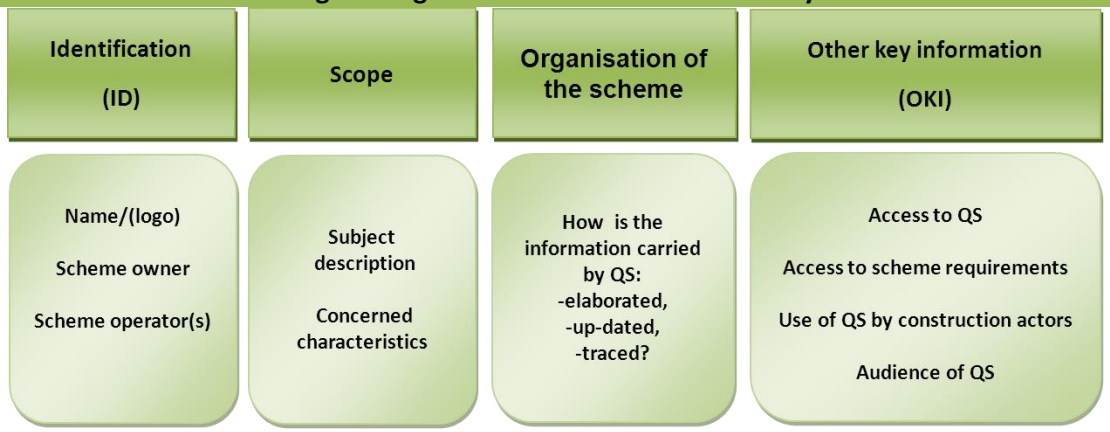
The section 'Scope' contains information on the concerned subject (i.e. type of product, system, competence, work performance) and on the concerned characteristics (e.g. of products, skills) (more details in appendix 1.1).

The section 'Organisation of the scheme' describes which information contained in the concerned QS (certification or TA) is collected, how, by whom, where and how often (more details in appendix 1.1).

The section 'Other key information' (OKI) contains the following information:

- access to reference documents (e.g. specifications) (via internet, on demand),
- access to the outcome of the certification/evaluation procedure (certificates, evaluation document),
- possible use of QS by insurers (if relevant, detailed information can be recorded),
- possible use of QS by construction actors (if relevant, detailed information can be recorded),
- indication of the number of QS (e.g. valid to date, recorded/withdrawn in 2012/2013).

Figure 5 : generic structure of the directory



1.4 Development of a web-based directory

This chapter presents the main steps of the development of the web directory of QS. It also addresses how the directory was populated. A full deliverable was written that gives more technical details on IT specifications (Appendix 1.2)

1.4.1 IT specifications and tool implementation

The aim of these specifications is to "translate" the designed structure of the directory in a language that can be interpreted by IT developers.

Technical demands of the IT-department of the EC were taken into account in order the web directory to be compatible with the IT environment of the Commission. IT options selected by the ELIOS 2 team were accepted by the Commission (appendix B of appendix 1.2).

Four users' profiles were defined. Table 4 summarises the rights for each category. For each signs owner/provider willing to record description of their QS, one "manager" is nominated. This manager may nominate "contributors" belonging to his own organism or to another organism acting as an operator according to the rules of the QS scheme.

Table 4: rights of users categories

Rights / Type of user	Online consultation / printout of QS description	QS description record / modification	QS description publish / unpublish	Management of invitations, registrations
Web site user	✓			
Manager (one per scheme owner)	✓	✓	✓	
Contributor (several, nominated by the manager)	✓	✓	✓	
Administrator	✓	✓ (tests)	✓	✓

No technical difficulties were met to implement the web-based directory according to the IT specifications. Managers and contributors benefit from on line tutorials and pop-up explanation windows for the registration process and at each step of the record process.

Four web pages have to be filled-in that correspond to the four sections of the directory structure (ID, scope, delivery process, OKI). Once recorded, information can be updated. A QS file is published by the manager who can also "unpublish" it.

The tool can be accessed from http://signsdirectory.elios-ec.eu/. A link to the directory was created on the ELIOS 2 web page http://www.elios-ec.eu/en/introduction.

Figure 6 is a printout of one QS record of the directory concerning qualification of installers of solar PV panels.

1.4.2 Populating the directory

According to design specifications, the record of the description of QS in the directory is made on a voluntary basis by representatives of sign owners (i.e. manager or contributors as defined in the hierarchy of users' profiles).

The interest of this option is to avoid inaccurate records and to consequently avoid claims from signs owners/providers against potentially incorrect or wrong information. A counterpart of this option is that huge efforts have to be made to convince contact persons at the scheme-owner organisation to accept an invitation and have them filling-in online forms.

Experience showed that the registration and record process are easy to manage. Nevertheless, time spent by managers or contributors to register and record QS descriptions is not balanced by any commercial perspective.

Though the invitation to populate the directory referred to the support of the General Directory Enterprise and Innovation, the notoriety of Elios2 was not yet strong enough to attract a great number of contributors. Some sign providers just didn't wish to answer.

In order to promote the directory, a number of actions were carried out by the Elios2 team to raise interest of potential voluntary collaboration and increase the number of recorded QS:

- Direct assistance to filling-in description template at the beginning of the launch phase. This action demonstrated the registration procedure was easy and the time to record one QS was limited (between 10 and 15 minutes). This was confirmed by further spontaneous registrations and records.

- Promotion through presentation or emailing concerning the Elios2 project and directory to European organisations concerned with QS on construction products and systems (
- Table **5**).

Table 5 : actions of promotion by European and local networks

Date	Network	Media
26/06/2012	Reinsurer	6e Matinée Décennale SCOR (SCOR 2012)
24-25/10/2013	UEAtc	Announcement during UEAtc meeting
28/11/2013	Local authorities	Assises départementales de l'eco-renovation (EPA 2014)
11/02/2014	EOTA	Email to members of the EOTA
31/03/2014	AFOCERT	Email to members of the association
02/04/2014	French NB-CPR	Email to members of the French GNB-CPR
31/03/2014	GNB-CPR	Information NB-CPR/ALL/14/118 about the Elios2 PROJECT
03/04/2014	GNB-CPR	Email to members of the GNB
10/04/2014	GNB-CPR	Presentation/discussion during AG-GNB
12/11/2014	GNB-CPR	Reminder NB-CPR/ALL/14/133 sent to members

Most of the main QS providers are members of these networks (the GNB-CPR has about 550 members) and were then informed through different channels.

- Advertisement on professional web sites (Table 6).

Table 6 : actions of promotion on the web

Date	Network	Media
10/06/2014	ECTP	www.ectp.org
21/07/2014	CSTB web sites	www.cstb.fr / http://evaluation.cstb.fr/
24/07/2014	Construction 21	www.construction21.org

- Email/phone contacts with information bodies specialised in construction in order to get more contacts (AT, CY, DE, DK, EE, EL, FI, IE, LT, LU, LV, MT, SE, UK) (appendix 1.4).

Some answers confirmed no or very few QS providers who were likely to contribute (LV, MT, CY).

- Additional emailing to certification bodies not belonging to above mentioned networks Appendix 1.4 contains the record of initial contacts and reminders with 132 organisations in Europe covering all EU-28 countries and the four subjects.

These actions, together with reminders sent to contact persons using recommendations from the top level management of European organisations resulted in recorded QS covering the four subjects and seven EU-28 countries. Figure 7 is a screen shot of the directory as seen by web-users.

Figure 6 : printout of a QS concerning eco-technology (qualification of installers)

Print from the quality signs repository of ELIOS 2 (http://www.elios-ec.edu/)

IDENTIFICATION OF THE QUALITY SIGN			
Name	QualiPV		
Subject	Competence (Companies/persons)		
Country	France		
Scheme Owner	Qualit'EnR http://www.qualit-enr.org/		
Scheme operator(s)	-	-	

SCOPE OF THE QUALITY SIGN	
Concerned activity(s):	Concerned competence(s):
solar photovoltaic (installation of grid-connected generators)	Verification of professionnal activity Verification of adequate human and financial resources Verification of adequate material resources Verification of in-house technical expert Verification of experience in the activities Verification of required legal insurance for the activities Quality control on site 10 point quality label charter solar photovoltaic (building integration of grid-connected generators)

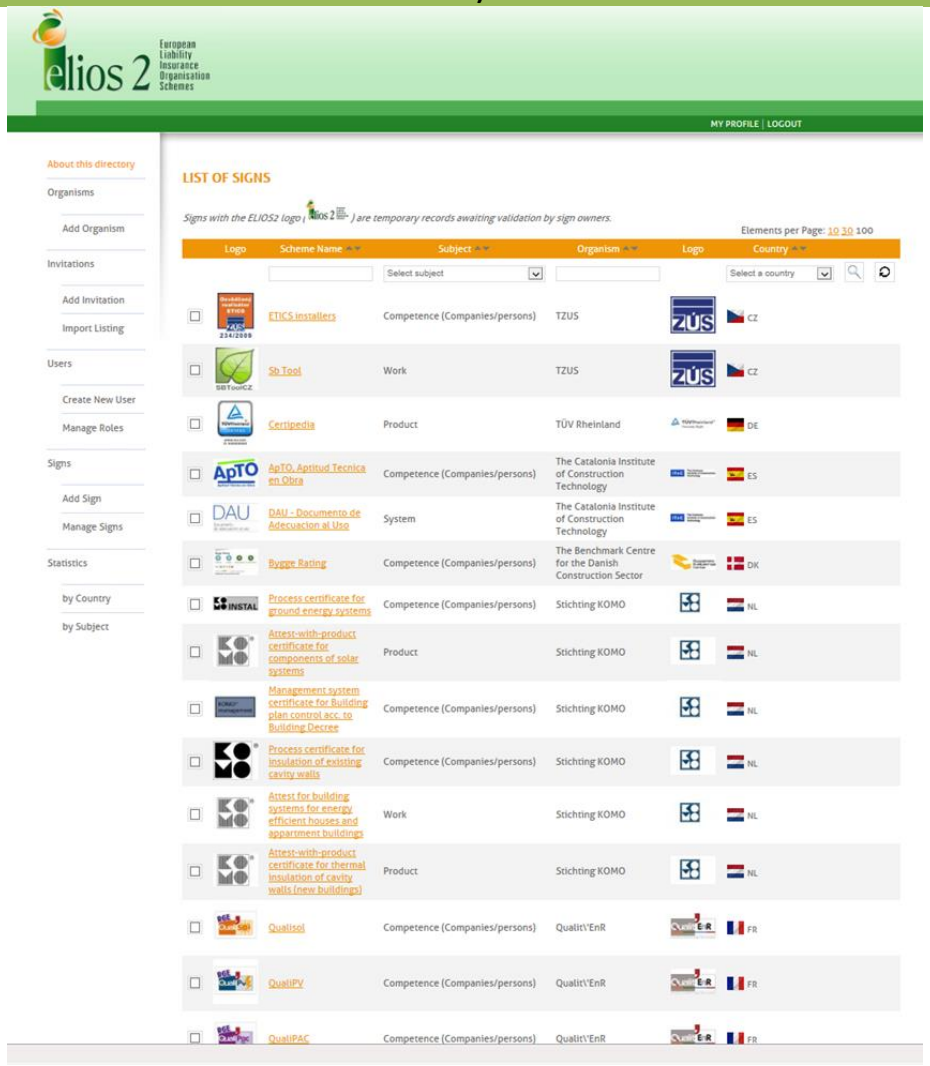
ORGANISATION OF THE QUALITY SIGN DELIVERY SCHEME			
Specifications for the quality sign scheme	- Defined by a college involving independent experts representing the concerned parties/stakeholders - Defined by a certification body		
Type of evaluation	Third Party	Validity Period	4 years
Initial procedure performed by	An independant examination/certification body		
Follow-up procedure?			
Is there a follow-up procedure?	Yes	Frequency	every year
Follow-up procedure performed by	The applicant under the responsability of the certification organism		
Accreditation	Accréditation Cofrac n° 4-0560 - www.cofrac.fr		
Links with associated quality signs	-		

OTHER KEY INFORMATION			
Scheme requirements availability	Publicly available (Internet)		
Availability of certificates	Publicly available (Internet)		
Use of Quality Signs by Insurers	Yes	Quality sign may be required for insurance and/or may give a discount on insurance fee	
Other Uses	Yes	Quality sign may be required for granting financial support from local entities.	
Number of valid quality signs to date 2014	1500		
Number of quality signs registered in 2013	1759	Number of quality signs withrdawn in 2013	-
Number of quality signs registered in 2012	2966	Number of quality signs withrdawn in 2012	-

This directory contains information provided by quality sign owners. However, quality signs with the "Elios 2 test" logo are filled in by the Elios 2 team. These temporary quality signs are awaiting validation by concerned sign owners.
In any case the Elios 2 team cannot guarantee the validity of the information found here nor be held responsible for the

October 12, 2014

Figure 7 : screenshot of the display page of QS (alphabetic order) (situation on 2014 December 23)



In order to increase the population of the directory, the Elios2 team had to adapt the rule that was initially adopted. According to this rule, published information was recorded by duly mandated representative of QS providers. A disclaimer at the foot of each QS print-out draws the attention on this rule (Figure 6).

The “ELIOS 2-test” QS provider was then created. Descriptions of corresponding QS are made by Elios2 partners using available information from the web-sites of QS providers. Information is copied from web sites and pasted in QS description forms. Some pieces of information cannot be found on web sites so that information is incomplete. A warning message is displayed on the front page of the directory (Figure 7) to highlight the temporary status of the “ELIOS 2-test” QS, that are clearly identified by the ELIOS 2 logo.

Concerned QS providers are informed such records are present in the directory and can be seen by web-users. They are invited to check information and to contact the Elios2 team to modify/complete/update recorded information.

1.5 QS: contextual framework

QS participate in creating confidence between suppliers and buyers of goods and services. Appendix 1.3 presents in detail reasons why QS are made available to construction actors (i.e. rationale of QS).

The relevance of QS that refers to the adequacy of the information content of QS is also presented in detail in the same appendix.

This allows defining assessment criteria of QS used in the present chapter that addresses how QS are used by construction actors with a specific focus on risk assessment by (re)insurers. The sources of information used for this analysis are the descriptions of QS provided by the directory concerning the four selected subjects that concern both goods (products, systems) and services (competences, performances of works). An electronic survey by constructions actors and phone interviews also provide additional information.

1.5.1 Flow of information and access to QS

According to its role in the construction process, each construction actor has specific needs for information at various stages of a project. Information carried by QS aims to fulfil some of these needs.

QS concerning a given subject is likely to contain relevant information corresponding to these various points of view.

The following actors will for instance look for different information about a construction system:

- designers: assessed characteristics of a system in order to define project specifications answering the demand of the client,
- contractors: installation instructions, e.g. how to interface a system with other building parts,
- facility managers: elements to organise maintenance plan,
- insurers: information concerning potential risks, expected performances and limits of a system.

Figure 8 is an attempt to represent part of the flow of information (arrows) for QS concerning the four categories of goods and services addressed by the ELIOS 2 project.

A client (e.g. a property developer) will for instance be keen to display QS concerning performances of buildings to potential investors/tenants. Manufacturers/suppliers will inform their direct and indirect clients of the characteristics of construction products and systems they produce/deliver.

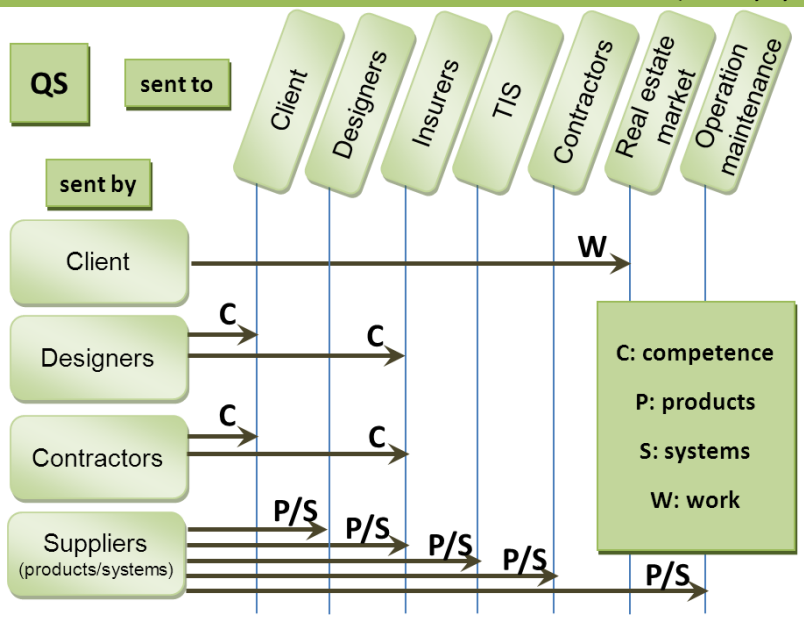
Many other situations could be illustrated (e.g. some contractors/suppliers can send QS concerning works to the market when they provide complete houses or office buildings) but we chose not to be exhaustive for the sake of clarity of the figure.

As far as risk assessment is concerned Technical Inspection Service (TIS) (e.g. building controller) is a key actor who uses QS concerning mainly construction systems and competences as well as products.

Its role and responsibility depends on national contexts (see chapter 3). Its mission can for instance include:

- Assessment of the compliance of the planned construction project vis-à-vis local regulatory aspects (e.g. structural, energy, acoustics) at the stage of the building permit,
- Assessment of risks from design documents,
- Control of the execution of works by contractors during the site phase
- Supervision the control of quality management plans of contractors
- Check of compliance to regulatory aspects before hand over.

Figure 8 : illustration of some main information channels for QS on P, S, C and W



To ensure his mission, TIS also uses a lot more information exchanged between participants to a construction project (e.g. plans, design notes, site reports). During his mission, TIS can play a key role vis-à-vis insurers.

TIS can indeed provide crucial information to the insurer to assess specific project-related potential risks before and during the site phase (e.g. pathologies, difficulties due to the availability of technical and human resources). This point is further developed in section 1.5.3 (QS and risk assessment).

QS recorded in the directory show that users can very often access via internet to QS scheme requirements and to the outcome of the delivery procedure (i.e. certificate or TA document). In some cases, it may nevertheless require some efforts to have a clear perception of the ins and outs. Direct contact with experts is advisable to better understand the context. Most web site invite web-user to contact QS provider.

Restricted access may be decided by scheme owners. This is for instance the case for QS concerning a particular site or when QS answer specific demands of one actor (Atex for instance).

1.5.2 Use of QS

The use of QS by construction actors was addressed through three actions:

1. Analysis of directory records,
2. Electronic survey,
3. Phone interviews.

1.5.2.1 Analysis of directory records

In the course of QS description record (OKI section), managers/contributors belonging to QS provider organisations are asked two questions:

"To your knowledge, is the QS you are describing used:
1. *by insurers,*
2. *by other stakeholders?"*

The answer may be "yes", "no" or "do not know". If the answer is yes, the manager/contributor who is recording information is asked to provide more details. Declarations of signs providers are sometimes supported by the indication of internet links (HQE tertiaire) or the availability of printed documents (e.g. QUALIBAT). Though the number of recorded signs (43 on 2014-12-23, including ELIOS2-TEST QS) is limited, answers of sign owners (as well as ELIOS2-TEST QS) give a first guess of the incidence of QS on insurance premium for IDI contracts and more generally for risk assessment (Table 7). QS on competence happen to be the most frequently cited influential QS.

Table 7: incidence of QS on insurance premium and risk assessment (as declared by QS providers) (update 23-12-2014)

	Y	N	DNK	possible impact on insurance premium (IDI)	use for risk assessment
product	4		5	2	4
system	2	1			2
competence	8	7	3	6	2
work	3	5	4	1	2

Table 8 displays answers to the second question. The range of actors potentially covers all the construction supply chain.

Table 8: use of QS by construction actors (as declared by QS providers) (update 23-12-2014)

	Y	N	DNK	mentioned actors
product	7		2	designers, clients, public authorities (subvention)
system	3			client, designers, contractors, TIS
competence	14	3	1	public/private clients, designers, contractors, public authorities (subvention)
work	6	3	3	clients, designers, public authorities (subvention), facility managers

1.5.2.2 Electronic survey

This chapter presents the main aspects of the electronic survey. More details can be found in appendix 1.3.

Objectives

The survey that the Elios2 team proposed to carry out aims to assess the relevance and impact of QS on the performance of the construction industry. The list of QS is not limited to certification or TA concerning the four subjects (products, systems, competences, and works). Other signals sent by suppliers to buyers are also included such as branding or reputation. The role of inspection both in factory and on site (i.e. TIS) is also addressed in this survey.

The objective was to question:

1. the reliability of QS such as reputation, first-party certification, second-party certification, third-party certification and on-site inspections (construction sites and factories).;
2. the influence of QS on items such as pathology, safety, energy performance of buildings;
3. the impact of the QS on the competitiveness of the industry;
4. the motivation for applying for a QS for products and systems;
5. the use of QS by the insurance sector.

Structure

The survey targets five categories of actors: 1) suppliers (e.g. manufacturers), 2) architects/technical designers, 3) contractors, 4) clients and 5) people working for the insurance sector.

The questionnaire was organised in four parts:

1. The first part presents the characteristics of the respondent.
2. The second part deals with the relevance of QS.
3. The third part is about the impact of QS.
4. Then additional questions are proposed to three categories of actors (suppliers, clients and people working for the insurance sector):
   - For suppliers, the aim is to identify the origin for applying for QS and the competitive advantage provided by QS.
   - For clients, the goal is to appreciate how they integrate QS in their selection procedures.
   - Finally, people working for insurance are questioned about the way they integrate QS in risks assessment for construction project.

Implementation

The electronic survey is based on the platform provided by the software company Survey Monkey (https://fr.surveymonkey.com/). Other options were considered (e.g. EU-survey tool (http://ec.europa.eu/eusurvey)) that provide similar functionalities. The key point of these tools is the availability of email lists.

A draft questionnaire was developed by CSTB, tested by Elios2 partners and presented to forum members. An amended final version was available in June 2014.

Three versions of the same questionnaire were developed: one in English, one in French and one in Romanian. For each questionnaire, a different approach was followed to reach targeted actors:

- A CSTB database was used for the survey in French. About 22 000 French speaking actors belonging to the targeted population were contacted and were likely to answer online to the questionnaire. It is nevertheless not possible to know the exact number of people who were reached due to errors and duplication of email addresses.

- The English questionnaire was firstly sent to targeted actors who subscribed to the Elios2 newsletter and to persons present on lists provided by some members of the consortium. After Forum 6 in June 2014, targeted groups of actors could answer the questionnaire by clicking on the following Internet link: https://fr.surveymonkey.com/s/qualitysigns.
  Members of the consortium and professional European networks were invited to ask their members to answer the questionnaire through this link (i.e. the European Construction Industry Federation (FIEC), the European Network of Building Research Institutes (ENBRI), the European Council for Construction Research Development and Innovation (ECCREDI), the European Construction Technology Platform (ECTP)). An announcement was also made on the ECTP web site on 2014/04/28 (www.ectp.org).

- The English questionnaire was translated in Romanian by a senior researcher working at the national institute INCD URBAN-INCERC (Institutul Naţional de Cercetare-Dezvoltare in Construcţii) (http://www.incd.ro/). The Romanian questionnaire (Word format) was sent by email to local contacts. All questionnaires which were filled were redirected to CSTB (PDF files). Then data were entered into the web platform.

Respondents

A total of 889 answers were recorded (Table 9). Some of these answers were discarded for various reasons (incomplete, lack of coherency, randomly filled in). Finally, 600 French answers, 38 answers from Romania and 38 answers from other EU-28 countries were usable.

The over representation of France has three main reasons. First, the availability of a great number of emails addresses. This was not the case for other EU-28 countries in spite of the efforts of some contacted organisms. Second, the language issue is a difficulty. Without the unexpected initiative to translate in Romanian language, the chance to get answers would have not been so high in this country. Third, most contacted organisations argued that they do not wish to take over the dissemination of a survey they have not designed (even if they share the interest for the topic). The characteristics of this panel are taken into consideration in the analysis of data.

Table 9 : Sample of answers to online questionnaire

	France	Romania	Rest of EU	Total
Supplier	188 (24%)	10 (26%)	9 (17%)	207
Architect/technical designer	311(39%)	9 (24%)	13 (24.5%)	333
Contractor	144 (18%)	13 (34%)	4 (7.5%)	161
Client	115 (14%)	3 (8%)	6 (11.5%)	124
Insurer	31 (4%)	3 (8%)	13 (24.5%)	47
Other	9 (1%)	0	8 (15%)	17
Total	798	38	53	889

Many of the respondents have professional activities outside the country of the head-office of the company (Table 10). Most suppliers and insurers develop some business outside their national market. The view reflected by the panel is then wider than the view from three single countries, though it is difficult to further qualify this aspect.

Table 10 : Activities in foreign country

	France					Romania	Rest of EU	Total	%
Operation in foreign country	Supplier	Architect/ technical designer	Contractor	Client	Insurer				
Yes	125 (66%)	105 (34%)	38 (26%)	23 (21%)	20 (67%)	13 (34%)	29 (64%)	353	41
No	63 34%)	206 (66%)	106 (74%)	87 (79%)	10 (33%)	25 (66%)	16 (36%)	513	59
Total	188	311	144	110	30	38	45	866	100

1.5.2.2.1 Relevance of QS

Methodology

The panel was asked to rank (from 1 to 6: 1 being “no trust”, 6 being “high trust”) nine elements contributing to send signals to construction actors about different elements of construction projects (Table 11):

- Branding (marketing signal),
- On-site inspections by an independent person of the production process of construction products, (factory inspection)
- Technical approval,
- On-site inspections by an independent person of the production process of construction work, (construction site inspection, e.g. TIS)
- CE marking,
- Reputation (of company) (different from branding),
- First party certification (in this case conformity assessment activity is performed by the person or organization that provides the object),

- Second party certification (in this case conformity assessment activity is performed by a person or organization that has a user interest in the object),
- Third party certification (person or body that is recognized as being independent of the parties involved).

The aim of the analysis was to evaluate the reliability of the aforementioned elements and to examine how actors from the panel evaluate these elements. The answers obtained from the online survey were expressed in a contingency table in order to assess whether observations were independent of each other (Pearson's chi-squared test χ^2 is used to determine whether there is a significant association between two variables, see appendix 1.3).

Results

- The level of trust given to the nine elements depends on countries (when the test is used with three countries at 1% significance level – the significance level is only 5% for "third party certification").

- The chi-squared test excluding the Romanian sample, indicated independency between the nationality and the level of trust in several elements (at 5% significance level): "branding", "first party certification", "second party certification", "third party certification", "reputation", "CE marking". It means that there is no relationship between the nationality and the level of trust given to those elements (each group of countries has the same opinion).

- Conversely, dependency was proved for "technical approval" and "on-site inspections by an independent person of the production process of the construction work / product". In these cases, the nationality has an influence on the level of trust.

- "Branding" is valued by suppliers while architects/technical designers do not attach great importance to this sign. Indeed, branding is a marketing practice that appears to be better adapted to suppliers who sell services/products than to architects.

- Conversely, there was no relationship between the activity and the level of trust for the following elements: "on-site inspections with an independent person throughout the production process of the construction product/work" and "CE marking".

- "On-site inspections with an independent person throughout the production process of the construction product / work" are considered as the most relevant elements. Actors from the rest of Europe ranked it first. This situation apparently results from the over representation of insurers in this sub-sample. Indeed, insurers represent one third of the respondents (13 out of 38). As in France, they rely more on on-site inspections. They consider that it is the best way to monitor the quality. This was also confirmed by interviews.

- "CE marking" is ranked the highest in Romania. In this country, it appears that certification and QS dedicated to the construction industry started about 20 years ago. Thus, no national sign was in place. Conversely, most Western countries had a longer tradition with certification procedures and quality as a source of competitive advantage on the international market.

1.5.2.2.2 Impact of QS

Most of the actors of the panel share similar views on the influence of QS concerning construction products, construction systems, competences of individual/companies and works.

Table 12 is a synthesis of the six tables of appendix L of Appendix 1.3 for construction products. Appendixes M, N and O of Appendix 1.3 contain similar information for respectively systems, competences and work performances. Most actors agree to state that the strongest impact of QS is on building safety and energy performance of buildings (Table 12).

The impact on pathology reduction is comparatively lower and the effect on insurance costs appears to be quite weak.

Table 11 : Relevance of the following elements contributing to QS (all categories)

1 being "no trust" 6 being "high trust"	1-2			3-4			5-6			No opinion (all EU)	Total		
	France	Romania	Rest of EU	France	Romania	Rest of EU	France	Romania	Rest of EU		F	R	R. of EU
Branding	58 (10%)	0	7 (18%)	262 (44%)	9 (23%)	12 (32%)	268 (45%)	24 (63%)	16 (42%)	20	600	38	38
On-site inspections with an independent person throughout the production process of the construction **product**	63 (10%)	0	3 (8%)	211 (35%)	6 (16%)	4 (11%)	298 (50%)	30 (79%)	29 (76%)	32	600	38	38
Technical approval	39 (7%)	0	1 (3%)	217 (36%)	8 (21%))	6 (16%)	336 (56%)	25 (66%)	30 (79%)	14	600	38	38
On-site inspections with an independent person throughout the production process of the construction **work**	37 (6%)	0	2 (5%)	200 (33%)	8 (21%)	5 (13%)	352 (59%)	27 (71%)	29 (76%)	16	600	38	38
CE marking	177 (29%)	1 (3%)	6 (16%)	267 (45%)	11 (29%)	19 (50%)	143 (23.8%)	23 (61%)	12 (32%)	17	600	38	38
Reputation	67 (11%)	0	2 (5%)	315 (53%)	8 (21%)	19 (50%)	211 (35%)	27 (71%)	15 (39%)	12	600	38	38
First party certification (in this case conformity assessment activity is performed by the person or organization that provides the object)	144 (24%)	1 (3%)	10 (26%)	327 (54%)	20 (52%)	19 (50%)	84 (14%)	16 (42%)	7 (18%)	48	600	38	38
Second party certification (in this case conformity assessment activity is performed by a person or organization that has a user interest in the object)	78 (13)	1 (3%)	5 (13%)	306 (51%)	11 (29%)	17 (45%)	165 (27%)	26 (68%)	13 (34%)	54	600	38	38
Third party certification (person or body that is recognized as being independent of the parties involved)	44 (7%)	0	1 (3%)	181 (30%)	6 (16%)	10 (26%)	331 (55%)	29 (76%)	26 (68%)	48	600	38	38

Table 12 : Influence of QS concerning construction products (all categories of actors)

	FR	RO	Rest of EU	FR	RO	Rest of EU	FR	RO	Rest of EU	All EU	
1 being "weak" 6 being "high"	1-2			3-4			5-6			No opinion	Total
Pathology reduction	50 (10%)	1 (3%)	4 (13%)	211 (42%)	17 (45%)	11 (37%)	187 (38%)	17 (45%)	10 (33%)	59	567
Safety	21 (4%)	0	2 (7%)	209 (42%)	7 (18%)	9 (30%)	244 (49%)	31 (82%)	17 (57%)	27	567
Insurance costs	84 (17%)	1 (3%)	6 (20%)	203 (41%)	14 (37%)	11 (37%)	112 (22%)	18 (47%)	8 (27%)	110	567
Insurance cover	78 (16%)	3 (8%)	5 (17%)	191 (38%)	13 (34%)	10 (33%)	122 (24%)	18 (47%)	9 (30%)	118	567
Energy performance of buildings	36 (7%)	1 (3%)	3 (10%)	165 (33%)	8 (21%)	9 (30%)	275 (54%)	29 (76%)	16 (53%)	25	567
Introduction of innovation	66 (13%)	2 (5%)	7 (23%)	209 (42%)	8 (21%)	8 (27%)	191 (38%)	26 (68%)	11 (37%)	39	567

QS are also perceived as a stimulus for cross-border activities by more than 40% of the respondents of the survey (Table 13). Moreover, a majority considers that it is not a source of protectionism between countries (Table 14).

However, while the nationality does not have influence on this opinion (within the limits of the sample of respondents), the professional activity does. For example, 26% of the suppliers think that QS are a barrier to business on cross-border activities (Table 13).

Table 13: "Do you think QS have an Influence on cross-border activities in the construction industry?"

	Supplier	Architect/ technical designer	Contractor	Client	Insurer	Romania	Rest of Europe	Total
Yes, it is a barrier to business	31 (26%)	26 (13%)	12 (14%)	4 (6%)	6 (30%)	4 (10%)	7 (23%)	90 (16%)
It has a stimulating influence (on cross border activities)	51 (42%)	78 (39%)	34 (38%)	27 (40%)	8 (40%)	27 (71%)	17 (55%)	242 (42%)
No influence	25 (21%)	29 (15%)	21 (23%)	11 (16%)	1 (10%)	1 (3%)	6 (19%)	95 (17%)
No opinion	14 (11%)	29 (33%)	23 (25%)	26 (38%)	4 (20%)	6 (16%)	1 (3%)	141 (25%)
Total	121 (100%)	200 (100%)	90 (100%)	68 (100%)	20 (100%)	38 (100%)	31 (100%)	568 (100%)

More than half of the French suppliers of the sample perceive QS as source of protection between countries (Table 14 and Appendix P of appendix 1.3). Suppliers are also the most exposed to the international competition among the five categories of actors.

Table 14 : QS as a source of protectionism between countries

	Supplier (France)	Arch./ tech. designer (France)	Contractor (France)	Client (France)	Insurer (France)	Romania	Rest of Europe	Total
Yes	63 (52%)	72 (36%)	35 (39%)	17 (25%)	6 (30%)	12 (31%)	9 (29%)	214 (38%)
No	48 (40%)	101 (50.5%)	46 (51%)	41 (60.3%)	13 (65%)	17 (45%)	19 (61%)	285 (50%)
No opinion	10 (8%)	27 (13.5%)	9 (10%)	10 (14.7%)	1 (5%)	9 (24%)	3 (10%)	69 (12%)
Total	121	200	90	68	20	38	31	568

Suppliers of construction products apply for QS to fulfil demands of the design team and of clients (on products characteristics). Applying for QS also brings some advantages. It is a source of competitive advantage and it improves the image of the company. However, the impact on R&D and innovation appears to be more limited (appendixes H to O of appendix 1.3). The procedure leading to QS is also considered as expensive by three-quarter of the French respondents (appendix Q of appendix 1.3.

1.5.2.3 Phone interviews

Respondents to the electronic survey were questioned about their will to participate to phone interviews in order to leave no loose end untied. Interviews mainly focused on people working for the insurance sector since they are at the core of the Elios2 project and there was a relative lack of answers from the insurance sector in the online survey (name/activity/date of interviews of the nine interviewees in appendix 1.4).

Phone interviews had two objectives:

1. To integrate the opinions of key European actors who have a broad view on the relevance and impact of the QS on the performance of the construction industry (e.g. people representing federations of actors at the European level);
2. To have the opportunity to further explore some outcomes of the online survey.

The main outcomes of the interviews are as follows:

- Risk assessment is a case by case activity for construction insurers. Characteristics of the project (e.g. financial aspects, technical difficulty, activity records of contractors, novelty of design and technical solutions) are taken into account and weighted by insurers when underwriting for a given project;
- Insurance companies firstly rely on their own statistics and records. They better know the few major contractors than the multitude of SMEs operating on the market. QS concerning competencies of companies are important elements for insurers to assess their risks. The mere existence of such QS is nevertheless not sufficient. The scope, the validity period, the periodic renewal of these QS is essential for insurers.
- Control on construction site is considered as the best way to reduce building defects and insurance premium. In some cases (e.g. on markets where there is an explicit demand for high energy performances) a developer may wish to have specific controls that will allow him to send signals to the market concerning these performances (e.g. .by means of QS concerning performances of works) The extra cost associated to this control will at the end be paid by the client (i.e. the purchaser of the low energy building).

- One insurer considers that risk will increase with foreign contractors since they do not know the standards as good as local companies do. Moreover, the main barrier is language since there is a risk for workers to misunderstand specifications of the project (according to this insurer, by experience, there is more defect with foreign contractors / sub-contractors);
- The risk with eco-technologies such as PV panels is evaluated according to the function of and the activity that is done in the building (for example, PV panels for a school are not considered as risky as when they are installed on buildings hosting industrial activities);
- Insurers also evaluate both the financial and the technical capabilities of companies. They can refuse a candidate if a minimum threshold has not been reached;
- For complex projects, some insurers require seeing the plan of the project and they will carry out extra audits to reduce the risks. The company in charge of the project will have to present a report to explain how they intend to reduce the risks;
- Every country has its own standards and this is very strong in construction since construction processes may differ from one country to the other. Consequently it is more difficult for foreign companies who are less aware of these standards to win tenders;
- In a country like Romania, there is not a long tradition with standards. Thus, CE marking (with reference to harmonised standards) is perceived as a strong progress.

1.5.3 QS and risk assessment

As further highlighted in chapter 3 (Work package III), insurers need access to **discriminant information** to assess their risks. Discriminant information helps making a difference between the risks of goods or services. Depending on the context of construction projects the importance for such differentiation is more or less important. Discriminant information may be for instance less essential for the realisation of “ordinary” buildings (e.g. individual houses) using traditional techniques than for projects where non-standard/innovative products/systems are incorporated into building works.

As shown by statistics on building pathology, products are far from being a critical source of building defects (AQC 2013). QS on construction products are nevertheless important for designers and contractors as they bring evidence that expected characteristics are met.

Due to the importance of both design and site implementation on the final performances of works and on building defects, QS concerning competences are relevant to assess risk. The selection of a competent designer or installer/contractor (according to the technical complexity of the project) will increase the chance that expected performances of works are met and the occurrence of defects is limited.

Such a choice becomes even more important when innovative systems are planned to be incorporated in building works. QS on construction systems aim to provide characteristics of the elements of the system, information on its scope and limits as well as conditions (concerning system design, installation/implementation, maintenance) to be fulfilled in order expected performances of works are met.

This is for instance the case for PV systems where the “quality” of the installation/incorporation in building parts is crucial for both energy performances and other expected performances (e.g. rain water protection of building works) are met. This situation advocates the availability of information demonstrating that the company in charge of the execution is competent to perform such installation. Insurers may find such information in QS concerning the competence of the company.

The former EU-Intelligent Energy-Europe programme PVTRIN project collected information on the certification of PV installers in Europe (PVTRIN 2011). It highlighted that few EU-28 countries had developed accredited certification schemes for PV installers (MCS in UK, QualiPV in France) before 2011. The Elios2 directory records an additional Dutch QS on competence of installers of photovoltaic and solar thermal systems. Some other QS based on the respect of a quality charter (PVQUAL in Belgium) do not provide comparable information than previously mentioned QS.

Information recorded in the Elios2 directory aims to inform users of QS about differences between QS concerning a given subject (competence of PV installers in this case). Some QS are more likely to bring discriminant information than others. The appreciation of the "value" of QS highly depends on the answers to the question that were raised at the beginning of the Elios2 project: who initiates QS?, what is the exact scope of QS?, who provides information carried by QS?, how is the information carried by QS elaborated, up-dated, traced?

As stated early in the project (forum 2), risk assessment does not result from the selection of items on a check list. It rather results from the weighting of information coming from different sources. QS are one of them. Table 15 gives an indication on the **relevance of the four types of QS for insurers when they underwrite**. The level of relevance (A, B, C) refers to the likelihood for insurers to find pertinent (i.e. discriminant) information in concerned QS.

Insurance contracts may concern construction actors or building works. QS concerning one type of subject may be relevant for a certain type of insurance contract and may not be relevant for another kind of contract.

For a given type of insurance contract:

- a "A" level means the concerned type of QS is likely to contain/carry relevant information for insurers to assess their risks. This does not mean that all QS of the same type (e.g. QS on competence) have the same relevance. The context of the project, the way QS are elaborated, up-dated, traced are for instance taken into consideration to weight information.

- a "C" level means that the concerned type of QS is not relevant, i.e. insurers consider this type of QS does not contain/carry discriminant information.

For IDI (covering –according to contracts- damages of newly constructed property caused by faulty design, engineering, workmanship, or materials), the emphasis will be on QS concerning competence of designers/contractors (A) or construction systems (B) rather than QS on construction products (C).

An indication of the importance of QS on competence for insurers is that, according to some QS providers, some insurers are likely to take concerned QS into consideration when underwriting. For example, the French QS-provider QUALIBAT advertises that insurers like Allianz, MMA, SMABTP and others are likely to favour the display of a competence QS. The possible tariff advantage is of course not automatic as QS is only one element of the risk assessment by insurers.

Some insurers also advertise they take into account QS concerning performances of works when underwriting IDI contracts (Generali, AXA for the NF HQE BATIMENTS TERTIAIRES for instance). This type of QS indeed attests the technical design and organisation of the concerned construction project, as well as environmental issues and other subjects are carefully taken into account. These actions aim to improve the "quality" of works and are likely to limit building defects.

The mere display of a QS on work performances (generally environmental performances) is of course not sufficient as such to trigger a reduction of premium, but this kind of QS is one among many other elements taken into account by insurers when assessing their risks.

Table 15 : Relevance of QS used for risks assessment by insurers (source Hannover-re, CEA)

insured (construction actor or building work)	type of insurance contract	QS on			
		construction PRODUCT	construction SYSTEM	individual/ company COMPETENCE	performances of WORK
Manufacturer	TPL	A	C	C	C
Contractor	TPL	C	B	A	C
architect/engineering	PI	C	A	A	C
building work	IDI	C	B	A	A

LEGEND	**A:** high relevance	**B:** medium relevance	**C:** no relevance
	TPL: Third Party Liability insurance	**PI:** professional indemnity	**IDI:** inherent defects insurance

1.6 Conclusions and recommendations

This chapter presents the outcomes of the work carried out referring to the expectations of the call for tender. It also suggests some recommendations for further investigations.

1.6.1 Results/conclusions from WP1

- *An inventory of quality/conformity marks in all EU-28 countries used in construction markets for products, processes, works, technical equipment and professional qualifications together with an appraisal of the level of impartiality of the procedures that are used to deliver the quality marks;*

The creation of an online directory of QS was achieved. The directory was not designed to be a mere list of available QS. Would it have been the aim of this task, the list of QS providers contacted during the project could have been an appropriate answer. The ambition was higher.
The added value of the now available Elios2 e-directory is to give access to reliable information on QS concerning construction products, construction systems, competences and (performances of) works: http://signsdirectory.elios-ec.eu/.

The reliability of information is ensured by the fact that owners/providers themselves record descriptions of QS they deliver. The level of detail in the description was adapted so as to balance the relevance of information and the time needed to fill in the four web pages for each QS.

The relatively limited number of recorded QS does not come from specific difficulties to register and record QS descriptions; all contributors could confirm this assertion. They do not come either from the lack of efforts to attract contributors; in addition to some web pages of information, all important European networks of QS providers have been contacted through different channels of information (meetings, emails).

Reasons are more related to:

- the fact that the link between QS and insurability is not straightforward for all QS providers. Some providers clearly stated that their QS is of no value for insurers (DIBt, QS on products).
- the lack of spontaneous notoriety of the Elios2 project in spite of promotion actions through European networks of QS providers,
- a form of scepticism of QS providers about a European project on the issues addressed by Elios2

Disturbances introduced among European providers of QS concerning products/systems by comments in relation to the implementation of the CPR since July 2013 also probably played a role in the low level of QS records. The intense communication concerning the will to withdraw national QS on products was felt in contradiction with the invitation to record such QS within the frame of the Elios2 project commissioned by the European Commission.

In spite of this, the four categories of subjects (construction products, construction systems, competences and works) are present in the directory. They come from nine countries, knowing that several EU-28 countries could hardly be present in the directory as no QS in construction are available (LV, MT) or are very scarce (CY, RO, SK), if we except CE marking due to its legal and mandatory status.

In order to increase the population of the directory, the Elios2 team adapted the original QS record procedure. The “ELIOS 2-TEST” QS provider was created. Descriptions of corresponding QS are made by Elios2 partners using information available from the web-sites of QS providers. Some pieces of information could not be found on web sites so that the information cannot be complete. Moreover the risk to record inaccurate information is hardly unavoidable.

Concerned QS owners/providers were informed ELIOS 2-TEST QS are present in the directory with a visible distinctive ELIOS 2-TEST logo. They were invited to check information and to contact the Elios2 team to modify/complete/update recorded information. Some QS providers did. Some refused to have their signs displayed on the directory web-site. This recruitment procedure can in any case only be temporary if reliable information is sought.

- *A critical analysis of the rationale and of the relevance of the information provided by the quality marks to the operators of the construction value chain and to investors, including the compatibility and complementary issues with the CE marking;*

QS on construction products, construction systems, individual/companies competence mainly aim to provide information for construction actors to select appropriate and ‘trustable’ products, systems and competences according to each specific construction project. They help to make a difference between “similar” goods and services proposed on the market. In addition, QS on performances of building works carry information concerning the whole building through an analysis of the (management of a) construction project.

In all EU-28 countries and moreover in countries with very few QS in construction, CE marking participates in the dissemination of information concerning characteristics of construction products.

The issue of complementary and compatibility of the different specific QS with the CE marking has to be addressed according to the core question of the Elios2 project: "*facilitate access to insurance by self-employed builders and small building firms so as to stimulate innovation and the promotion of eco-technologies in the European Union*".

Investigations carried out during the Elios2 project clearly showed that the CE marking does not play a key role in the underwriting process, especially for the risks incurred by self-employed builders and small building firms. The two main reasons seem to be:

- Generally, **QS on construction products** are not crucial for insurers to assess their risks when underwriting.

  Indeed, building defects mainly come from design or execution of works. Construction products are more rarely involved as such so that the relevance of QS on products is very low for insurers as far as IDI contracts are concerned. This type of insurance contract is essential as far as the development of eco-technologies is concerned.

  Construction products are not recorded as such in pathology databases and by insurers as a major source of risk/pathology.

- More specifically, when underwriting, insurers are interested in QS carrying **discriminatory information** on subjects they know by experience are sources of risk/pathology (e.g. design, competences) that may be the origin of future claims.

  As a general rule, mandatory QS cannot be considered as carrying discriminatory information as all concerned products display this sign. Concerning CE marking, some potential discriminatory information could be found in the DoPs, but this reference does not seem to be used by the actors of the insurance sector.

The complementarity role of specific QS is illustrated by the fact that some insurers advertise on possible tariff advantages for contractors who can display QS, for instance, on competences. The "value" of QS on competence is implicitly recognised positively even if possible advantages are of course not granted automatically.

Similarly, some insurers also advertise on advantages for projects displaying QS on work performances. It must be emphasised that QS remain one element among many others for insurers to assess their risks.

However, in terms of compatibility, the limit of such a situation is fixed by the rules of the single market and namely by the CPR (chapter 1.2.3)

The decision of the European Court of Justice (ECJ 2014) mentioned in 1.2.5, even if this decision refers to the Construction Products Directive of 1989 replaced since then by the Construction Products Regulation (CPR), highlights the difference between compatible and incompatible use of national QS concerning construction products within the European Market.

According to this decision the German law **which imposes additional requirements on construction products**, even if they already bear the CE marking, violates the right on the free movement of goods in the single European market.

A **national law** cannot stipulate that CE marked construction products are subject to additional national requirements imposed with a national QS to access the domestic market before their use and sale.

It appears that 2 criteria have to be taken into account:

- The first one is natural: the incompatibility only applies when a QS covers a characteristic already included in the harmonised European standard (hEN) cited in the Official Journal of the European Union (see FAQ 19). In other words, if there is an identity or an overlap between the object of the requirement and the CE Marking. If on the contrary, there is no risk of incompatibility when the QS do not concern the essential characteristics of a product (e.g. competences of an actor).

  N.B.: According to the article 2 of the CPR kits, i.e. sets of separate components that need to be put together to be incorporated in the construction works, are regarded as products.

- The second one is more complicated and reports to the frontier between voluntary and compulsory: it is the existence of a "legal" or "public" requirement. The exact definition of such a requirement is given by the CPR (Article 8.3): it is a requirement "*imposed by public bodies or private bodies acting as a public undertaking, or acting as a public body on the basis of a monopoly position or under a public mandate*"

These principles can be illustrated by a potential situation involving the access to insurance.

Services providers have not to be obliged to obtain additional QS on the products they use to access to insurance in a Member State where the insurance is compulsory. Even if this requirement is imposed indirectly by the insurance sector.

It could also be the case if a public body as for instance the BCT in France (Bureau Central de Tarification) imposed this requirement to access to insurance. It would be a way to reintroduce, indirectly, QS with national connotation in the harmonised field covered by the CPR.

On the contrary, a simple market driven incitation (without any kind of constraint due to a monopolistic or systematic position of the market) cannot be seen as a violation of the rules of the European Union.

- *An appraisal of the conditions and of modalities to be followed by construction operators in order to access to the quality/conformity marks, including those related to the mutual recognition of the marks by Member States;*

Descriptions of QS recorded in the Elios2 directory show that certification rules (for products, competences, works), evaluation frameworks (for systems), or the outcome documents of certification (i.e. certificates) or technical approval schemes in many cases can be easily accessed through internet, or can be made available by the sign providers on request. In some cases there may be restrictions of access that are part of specific rules of a given scheme. These restrictions are then known to applicants.

The structure of the directory has been designed to help users to make a parallel between descriptions of QS concerning similar goods or services. This kind of comparison is focused on the core of the schemes, i.e. the owner, the scope and the delivery process. When more QS are recorded in the directory, this comparison helps construction actors to choose among several QS according to the scope as well as to other aspects with regard to their activity in their local context.

Construction actors may for instance be interested in characteristics of goods and services that echo some contingent factors (e.g. climate, culture, history). They may then prefer to select one QS rather than another QS. The availability of the directory of QS is a step towards a better knowledge on what is going on in EU-28 countries and a better understanding of the needs of operators in these countries.

The directory is then a potential tool to improve and increase mutual confidence in QS issued in EU-28 countries. The more is known about QS in different countries, the more constructive exchanges can take place to better assess and more easily develop mutual recognition of QS where relevant.

- *An assessment of the possible impact of the quality/conformity marks on the competitiveness of construction businesses and the functioning of the Internal Market;*

From the questionnaire survey it appeared that QS are perceived as a source of competitive advantage for a company and that it improves the image of the company.

As far as the functioning of the Internal Market is concerned, from the questionnaire survey it appeared that half (50%) of the respondents considers QS not to be a source of protectionism between countries. However, if we look at specific actors in the construction business, we see that 26% of the French suppliers think that QS are a barrier to trade on cross-border activities, and 52% of the same respondents perceive QS as a source of protectionism between countries.

The main objective of the CPR is *"to remove technical barriers to trade in the field of construction products in order to enhance their free movement in the internal market"*. By affixing the CE marking, manufacturers indicate that they take responsibility for the conformity of the construction product with the declared performance as well as compliance with all applicable requirements laid down in the CPR and other relevant Union harmonisation legislation providing for its affixing.

But the CPR (and CE Marking) only has relevance for construction products, and not for competences, for systems or performances of works. As we have seen before, insurers attach great value to QS on competences, rather than on construction products. So from the perspective of insurers, a kind of mutual recognition of competences (in design, in execution/installation) within Europe will probably allow a better assessment of risks of the insurers in different countries, and may lower barriers to trade.

An added value of QS in comparison with CE Marking is to bring appropriate information that is adapted to local markets in Europe. Mutual recognition of QS should take this statement into account as QS are and will remain very relevant for manufacturers and services providers (architects, technical designers, contractors) to highlight differences of products/systems/services they offer on these local markets.

From the survey, actors seem to agree the strongest impact of QS is on building safety and energy performance of buildings. The impact on pathology reduction is comparatively lower and the effect on insurance costs appears to be quite weak.

- *Evidence and assessment of the extent to which the quality/conformity marks are used in practice by the insurance sector, including in the context of cross-border services. The assessment will consider possible constraints on the Internal Market resulting from common practice in insurance.*

Insurers do use QS that are relevant for assessing their risks. Main sources of building pathology are known by statistical analyses of insurance claims. As a consequence, insurers are not equally interested by QS concerning construction products, construction systems, individual/company competence and performances of building works. The Elios2 study emphasised the importance of QS on competences.

A distinctive characteristic of relevant QS for insurance purposes is its potential to provide discriminant information during the underwriting process, i.e. information that draws attention of insurers on risk factors (e.g. use of construction systems according to their field of use, interface with adjacent building parts, requirement for a high level of competence in design/installation).

1.6.2 Recommendations

Promote the e-Directory

We recommend that the EC promotes the e-directory of QS at the EU level in order to create conditions for a better understanding of the scope and limits of each type of QS. The information provided by the directory is an important element for future actions of the EC in the construction industry, with respect to the diversity of local situations. In particular, it could be used to:

- Quickly access essential descriptive information (ID, scope, organisation of the scheme, use of QS by insurers);
- Compare QS concerning similar subjects in different EU-28 countries;
- Assess the added-value of each QS.

Experience with populating the QS Directory showed that it needs limited effort to record QS descriptions in the directory for a person whose daily activity is QS delivery for a given subject. By attracting new contributors to populate the e-directory, the EC could quickly collect added-value information for future developments (e.g. mutual recognition of QS).

Further highlight links between QS and insurance

The development of insurance requires access to information allowing the assessment of risks. The e-directory provides a view of QS providers on the potential use of QS for insurance. The EC could foster an exchange between QS providers and insurance in order to analyse possible improvements in the information carried by QS, aiming to reduce building defects (of any kind) in the future, especially when eco-technologies are incorporated in building projects.

Existing QS are presently not explicitly meant to produce information for insurers. There may exist a potential to amend existing QS or develop new types of QS that would more explicitly help risk assessment. Initiatives to promote exchanges on the use of QS for insurance purposes could be supported by the e-directory.

CHAPTER II – WORK PACKAGE 2

2.1 Introduction

2.1.1 Expectations and objectives

Work Package 2 of the Elios2 project deals with the following objective of the call for tender: *"Development of indicators and monitoring of the evolution of quality in construction and of the pathology related to construction design and techniques and the integration of eco-technologies"*

"This will include among others:

- *A review of existing research work and data sources on quality in construction and building pathology, including an assessment of the value of the various source, their complementary aspects and their potential for use in risk appraisal;*
- *An analysis of the needs and of the criteria to develop an EU-wide database on quality and pathology indicators, in particular the potential value of this information for the construction and the (re) insurance sectors, the conditions and the modalities to gather, exploit and disseminate relevant data and information to all parties concerned,; the maintenance and the exploitation of the data base after the termination of the pilot project, etc.;*
- *A validation of the format of the information that the EU-wide database should provide, e.g. by type of construction products, process, building, by category of defects, by regions, etc. and of relevant media support, e.g. webzine, publications, alert on major defects, etc."*

2.1.2 Methodology

Following the call for tender (and the deliverables and the tasks specified therein), the work program was divided into five phases:

1. State of the art on quality in construction and building pathology;
2. Needs and criteria to develop an EU database on quality and pathology indicators;
3. Setting up a format for the database, validation and data requirements;
4. Develop, test, validate and update pilot version of database;
5. An assessment of the functioning of the EU wide pathology database and of the options to be envisaged for their maintenance and exploitation after Elios 2[3]

In Table 16 the activities and methodologies followed within each phase are shown in detail:

[3] Although this is not a formal deliverable, this point is mentioned under sect. 1.3.2 of the Service Contract

Table 16: Work program of WP2 and methodology used for each activity

Activities	Methodology applied
1: State of the art on quality in construction and building pathology	
1.a Definition of construction quality and building pathology	Literature; team discussions.
1.b Review of existing research work and data sources on state of the art of building pathology	• Desk study; • Investigating German, Italian, Portuguese, Dutch, French, Danish, Belgium and UK pathology sources and databases, and the organisation and business models behind these databases; • Preparing a survey 'Existing services and databases for pathology information managed by AQC', by CSTB; • Interviews
1.c1 Selection of 10 eco-technologies to be used for case studies	Desk study (definitions of 'eco-technology' in relation to 'sustainable construction'), gross list of eco-technologies, and selection of 10 eco-technologies.
1.c2 Questionnaire and case studies on 10 selected eco-technologies	• Preparing a questionnaire for gathering information on the 10 selected eco-technologies; • Making a list of organisations/ bureaus in Europe to be approached for the questionnaire; • Setting out questionnaires by the WP2-partners and making draft case studies for the 10 selected eco-technologies by NHBC; • Collecting information from interviews and questionnaires on the availability of data on pathology of eco-technologies in EU-27; • Making case studies for the pathology of 10 eco-technologies and analysis of the results; • Meetings with Insurance Europe on cooperation between Elios 2 and the European insurance sector.
1.d Assessment of the value of existing research work, data sources	Analysis, interviews, desk study, team meetings
2. Needs and criteria to develop an EU database on quality and pathology indicators	
2.a Analysis of the needs and criteria of insurers	Workshops with Hannover Re and Allianz, and interviews with other insurers and stakeholders on the information needs of insurers with respect to data/information on pathology of innovative products, and on the structure of the database for pathology of eco-technologies.

2.b Program of requirements for the pilot database	Preparing a 'program of requirements' for the EU pathology database for eco-technologies.
3. Setting up a format for the database, validation and data requirements	
3.a Setting up a format for the database	Making specifications for the pathology database, based on the program of requirements
3.b Validation of the format	Validating the proposed pathology database architecture by introducing the information from a number of pathology cases into the database.
3.c Definition of informatics requirements for the database	
4. Develop, test, validate, populate, and update pilot version of database	
4.a Development of a pilot version of the database	
4.b Testing, validation and population of the database	Population of the database with pathology cases, delivered by team members and from case studies.
4.c Updating of the database	Continuous activity
5. An assessment of the functioning of the EU wide pathology database and of the options to be envisaged for their maintenance and exploitation áfter Elios 2	• Desk study on the functioning and operating models of existing databases. • Meetings and discussions with the WP2-project partners and other potential external organisations, on their possible contribution to an EQEO (Eco-technologies Quality European Observatory).

2.2 State-of-the-art of quality in construction and building pathology

2.2.1 Definition of building pathology

Building Pathology can be defined as the systematic study of building diseases with the aim of understanding their causes, symptoms and treatment (Watt, 2007).

According to CIB (1993), Building Pathology is defined as the systematic study or treatment of building defects, their causes (aetiology), their consequences and their remedies (or therapy).

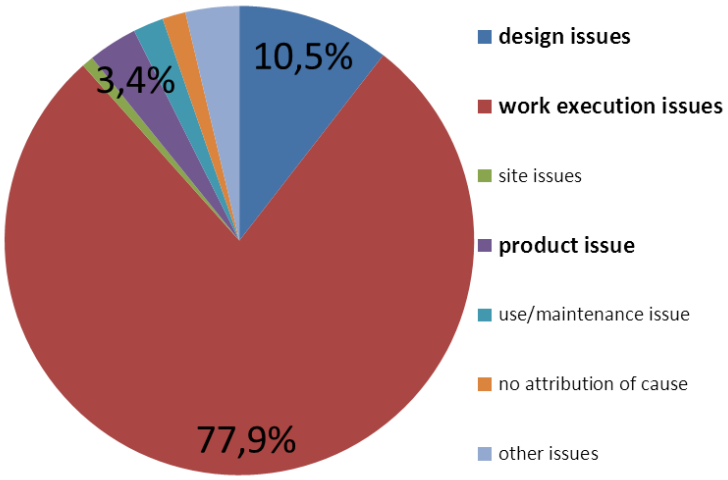
The following comprehensive definition of building pathology can be given: building pathology provides an interdisciplinary approach to the study of defects and performance in order to develop appropriate remedial and management solutions. It considers how the structure and materials of a building relate to its environment, its occupants and the way the building is used, so as to develop a better understanding of building failures.

2.2.2 Building pathology and construction quality

Building pathology can be considered as the appearance of lack of quality (or 'non-quality') of construction works. The causes of 'building pathology' can be very wide, coming from insufficient skills of or faults by actors during the development process or construction process, loose design, inadequate processes, defective building products, ageing of building materials, imperfect implementation, etc.

Pathology is created by all these imperfections, most of them resulting from human actions. In Figure 9 it is shown that most pathologies arise from work execution issues.

Figure 9: Origin of building pathology in France, during 1995-2012 (adapted from AQC 2013, p.25)



As outlined in the tender specifications, one of the goals of WP2 is "*To develop indicators and a mechanism to monitor the evolution of quality in construction and the pathology related to construction design techniques and the integration of eco-technologies*".

In order to underwrite a risk, the insurer deals with technical information to assess his risk, helped by his knowledge of the corresponding and/or foreseen pathology.

For insurers, 'quality indicators of construction' are more of a statistical nature. On the basis of a large database of pathology records, it would be able to measure for example the number of damages of buildings each year, or the amount of money to repair the damage.

This is what amongst others, Agence Qualité Construction has done in the report 'Pathologie et statistiques; Sycodés; pathology and statistics' (AQC, 2013). The database collects building defects reported by insurance construction experts within the frame of the French national insurance context. Defects are assessed from a technical point of view. Statistics on defects and costs of repair are established.

This is how we would interpret the concept of 'non-quality in construction' in the context of building pathology. 'Non-quality indicators of construction' are in fact statistical indicators of a large set of building pathology data.

2.2.3 Review of existing research work and data sources on state of the art of building pathology

2.2.3.1 CIB Working Group

One of the commissions of the International Council for Research and Innovation in Building and Construction (CIB) is the Working Group W086 Building Pathology.

W086 Building Pathology is essentially concerned with learning from past and current building pathologies and encouraging the systematic application of that knowledge to the design, construction and management of buildings.

In this context, objectives of W086 are to produce information that will assist in the effective management of service loss, to develop and evaluate methodologies for assessment of defects and failures and consequential service loss, to apply systematic approaches to the investigation and diagnosis of defects and failures in buildings of all types and at all stages of life, to audit buildings in use to check the veracity of service loss prediction methodologies and to promulgate findings to all those involved in the production and management of buildings (www.cibworld.nl).

In 2013 the CIB W086 commission published a 'State-of-the-Art Report on Building Pathology' (CIB W086, 2013).

2.2.3.2 Sources on building pathology

The majority of the publications on building pathology refer to defects, damage and decay of 'traditional' building materials, products and building components, i.e. foundations, structures, concrete, roofing, facade, rendering, plumbing, equipment.

For example a monograph as Building Pathology (Watt, 2007) refers to defects, survey techniques and remediation of common building materials, often applied for centuries, and does not mention the risks of new products and technologies. Service life manuals (e.g. BCIS, 2006; SBR, 2011) also refer to common applied building products.

The development of eco-technologies creates a new context. In contrast to sources on quality/conformity marks, it is more difficult to identify specific sources on pathology. The recent emergence of associated pathology just starts to be recorded. Nevertheless, some sources of information are proposed which allow beginning investigations.

Obviously, building services, and in this respect also eco-technologies that include building engineering artefacts as well as electrical and/or mechanical engineering parts, receive less attention by building pathologists than building materials and components.

Another observation is the fact that building pathology sources address especially the in-use period of building components, i.e. degradation by external causes or ageing.

In Appendix 2.1, the sources are gathered to identify pathology issues linked to construction sustainability in the EU-28, grouped as:

- Professional actors;
- Pathology records;
- Prevention, good practices;
- Professional journals;
- Books-reports-proceedings;
- Standards;
- Scientific articles.

2.2.3.3 Defects and their causes

Defects, failures and faults

During their lifetime, building components have to contend with defects, resulting in performance loss, through ageing and use. Most defects occur through the effects of external agencies on building materials and building parts.

Douglas and Ransom (2007) describe these as the principal components of the weather, namely solar radiation, moisture and air and its solid and gaseous contaminants; biological agencies, in particular fungi and insects; ground salts and waters; and manufactured products used in conjunction with building materials, for example, calcium chloride.

Other authors classify the degradation mechanisms into: biological, chemical, physical, mechanical (including wear-and-tear and misuse).

Building defects often arise as a result of complexity. The consequences of these defects are twofold:

- The expected building performances may be altered;
- Some of the actors may be liable for defects (inadequate design, misuse of products; shortcomings in construction, installing and maintenance).

Douglas and Ransom (2007) propose a clear distinction between a *building defect* and a *building failure*. A *defec*t is a shortfall in performance occurring at any time in the life of the product, element or building in which it occurs. A *failure* is the termination of a product or element's ability to perform its intended function; the end of the service life of the product/element had been reached.

In certain legal frameworks a distinction would be made between a *fault* and a *failure* (Douglas and Ransom, 2007). A *fault* would be classified as a *defect*, that which caused or triggered the *failure*. A *failure* is the *damage* resulting from a defect. "*This is important for the courts when it comes to assessing the cost of remedying construction failures to ascertain the extent of damages awarded to the aggrieved party if a case has been proved against the contractor or designer*." (Douglas & Ransom, 2007).

Classification of defects and failures

Building failures can be categorised into several groups as listed in Table 17. The failure classifications are not mutually exclusive – some overlap with one another.

Table 17 : Typical categories of failures (Douglas and Ransom, 2007)

Failure type	Example
Aesthetic failure	Crazing or shrinkage cracking of concrete or render Flaking and peeling of paintwork. Bossing and spalling of render. Staining and soiling of finishes Chipped, dented or lipped floor/wall/ceiling finishes and veneer to doors.
Functional failure	Misalignment of building components such as doors and window not operating properly Leaks in elements such as roofs, walls and floors. Sagging of floors.
Failure of materials	Chemical attack of rendering, mortar or brick. Fungal attack of timber. Corrosion of metals.
System failure of components and elements	Carbonation of concrete, leading to corrosion of reinforcement and subsequent cracking and spalling of concrete members. Debonding and bubbling of membrane from substrate owing to moisture or incompatibility.
Structural failure	Subsidence (a downward movement of a building caused by below ground factors – such as desiccation of clay soil). Settlement (a downward movement of a building caused by above ground factors – such as overloading).
Non-structural failure	Delamination of roof tiles and slates. Cracking and debonding of plaster or rendering. Blistering and peeling of paint coatings Tenting, debonding and bubbling of floor coverings.
Reversible failure	Jamming of doors and windows as a result of moisture intake by these components – usually in winter; in the summer the wood dries out and the windows and doors become unstuck.
Irreversible failure	Chemical reactions such as sulphate attack on mortar or rendering. Excessive distortion in beam/slab, column or wall owing to structural movement.

The Dutch Standard for Condition Assessment of Buildings made a framework of defects indicating the importance as to what extent does it influence the functioning of the building component.

Although the condition assessment process is not meant to analyse the causes of the defects, the framework already gives some indication, especially the categories 'basic quality' and 'maintenance' (See Table 19). Critical defects significantly threaten the function of the building component.

Generally material intrinsic defects like corrosion and wood rot, defects that threaten the building structure, e.g. stability and distortion, and 'functional defects', are weighted as critical defects.

Functional defects are those that are already associated with a failure. Serious defects are gradually damaging the performance of building components, for example defects in the material surface.

Table 18: Framework for the importance of defects, Dutch Standard for Condition Assessment (NEN, 2008/2011; Straub, 2009)

Importance	*Type*	*Explanation*
Critical	Basic functioning Basic constructional Material intrinsic Basic quality	Critical defects harm directly the functioning of the building component
Serious	Minor functioning Minor constructional Material surface Basic quality and ageing of secondary components	Serious defects mean degradation of a building component, without directly harming its functioning
Minor	Lacking preventive maintenance actions *(1)* Finishing Basic quality and ageing of tertiary components Theoretical deterioration *(2)*	Minor defects do not harm the function of building components

Notes: (1) Preventive maintenance actions meant to keep the building component in running were not executed, e.g. legal tests. (2) Condition assessment based on the theoretical service life of the building component; this may be applied if the condition cannot be assessed (visually).

Causes of defects and failures: product-related and human-related

Most defects are located at 'singular points', where the interface between products, skills, know-how is concentrated. Main categories of defects, caused by human sources (designers, constructors, installers, etc.) could be listed as (CIB, 1993; Douglas and Ransom, 2007):

- Pre-design (poor or inadequate brief);
- Design (poor detailing, inappropriate specification, inferior quality of design or materials used);
- Products (faulty manufacture, damage as result of faulty delivery, damage resulting from inadequate storage of protection);
- Construction errors (poor workmanship, inadequate supervision, vandalism);
- Maintenance errors.

The factor method modifies reference service lives by factors to take account of the specific in-use conditions (ISO 2000). The Dutch Foundation of Building Research (SBR) decided to make a practical application of the factor method and to list the criteria belonging to each factor (SBR, 2011; Straub 2012).

The factors and criteria could be used as a reference for the causes of defects. The factors are:

- Quality of components (material and products);
- Design;
- Work execution;
- Indoor environment;

- Outdoor environment;
- In-use conditions;
- Maintenance.

In the questionnaire for the case studies on eco-technologies and data sources (see Section 2.3.4) a distinction will be made between requirement management, delivery issues, installation problems and operational failure. See Table 19.

Table 19: Eco-technologies questionnaire, Possible causes of failure (NHBC, 2013)

Requirement management	Change in client's requirement Misunderstanding of the effectiveness of the technology Poor project management Inaccurate engineering or architectural data
Delivery issues	Late delivery Storage issues Awkward packaging Poor transport of product
Installation problems	Incorrect design for installation Incorrect installation documentation Failure in installation Commissioning failure
Operational failure	Product failure once installed Incorrect user documentation

2.2.3.4 The use of building pathology data

Building Pathology data is being used by a range of market players, amongst others real estate owners and managers, housing organisations, architectural offices, construction companies and installers, manufacturers, certification organisations, building inspection services, loss adjustors and insurance companies.

Building pathology reports can be made directly for the interest of a certain party (for example a contractor involved in a claim by his client, or the court in a litigation process), but pathology information may well be of interest to all building participants and building 'educators', including insurers.

The use of pathology data by brokers and insurance companies is further worked out in Chapter 3.

2.2.3.5 Building pathology data for eco-technologies from literature

A first analysis of monographs on building pathology (Douglas and Ransom, 2007; Harris, 2001; Marshall et al., 2009; Watt, 2007), research papers (proceedings of CIB W086 congresses) and scientific journal papers (Structural Survey, Journal of Building Appraisal) makes clear that research and new knowledge on deterioration and remedial work of ancient work and traditional building methods, is much more prominent than building pathology knowledge of new (eco) technologies.

Besides, much research is done in other continents, under different environmental and cultural circumstances and focusing on different specific materials, products and technologies.

However, the defects of some eco-technologies like photovoltaic panels or wind turbines received some attention in certain studies.

Next to the data being collected by means of the questionnaire (see Section 2.2.4), professional journals published in the countries covered by the consortium, guide books, internet publications, has revealed more information on building pathology of the selected eco-technologies.

Examples of studies/publications on pathology of eco-technologies:

- Del Percio, S. (2009) Case Study: A practical Look at the Risks of Green Roofs, internet 21 May 2012.
- Energy Efficient Best Practise in Housing / BRESEC (2004) Domestic Ground Source Heat Pumps: Design and installation of closed-loop systems, Good Practise Guide.
- Passarelli, G.R. (2009) Sick Building Syndrome: An overview to raise awareness, Journal of Building Appraisal, 5(1): 55-66.
- PIPAME (2009) Diffusion des nouvelles technologies de l'énergie (NTE) dans le bâtiment ; conclusion du groupe de travail interministériel, Juin 2009
- Villan, J.E. (2009) Pathology of light facades, Journal of Building Appraisal, 5(2): 149-159.
- Warmtepomp is gevoelig voor fouten, GAWALO, mei 2010.
- Yu, C.W.F. and J.T. Kim (2010) Building Pathology, Investigation of Sick Buildings – VOC Emissions, Indoor and Built Environment, 19(1):30-39.
- IFB Bauforschung (2011), Schäden beim energieeffizienten Bauen und Modernisieren, Forschungsbericht
- Shipp, M. & Steven Manchester (2012), The fire risks of renewable energy technologies, BRE Global Limited, presentation for The Institution of Fire Engineers 2012 AGM & International Conference "New technologies in the fire world'.
- AQC (2012), Retours d'expériences (REX), Bâtiments performants & Risques, résultats 2012, rapport, programme « Règles de l'Art Grenelle Environnement 2012 ».
- Gesamtverband der Deutschen Versicherungswirtschaft e. V. (German Insurance Association) (2010)- Renewable energies, Overall survey of Engineering Insurers within the German Insurance Association (GDV) on the level of technological development and the technical hazard potential.
- GDV, Die Deutsche Versicher (2012), So vermeiden Sie Schäden an Photovoltaikanlagen. Versicherungswirtschaft präsentiert ersten technischen Leitfaden für Solarstromanlagen, Pressebericht, 8/6/2012
- FOV, Federatie van onderlinge verzekeringsmaatschappijen in Nederland, Technische Commissie Schadepreventie (2012) Zonnepanelen – daar komt meer bij kijken dan alleen een opgaande zon. Technische preventiebrochure.
- Saretec (2013), Sinistres photovoltaïques, rapport Saretec, Direction Technique, 18/10/2013, see : www.qualiteconstruction.com/fileadmin/medias/observation/pathologie-etudes/etude-patho-installations-photovoltaiques-2013-10.pdf et « Les pathologies des installations photovoltaïques en toiture : quand l'innovation fait déraper » dans Le Moniteur 10 Dec. 2014

2.2.4 Selection of 10 eco-technologies to be used for the case studies

2.2.4.1 Definition of eco-technology

OECD–EUROSTAT define 'environmental technologies' as: "*environmental technologies help to measure, prevent, limit or correct environmental damage (pollution of water, air, soil) as well as problems related to waste, noise, landscape degradation, biodiversity loss and depletion of resources*"[4].

In the 'Environmental Technologies Action Plan (ETAP)[5] of 2004, the European Commission defines 'environmental technologies' as: "*Any technology whose use is less environmentally harmful than relevant alternatives*". This definition is based on the definition given in Chapter 34 of Agenda 21 of the United Nations for environmentally sound technologies.

This states that, "*Environmentally sound technologies protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substitutes (…). Environmentally sound technologies are not just individual technologies, but total systems which include know-how, procedures, goods and services, and equipment as well as organisational and managerial procedures*"[6].

The 'Eco-innovation Action Plan (EcoAP)' of the European Commission (2011)[7] uses the term 'eco-innovative technologies', whereby an eco-innovation is described as: "*any form of innovation resulting in or aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment, enhancing resilience to environmental pressures, or achieving a more efficient and responsible use of natural resources*."

The Communication 'Strategy for the sustainable competitiveness of the construction sector and its enterprises''[8] uses the term 'environmental technologies' as one of the "*services (to be taken up by the construction sector) to address issues such as health and safety, energy efficiency, green building, disaster resilience, indoor climate, re-use/recovery/recycling and design to fit*".

These definitions all express the same idea, namely: technologies that contribute to sustainable development / sustainable construction.

2.2.4.2 'Eco-technologies' and 'sustainable construction'

The Elios2 project is conducted within the framework of the 'Lead Market Initiative for Sustainable Construction'. Therefore, the term 'eco-technology' should be seen in the context of sustainable construction. What is meant by 'sustainable construction'?

[4] This is in line with the paper 'L'industrie des biens et services environnementaux, Manuel de collecte et d'analyse des données', OECD – Office Statistique des Communautés européennes. 1999.
[5] European Commission, COM(2004) 38 final, Brussels, 28.1.2004
[6] http://www.un.org/esa/dsd/agenda21/res_agenda21_34.shtml
[7] COM(2011) 899 final, Brussels, 15.12.2011
[8] COM (2012) 433 final, Brussels, 31.7.2012

A definition by the European Commission is from 2007:

> *"Sustainable construction can be defined as a dynamic of developers of new solutions, investors, the construction industry, professional services, industry suppliers and other relevant parties towards achieving sustainable development, taking into consideration environmental, socio-economic and cultural issues. It embraces a number of aspects such as design and management of buildings and constructed assets, choice of materials, building performance as well as interaction with urban and economic development and management. Different approaches may be followed according to the local socio-economic context; in some countries, priority is given to resource use (energy, materials, water, and land use), while in others social inclusion and economic cohesion are the more determining factors" (EC Task Force on Sustainable Construction, 2007:4)."*

In this definition there seems to be an overlap with 'sustainable (urban) development', or 'sustainable town planning' for which the European Commission has written a Communication in 2006[9].

Some find this approach too broad, and favour to define sustainable construction by the three 'traditional pillars' of sustainability*: ecological (or environmental) performance*, *economic performance* and *social performance* of buildings[10].

The study 'The Lead Market Initiative and Sustainable construction: Lot 1, Screening of national building regulations' (PRC Bouwcentrum International, 2011), uses the following definition:

> *"sustainable construction: the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a construction works' life-cycle from initial planning approval to design, construction, operation, maintenance, renovation and deconstruction."*[11]

In this context the Elios2-team has defined 'eco-technologies' as: "***technologies which are (supposed to) contribute to the environmental performance of buildings (and whose use is less environmentally harmful than relevant alternatives)"***.

In the aforementioned study of PRC Bouwcentrum International (2011), the following topics are considered to make up environmental performance:

- Energy;
- Water;
- Waste and pollution;
- Protection of biodiversity and natural environment;
- Minimization of the use of resources.

For each of these topics, it is possible to identify a range of 'eco-technologies', like given in Table 20:

[9] 'Thematic Strategy on the Urban Environment', COM(2005) 718 final, Brussels, 11.1.2006

[10] See CEN/TC350 – Sustainability of construction works

[11] This study approaches sustainable construction from a broader sense than the three traditional pillars, by including 'functional performance'.

Table 20: Examples of eco-technologies for the different topics of environmental performance

Topic of environmental performance	*Examples of eco-technologies*
ENERGY	
Energy performance	'passive house' / 'active house'
Usage of renewable energy sources	photovoltaic panels (PV's)
	wind turbine
	solar hot water (SHW)
Energy efficiency techniques	mechanical ventilation with heat recovery (MVHR)
	heat pump
	domotics, e.g. controls for space heating
Thermal insulation	insulation made of bio-materials, like natural fibers (hemp)
	Cavity wall insulation (CWI)
	Solid wall insulation (SWI)
	double skin curtain wall / façade
	EPS (expanded polystyrene) insulants
	Vacuum-insulated panels (VIP's)
	double glazed windows with evacuated units
Other energy conservation techniques	passive shading devices (e.g. sun breezes)
	grey water heat recovery
WATER	
Water conservation techniques	green roof / brown roof
	in house water-treatment system
	rainwater catchment basins, grey water harvesting
Water efficiency/management techniques	low-water use appliances, like spray taps, flush toilets
	ultra low water-efficient plumbing fixtures
	Sustainable urban drainage systems (SUDS)
	porous pavements
Water metering	water leakage detection systems
MINIMIZE POLLUTION	
Minimize waste during construction	biological waste treatment systems to treat waste on-site
Separate/recycle waste	composting toilets
	waste containers
Limitation of emission of CO_2, ozone depleting gasses, greenhouse gasses	ammonia cooling agent in cooling systems
Limitation of toxic chemicals	low VOC materials (paints, kits, glues)
Protect biodiversity and natural environment	roof garden
MINIMIZE THE USE OF RESOURCES	
	metal storage/ shipping containers

Re-use or recyclability of construction works, their materials and parts after demolition	aluminium or steel frame components/systems (up to 90% recyclable)
Usage of renewable materials	wood, bamboo
	paper-based
Minimize materials	Bubble Deck floors

2.2.4.3 Criteria to select 10 case studies for eco-technologies

It must be emphasized that the examples of eco-technologies mentioned in the table above are generally perceived to have a favourable impact on the environmental performance of buildings, but that some of these technologies may not be so environmentally friendly when all matters are considered with sufficient knowledge.

For example: Vacuum Insulation Products may be considered to be an eco-technology, because these products improve thermal performances while minimizing transport and thickness of construction elements. However, at the moment, there is little information about production and no statistically relevant knowledge about waste produced on site due to damage during installation and practical service life. So in reality VIP products may turn out to be not quite so environmentally friendly or not friendlier than a traditional insulation product.

However, the aim of Elios2 is not to study, or to give a judgement on the environmental performance of certain eco-technologies, but to select 10 case studies for studying the relationship with insurance, and setting up a pilot database. The criteria for selection are:

- Technologies that are mature enough, are available on the market and are commonly applied in construction in most European countries for a certain period of time to have some claim feedback from insurers, and experience on pathology data, typical risks;
- Technologies that may sometimes also be perceived to be 'problematic' or 'risky', in the sense of building pathology, defects, damages, non-performance etc. during the design, installation or use of the technology.

2.2.4.4 Final selection

On the basis of expert judgement of the team members of WP2, and on the basis of the two criteria mentioned above, the team chose the following ten technologies for setting up a pilot database:

1. Photovoltaic panels (PV's);
2. Ground source heat pumps;
3. Double skin curtain walls / façades;
4. Mechanical ventilation with heat recovery (MVHR);
5. Vacuum-insulated panels (VIPs);
6. Bio-material-based insulation, e.g. straw, hemp, sheep's wool;
7. Paper-based insulation;
8. Rainwater harvesting, including catchment basins & grey water re-cycling;
9. Green or brown roofs;
10. Low VOC materials, e.g. paints, kits & glue;

These technologies are expected to be mature enough, available on the market and commonly applied in most EU-countries. The choice of these 10 technologies was endorsed by the Commission.

2.2.5 Questionnaire and case studies on 10 eco-technologies

The WP2-team has developed a questionnaire that was used for collecting information on the availability of sources on building pathology in Europe. See Appendix 2.2 for the questionnaire.

The questionnaire was also used as a guideline for the team members of WP2 during interviews with relevant organisations (insurers, building inspection services, certification bodies, national agencies, etc.) in several European countries.

The questionnaire was specifically aimed at finding answers on the following key questions:

- To what extent are data on building pathology, especially with regard to eco-technologies, available in Europe; which organisations have databases on defects, damages and their causes?
- Are these data publically available, and/or are the organisations willing to share this data in a European database?

Response

An invitation to complete the (online) version of the questionnaire was sent to 445 organisations within a broad range of businesses/sectors, in 13 EU countries. The WP2-partners sent a personalised introductory e-mail where possible, followed by a survey link, and a reminder where appropriate.

Sometimes no questionnaire was filled in, but a telephone interview was held, and/or information exchanged by email.

At the closing date of 1st October 2012, 70 filled in questionnaires were received, with additional information from 17 interviews/email exchanges. This means a response rate of 20%, which may be considered successful for a relatively 'cold' survey of this nature.

As can be seen from Table 21, the questionnaire had a relative strong UK response rate, since the questionnaire survey was performed by NHBC, who has an extensive network of contacts with UK-based organisations and companies.

Table 21 : Distribution over the countries of the invitation to fill in the questionnaire and the response

	Number of organisations approached	Response with filled in q'naire	Response by phonecall/ email	No response
UK	327	48	0	279
Netherlands	6	3	3	0
Denmark	12	9	2	1
Sweden	8	3	2	3
Finland	3	1	2	0
Poland	5	0	1	4
Czech Rep.	1	1	0	0
Hungary	2	0	2	0
Belgium	36	3	0	33
France	35	1	0	34
Spain	4	0	0	4
Portugal	3	1	2	0
Italy	3	0	3	0
Total	445	70	17	358

Table 22 shows the distribution over the sectors (government organisations, architects, etc.).

Some respondents filled in the questionnaire for more than one eco-technology. This is also shown in Table 22. In total 204 responses for the 10 eco-technologies were received.

Table 22: Distribution of the responses over the businesses/sectors, and number of responses per eco-technology.

Sector	Number of q'naires sent	Number of q'naires returned	Number of responses per eco-technology										
			PV's	Ground source heat pumps	Double-Skin Curtain Walls/ Façades	Mech. Ventila. With heat recovery	Vacuum Insulated Panels (VIPs)	Bio-Material Insu-lation	Paper-Based Insulation	Rain-water Harves-ting	Green and Brown Roofs	Low-VOC Materials	TOTAL
Government organisations	30	2	1	0	2	1	0	1	2	1	2	2	12
Architects	16	3	1	1	0	1	1	0	0	0	0	0	4
Housing organisations	16	8	7	4	0	5	0	0	2	4	0	1	23
Quantity surveyors	2	0	0	0	0	0	0	0	0	0	0	0	0
Manufacturers	74	3	2	1	1	2	3	0	1	1	1	2	14
Retailers/merchants	5	1	0	1	0	1	1	0	0	1	0	0	4
Construction companies	25	6	2	0	1	2	1	0	1	3	1	1	12
Installers	30	3	2	1	0	1	1	0	0	0	1	0	6
Building inspection services	15	2	4	0	2	1	0	2	1	1	3	2	16
Certification bodies	10	4	3	1	3	0	0	5	3	1	4	2	22
Accreditation organisations	4	0											0
Insurance companies	98	10	4	2	2	2	0	3	2	3	4	1	23
Trade associations	34	5	2	0	0	0	0	0	0	0	0	0	2
Professional institutes/universities	28	9	1	0	1	0	0	2	1	0	0	2	7
Consultancies	6	2	0	0	0	0	0	0	0	0	0	0	0
Other	20	3	4	2	0	2	2	3	3	1	3	2	22
Business in more than one sector/unknown	32	9	7	1	3	4	2	4	4	3	5	4	37
Total	445	70	40	14	15	22	11	20	20	19	24	19	204

Case studies

On the basis of the filled-in questionnaires received, WP2-partner NHBC compiled ten case studies.

The case studies are added as separate files to this Final Report in Appendix 2.3.

Each case study describes:

1. Introduction to the technology
2. Available types of technologies
3. The market
4. Some figures on the diffusion in the European market
5. Application of the technologies
6. Characteristics of the industry
7. Construction/installation process, players in the market, actors involved in the design, the production, the delivery, the technical control, the certification, the installation in the building and the operation/maintenance of the technology
8. Organisational and quality aspects (skills, quality marks, professional qualifications)
9. Regulatory aspects, technical regulation
10. Strengths, weaknesses, opportunities, threats of the technology

Conclusions from the questionnaire survey

As stated before, the questionnaire had a relative strong UK response rate. Nevertheless, the 70 returned and filled-in questionnaires enabled us to draw some general conclusions on a European scale, and to assess the available pathology information in the pan-European construction sector on a number of criteria, like:

- informative value;
- potential use for making a pilot database with information on defects/failures of eco-technologies;
- potential use for risk appraisal or other purposes (like building control);
- complementary aspects.

It can be concluded that a detailed EU-database is supported by a significant number of people in the European construction industry; however certain doubts and provisions are expressed:

- It may be hard to gather information on pathology, since the information is often confidential;
- Besides, only few sources collect data on building defects in a systematic manner, and information on defects of eco-technologies is scarce anyway. With some organisations the data collection is very low-key, and only meant for internal knowledge-sharing, or for developing ‘do’s’ and ‘don’ts’, rules of thumb or a description of specific solutions;
- Even if it is possible to gather a sufficient amount of data initially (at the start of the database), the problem will then be to keep the database up to date.

In order for the information provided by the database to be useful, several respondents warned for the fact that the rules, building practices, roles of the authorities, education of people in the construction sector, climatic conditions etc., differ from one country to another.

Manufacturers produce construction products in/for each member state taking into account those diverse conditions, so that for example a typical ground source heat pump installation can be different from country to country.

It means that it will be difficult to transfer knowledge on pathology from one country to another, or even to make the information on pathology comparable. In order to overcome this problem it would be necessary for each technology to describe the specific constructive and climatic issues (for example: how to seal a canvas roof? what are the national standards for green roofs, if any?).

Some respondents also noted that the reasons behind failures of technologies should accurately be reported to enable evidence based decisions to be made.

An overall conclusion is that with appropriate care and due diligence a database could be constructed thereby enabling the EU construction industry to identify (qualitatively, and possible also quantitatively) the potential risk of damage/defects due to or affecting eco-technologies.

The survey found that respondents perceive a significant value in training on eco-technologies. This is a fact where a link with the European Build Up Skills initiative (www.buildupskills.eu) can be established.

The survey has identified details of who holds databases and the type of information collected.

2.3 Needs and criteria to develop an EU database on quality and pathology indicators

2.3.1 Introduction

In this section the information needs and criteria of insurers for a pathology database are analysed. It is mainly based on two workshops with Hannover Re and Allianz France, followed by subsequent interviews with insurance companies and technical inspection service providers, held within Work Package 3 (a.o. FFSA, SMA, MMA, ASEFA, AXA Spain, VHV, see Table 25).

Also a questionnaire survey, conducted within Work Package 3, gave some input.

Firstly the role pathology plays in this underwriting process is described. Then, the way how pathology can help risk insurers with their risk assessment is analysed. A number of existing pathology databases used by insurers are described. This leads to a program of requirements for the pilot database.

2.3.2 Role of pathology in the underwriting process

The underwriting process is described in Chapter 3 (see 3.4.1).

Information on pathology is a key element in the risk assessment by the (re)insurer. It's especially true when the guarantee covers the global activity of an actor.

For innovative products like eco-technologies, statistical data on claims of defects/loss are in most cases not available, so information on pathology cannot be used quantitatively for pricing. For pricing, the (re)insurer uses other methods/sources, or a case-by-case approach.

2.3.3 How can building pathology help insurers in their risk assessment?

The purpose of the EU pathology database for eco-technologies is clear, its main objective being to help insurers in their risk assessment of innovative construction technologies, especially eco-technologies.

But how can the science and knowledge of building pathology help insurers in this process of risk assessment of building processes, actors and products?

The relationship between risk analysis and pathology has been worked out in Appendix 2.4. It can be summarized as follows:

- Building pathology is the systematic treatment of building defects, their causes, their consequences and their remedies. Diagnosis, which is the basic part of the building pathology discipline, is aimed at getting insight in the decay process suffered by the building components: the evolution from a performance to a non-performance condition, identifying the defects/ failures, their causes and effects/consequences.

- Building pathology information may help the insurer in his risk assessment in two ways:

  - *Qualitatively*, by improving the technical knowledge of the insurer on a particular product/technology. The insurer may use this technical knowledge for formulating strategies for conditions for the acceptance of these products/technologies for insurance coverage.
  - *Quantitatively*, by providing statistical information on the frequency/probability of occurrence and the losses, that the insurer may use to do the pricing of a cover, propose guarantees and word exclusions.

To carry out a *quantitative risk analysis*, in order to be able to estimate the risk in financial terms, an insurer also needs information on chances and probabilities (risk = chance X effect). The insurer needs not only the probability of occurrence of a hazard or a defect/failure, but also the probability of the loss or amount of damage which corresponds to the occurrence of each hazard/defect/failure. By combining these probabilities the risk function expressing the probabilities of the different amounts of loss being exceeded can be obtained.

Insurers usually derive these probabilities from internal databases with statistical information from claims. Obviously, the more traditional a building product or a construction technology, the more statistical pathology information will be available. For innovative products/technologies, like eco-technologies, there is less or no historical information available. In this case the pathology information for these products/ technologies can only be used qualitatively.

Besides, the administrative processing of claims in the database of the insurer is usually being performed by legal people of the insurer and not by technical people.

The result is that it is often difficult to make an analysis of the causes of defects, and the defective parts. For technical risk assessment the information from claims is therefore usually not very useful.

That means that the available information cannot be used for calculating risk premiums, but only *qualitatively* for improving the technical knowledge of the insurer on these particular products/ technologies. The insurer may use this technical knowledge for formulating strategies for conditions for the acceptance of these products/technologies for insurance coverage.

2.3.4 Examples of existing databases used by insurers

In Appendix 2.5 an overview of some existing pathology databases is given.

From this comparison it appears that an inspiring example of a database on building defects for insurance purposes is the REX BBC database, that was developed for AQC (France).

The REX BBC survey takes the form of a field investigation aimed to capitalise the 'non-quality' and the 'opportunities for quality' met on each selected building operation.

Data is gathered in-situ by experts during visits of low energy buildings and using meetings with actors who take part in their design, construction or use.

Today, approximately 300 buildings cases are recorded in the REX BBC database. The defects and pathology directory is filled by means of forms, and accessible by means of a website (with a login code and password).

The recorded data is as follows:

1) Operation characteristics,
2) Interview(s) (actor + visit) information,
3) Defect(s) information.

The origins and impacts of recorded difficulties, dysfunctions, damages and defects are described. Corrective solutions and good practices are described too; they represent enhancement tracks for all construction actors.

The REXBBC database offers many functionality levels:

- An input interface to enter the return of experiences of site visits, using a predefined nomenclature;
- A search interface allowing data extraction:
  - by technical lots or elements
  - by origins of defect
  - by impacts
- An administration interface allowing an administrative and technical management of gathering partner accounts and a real time access to statistical description of the operations panel.

REX BBC is an example of a database among others that could well serve the information needs of insurers for *qualitative* risk assessment of innovative products.

In this way the REX BBC database was considered as an inspiring example for developing the Elios2 database (for instance the type of data, the data structure and the presentation of results).

But also other databases were an inspiration for WP2, for example the databases of the Building Defects Fund, the Benchmark Centre for the Danish Construction Sector, or the Technical ABC-list of Woningborg (Netherlands).

2.3.5 Functionalities of the database

The required functionalities of the database, from the viewpoint of insurers, are the result of the following observations:

- For innovative construction products, like eco-technologies, there is a lack of statistical data and claim history available. A quantitative risk assessment is thereby difficult for these technologies. Since there is not enough pathology feedback to be able to extract a statistical law regarding its failure, risk evaluation of innovation has to be made upon specific technical inherent risk assessment. The analyst will have to focus on a predictive failure analysis based on his knowledge of the technology, through a qualitative approach.

- But also for those products/technologies where an extensive claim history exists, insurers are not interested in contributing to a pure statistical database, reporting numbers of claims, since it touches their confidential internal pricing.

- Besides (as has been outlined already in Section 2.4.4) the technical classification of claims for eco-technologies (or for other innovative products or technologies) by the insurer is a problem: it has to be done by experienced staff that can classify the claims, but it is unlikely that most insurers have this expertise or the computational systems to differentiate 'eco-technological' claims from other claims.

- If insurers are not willing or able to provide statistical information on claims, who else can provide it? There are only a few public organisations who collect pathology information in a systematic way, like AQC (France) and the Danish Building Defects Fund (Denmark). But the number of pathology cases for innovative products like eco-technologies collected by these organisations has been very limited up till now.

- Reviewing these problems with the delivery and collection of quantitative pathology data for eco-technologies, preliminary discussions with insurers indicate that they seem to be content with a database that provides pure qualitative technical information on failures/defects of eco-technologies. They can use this information for improving their internal technical knowledge on particular products/technologies, and for formulating strategies for conditions for the acceptance of these products/technologies for insurance coverage.

- That means: a database with only qualitative technical data, and no information on the number of contracts underwritten, and no statistical data disclosure.

- Such a 'qualitative' database could be filled with pathology information from various sources: not only individual pathology cases collected by (semi-) public organisations like AQC or Danish Building Defects Fund, but also information at an aggregated level in the form of Defect Information Sheets, Prevention brochures, papers etc., provided by numerous organisations. Such data, as well as the information from the 10 case studies could be used for the pilot database, to be developed within Elios2.

- Furthermore, discussions with insurers also indicate that they would be interested in another form of exchange of information, namely the creation of an 'eco-technologies Warning procedure' (Procedure d'alerte) for some specific eco-technologies.
  The idea is to be able to gather and communicate the existing information 'rapidly', for a short list of eco-technologies that are commonly used and that have shown some issues during their life-cycle, according to the literature review or to what is known from the building practice. The description of a defect or failure can be very simple.

- Finally, insurers would be interested in a simple directory of quality signs for eco-technologies.

Thus, it becomes clear that the insurance industry would be interested to have a tool with the following functionalities:

1) A database with pathology records, that provides qualitative technical information on the pathology of eco-technologies (without any statistical data disclosure of claims).
2) A 'Warning procedure' (or hazard notification procedure), where interlocutors in each country can report issues/defects.
3) An overview of quality signs for eco-technologies (as an extract from the quality signs directory to be developed within WP1).

The tool to be developed should at least have these three functionalities. We will call this tool: Eco-technologies Quality European Observatory (EQEO).

2.3.6 Information needs of insurers for the database

According to the questioned insurers, the database should in any case contain information on the following items, as part of the description of a certain pathology:

- Information provider
- Name of the construction work or project
- Location of the work
- Type of construction work
- Starting date and end date of the work
- Date of the defect/failure
- Type of eco-technology
- Defect/failure type
- Defective part
- Cause of the defect/failure
- Description of the defect/failure/damage
- Effects of defect/failure (damage, loss to third parties etc.)

If possible, the database should also give information on:

- How to avoid the loss/failure/damage (lessons learned)
- Is the installer specialized in that technology (is it his normal and main activity)?
- Level of innovation involved
- New product on the market?
- Geographical use of the product
- Adaptation to the climate

2.3.7 Framework for a 'Warning procedure'

2.3.7.1 Existing warning procedures

For cases where there is a clear and immediate risk for health and safety, there already exist warning procedures, like RAPEX (on a European level), or national agencies exchanging information on hazardous products, like pharmaceutical or life-science products, or even on construction products (see the example of hazardous Dutch PV-panels in the frame hereunder).

RAPEX

RAPEX (http://ec.europa.eu/consumers/safety/rapex/index_en.htm) is the EU rapid alert system that facilitates the rapid exchange of information between Member States and the Commission on measures taken to prevent or restrict the marketing or use of products posing a serious risk to the health and safety of consumers with the exception of food, pharmaceutical and medical devices, which are covered by other mechanisms. Since 1 January 2010, as regards goods subject to EU harmonisation regulation, the system also facilitates the rapid exchange of information on products posing a serious risk to the health and safety of professional users and on those posing a serious risk to other public interests protected via the relevant EU legislation (e.g. environment and security). Both measures ordered by national authorities and measures taken voluntarily by producers and distributors are reported by RAPEX.

Netherlands Food and Consumer Product Safety Authority (NVWA) warns for flammable solar panels
Newsflash of 19/2/2013[12]: "The Netherlands Food and Consumer Product Safety Authority (NVWA) warns against certain types of solar panels of the brand Scheuten (model Multisol). In these solar panels there is a faulty electrical connection that is flammable. These solar panels have caused in other European countries at least 15 roof fires. In the Netherlands, approximately 15,000 of this type panels are placed. These solar panels have a fire hazard, but have, so far as known, not caused fire.
The solar panels are dangerous because a cable in the junction box behind the solar panel makes a poor contact with the Printed Circuit Board (PCB). This may cause sparks and can make the housing of the terminal box damage, melt and smolder. Then sparks can skip to the roof and cause fire. This risk increases as the sun gets stronger and as the solar panels age. The NVWA gives this security warning, because the trustee of the bankrupt and responsible business fails to do this. To warn the public also an advertisement will appear in three national newspapers.
People, who have dangerous solar panels on their roof, are advised to switch off the panels safely."

[12]www.vwa.nl/actueel/nieuws/nieuwsbericht/2030101/nvwa-waarschuwt-voor-brandgevaarlijke-zonnepanelen

2.3.7.2 Warning procedure for insurance purposes

The disadvantage of the aforementioned warning procedures like RAPEX, for insurers is that the system does not alert for other issues not related to health and safety, i.e. situations where significant costs may be incurred. Insurers have another (or at least a broader) scope of view. Insurers are of course mostly interested in risks where (potential) physical damage is involved, leading to claims.

Contrary to the RAPEX system referred to above, the warning procedure that insurers are interested in, should report on chances on an accident, a defect or a failure, and the detrimental effects thereof (in financial terms), i.e. on risks:

- Failure description
- Occurrences thereof
- Consequences

Given the reasoned reluctance of the insurance industry to make statistical data available, the number of occurrences is not going to be introduced. One may ask: how relevant is such data if the number of occurrences is not part of the system that generates warnings?

To prevent every new pathology case from being considered a risk, it requires an expert opinion to determine whether a case is to be considered sufficiently important, taking into consideration that the alert is intended for pan European use.

Responsibility for issuing such an alert should, in the view of the Elios 2-team, therefore be given to an expert committee that brings together technical knowledge about construction products/technologies, pathology and available competence among construction actors for all EU member states.

If the intention is to have an alert system, it should in any case introduce the possibility of collecting data allowing to filter out 'priority' cases, i.e.

- Cases where there is a clear and immediate risk for health and safety;
- Cases where there is a clear and immediate risk for severe economic damages (one such case may lead to significant direct or indirect damages);
- Cases where there is no clear and immediate risk for health and safety and/or severe economic damages (you need a lot of such cases to arrive at cases where health and safety are impaired or at a significant economic damage).

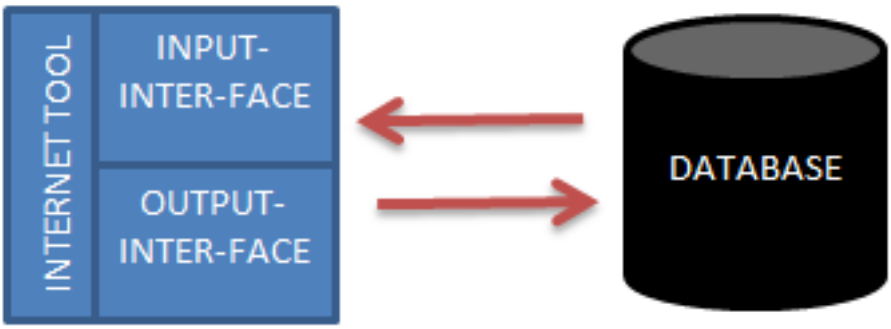
This 'filtering' would reflect the perception of the data provider, which does not necessarily mean that the experts evaluating the data would agree, but such information would allow the experts to take notice of priority cases first.

2.4 Setting up a format for the database, validation and data requirements

2.4.1 Introduction

A database has an input side (with input fields) and an output side (to extract results from the database), facilitated by a web tool. See Figure 10.

Figure 10 : Scheme of database / web tool

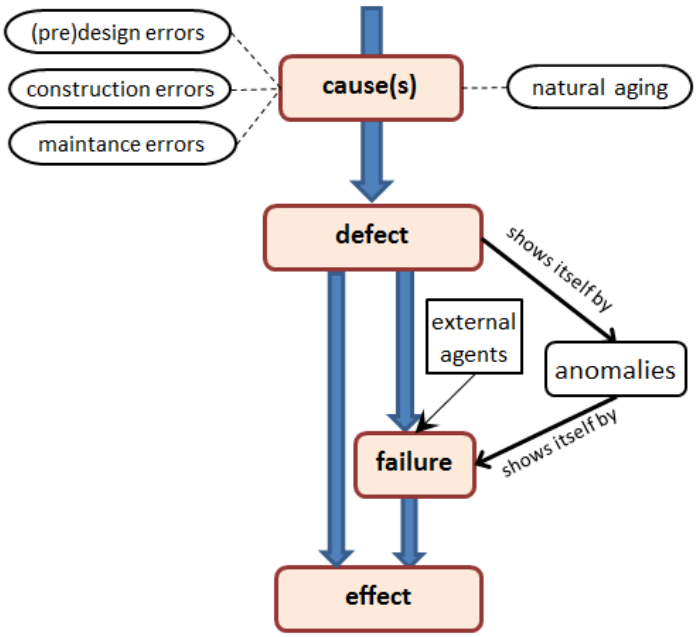


At the basis of the design of the pathology database is the description of a pathology case. This is analysed in Section 2.4.2. The output side, with a detailed search function, is described in Section 2.4.3.

2.4.2 The input side: description of a pathology case

A pathology case is structured according to the following cause-defect-failure/effect chain (Figure 11).

Figure 11 : The cause-defect-failure/effect chain in a pathology case (adapted from CIB W086 1993)



The core elements in this description are ‘defect’ and ‘failure’:

A *defect* is a situation where one or more building components do not perform its/their intended function(s); it implies a shortcoming in respect of some normative or perceived standard or requirement. For example: a crack in a partition wall. The type of defect may vary widely; from a minor crack to a major crack. Defects are caused either by natural ageing or by errors or omissions (arising from imperfect human activities) during different stages of the building process.

A *failure* is a situation in which a specific required function cannot be fulfilled any longer. For example: a minor crack in the wall may to lead to loss of an aesthetic function, a major crack may imply the collapse of the wall and so the termination of the required use.

Defects can either remain in a latent form, or manifest themselves by the action of *external agents*. Interaction between external agents and defects is the necessary condition for the manifestation of the decay as failure. The failure of building components can be structural, i.e. loss of certain physical, chemical and technological characteristics. Or it can be performance failure, i.e. the drop of the initial performance level below an established acceptable limit. Or – most commonly – it may concern both aspects.

As a consequence of the failure, the *effec*t (damage, injuries, non-functioning etc.) appears at the end of the process. But also a defect without a failure can lead directly to an undesirable effect.

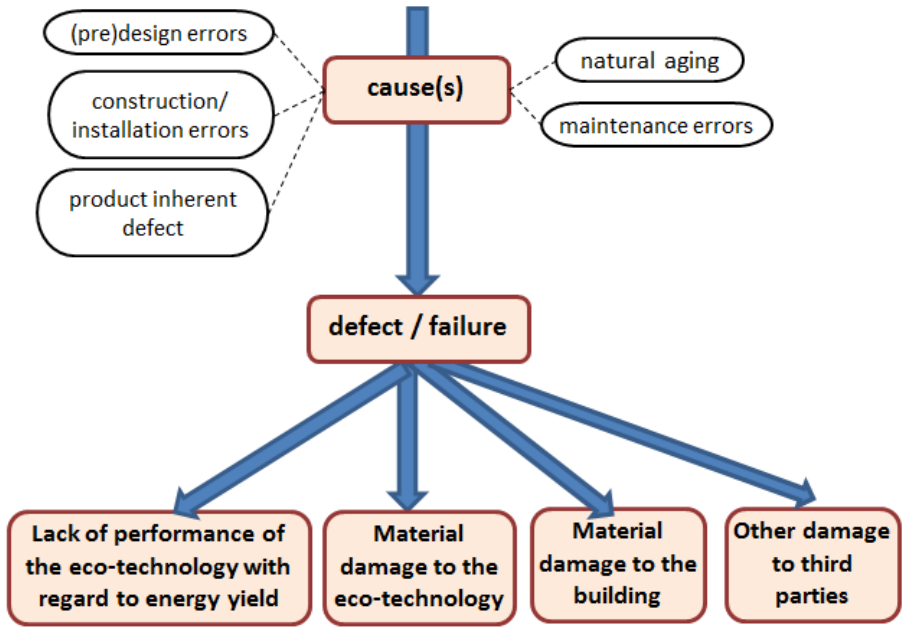
The *defective building component* can be the same as the *failed building component* (like in the example of the crack in the partition wall leading to collapse of the same wall), but they can also be different.

For example: a crack in a facade wall, leading to water leakage entering in the electrical system behind the wall, causing a failure of the electricity system.

Ideally, all these elements are known from a certain pathology case, and can be specified in the input fields. But in many cases, only a general description of the pathology is known. Therefore, also a field ‘general description of the pathology case’ is included.

The diagram can also be depicted as follows (combining defect and failure, and adding the typical insurance effects) (Figure 12):

Figure 12 : Simplified cause-defect/failure-effect scheme with four typical insurance 'effects'



2.4.3 The output side: search functionality of the database

Search functionality

A multi-criterion search facility is available on the public part of the pathology web tool. All the criteria are provided with a default value and this default value can be easily set by user (Figure 13).

Figure 13: ***Search form, where the criteria for selecting the pathology cases can be specified***

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In the following table you can specify the criteria for selecting the pathology cases:

items	*= /≥ ≤*	*selection criteria*	*remark*
Type of eco-technology - category	=	predefined categories, plus empty field for free search text	all eco-technologies by default
Specific type of eco-technology		*free search text, for example *insulation**	
Countries where the construction work of project were executed	=	predefined categories	all countries by default
Geo-climatic character of the location of the construction work or project	=	predefined categories, plus empty field for free search text *free search text, for example *facade**	all geo-climatic characters by default
Type of construction work	=	predefined categories, plus empty field for free search text *free search text, for example *office**	all construction works by default
Works/projects executed between .... and	≥≤	≥ 01-05-2010 ≤ 01-07-2012	default selection: ≥ 01-01-1970 ≤ present
Date of the defect/failure	≥≤	≥ 01-01-2011 ≤ 01-12-2011	default selection: ≥ 01-01-1970 ≤ present
Type of defect/failure	=	predefined categories, plus empty field for free search text *free search text, for example *warranty**	all defects/failures by default
Defective/failed building component	=	Predefined categories	all components by default
Consequences/effects of the defect/failure	=	Predefined categories	all conseq. by default
Cause of the failure/defect	=	predefined categories, plus empty field for free search text *free search text, for example *installation**	all causes by default
Quality signs involved	=	Predefined categories selection on specific type of quality sign: *name of the sign*	all signs by default
Lessons learned	=	*free search text, for example *control**	

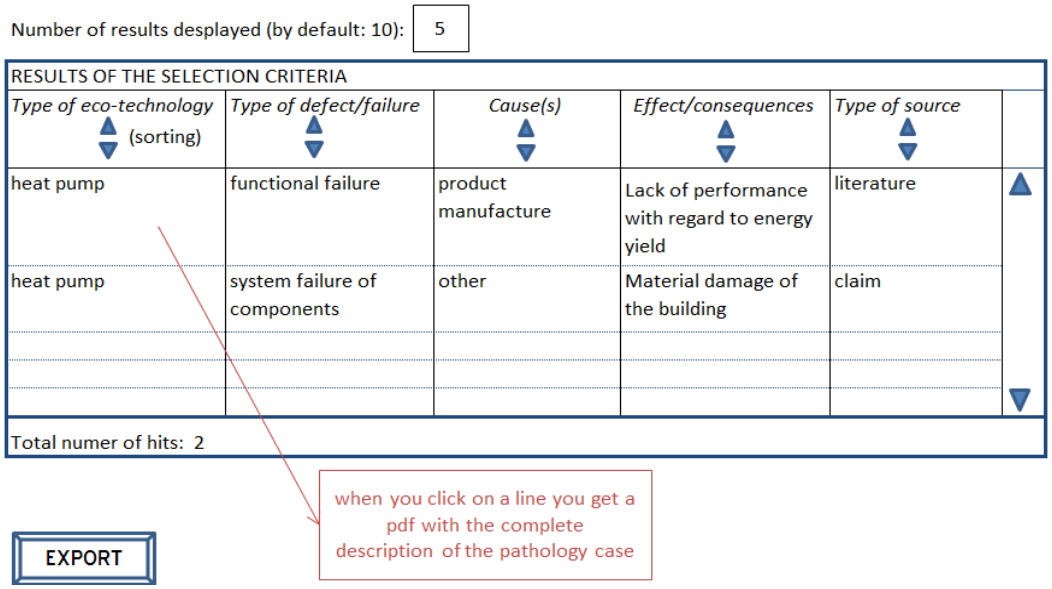
OK

Result of the selection of pathology cases

In the result screen (Figure 14), the following data are displayed:

- Type of eco-technology
- Type of defect/failure
- Cause(s)
- Effect/consequences
- Type of source

Figure 14 : Results screen



Detail view of a pathology case

A certain pathology case, appearing in the result screen, can be viewed in detail. See Figure 15 for an example.

2.4.4 Validation of the proposed pathology database architecture

On the basis of the Needs of the Insurers, described in Section 2.3, and the functionalities described above, the format for the database architecture has been worked out. See Appendix 2.6 The proposed database architecture has been validated by introducing the information from two pathology cases into the database:

- Flammable solar panels with a fire risk;
- Cellulose insulation with addition of ammonium salts, with a fire and health risk.

The database architecture should at least permit introducing information considered relevant for its purposes. The conclusions of the validation are:

- The two cases could be introduced without major difficulties.
- A few improvements were suggested and reported.
- The informatics requirements for the database could be finalized, on the basis of which the pilot database can be developed.

2.4.5 Definition of the informatics requirements for the pilot database

The specifications for the pilot database and the internet device are elaborated further in Appendix 2.6

Figure 15: The cause-defect-failure/effect chain in a pathology case (adapted from CIB W086 1993)

Name of information provider: NHBC
Date of filling in this pathology record: 2013-12-13
Source
Type of source for the description of the pathology case: Inspection report
Name/title of the source: www.greentower.uk
Construction work where the eco-technology is installed and the defect/failure occurred
Name of construction work or project: The Green Office Tower
Country or countries: UK
Town: London
Geo-climatic character: Near the coast
Type of construction work : New / Office building / high intrinsic technical risks
Starting date of the work : 2010-01-01
End date of the work : 2012-01-01
Has the construction work or project been completed? : yes
Was there a completion survey: yes
If yes, what was the date of the completion survey? 2011-12-30
Technical Inspection Service (TIS) contracted?: no
Eco-technology
Type of eco-technology involved in the defect/failure: PV-panels
Specific type of eco-techology: Superimposed PV panels
Description of the defect/failure
General description of the pathology: defective power supply caused fire
Type of defect/failure: System failure of components
Defective building component: Other: power supply
Failed building component: Other: PV-panel
Type of consequence/effect: Material damage to the building
Was the defected product repaired or replaced?: Not yet
Has the cause of the defect/failure been analysed, or is it known?: Yes
If yes, what has been the cause (global or in detail)?: Construction/installation problems
Other, please describe the cause:
Quality signs and qualifications
Were there quality signs in place at time of construction?: yes
Type of quality sign related to the ecotechnology: Products and competences
Name of quality sign: Qualibat, Avis Technique
Is the contractor/installer specialized in that technology? : 5-10 years of experience
Lessons learned: Don't know
Other comments or remarks:

2.5 Develop, test, validate and update the pilot versions of the database

In May 2014 the web tool with access to the pathology database became operational and online: http://pathologydirectory.elios-ec.eu/pathologies/index.

The database offers:

- an input interface (to enter the information from pathology cases in a number of input fields using a defined nomenclature),
- a search interface allowing data extraction by type eco-technology, type of defect/failure, type of construction work etc.
- an administration interface allowing an administrative and technical management of gathering partner accounts;

The ambition was to populate the database with at least 30 pathology cases for three eco-technologies (PV-panels, bio-based insulation material, heat pumps), so 10 cases per eco-technology.

The three eco-technologies were chosen on the following criteria:

- They are clearly identifiable in order to avoid technical uncertainty about their field of application.
- They are widespread across Europe in order to be relevant to the observatory.
- They are sensitive in the sense that the study led up till then has enabled the detection of existing claims or of the possible risk of claims concerning this field.

The cases were provided by the project partners (NHBC, CSTB, SBi, ARCADIS, TSUS), from a variety of sources:

- The ten cases on eco-technologies, performed by the WP2-team as part of Elios2;
- Public internet sources;
- Collected experience from test institutes, research institutes, insurance federations.

From Table 23 it can be seen that this ambition has been achieved. At present 64 cases were recorded in the database, representing experiences with defects and failures of four eco-technologies in 10 countries.

Table 23 : Number of eco-technologies and covered by the pathology cases

Eco-technology	*Number of pathology cases*	*Countries covered*
Heat pumps	19	Ireland (3x), UK (1x), Bulgaria (1x), Poland (1x), Spain (1x), France (5x), UK (10x), Netherlands (1x)
Insulation made of bio-materials, like natural fibers	20	Denmark (2x), France (7x), UK (8x), Netherlands (2x), Czech Rep. (1x), Sweden (1x)
PV-panels	24	Greece (1x), Spain (1x), France (11x), Germany (1x), Netherlands (3x), Denmark (1x), UK (9x),
Solar hot water	1	Poland (1x)

Some findings from the process of populating the database:

- The pathology cases were mostly derived from collected experiences and lessons-learned. Hardly any detailed project-related pathology could be found.
- The field most often used in the database was: “general description of the pathology”. A number of input fields were not used.
- The distinction between defect and failure in the description of a pathology case, is - and remains - difficult.
- Some recommendations were given for the future improvement of the database.

After the population, the operational and filled database was validated by representatives of the insurance sector and technical inspection services from the project team, as well as from the forum members. These representatives confirmed the relevance of the choices made by the project team, and expressed their support for the database’s architecture, functionalities and contents. They also showed interest in a future consolidation by means of a further population. This confirmed the relevance of the choices made by the project team.

2.6 An assessment of the functioning of an Eco-technologies Quality European Observatory (EQEO) and of the options to be envisaged for their maintenance and exploitation after Elios 2

2.6.1 Introduction

In Section 2.3.5 it was concluded from the views of representatives of the insurance industry that insurers would be interested in a web-tool, that we have called Eco-technologies Quality European Observatory (EQEO), offering, as the most prominent feature, a database with pathology records, that would provide qualitative technical information on the pathology of eco-technologies (without any statistical data disclosure of claims).

Although it was not part of the Terms of Reference to work out a complete operation and business model for this Observatory, some elements for the possible future set up and maintenance of an EQEO will be highlighted in this chapter. We will do this by means of the ‘9 building blocks’ of the ‘Business Model Canvas’ of Osterwalder & Pigneur (2010).

These 9 ‘building blocks’ refer to:

- Customer segments
- Value propositions
- Channels
- Customer relationships
- Revenue streams
- Key resources
- Key activities
- Key partnerships
- Cost structure

2.6.2 Customer segments

The 'Customer Segments' define the different groups of people or organizations that the EQEO aims to reach and serve.

Insurers (or companies working for them, like brokers or loss adjusters) are the prime customer for pathology information.

But pathology information may well be of interest to all building participants, like: regulations and code makers, designers, contractors, implementers of quality assurance systems, insurance companies, building inspectors, planners, 'educators', etc.

Indeed, several existing national pathology databases serve a broad range of building practitioners, so it could be expected that also a European pathology database could expect a broad interest.

2.6.3 Value propositions

'Value Propositions' describe the bundle of products and services that create value for a specific Customer Segment.

Examples of values that an EU-pathology database could offer:

- Giving access to information on pathology cases presented in a uniform way, enabling construction practitioners to identify and assess the potential risk of defects/damages due to or affecting eco-technologies on a European scale (instead of a national scale). This can be interesting for, for example, a contractor working abroad, or an insurance company that has to assess the risk of foreign technologies;
- Providing a 'Warning procedure' (or hazard notification procedure), where interlocutors in each country can report issues/defects;
- Providing an overview of quality signs for eco-technologies;
- Providing a tailored risk analysis of certain eco-technologies for specific customers;
- Research institutes could quickly investigate the transnational joint pathologies. A national research centre on construction materials and products gave us the following example (not an eco-technology):

  "Since 2009 we have noticed a huge increase in loosening of top layers on concrete floors. Initially, the insurance covered such pathologies, but this did not last. More and more contractors started losing a lot of money because of the claims. It has taken our Institute quite some time to become aware of the situation in surrounding countries like Germany and France. In France, a similar pattern developed, both in terms of pathology and the intervention of the insurers. Through an international database, it might have been possible to contact AQC and others faster to initiate a pilot study and there would have been room for a qualitative and quantitative comparison (e.g. comparison of used concrete specifications, ...)."
- Pathology information sheets with 'lessons learned' could serve a broad range of customers, for example education or training institutes. Already a large number of institutes and organisations in Europe provide such information sheets.

2.6.4 Channels

The 'Channels' describe how the EQEO-organisation communicates with and reaches its Customer Segments to a deliver a Value Proposition.

Since the EQEO is principally a web tool, the most obvious 'channel' is the internet. But then there are several possibilities: a standalone website, or a partner-owned website, for example in collaboration with insurers federations or research institutes.

In order to communicate and reach the potential customers, the internet website of the EQEO should also be able to:

- Give information on the products and services offered by EQEO, and the accompanying Value Propositions;
- Deliver Value Propositions to customers;
- Provide customer support.

2.6.5 Customer relationships

The Customer Relationships describe the type of relationships the EQEO-organisation establishes with specific Customer Segments. The following categories of Customer Relationships can be distinguished for the EQEO:

- Personal assistance (human interaction)
- Dedicated assistance (e.g. 'key-account' managers serving specific Customer Segments, like insurers, training institutes, research institutes);
- Self-service (the customer can help himself by means of the website)
- Automated services (e.g. personal online profiles give access to customized EQEO-services)
- Communities (e.g. online communities, allowing exchange of knowledge and solve each other's problems; the 'warning-procedure' or 'hazard notification procedure' discussed previously is an example of such a insurers community);
- Co-creation (e.g. customers can assist in giving content to the EQEO).

2.6.6 Revenue streams

The Revenue Streams represent the cash the EQEO-organisation generates from each Customer Segment. Revenues minus costs create earnings or profit. That is: in case the EQEO is set up as a commercial organisation, depending on external revenues from customers.

There are several ways to generate Revenue Streams with an EQEO:

- Usage fee: each customer pays a fee for access to the database. The more a service is used, the greater the revenue streams.
- Subscription fees: customers buy (monthly or yearly) a continuous access to the database.
- Consultancy fees: customers pay for certain products or services delivered by the EQEO organisation, e.g. publications, pathology information sheets, risk analysis, etc.

In case of a non-profit, or non-commercial, organisation, with free public access to the database, there should be a permanent stream of financial contribution by a benefactor (sponsor), for example a federation of insurers, public stakeholders, and/or the construction industry.

Of course, also a combination of commercial revenues with a permanent contribution by a benefactor is feasible.

External revenues from customers could be minimized when the customers themselves collaborate in the operation of the EQEO, for example by providing the EQEO with pathology cases for free. Such a model can be characterized as 'give and take': the partners can only have access to the information as long as they provide *x* number of pathology cases each year.

A variation on this model is when the sponsor demands from its contractors to deliver pathology cases. For example: in case the European Commission is the main sponsor, it could stipulate in contracts for certain technical studies, commissioned by Commission, that the contractor should include useful information on pathology of eco-technologies into the database.

2.6.7 Key resources

Key Resources describe the most important assets required to make a business model work.

For the EQEO, the Key Resources are:

- Physical: for example a database infrastructure, and maybe an office facility for a secretariat.
- Intellectual: for example partnerships with other providers of pathology databases.
- Human: for example technical experts, or building inspectors, working for the EQEO.
- Financial: for example financial contributions or guarantees by sponsors or funders.

2.6.8 Key activities

Key Activities describe the most important things a company must do to make its business model work and to operate successfully. Like Key Resources, they are required to create and offer a Value Proposition, reach markets, maintain Customer Relationships, and earn revenues.

Obviously, the Key Activities depend on the business model chosen.

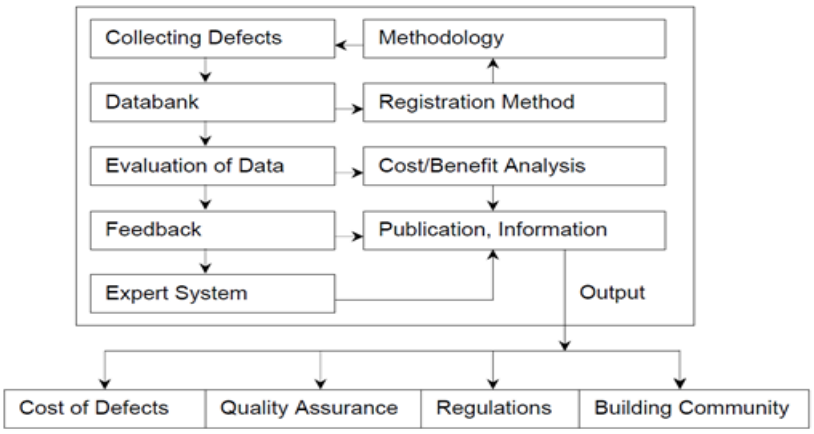
For example, when the EQEO has the ambition to offer general and broad use of the pathology database, granting access to any interested organisation or person on a European scale, some conditions ought to be fulfilled in order for it to be successful as an information centre:

- It requires a systematic feedback and processing from experiences and pathology knowledge. This leads to the necessity of collecting, recording and evaluating data, to cost/benefit analysis and to providing information to the users.
- Reporting and registration must be based on a clear view of the use that will be made of the processed information (or in other words: 'input' and 'output' conditions must be clearly related); this condition is emphasized to avoid costly activities only for the sake of collecting data;

- The quality of the pathology data (input and output) should be secured. Before pathology data can be used by insurers (or other interest groups in the building sector), they must be sure that that data is relevant and not accidental. That means that the data must be evaluated and processed by technical experts to select only the relevant data. The relevancy of the data depends on a number of factors, such as:
    - importance of the defects/failures (health and safety, significance of the technical and economic damage);
    - indication of the occurrences of the defects/failures;
    - likelihood of the defects/failures continuing to occur in future;
    - indication that the defects/failures have a European significance, that means that the defects/failures (might) occur in several EU-countries.

The framework for such a general (broadly used) database has been given by the CIB Committee W086 in their State-of-the-art-report of 1993 (Figure 16).

Figure 16: The method of application of experiences from building pathology and using expert knowledge in a database (from CIB W086, 1986)



The system illustrated may be divided into two important parts:

- The top part (collecting data, database, registration method, methodology) is aimed at continuously improving information gathering;
- The bottom part (evaluation of data, feedback, expert system) is aimed at:
    - evaluation of data and establishing whether data is useful;
    - establishing a technical expert analysis;
    - publication of information and making it available.

2.6.9 Key partnerships

Key Partnerships describe the network of suppliers and partners that make the business model work.

Four different types of partnerships are distinguished:

- Strategic alliance between non-competitors, e.g.:
  - Agence Qualité Construction (France), Building Defects Fund (Denmark), NHBC (UK) as examples of national interlocutors for providing pathology information;
  - ENBRI (European Network of Building Research Institutes);
- Cooperative competition ('coopetition'): strategic partnerships between competitors, e.g. competing insurance companies;
- Joint ventures to develop new business, e.g.: commercial publishers of pathology sheets or pathology working together with Technical Inspection Services bureaus;
- Buyer-supplier relationships to assure reliable supplies, e.g. contracts with TIS bureaus to deliver pathology data (in an anonymised form)

2.6.10 Cost structure

The Cost Structure describes all costs incurred to operate a business model.

Costs incurred obviously depend on the definition of the Key Resources, Key Activities and Key Partnerships. Typical cost centres for the operation of the EQEO database are indicated in Figure 17.

Figure 17 : Typical cost elements for operation of a pathology database

- Collection of defects
- Inspectors?

- Secretariat
- Database manager
- Reviewing methodology and registration method

- Evaluation and analysis of data
- Making publications/ disseminating information;

2.6.11 Four possible business models

On the basis of the 9 building blocks for generating business models for a future EQEO, described in the previous paragraphs, four models can be thought of:

1. Operation on a non-profit basis with free public access;
2. Operation on a commercial basis with paid access;
3. Operation on the basis of a mix of commercial – non-profit;
4. Operation on a 'give-and-take' basis with limited access to a group of partners

1. Operation on a non-profit basis with free public access

The non-profit set up is characterized by free public access.

In this non-profit model a permanent (virtual or real) European working group is organized and maintained that studies and analyses pathology information for the database, selects data that has a European relevance and that is technically and economically significant and at least supports the dissemination of the information. It could be supported by inspectors all over Europe, who visit building sites and have in situ interviews on issues regarding 'non-quality'.

Such a working group could be established for example by the ENBRI institutes (European Network of Building Research Institutes) in collaboration with AQC and the Danish Building Defects Fund.

This group of organisations, institutes and experts comprises sufficient technical competence and presence throughout Europe.

At least some of the ENBRI members collect and/or evaluate pathology information at the moment, but as far as we know, there is no ENBRI structure that permits studying pathology cases at a European level. An example on a national level is the PATORREB pathology catalogue supported by eight Portuguese universities (www.patorreb.com)

This model would require a permanent stream of financing at least a secretariat (who manages the database), the external consultants, and the providers of information. Possible funders are:

- Federations of insurers;
- Other stakeholders of the construction industry or the research world;
- The European Commission;

An option is also to organize the working group at a European level within the Joint Research Centre[13], comparable to the NREL (National Renewable Energy Laboratory) in the USA[14]. NREL offers for example a pathology database on PV modules[15].

As proposed before, a possibility is that the European Commission prescribes that certain European Studies on eco-technologies share their knowledge by filling the database with research conclusions.

In a more modest set up, an option is also not to have a EU pathology database filled with pathology cases, but just to have a European web platform where pathology information sheets, studies on eco-technologies etc. are published, with an aggregated analyses of pathology experiences.

[13] The JRC provides independent scientific and technical advice to the European Commission to support European Union policies. It has seven scientific institutes, laboratories and research facilities.

[14] The National Renewable Energy Laboratory (NREL) is the United States' primary laboratory for renewable energy and energy efficiency research and development. NREL is a government-owned, contractor-operated facility, and is funded through the U.S. Department of Energy. This arrangement allows a private entity to operate the lab on behalf of the federal government under a prime contract. NREL receives funding from Congress to be applied toward research and development projects. NREL also performs research on photovoltaics (PV) under the National Center for Photovoltaics. NREL has a number of PV research capabilities including research and development, testing, and deployment.

[15] http://www.nrel.gov/pv/performance_reliability/failure_database.html

2. Operation on a commercial basis with access on a subscription basis

In this model the database is managed by a market party (for example a publisher), on a pure commercial basis.

The pathology cases could be delivered by a number of expert bureaus who receive a fee for each case. The market party gets his revenues by subscriptions or a usage fee for entrance to the database. Depending on the business model, there is a full or only limited moderation by the market party of the cases before they are published.

There are several national examples of such commercial databases, like the NBD Bouwgebreken of SDU Publishers (Netherlands), (http://bouwgebreken.sdu.nl/bouwgebreken), or 'Schadis – Die Datenbank zu Bauschäden' of Fraunhofer Institut IRB (Germany) (www.irb.fraunhofer.de/schadis/).

3. Operation on the basis of a mix of commercial – non-profit;

In case a fully non-profit set up (with free public access) is not reachable, a part of the activities of the EQEO can commercially be exploited. This is how for example Agency Qualité Construction (AQC) in France operates.

AQC is an association that aims to prevent building defects and promote quality in construction, and is financed by the contributions of its members (governmental and professional construction organisations including insurers associations). AQC has both free and paid services/publications as well as some services that are only accessible for its members.

4. Operation on a 'give-and-take' basis with limited access to a group of partners

In this model the pathology information is provided by a limited group of partners, for example insurance companies, AQC, Danish Building Defects Fund. The partners have a contractual agreement with a separate organisation that operates the database.

Only the partners have access to the information in the database.

This model is thus characterized by 'give and take': the partners can only have access to the information as long as they provide *x* number of pathology cases each year and give financial contribution for the organisation that operates the database.

2.6.12. Weighing the four business models

In Table 24 the 4 business models sketched in the previous section are weighed (with + or -), against three criteria:

1. Access (free public access, or limited access);
2. Scope (number and extent of pathology data, prescription of specific constructive and climatic issues in order to make pathology info comparable, aggregation of pathology data);
3. Cost (high cost, low cost).

A prerequisite is that in all models the quality of data is guaranteed meaning:

- The input data is evaluated by independent technical experts to select only that data which is relevant and have a European significance (it would be irrelevant for a European database to use information that is only relevant at local or national level).
- An aggregated analysis of the output data (that can be used to make publications, Defect Information Sheets, lessons learned).
- A systematic feedback and processing from experiences and pathology.

Table 24 : Weighing the four business models for the operation of an EQEO

	Access	Scope	Cost
Model 1: Operation on a non-profit basis.	++ (free public access)	++ (can be as broad and extensive as the sponsors want)	- (no revenues)
Model 2: Operation on a commercial basis.	- (paid access)	+/- (scope depends on commercial revenues)	++ (profit-based)
Model 3: Operation on the basis of a mix of commercial – non-profit;	+/- (some services for free, others against a fee)	+ (scope depends partly on commercial revenues)	+/- (partly profit-based)
Model 4: Operation on a 'give-and-take' basis	-- (limited access to a group of partners)	+/- (scope is limited to, and depending of the input of the partners)	++ (low costs to collect data)

It is clear that, from the viewpoint of accessibility and scope, model 1 would be preferred. But from the perspective of cost, model 3 would be a good alternative.

2.7 Conclusions and recommendations

2.7.1 Conclusions from the WP2-study

Quality in construction for insurers

1. Building pathology can be considered as the appearance of lack of quality (or 'non-quality') of construction works. The causes of 'building pathology' can be very wide, most of them resulting from human actions or imperfections. In the context of this study, 'non-quality indicators of construction' are in fact statistical indicators of a large set of building pathology data.

Building pathology data for eco-technologies from literature

2. An analysis of the available literature (monographs on building pathology, research papers and scientific journal papers) makes clear that research and new knowledge on deterioration and remedial work of ancient work and traditional building methods, is much more prominent than building pathology knowledge of new (eco-)technologies.

However, the defects of some eco-technologies like photovoltaic panels, insulation products or wind turbines have been studied for a number of years and received some attention in studies by research institutes or insurance federations.

Building pathology data from insurers and national organisations

3. It is hard to gather comprehensive, reliable and exhaustive information on pathology, since the information is often confidential. Insurers are generally sceptic about sharing information since their knowledge and claims data is the result of research and expertise, which is the basis of competition between insurers. Insurers would therefore in principle only be passive users of a future pathology database.
4. Besides, only few organisations collect data on building defects in a systematic manner, and information on defects of eco-technologies is scarce anyway. With most organisations the data collection is very low-key, and only meant for internal knowledge-sharing, or for developing 'do's' and 'don'ts', rules of thumb or a description of specific solutions.
5. There are a few national organisations that have already established systems to regularly collect information, like AQC (France), Danish Building Defects Fund, NHBC (UK) or Woningborg (Netherlands). But they gather this information only for a specific purpose and for their local market. They don't seem to be very interested in pathology information from other countries. Besides, these organisations often do not collect information on the level of individual technologies.

Relationship between risk assessment by the insurer and building pathology

6. Building pathology information may help the insurer in his risk assessment in two ways:
   - *Qualitatively*, by improving the technical knowledge of the insurer on a particular product/technology. The insurer may use this technical knowledge for formulating strategies for conditions for the acceptance of these products/technologies for insurance coverage.
   - *Quantitatively*, by providing statistical information on the frequency/probability of occurrence and losses, that the insurer may use to do the pricing of a cover and propose guarantees.
7. For innovative products/technologies, like eco-technologies, there is less or no historical information available from claims. Besides, the administrative processing of claims in the database of the insurer is usually being performed by legal people of the insurer and not by technical people. The result is that it is often difficult to make an analysis of the causes of defects, and the defective parts. For technical risk assessment the information from claims is therefore usually not very useful.
8. That means that pathology information on innovative products/technologies (available in the market or with the insurer himself) cannot be used quantitatively, but only qualitatively.

Needs from the insurance industry

9. The insurance industry would be interested to have a tool with the following functionalities:
   - A database with pathology records, that provides qualitative technical information on the pathology of eco-technologies (without any statistical data disclosure of claims).
   - A 'Warning procedure' (or hazard notification procedure), where interlocutors in each country can report issues/defects.

- An overview of quality signs for eco-technologies (as an extract from the quality signs directory to be developed within WP1).

Pilot database

10. On the basis of the needs and requirements of the insurers, a pilot database was developed, and made accessible on the internet. The database offers:
    - an input interface (to record the information from pathology cases in a number of input fields using a defined nomenclature);
    - a search interface allowing data extraction by type of eco-technology, type of defect/failure, type of construction work etc.;
    - an administrative interface allowing an administrative and technical management of gathering partner accounts.
11. The pilot database was populated with 64 pathology cases, representing experiences with defects and failures of four eco-technologies in ten countries. From the process of populating the database with pathology cases, it appeared that the distinction between defect and failure is, and remains difficult in practice. In fact, the field most often used in the input interface was "general description of the pathology".
12. During the validation phase of the pilot database, some recommendations were given for the future improvement of the database.

Support for an Eco-technology Quality European Observatory (EQEO)

13. From the questionnaire and interviews with representatives of construction organisations and insurers, it appeared that an EQEO, and a detailed pathology database (such as the pilot database) as most prominent part of it, is supported by a significant number of people in the European construction industry. For example, Insurance Europe has expressed that they "*support the objective of increased availability and exchange of information on a cross-border level, and believes that the EQEO could be the right platform for such exchange* (…) *It has the potential to improve the quality and availability of the information for insurers and other stakeholders in the construction sector dealing with eco-technologies on a regular basis. Such data-gathering initiative should also help reduce knowledge deficits during the underwriting process (i.e. when insurers assess the risk)*"[16].

    However certain doubts and provisions are expressed by interviewees and Insurance Europe:

    - It will be hard to gather information on pathology (which is in line with our own findings in populating the pilot database);
    - For builders and insurers to have an accurate picture of the situation at EU level, the database will have to contain information from a widespread geographical area. However, the factors and data used for risk assessment can strongly differ among member states because of local regulations, building practices, roles of authorities, education of people in the construction sector, climatic conditions and geographical needs. It means that it will be difficult to transfer knowledge on pathology from one country to another, or even to make the information on pathology comparable.

[16] Letter of Insurance Europe to the European Commission, 3 June 2014

In order to overcome this problem it would be necessary for each technology to describe the specific constructive and climatic issues.

- Even if it is possible to gather a sufficient amount of data initially (at the start of the database), the problem will then be to keep the database up to date.

2.7.2 Recommendations

From the study, and the development and population of the pilot database, it has become clear that there is a lack of exchange of information at the European level on the pathology of eco-technologies.

There are several possibilities to improve the situation with different levels of ambition:

1. *European Working Group on Sustainable Construction Technologies*

To boost the uptake of innovative eco-technologies, and associated risk insurance schemes, the European Commission could establish a dedicated European Working Group on sustainable construction technologies, organizationally accommodated within the Joint Research Centre, and comparable to the NREL (National Renewable Energy Laboratory) in the USA. Such a Working Group should focus on "giving creative answers to today's sustainable development challenges", conducting fundamental science, coordinating the results of European technical studies initiated by other DG's, sustainable construction analysis, validation of new products for the commercial market, and collection and dissemination of pathology information for the European construction industry.

2. *Eco-technologies Quality European Observatory (EQEO)*

Second in ambition would be to establish an EQEO, with a pathology database as central part, but including other functionalities as a 'Warning procedure' (or hazard notification procedure), an overview of quality signs for eco-technologies, training modules, etc.

Paramount for an EQEO to be successful in the long run is that a solid and continuing funding of the activities of the EQEO is secured from committed stakeholders (federations of insurers, or other public or private stakeholders from the construction industry or the research community). This funding could be combined with commercially exploited services employed by the EQEO. We recommend that a solid business model on this basis (funding by stakeholders supplemented with commercial exploitation by for example a publisher) is worked out further, including probing the further commitment of potential stakeholders.

3. *Existing web-portals of the European Commission*

If options 1. and 2. are not feasible, a more modest set up would be to have an EU web-tool, where Defects Information Sheets, studies on eco-technologies, etc. can be stored in a simple catalogue or library, perhaps supplemented with an aggregated analysis of pathology experiences and with links to other website (e.g. RAPEX).

Such a web-tool could for example be the Build Up web-portal (www.buildup.eu) or the 'European Build Up Skills Energy Training for Professionals' (www.buildupskills.eu).

4. *Exploit the results from EU research project on construction materials and eco-technologies*

EU research projects could be a valuable source of information on building pathology, and could therefore be a useful input for the EQEO and/or other means of exchange of information on pathology. To be able to exploit the results of future EU research projects, an option is to include a clause in the grant contract of such projects, demanding that, at the end of the project, the project team should provide the European Commission with the relevant pathology research data resulting from the project.

5. *Organizing meetings for insurers for the exchange of pathology information*

For the insurers and other interested parties, a first sept in the direction of an exchange of pathology information at a European level, would be to organize meetings, whereby national experiences on defects and failures on certain eco-technologies can be discussed.

CHAPTER III – WORK PACKAGE 3

3.1 Introduction

3.1.1 Expectations and objectives

Work Package 3 mainly deals with one of the objectives of the call for tender: *"Analysis of the conditions for a greater convergence or mutual recognition of the construction insurance regimes and identification of the criteria and the modalities for the development of insurance schemes that could support cross border services and the cover of building sustainability performances."*

This will include among others:

- *Policy formulation about the role, the regulatory framework and the financing of construction insurance within the context of national strategies for energy and climate change and national plans for energy efficiency in building;*
- *An analysis of the position of construction insurance in comparison with other mechanisms for the protection of investor's interest;*
- *Identification of information needs about construction insurance within the framework of article 21 of the Services Directive 2006/123/EC, together with concrete proposals for on-line information tools for construction enterprises and ad hoc advice to "Points of single Contact";*
- *Assessing good practice and the criteria/modalities for new schemes that could support cross border services and the cover of building sustainability performances, including the proposal of concrete schemes;*
- *Updating the mapping of insurance regimes in the EU-27 based on the information gathered during the Elios pilot project."*

3.1.2 Methodology

The actual final report chapter is the synthesis of six different deliverables, as specified in the call for tenders. Accordingly the chapter 3 is divided into six parts, as follows:

- 3.2: Update of the mapping of insurance regimes in the EU-27 made in Elios 1 pilot project
- 3.3: Review of different mechanisms that exist to protect investors' interests
- 3.4: Information needs about construction insurance
- 3.5: State of the art of insurance schemes in the EU-28 and transition paths
- 3.6: Analysis of conditions for greater mutual recognition of construction insurance regimes
- 3.7: Recommendations for policy formulation

The complete text of the corresponding deliverables can be found in the appendixes. Considering its specificities, the update of the mapping was carried out differently from the rest of the work-package deliverables.

Table 25: Work program and methodology used

Activities and Methodology used
1: Update of the mapping
Information necessary to update the mapping made during Elios 1 was gathered through four different channels along the whole study:
Insurance Europe A first general tool was the creation of a questionnaire, spread through the different insurance federations by Insurance Europe. This approach has been very deceiving, proving a very low rate of return, with a great variability in the answers for a same country, depending on level of knowledge of the persons filling in the questionnaire. The questionnaire can be found in the Appendix.
Allianz As a subcontractor of work-package 3, Allianz's main task was to update the mapping gathering information from its own internal network of branches on local markets. After receiving answers to the questionnaire from almost all its surveyed 17 branches, Allianz identified three countries subject to noticeable changes. A focus on these countries has been made in order to make the final mapping update.
Hannover Re As leader of WP3 Hannover Re was in charge of retrieving information from the insurance companies through two channels: - Hannover Re's internal network of construction underwriters, which has been notably used to gather information on the Scandinavian insurance markets and to edit the new Croatia's regime, which has then be validated by a specialized lawyer. - During direct meetings with insurers, as for other deliverables (see hereafter)
Apave In order to deepen their understanding of the way the Technical Inspection Control operates throughout the European countries, and plot the similarities and differences between them, APAVE first made a Questionnaire and then contacted directly competent resources in 14 countries. Considering the importance of Technical Inspection in the insurance underwriting process, the information gathered by Apave has been integrated in a new paragraph in the Mapping of the concerned countries, in order to extend its content and share this information.
2. Other deliverables
Hannover Re Regarding the study in general, meetings were held directly with major national companies in western countries with important construction insurance markets. Following meetings have been carried out: For France: FFSA (French insurance federation); MAF (architects federation); CAPEB (SMEs federation); Allianz (general insurer and sub-contractor of work-package 3); SMA (construction insurance specialist); MMA (general insurer) For Spain: ASEFA (construction insurance leader); AXA Spain (general insurer); Allianz Spain (general insurer) For United Kingdom: NHBC (home warranty insurance leader); Allianz UK (general insurer) For Germany: VHV (construction insurance leader) with specialized construction lawyer; HDI Gerling (general insurer) The objective of these meetings with the insurers is to deal with WP3's topics especially; however they also address the questions of quality signs and pathology. Agenda of these meetings can be found in the Appendix.

Were also met the major construction reinsurers, which was the opportunity to take advantage of their global point of view: SCOR (one of the leaders in IDI covers) Munich Re (leader in Engineering covers) Regarding more general regulation framework we contacted and obtained answers from: European Insurance and Occupational Pensions Authority (EIOPA) European Commission - DG Market and DG Enterprise Regarding the energy performance guaranties specifically: - We participated in January 2013 to a conference organized by the FFB (Fédération Française du Bâtiment 2013) - We visited in February the Green Office Meudon, the first major French positive energy building, developed by Bouygues Immobilier (Smartgrids - CRE 2011)
SBi To further pinpoint the characteristics of national regimes of construction and insurance and develop the analysis in terms of providing a sound foundation for the policy recommendations the following work was undertaken: - Overview of construction regimes and business systems and theories on transition paths. - Three qualitative case studies representing archetypical (construction) regimes has been conducted as a part of the horizontal analysis. The analysis is based on the following countries: France, UK and Denmark . Thus the number of case studies of insurance regimes and transition paths were limited to one example representing each of the distinct construction regimes identified. - A work plan and proposal for the execution of the vertical analysis. This part highlights the methodological approach as well as data sources applied. - Conclusions form the study for discussion and verification in the project group.
Apave Apave has also actively taken part in the editing of the description of the TIS role in the “information needs about construction insurance” deliverable.

3.2 Update of the mapping of insurance regimes

Based on the information gathered during the ELIOS pilot project mapping, this study first updated the information about the current different construction insurance regimes in force in the EU-28.

In a second time, this description of the legal framework has been extended to the Technical Inspection Services (TIS) in the countries were information could be collected.

The complete mapping of the 28 European community member states can be found in appendix.

With the final objective of sharing valuable information between the actors of construction insurance the information presented should give answers to the following questions for the selected countries:

- What are the legal requirements in order to define the local risks of operation?
- What guarantees are mandatory or requested by the market? What is covered?
- What are the existing technical inspection services? Are they supporting insurance activity?

3.2.1 Selected construction insurance schemes

Considering in first place the object of the study, i.e. eco-technologies, and according to the tender, we chose to ignore in our assessment property insurance guarantees such as household / home and content insurance or Construction All Risks (CAR) insurance.

Those guarantees protect from risks that are not necessarily linked to inherent defects of the construction work (i.e. caused by the construction work itself), but rather to causes that are external to the work, and therefore do not deal with the technologies themselves, all the more innovative ones, object of this study.

The study will focus essentially on liability insurance, whether general Third Party Liability (TPL), Professional Indemnity (PI) or long term Inherent Defect Insurance (IDI).

Considering the purpose of the study, i.e. access to insurance for SME's, we also chose to ignore guarantees taking place before handover (completion of construction), that are widely common and not closely linked with the technology itself.

Therefore the Third Party Liability guarantees taking place during construction is not assessed. Manufacturers' product guarantees are also ignored for the same reasons.

The existing tax incentives will be further surveyed and more generally the regulatory framework regarding incentives for sustainable constructions, with the difficulty that these incentives can change from one day to the next.

Considering this scope for the study, we will focus our analysis toward the following guarantees, on its post completion part regarding Third Party Liability (Insurance Europe Publications 2012):

- Third Party Liability (TPL)
- Professional Indemnity (PI)
- Inherent Defect Insurance (IDI)

In order to clarify the content of those guarantees, hereafter are some general definitions:

Third Party Liability (TPL)

TPL is a liability that covers bodily injury and/or material damage caused by the insured, whether individuals or corporations, to a third party as a result of action or inaction, or negligence, and which injury and/or damage must be remedied.

Professional Indemnity (PI)

PI insurance, also called professional liability insurance, is a form of third party liability insurance that protects professional advice and service-providing individuals and companies from bearing the cost of a negligence claim made by a client, and damages awarded in such a civil lawsuit.

The coverage focuses on alleged failure to perform on the part of, financial loss caused by, and **error or omission** in the service or product sold by the policyholder. These are potential causes for legal action that would not be covered by a more general liability insurance policy which addresses more direct forms of harm.

Inherent Defect Insurance (IDI)

IDI is a long-term insurance covering damages to the construction which result from an inherent defect discovered after completion and after the owner has taken over the property.

> *Inherent Defect*: any defect in the structural works which is attributable to a defect in design or workmanship or materials.
>
> Structural works: all internal and external load bearing elements essential to the stability and strength of the premises (including subsidence / heave of the soil).

While those guarantees rely on the same basis, they may have differential characteristics depending on their local implementation. Thus, we may find the following cases:

- Existence of different liability regime based on legal or contractual obligations
- Possible choice of an applying legal framework that is different from the framework of the Member State of the insured, considering the non-application of the "overriding mandatory provision" to insurance, according to the "Law applicable to contractual obligations (Rome I)"(European Parliament and of the Council 2008) in Article 7 - Insurance contracts, Article 9 - Overriding mandatory provision
- The regime can be based on fitness for purpose obligations or duties of care. Within the same regime, the obligation can change depending of the type of insured (e.g. fitness for purpose for contractors and duties of care for designers)
- Insurance can be compulsory or not
- Scope of the guaranties :
  - Type of construction works concerned (by the law)
  - Amount covered / possibility to limit the indemnity
- Legal definition of "handover" or "date of completion", determining the time limits of the guarantees.
- Length of the guarantees (IDI can be of 5 to 12 years long)
- Liability based on no fault or on proven fault, determining where the burden of proof lies
- Exemption clauses
- With or without recourse on responsible entities
- Claim management: claims made or risk attaching bases
- Legal delays for claim management
- Limitation period to activate the guarantees

3.2.2 Classification of the different situations

In order to focus our analyses we classified the insurance regimes by different legal frameworks situations and insurance situations.

Based on the ELIOS "overview of national liability and insurance systems in 27 EU Member States", we can already draft two important categories of situations: countries where an Inherent Defect Insurance (IDI) long term cover is widespread or even mandatory and other countries, with no post completion covers or very limited covers.

Countries with "widespread" IDI:

Belgium	Denmark	Finland	France	Ireland	
Italy	Latvia	Netherlands	Spain	Sweden	UK

Other countries:

Austria	Bulgaria	Cyprus	Czech Republic	Estonia	
Germany	Greece	Hungary	Lithuania	Luxembourg	Malta
Poland	Portugal	Romania	Slovakia	Slovenia	

It is also interesting to point out that the existence of IDI on a market is disconnected from the national legal schemes. Thus we only encounter a legal compulsory system in the following countries:

Denmark	Finland	France	Italy	Latvia	Spain

While in the following ones the insurance is voluntary:

Ireland	United Kingdom	Netherlands	Sweden (since summer 2014)

3.2.3 Construction Insurance Market

Beyond the presence of IDI covers, as supported by the "State of the art of insurance schemes in the EU-28 and transition paths" analysis, it appears that one of the main criterion to distinguish the situations is the general development of the country, whether it be from its economic wealth point of view or the size of the insurance markets based on an historic development of quality in construction.

This assumption is notably based on the fact that insurance is expensive and that insurers are mainly interested by what they call mature markets where wide spread products can generate profits. If more emerging markets might be of interest for an insurer it is by their growing potential, but never at the expense of a limited and controlled risk (achieved through limited guarantees).

This development criterion is reflected at a European level by a clear distinction between western and eastern countries. Eastern countries seem to rely on simple liability with limited covers while western countries implemented more extended covers like IDI (with the notable exception of Germany and Austria which developed a specific set of responsibilities in order to achieve quality in construction).

As already underlined, within western countries, each country seems to have very specific insurance schemes, mostly around IDI covers.

Hence a 2nd criterion of classification seems to be the type of IDI coverage those countries have historically developed through their custom practise of insurance.

Interestingly beyond our acknowledgement of independency between legal framework and existence of IDI, we observe that compulsory insurance does not necessarily means widespread subscription of IDI by the public. Italy is in this regard a good example, while theoretically IDI is compulsory on housing, the market stays very small. On the contrary Spain's market is now nearly inexistent because of the economic situation and not the consumers' behaviour.

From a market size point of view, retrieving valuable information proves to be particularly difficult considering:

- Responses from the 17 branches of Allianz showed that there is a discrepancy between the countries on the availability of the information. Most of the countries have no information available. Others countries consider that the information is private and not public. Finally a very few published figures are available, while provided figures in the questionnaires didn't seem to be reliable.
- Databases do not provide comprehensive information. For example the database of the OECD: Construction insurances (PI or TPL) are mixed with the General Liability. It is therefore impossible to distinguish or separate the features according to the type of insurance.
- Partial complementary information is available regarding Architects and Engineers PI insurance, at the European level, from private sources (Finaccord 2013). Nonetheless, even though ten European countries are studied (Austria, Belgium, France, Germany, Italy, the Netherlands, Poland, Spain, Switzerland and the UK), and that one of the 12 defined categories is architecture and engineering, the indicated gross written premium of EUR 2,313.8 million is not split. Information regards Engineering at large, without any specific distribution between CAR/EAR (warranty during construction works) and IDI, PI or TPL (liability warranties) on the other hand.
- Annual reports of insurers do not provide detailed information, lines of business are summarized in a limited number of main lines of business: Motor, Property, Liability, Specialty lines.

Available accurate figures of main European non-life insurance markets (Insurance Europe Publications 2014) show that:

- In comparison, with its historic leadership regarding IDI, France maintain a level of direct premium of 2 500 M€ (FFSA 2014)
- The UK Home Warranty market is still the second biggest IDI market, with premiums in the 200 M€/year
- The IDI Spanish direct premiums were 364 M€/year in 2007 (ICEA - Investigación Cooperativa entre Entidades Aseguradoras y Fondos de Pensiones 2008), and progressively dropped down due to the economic situation, to reach 25M€/year in 2014
- Italian IDI market is generating an insurance premium of around 20 M€/year, even though the guarantee is compulsory
- Regarding IDI, from an absolute value point of view, the other IDI markets are not in the same order of magnitude. Nonetheless, Scandinavian markets are quite developed.

Comparison of other construction guarantees premium level, mainly TPL and PI, is impossible considering the absence of distinct information for construction guarantees. Historically, all Third Party Liabilities were mixed altogether (automobile, products …) and insurance federations cannot retrieve breakdown figures for the different lines of TPL. It is very often even mixed with property figures (Insurance Europe Publications 2014).

3.2.4 General Update Results

Since their mapping during the ELIOS study, European construction insurance regimes have been subject to significant changes in some countries.

We can especially identify the following evolutions:

- Croatia joined the European Union the 1st July 2013. As its departure from a communist political regime to an independent republic only occurred in 1991, Croatia's construction legal regime and insurance practice are still very young and therefore limited. In addition, the construction sector suffered dramatically from the post 2008 credit crunch and government fiscal deficit.
- The Swedish compulsory IDI cover has been cancelled the 10th April 2014. However, even though the obligation disappeared, insurers don't seem to be very pessimistic regarding the evolution the insurance demand.
- Spain insurance market is still expecting to see the extension of its compulsory IDI with a three year cover for "habitabilidad". This delay is certainly linked to the current bad shape of the local construction industry.
- In Austria, as of 1st August 2013, the mandatory insurance for master builders and developers, real-estate agents and real-estate administrators must cover not only persons and property, but also financial losses.
- In the Netherlands, the Ministry of the Interior is working on a new "private building control" to be contracted by the building partners. The law is foreseen to be enforced in 2015.

Therefore, we can perceive that even though there is a willingness to extend the covers and sometime enforce compulsory systems, the bad economic conditions, are probably holding back those evolutions.

3.2.5 Links with single points of contact

As expressed in the Services Directive 2006/123/EC:

> *"(48) In order to further simplify administrative procedures, it is appropriate to ensure that each provider has a single point through which he can complete all procedures and formalities (hereinafter referred to as 'points of single contact'). […]*
> *Art. 21 […] Where appropriate, advice from the competent authorities shall include a simple step-by-step guide.*
> *Information and assistance shall be provided in a clear and unambiguous manner, shall be easily accessible at a distance, including by electronic means, and shall be kept up to date. […]"*

In other words, each country should provide accessible information notably about insurance subscription on its territory through a point of single contact.

One of the major difficulties in providing centralized information regarding insurance through this "single points of contact" is that the requirement of the service directive applies to "the competent authorities" of the countries. It is the governments that must provide information, about all procedures, including insurance. Consequently the insurance federations are not directly involved in the procedure, but rather subcontractors providing information to feed the "single points of contact".

Another difficulty is linked with the large array of information to be provided: actors of the construction sector amongst many other providers of services, access to insurance through many other procedures and formalities.

Hence, even though the list of "single points of contact" can actually be found on the related European Commission internet site (European Commission 2015), the information provided by the governments regarding insurance suffers some serious problems of clarity and readability for non-specialists. Some drawbacks were already pointed out in an EC study called "*The functioning and usability of the Points of Single Contact under the Services Directive - State of Play and Way Forward*", Deloitte and Tech4i2, 21/01/2012 (European Commission - Directorate General for Internal Market and Services 2012).

In fact, to our knowledge, companies prefer to contact insurers or insurance federations directly without knowledge of this access tool or of the linked national information. Nonetheless, from the Elios2 perspective, the EC internet site is a great opportunity of providing centralized access to information about insurance throughout Europe. We therefore recommend sharing and promoting this internet resource (Appendix 3.6).

3.3 Financial mechanisms for protection of investor's interest

Apart from insurance as described in the mapping, other financial mechanisms essentially regard energy performance.

3.3.1 Energy performance guarantees

True Energy Performance Insurance can be found through Energy Savings Insurance (ESI). Nonetheless this type of protection is apparently no yet developed in Europe. May 2010 EC report (European Commission - Directorate General JRC 2010), specifies that:

> *"ESI is a formal insurance contract between an insurer and either the building owner or third-party provider of energy services. In exchange for a premium, the insurer agrees to pay any shortfall in energy savings below a pre-agreed baseline, less a deductible. Pricing is typically expressed as a percentage of energy savings over the life of the contract, although it is sometimes expressed as a percentage of project cost. The premium is paid once, in the first year of operation.*
> *Such policies are non-cancellable, so the owner is guaranteed to have access to the insurance for the originally agreed contract term.*
>
> *Energy saving insurances typically insures annual savings expectations (a "volumetric" approach). Energy-savings insurance can reduce the net cost of energy-saving projects by reducing the interest rates charged by lenders, and by increasing the level of savings through quality control. […]*
> *ESI is widely practiced in Canada and in the US; in Europe the global market of risk transfer is slowly growing up, but insurance products such as ESI are still limited. In the US several insurance companies already offer ESI, which traditionally has been used to guarantee power reductions at retrofitted buildings. State governments have led ESI efforts, with several requiring such insurance from firms that provide energy management services in state-owned facilities."*

If Energy Savings Insurance (ESI) is an insurance protection, other forms of contractual financial protection exist, commonly referred to as Energy Performance Contracts (EPC):

> *"An EPC is a performance-based procurement method and financial mechanism for building renewal whereby utility bill savings that result from the installation of new building systems (reducing energy use) pay for the cost of the building renewal project. A "Guaranteed Energy Savings" Performance Contract includes language that obligates the contractor, a qualified Energy Services Company (ESCo), to pay the difference if at any time the savings fall short of the guarantee."* (EUESCO 2011).

Indeed EPCs looks very attractive since for the customer the cost of the improvements' investment is paid back from the savings, while the risk of the savings falling short is bared by the ESCo (Sustainable Energy Authority of Ireland 2013).

It is clear that the EPC market is essentially aimed to the industrial and corporate buildings, where:

- The construction process is often a Build-Operate-Transfer (BOT) project type, where design, construction methods and building operation (including maintenance) are totally integrated and assessed as a whole (from the very beginning of the project).
- The energy use of the building is organized, with a defined range of "normal activity". Single users' behaviour have nearly no impact on the effective energy consumption, hence performance, of the building.

Therefore this type of protection doesn't totally satisfy one of the underlying goals of the Elios2 project which is to promote eco-technologies' activity, including when intended for housing.

Even though, as stated out here before, apart from self-financial protection, i.e. auto-insurance, at this stage of the study, Energy Performance Guarantees appear to be the only existing non-insurance general protection in Europe.

On the other hand, the need for an equivalent insurance protection grows rapidly in conjunction with the development of Energy Performance Contracts throughout Europe (ENHR 2011), at the moment, pure insurance offer seems to fail in its attempt to cover completely these new requirements.

We will see in following paragraphs the reasons underlying this situation and where non insurance solutions exist.

After discussion with different actors of the market, Energy Performance Guarantees appear to be currently almost inexistent in the European insurance market.

The only real existing European performance guarantees concern specific equipment: essentially photovoltaic panels. The following cases could be identified:

- Solar Insurance & Finance - Solarif (Solarif 2015);
- Munich Re offer, but it concerns a few selected very large industrial PV panels manufacturers.

Even though these insurance offers may appear as a success, it remains focused on a specific system and can hardly be extended to a whole construction. The problem of insuring performance of a building is far more complex and represents a huge challenge as we will see in the following paragraphs.

On the other hand, some brokers tried to implement some specific guaranties on the installation of efficient boilers within private renovation works, but it apparently did not find commercial success, mainly because of a lack of the demand from the consumer.

Otherwise, we can see the development of some guarantees on the equipment malfunctioning (e.g. on PV panels), or machinery breakdown (MB), with possible business interruption (BI) extensions, but not on real performance guarantees.

3.3.2 Guarantee of Conventional vs. Real performance

Conventional performance is the theoretical performance of a construction work, based on the technical characteristics of the construction, under standard conditions of use (set of usage rules and maintenance requirements made by the designer).

It has to be opposed to the real effective performance of the building, expressed by the real energy consumption or production of the building. This performance is achieved according to the behaviour of the user, which depends on its own definition of what is normal, for instance in terms of perceived comfortable temperature or aeration of the rooms.

While the design and construction of the building is based on a conventional performance, the achieved performance is partly based on outstanding variables, behaviour of the user and effective climate conditions for example.

The Conventional Performance requirements are met if certain materials are used and follow a set of implementation rules. Therefore the effective real performance is not a requirement and can hardly be a factual objective in construction works where performance depends on the user's behaviour.

3.3.3 Measuring the energy performance

The 2010/31/EU (European Parliament and of the Council 2010) directive which aims to increase building energy performance requires from the state members to develop a calculation method in order to assess energy performance regarding the "energy performance of a building" (European Renewable Energy Council 2015).

By definition these theoretical tools rely on a very simplified appraisal of the real energy performance of a building not taking into account some important components of energy consumption (such as appliances). Therefore they give results that can be quite far from real life results, even though they are absolutely consistent with material and mechanical laws.

The existence of various tools increases even more the gap between theoretical design rules used to build and the effective consumption.

The question therefore becomes: what type of energy performance can be insured? Is it possible to insure the gap between expected performance and observed performance?

If achieved, real performance can be simply measured by real energy consumption; it is not a desirable insurance product, since it does not cover inherent performance of the construction work. On its side, conventional performance still needs a standard framework that could assess material, design and workmanship of the construction work.

Considering the link between the energy performance and the equipment of the construction (notably HVAC) or the maintenance of the envelope/equipment of the building, the duration of the warranty has to be adjusted consistently with the lifespan of these elements.

3.3.4 Existing financial energy performance guarantees

Outside insurance protection, the only Energy Performance guarantees that could be found is aimed at office buildings, where:

- The final use of the building can be defined and foreseen independently from personal behaviour.
- The performance management systems are implemented from the very beginning of the project design, integrating all building actors as a whole. The different compounds of the final performance of the construction work, i.e. materials (products), design and workmanship must be assessed by the different responsible actors on common grounds. It has to be an integrated approach with operative problematic in mind.

In order to bypass the lack of guarantees from the private sector, some governments decided to encourage energy performance improvements through public financing, thus doing ESI and taking the risk of failure of the investment:

Germany:	KFW Bankengruppe (KFW 2015)
United Kingdom:	The UK Green Investment Bank plc (Greeninvestmentbank 2015)
Belgium:	Fedesco (Fedesco 2015) (for public buildings)

At a municipal level, Berlin City also carried out an Initiative through its Environmental Improvement Programme (EIP) (European Foundation for the Improvement of Living and Employment and Working Conditions 2000).

3.4 Information needs about construction insurance

This third study will present the construction insurance underwriting process in general, highlighting its specific information needs. Notably, it will try to clarify the main risk assessment principles and the role of the Technical Inspection Service in this process.

3.4.1 Construction Insurance Underwriting Process

The following description will present the general construction insurance underwriting process. As already mentioned, considering an innovative technology framework, the insurer cannot use his standard risk underwriting procedure which is based on statistical data on claims records and therefore profitability. The process is here based on a case by case approach, leading to specific insurance terms and conditions.

For instance, the presented different phases could take place following a request made by an owner who builds a work which includes an innovative technology, such as geothermal piles, and wants an Inherent Defect Insurance for his building.

The underwriting process usually includes the following phases:

1 - Insurance Application

The client, in our case the owner, may directly contact an insurer or ask for the help of a broker, in order to obtain the best insurance conditions from the market. If it's the case, it will then be the broker's mandate to adapt the insurance request to his client needs, collect and present the technical information to the insurers and in the end to compare the insurance offers. The broker will usually make a request to various insurers in order to obtain better conditions.

In all cases, it remains the policyholder's entire responsibility to provide to the insurer the proper and complete declarative information about his risk. In case of a claim, a misrepresentative risk statement could lead the insurer to deny (partially or totally) the cover.

2 - Global Check

From here on the underwriting process takes place inside the insurers walls.

First of all, the insurer will verify that the request complies with his general guidelines, which define the general scope of insurer's operation. Construction insurance being very particular, requiring very specific underwriting competences and possibly including a long tail financial exposure (e.g. IDI), the insurer will first verify if the type of cover fits into his portfolio (e.g. no IDI without recourse on TPL insurance). He will then often check for the type of construction (e.g. no offshore windmill). He also verifies that the amounts to be covered fit with its financial capacity. Consequently, the request may be rejected or could also be forwarded to a more competent department (e.g. Corporate Solutions).

Therefore, depending on their market position, some insurers may only cover small, typical construction works (e.g. dwellings), that do not use innovative construction techniques or technologies.

In order to do this global check, insurance companies usually use a standard checklist.

3 - Level of Interest

Based on the economic context and its internal policy, the insurer will then appraise its level of interest to provide such cover.

For example, if the project or contract is very small, the insurance company might not be interested to provide insurance, in order to prevent relatively high administrative costs. The selection criteria are logically closely linked to the insurers risk portfolio structure, such as:

- Administrative costs, including the expertise needed to study and cover a particularly market or risk;
- Risk appetite, depending on the type of cover and type of construction work (specific profitability criteria notably based on loss experience);

- Risk appetite, depending on the market conjecture and the insurer's financial conditions (e.g. necessity to develop or reduce the turnover of a class of risk / insurance line);
- Solvency requirements designed to ensure an insurer's financial capacity (subject to Solvency II EU directive requirements);

If the client also passes this acceptance stage, the insurer will do a specific risk assessment

4 - Detailed risk assessment

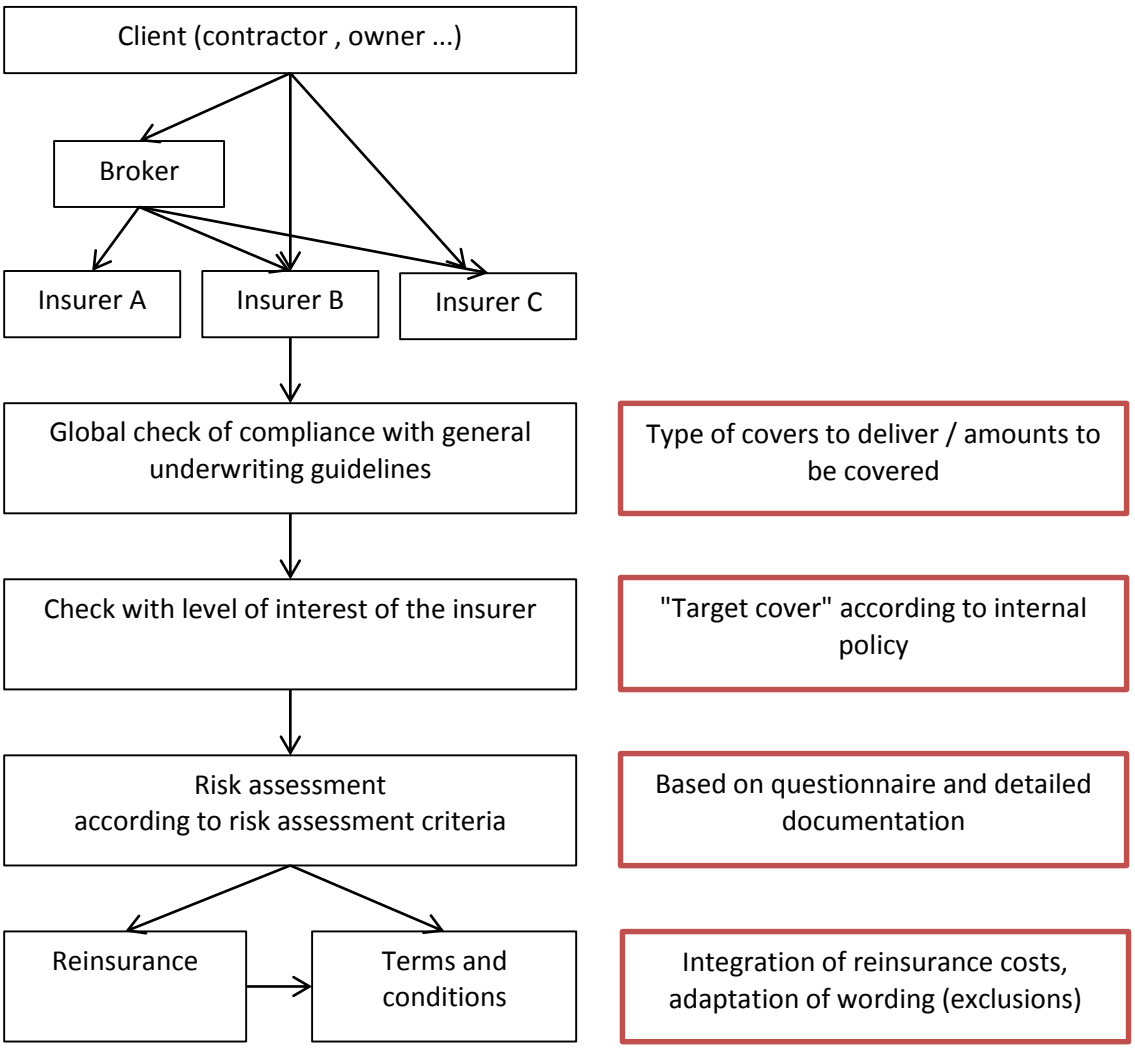
As presented more thoroughly in the corresponding section, based on his technical knowledge, the insurer will appraise qualitatively his technical risks for this specific project. He will also determine a level of exposure.

5 - Terms and conditions

Depending on his reinsurance treaty conditions, the insurer may need to take into account specific reinsurance terms and conditions in order to make its own offer. The reinsurers underwriting process follows the same stages as those of the insurer.

Based on his risk analysis, the insurer will adapt his offer's terms (e.g. by excluding some risks), and conditions (e.g. by limiting some cover extensions), taking into account his reinsurance cost. In accordance with the risk assessment, the insurance premium will of course also take into account aggravating factors coming from technical conditions.

Figure 18: The underwriting process



Therefore the insurance companies define their insurance guidelines and interest in regard of their global strategies and experience of the field. As free players in the market, the insurance companies are in their own right to use any non-discriminatory technical criteria, in accordance with regulation, notably the Services Directive.

3.4.2 Risk assessment principles

Considering innovative technologies, the risk assessment cannot rely on historical statistical data about claims and must rely on a qualitative prospective approach. Therefore, based on their knowledge in construction risk assessment and their experience, the technical inspector, the insurer and the reinsurer analyst have to qualify the risk according to various criteria, focusing on known pathology, and on failure cost and probability of occurrence.

This risk assessment is directly related to the type of insurance. Therefore there is not an unique risk assessment but various ones depending on the type of insurance, the policy (annual cover of per risk cover), and the risk itself.

During the underwriting process, the client usually needs to provide to the insurer additional specific technical information.

3.4.2.1 Risk assessment criteria

Regarding single covers (specifically linked to a construction work), the risk assessment made by the (re)insurer will globally deal with the different topics described hereafter:

a) Construction scheme

- Type of construction. Some risks are specific to technologies used in certain type of constructions. For example HVAC systems are critical for hospitals, where nosocomial disease is a risk.
- Nature of the work (new works / rehabilitation / turnkey project). The adaptation to an existing context is a source of interface risks.
- Intended use of the construction (to be sold / operated by the developer). The implication of the owner as a great impact on the care taken on the design phase, thus on the operating risks.
- Adequacy of planned maintenance
- Owner / developer experience and know how on this type of project
- Expected use of the construction by the owner (quality level requirements / opportunity of claiming the guarantees)
- Level of complexity / innovation. By definition the insurer hates prototypes, for which he lacks vision
- Surroundings (level of exposure) for the Third Party Liability assessment (damage to third parties).
- Cost of construction. Cost breakdown is an important tool to appraise the level of standard / quality expected.
- Involvement of a Technical Inspection Service

b) Natural event context (to be analysed even if not covered)

- External loads taken into account:
  - Weather exposure (wind / snow / rain);
  - Water intake (groundwater uprising / flood);
  - Earthquake loads.
- Design in regard of natural events :
  - Level of design loads in regard of specific national standards (national annex to Eurocode);
  - Necessity of further studies (ex: modelling) made by external engineering firm (cross check);
  - Type of stress assessed in the design in the light of the risks to cover (thermal gradient, fatigue).

c) Materials

- Conformity of materials/products with standards for critical elements (to be checked by TIS during construction);

- Quality of elements assembled in different countries and with different material origins (problems of consistency, tolerance, compatibility, common and shared regulations, to be checked by TIS during construction);
- Welding control (on-site vs. workshop welding / control of welding by trusted institute).

d) Systems

- Specific analysis of systems such as photovoltaic panels or heat pumps that require a set of specific criteria notably linked to their integration and interactions with the rest of the structure, including the envelope (see example of criteria for photovoltaic panels hereafter)

e) Design

- Intrinsic risks associated with the type of work (structural complexity, choice of technology / materials);
- Known pathology for this type of work, based on insurer's experience or expertise of the technology;
- Level of loads in regard of national standards;
- Adaptation to the context;
- Interaction with other construction elements (ex: effect of humidity on wood framework caused by high level of airtightness imposed in new constructions);
- Scale of design studies;
- Use of non-traditional techniques;
- Qualification / specialization of designers;
- Quality of the reports.

f) Technical Inspection Service (TIS)

For the insurer, the TIS role is of utmost importance. Being in direct contact with the construction actors and reviewing all designer's document, the TIS is considered as the eyes of the insurer. A great part of the identification of the risks comes from the TIS reports. As explained more extensively later, within the different possible assessments made by the TIS, only "risk assessment" reports will be useful in the underwriting process (as opposed to conformity assessment). Therefore, the insurer will assess the TIS work through:

- Qualification / trust in the TIS;
- Quality / specific knowledge of the person in charge of the control with this specific type of work;
- Type of reports and extent of the mission (mission / number of visits / nature of the reports);
- Adequacy of fees (evaluation of time allocated to the project).

g) Execution / methodology

- Type of contract. Structure of contractual relations between contractors has an impact on recourses possibilities hence extent of the cover;
- Qualifications / experience of contractors on this specific type of work;
- Construction / installation methods;
- Quality plan / self-check.

h) Surroundings / neighbouring

- Risks of impact of a defect on construction works with different owner (general liability risk); Ex: distance of neighbours (risk of fire spread);
- Exposure / amounts at stakes.

i) Existing works

- Standards to be applied;
- Level of connection with existing parts / compatibility risk;
- Adequacy of new work in regard of the existing one / analysis from a global point of view;
- Importance of the modifications on existing bearing structure;
- Specific risks of covered existing parts.

j) Construction work inherent risk

- Geometry:
  - Geometry of work (height, asymmetric geometry, non-alignment of bearing elements, "transparency" in lower levels);
  - Geometry of bearing parts (spans of simple or cantilever beams and floors, slenderness of columns / walls);
  - Depth of excavations;
- Structure: Innovative materials / Bearing elements / Bracing;
- Roof / Façade: Glass roof / Point fixed structural glazing.

k) Known pathology / claims on comparable work

As seen risk assessment is mainly dependant on the person making the analysis, his knowledge and experience on the type of construction, without any very specific and objective predominant criteria. However regarding inherent risks, based on their knowledge, insurers developed some specific internal confidential technical risk criteria for some now widespread eco-technologies such as Photovoltaic panels or Heating pumps.

For example in the case of photovoltaic panels, following criteria could be added:

- Surface of the installation (linked to the level of exposure but also to the seriousness and the effort put into the installation job)
- Type of building receiving the panels (e.g. farm building, houses or shopping mall)
- Presence of a diagnostic of existing parts
- Type of support (e.g. glass, tiles or membranes)
- Integrated panels or not (linked to an exposure to waterproofing risk)
- Qualification / expertise of installer regarding both electricity and waterproofing competences
- Type of panels and electrical components (linked to their sensitivity toward risks such as fire or corrosion)
- PV systems specific QS (e.g. MCS, RAL, QualiPV, TÜV long term sequential test)
- Type of maintenance contract

On the contrary, if the assessment concerns Professional Indemnity of an architect, the criteria will then be reduced essentially to:

- Qualification / specialization of designer;
- Quality of previous reports (if available);
- Loss record (even though it doesn't concern innovative technologies);
- Fees / Income / Financial health

3.4.2.2 Definition of relevant technical criteria

In relation to WP1, this section examines how signs are used to assess "eco technologies'" risks in construction insurance, and more specifically what constitutes a relevant technical criterion for the insurer.

As previously stated, regarding eco-technologies, the insurer's risk assessment is essentially qualitative, based on the underwriter's own experience, whether the risk is a stand-alone project or the activity of a company (manufacturer, installer …). It appraises the adaptation of the "eco-technolgy" to the construction work and its environment in general on a technical basis, to be translated into insurance terms and conditions.

In case of innovative construction systems, the insurer does not have the technical means to assess directly the associated risks. Therefore he also has to rely on information provided by experts and potentially carried by QS.

As a reminder, QS aim to bring information to construction actors in order to design, build and maintain building works that meet basic requirements (see WP1 1.2.2). QS do not aim as such to bring information to insurers in order to assess their risks. Nevertheless QS may contain useful information in the insurer's risk assessment procedure.

Insurers will for instance be interested in information concerning specific aspects of construction systems, e.g. their field of use (compatibility issue) or the required installation competences.

This information draws the attention of the insurer on aspects that may be a source of risks. For instance, if a QS on a given construction system highlights the use of a specific competence; this requirement will be taken into account by the insurer to assess its risks.

Table 26 : Examples of national QS used by insurers in their risk assessment of eco-technologies

Country	Name of the sign	QS delivered by
France	Avis Technique (ATEC)	CSTB
Germany	TUVdotCOM	TÜV Rheinland
Italy	Certificato di conformità (of TIS)	ACCREDIA (ex SINCERT)
Spain	Documentos de Idoneidad Técnica (DIT)	Instituto Eduardo Torroja
United Kingdom	MCS Certificate	Microgeneration Certification Scheme

Nonetheless, few QS can be considered as discriminating and give some information on the risk level. As a consequence, findings show that QS directly used by insurers for their risk assessment are very scarce, and essentially concerns competences or systems.

More specifically, construction products QS are not taken into consideration since they only reflect the compliance with standards, norms or requirements in general. As for other standards, on design for example, absence of compliance would be symptomatic of a possible failure or defect, but the presence of a QS, stating the compliance with the standard does not give any information in regard of the risk, or more precisely of any specific information about the risk.

Even though QS, in general, are rarely **directly** used by insurer in his underwriting process, it is not the case for the TIS, through his conformity assessment, at it is described in next section on the TIS role. Therefore, the TIS being somewhat an extension of the insurer regarding risk management, we can consider that QS are **indirectly** helping the insurers, by improving the construction quality.

3.4.2.3 Technical Inspection Service role

Alongside insurances, technical inspection services, which will be defined precisely in this part, become essential actors in the construction process. They participate in the protection of construction quality as well as the protection of the consumer, whether he is the person who builds, or the person who uses the construction.

In order to understand how their intervention could help eventually stimulate innovation or promote new technologies, their role and framework of intervention in each country have to be analysed precisely. Their means have to be identified as well in order to help involving them in the process, mostly with insurances, in countries where their participation could help better risk analysis. General references (CEBC 2006 ; Joao Branco Pedro 2010)

Technical Inspection Services as partners of construction quality

In the construction process, technical inspection services might play, depending on the country, a major role in evaluating risks or conformity. They often bring guarantees concerning the construction. This first part focuses on the definition of TIS and of their intervention. Differences between countries are stressed out, resulting of researches and surveys conducted during ELIOS 2. A recap table summarises at the end the examples that are given in this part.

Technical Inspection Services as Insurance partners

As it is described hereafter, generally TISs don't work for the insurers (with important exceptions). In fact, even though they were initially created to meet an insurance need, they are now more commonly appointed by another entity. Consequently, TIS missions are not intended for the insurer. Nonetheless, for the insurer, TISs remain the main risk information providers through their risk assessment missions.

Therefore, it is important to outline that the following description encompasses different TIS roles, including conformity check and risk assessment. Of these activities, insurers only directly take advantage of the risk assessment, during their underwriting process.

Nonetheless, more globally, TISs are participating in the improvement of the construction quality and are therefore also indirectly improving insurers' results.

Definition of Technical Inspection Services (TIS)

- ***Are TIS private or public bodies?***

TIS might be private, public or both in some countries. When they are public, they are mostly represented by local authorities. In these cases, administration carries out the checking of the construction but their intervention is mostly at the conception stage or at the completion stage. This is the case for Cyprus, Czech Republic, and Ireland for example. However, when projects become too technically complex, some local authorities transfer the responsibility of the technical inspection to private bodies, for example in Germany or in Sweden, where the technical aspect is exclusively undertaken by private bodies (Deman Jonas 2013 ; De Decker Thomas 2013).

Other countries such as Italy, Belgium or France have a private-control-based system of technical inspection. However, even in these countries, there might be a complementary public inspection for some specific stages of the construction (e.g. conception or completion, with certificates provided by local authorities) (Deman Jonas 2013 ; De Decker Thomas 2013 ; PCR 2011).

A third type of countries has both public TIS and private organisations. United Kingdom for example has building control bodies (BCB) of two types: Local Authority Building Control (LABC) or private sector Approved Inspector Building Control (AIBC) (Royal Institution of Chartered Surveyors 2015 ; Johnson Hugh 2015 ; Planning Portal 2015). Denmark and Spain also have public and private TIS (see Appendix 3.3). For Spain (Instituto de Ciencias de Construcción Eduardo Torroja 2015 ; Javier Lopez y Garcia de la Serrana), the city council on one hand and OCT (Organismo de Control Tecnico) on the other hand might intervene in the inspection process but they do not interfere. Their intervention however might differ, as it will be seen further on in paragraph A-3.

In the Netherlands, where the system is currently changing (Visscher Henk and Meijer Frits), at the moment, both municipal building authority and private approved inspectors can act in the inspection process, but the role of public administration is actually handed over progressively to private inspectors. The case of the Netherlands reflects the tendency of privatisation of technical inspection services, partly due to the lack of financial means and technical skills for public administrations (PCR 2011 ; Deman Jonas 2013).

- **Control of products and/or construction**

During the evaluation of the construction quality process, two aspects can be distinguished, one focusing on the products themselves, the second one being the use of this product within a precise context, and given some specifications relative to its implementation. The first aspect is discussed in this report, in the chapter on quality signs. The second one might be addressed by TIS specifically.

Therefore, it is important to stress out the difference between these two approaches: they might be complementary in the process but, in order to explain the role of TIS, the relevant one is about control of the construction. However, in some countries, such as Germany for example, some organisms do both certification of products and control of construction.

- **Accreditation**

Whether TIS are accredited or not depends on the country. It seems that, a priori, local authorities do not need any accreditation, except for some specific cases, such as in the Netherlands, where local authorities are supervised by a national building inspectorate.

For private bodies, most countries require at least an authorisation. Indeed, in Belgium, the BELAC gives accreditation to TIS, this responsibility is based on the COFRAC (COmité FRançais d'ACcréditation) in France or the SWEDAC (Swedish Board for Accreditation and Conformity Assessment) in Sweden. In Germany, The Netherland or Denmark, private controllers and engineers need to be accredited as well. In United Kingdom, UKAS inspection approves AIBCs. In Italy, the obligation of accreditation applies only for construction works of more than 20 Million Euros. This formal accreditation is covered at a European level by the E.A., European Accreditation (European co-operation for Accreditation 2015). This aspect is developed more precisely in part B of the corresponding deliverable.

When we talk about authorisations more than accreditations, some may correspond more to an obligation of insurance than a proof of competence. For example in Slovakia, TIS must have the authorisation of the chamber of construction engineers, in order to guarantee in some way there liability.

Framework of the intervention of TIS

- **Is their intervention voluntary or compulsory?**

Clear conclusions and answers to this question are difficult to sum up as in each country; the organisation depends on a lot of different factors that make it difficult to strictly classify the intervention of TIS. However some major frames of intervention have been drawn out.

During our researches, it has appeared that technical inspection services were required only rarely on a voluntary basis. An example of this exception could be Malta but there seems to be no real technical inspection included in the construction process.

However, a major difference appeared between legal obligation (mandatory by law) and obligation for insurance purposes (required by insurances).

Examples to illustrate the first case are: Germany, where the intervention of TIS is required in the frame of the building permit, Sweden, where assessment by a private organisation is mandatory (Visscher Henk and Meijer Frits), UK, where building regulation approval is needed as well (Royal Institution of Chartered Surveyors 2015 ; Johnson Hugh 2015 ; Planning Portal 2015 ; De Decker Thomas 2013). In Ireland, this obligation is more complicated: it is mandatory to refer to the building control authority but inspection is not systematic (Heritage and Local government of Ireland).

On the other hand, the intervention of TIS is almost exclusively required by insurances: in Belgium for example, depending on the value of the building (Deman Jonas 2013 ; De Decker Thomas 2013). It is however important to note that in this country, insurance is voluntary (but widely used).

Between these two cases (legally mandatory or required by insurances), a lot of countries have a mandatory-based system of technical inspection, whether it is required by insurances or by the government: Italy, France and Spain (Instituto de Ciencias de Construcción Eduardo Torroja 2015 ; Javier Lopez y Garcia de la Serrana ; Gobierno de Espana - Ministerio de Fomento 1999) illustrate this case. In each of these countries, the frame of obligation depends on the type (housing, public buildings, etc..) or the complexity (size, cost, etc...) of construction.

- **Who do TIS work for?**

Generally speaking, it can be conclude that when TIS are embodied by local authorities they work for the administration itself (Cyprus, Czech Republic, etc...) and when TIS are private bodies, they mostly work for the constructor or the owner of the project (Belgium, France, Sweden, UK, etc...).

Exceptions are when local authorities delegate to private controller as we have seen it might happen. In Germany, in the most important construction works, an independent body may intervene in addition to local building control, for the owner (De Decker Thomas 2013).

Therefore, TIS may act as a delegation of powers granted by the government, on technical aspects or for a client, whether it is mandatory or a specific technical assistance is wanted.

Moreover, a third case exists, with TIS working directly for insurers. This happens in United Kingdom for example, in the frame of the Home Warranty: indeed, NHBC produces its own norms and has a control service inspecting constructions.

Conformity assessment and risk analysis approaches

Depending most of the time on whether TIS are local authorities or private bodies, or indeed, whether they work for administration or owner of project, their role is different. We have distinguished two different fields of action: conformity assessment or risk analysis. The third part of this chapter defines more precisely the role of TIS, linked to insurances and liabilities. It will sum up the frame of intervention of technical inspection giving what interests us for ELIOS.

- **Conformity assessment**

Conformity assessment is based on regulatory requirements. It results most of the time in the production of certificates and attestations. Cyprus, Denmark, Ireland and Czech Republic are example of countries where TIS do essentially conformity assessment (Heritage and Local government of Ireland).
In Slovakia, the mission of TIS is checking the process and the products of construction according to the building permit. In France, conformity checking is also part of the mission of the technical controller but remains not the main objective. In Spain, OCT's are not in charge of the control of conformity but the city council is. Similar case happens in Belgium where TIS are not involved in the completion certificate (that is produced by the architect or engineer).

The Netherlands are specific as the system is changing (Visscher Henk and Meijer Frits ; Deman Jonas 2013) but inspection is carried out by municipalities on a base a precise protocol with checkpoints. This approach is typical of conformity assessment; however the establishment of such matrices had been based on a risk analysis approach in the first place (PCR 2011).

- **Risks analysis**

In countries where risks analysis is the primary aspect of the mission of TIS, standardisation of risk is the main objective. This is the case in Belgium (Deman Jonas 2013 ; De Decker Thomas 2013). In Spain (Instituto de Ciencias de Construcción Eduardo Torroja 2015) or in France, the intervention of TIS consists mainly on evaluating construction risks. In Sweden, technical controllers have a sort of risk analysis approach: a quality control plan is defined by a quality site manager for the construction.

Similarly, in UK, the approach is more of a risk analysis as decisions of TIS must be reasonable and they would be relieved of their liability (Johnson Hugh 2015).

This notion of liability and link to insurances is crucial as it will be seen in next paragraph. In order to carry out their analysis, TIS have different tools, such as quality signs that are described later.

- **Conformity assessment or risk analysis in relation with insurance regimes**

The research and investigations, mainly based on questionnaires and interviews, have resulted in a more precise definition of the role of the private technical inspector in the construction process.

Several factors are involved:

- The construction defect protection model
- The liability regime (legislative, contractual, etc.)
- Liability coverage (insurance, bank guarantee, etc.)

Even though no official classification of liability regimes exists, four types can be distinguished at present whose characteristics can be used to define the technical inspector's role. In this part the corresponding operating modes are identified and one or two examples are given to illustrate each particular case.

Type 1: Countries in which TIS role is essentially legislative-based and contractors are required by law to take out insurance to cover their liability

- The technical inspector assesses the construction risks. This helps to determine the construction insurance coverage required and prevent any further defects.
- The technical inspector is also delegated by the administrative authorities to inspect drawings and technical details and conduct on-site inspections in order to ensure that the project meets the regulations.
- Building contractors are required to provide ten-year and two-year warranties.

Case of France:

The technical inspection of constructions can be compulsory by law or optional but when it is not compulsory, it is often required to the owner by the insurance company. It is compulsory when stipulated by the legislation, particularly in the case of certain public assembly buildings, very high buildings and exceptional structures (span, depth, cantilever). Solidity, safety of persons, respect of earthquake construction regulations and regulations pertaining to accessibility for the disabled are the main concerns.

The technical inspector must take out ten-year warranty insurance. Like the contractor, the inspector has a public liability insurance obligation for 10 years after acceptance of the construction. General references (Deman Jonas 2013 ; De Decker Thomas 2013).

Type 2: Countries in which TIS role is essentially legislative-based but in which there is no legal insurance obligation for construction defects even though such insurance is widely practised

- Technical inspectors are delegated by the administrative authorities to inspect drawings and technical details and conduct on-site inspections in order to ensure that the project meets the regulations.
- When an owner chooses to take out ten-year inherent defect and two-year equipment cover, the technical inspector is called upon by the insurers but contracts with the owner in order to assess the construction risks.
- The technical inspector's role is therefore very similar to that of type 1 described above.

Case of Luxembourg:

The owner takes out optional ten-year and two-year liability insurance for the project concerned. All defects are covered without having to determine liability.

The technical inspector contracts with the owner or sometimes with the building contractors at the owner's request. The inspector's risk assessment is mainly based on the solidity of the main structures (frame/roof) but sometimes includes smaller structures defined under the terms and conditions of the agreement. The guidelines used to carry out the assessment are mainly German and Belgian standards.

Compliance with the regulations is determined by an approved organisation which performs acceptance of the completed work required by the operating authorisation. Technical inspectors are also approved organisations.

Type 3: Countries in which TIS role is essentially legislative-based but where contractor's insurance is neither compulsory nor frequently used

Case of Czech Republic:

Technical inspectors are very rarely called upon. Construction projects are inspected at the beginning and end of the project by the Building Inspection Department, which is a local authority, in order to grant planning permission and operating authorisation and during construction by government officials and approved engineering consultancies.

Type 4: Countries in which TIS role and insurance covers are completely or mainly contractual

- The role of independent technical inspectors varies considerably according to the country. When called upon, the inspector may contract with the Owner, the architect or the building contractor.
- The technical inspector is more concerned with verifying conformity than with analysing risks.

Case of Great Britain:

Technical inspection is very common due to both legal obligations and insurance practices. The law stipulates that all constructions must be inspected to ensure compliance with building regulations, starting with the planning permission phase. On-site inspections are then carried out during construction and a completion certificate is issued at the end of construction. The certificate guarantees that the building is fit for use. The owner decides whether inspection will be carried out by the local authorities or by an approved inspector such as the NHBC Building Control Service, a subsidiary of the NHBC insurance company. Inspections are often outsourced to avoid complaints in the case of defects.

In particular, insurers are often involved in the technical monitoring of housing construction. An insurer such as the NHBC thus has the necessary skills and human resources to carry out technical appraisal of construction projects (even before construction begins) and to inspect the work site even having remedial work carried out when necessary at the expense of the building contractor who has taken out the insurance.

The specific role of the Building Control Service is therefore to check compliance with rules established by the insurers (conformity) but it also means that construction risks are addressed. General References (Royal Institution of Chartered Surveyors 2015 ; Johnson Hugh 2015 ; Planning Portal 2015 ; De Decker Thomas 2013).

Case of the Netherlands:

The local building authority is responsible, both operationally and legally, for technical inspection which is carried out during both the design and construction phases (verification of compliance with building regulations).

Technical inspection is based on detailed design documents supplied by the owner to the service in charge of inspection of construction and housing.

Inspection concerns not only compliance with town planning regulations but also with the rules, technical standards and instructions in force including insulation, respect of environmental regulations, fire protection, etc.

The documents required now systematically include the design of the building foundations and a ground survey whose validity is checked by the service concerned. Inspection of the stability and solidity of the structures is usually outsourced to certified engineering consultancies. General references (PCR 2011 ; Visscher Henk and Meijer Frits ; Deman Jonas 2013).

The present approach helps us to understand the responsibility of technical inspection services in the field of construction and to determine their role in risk assessment. The party responsible for the risk and how it is insured must first be identified in each country. We could then study the tools and guidelines used by technical inspection services to analyse risks and identify the quality markers which enable them to insure a construction product or method.

A table summing up the main classifications and conclusions of this research can be found in Appendix 3.3 §.1.1.2.3.

It presents for some countries:

- If the TIS is Voluntary, Mandatory or Required by insurance;
- Who the TIS works for;
- if the TIS is private or public;
- the type of mission (conformity vs risk analysis);
- If the TIS is accredited and by who.

3.4.2.4 QS used by the TIS

As mentioned previously, technical building inspection involves both risk assessment and inspection using specific practices and methods based on technical guidelines that are specific to the country concerned (existence of building regulations, technical rules, etc.) which generally address one or more of the following actions:

- Assessment of compliance with regulations according to the use of the building as defined in the building permit
- Assessment of technical risks during design
- Supervision of construction and inspection carried out by contractors during construction
- Assessment of compliance in view of building acceptance or operating authorisation

Based on the above, insurers identify the structures/building parts at risk in order to determine the coverage to be applied. Some QS are also taken into account in risk assessment. These are mostly signs on construction systems and competences of designers/contractors.

Product performances, systems fitness

CE marking based on the declaration of performance of products provides information on essential characteristics of construction products related to basic requirements for construction work. This information is mainly based on existing harmonised standards. They can be used in conjunction with harmonised design rules (e.g. Eurocodes).

Such harmonized standards and rules are not available for innovative construction products. In this case, construction actors need information addressing the whole construction system (as defined in 1.2.1), i.e. relevant products characteristics, design, implementation and maintenance rules. Some specific QS (e.g. TA, see 1.2.4.2) carry such information. Trust in any of the above mentioned QS varies according to the subject and the origin of the QS.

Competence of building contractors

Recognition of the competence and professionalism of building contractors is also used during risk assessment. It is based on non-harmonised systems aimed at:

- Qualification of contractors by an accredited body – QUALIBAT in France,
- Pre-qualification of contractors in Germany and Great Britain,
- Certification of the construction process – KOMO in the Netherlands

Performances of building works

Labels and certifications which concern the building work as a whole are not used by the TIS for the purposes of technical assessment. Examples are EFFINERGIE, PASSIV HAUS, MINERGIE, QUALITEL, BREEAM and LEED. These signs concern the performance of building works after completion or during construction. They are not required by the regulations and are used for commercial promotion purposes.

3.4.2.5 Recognition of the profession of Technical Building Inspector

There are two possible ways of recognising the competence of technical building inspectors:

- The certification of services provided by the profession based on specific standard drawn up in conjunction with the insurers on the one hand
- Accreditation of conformity assessment bodies (CAB) according to standard ISO 17020 to determine the conformity of construction projects to regulatory requirements on the other hand

Accreditation of inspection activities in view of conformity assessment (CAB)

The State delegates validation of the competence and quality of the reports of Conformity Assessment Bodies (CABs) to the national accreditation body which regularly monitors the way in which they operate.

This system is already operating in several countries. Inspection bodies are accredited according to ISO 17020 as type A inspection bodies, that is, bodies that are independent of the parties involved, impartial and unbiased:

- The accreditation system maintained by the State guarantees the competence of all assessment bodies to inspect the regulatory requirements
- This accreditation system is an international support system that provides formal recognition of the competence of a network of technical inspection services
- The accreditation system exists in all the European countries (attached to the EA) and across the globe (attached to ILAC and IAF)
- An accreditation certificate issued for a given perimeter in a European country has the same value as an accreditation issued in another European country; it is also valid in countries having signed ILAC and IAF recognition agreements outside the European Union
- Each European country has only one accreditation body: UKAS in the United Kingdom, DAkkS in Germany, COFRAC in France (complete list available on the EA website, on the "members" page
- They are all members of a European organisation - EA (European co-operation for Accreditation) which harmonises the practices of national accreditation bodies. http://www.european-accreditation.org/ea-members. EA monitoring guarantees the equivalence of accreditation certificates issued in the different European countries by providing a solid foundation for mutual recognition

Nonetheless, it seems unlikely that accreditation, i.e. the inspection of regulatory requirements by an independent third party (CAB), inspire confidence to those who, like insurers, depend on these bodies to assess construction risks. Consequently, another path could be the certification of the services provided by a TIS.

Certification of technical construction inspection process

Certification of technical construction inspection process would be governed by the network of professionals and issued by an independent certification body which recognises that the provision of services is in conformity with the commitments defined in standard specific to the profession.

The service certification standard would be defined collectively by the service providers (network of professionals such as Consortium of European Building Control) and the insurers on a European level, and incorporate performance requirements for risk assessment and technical competence of inspectors.

This service certification approach is complementary to the ISO 9001 certification approach:

- It would be recognised by insurers
- The professional competence guidelines would be carried by European professional organizations
- The professional competence standard on a European level would be common to all the certification bodies
- The service certification attributed to a body in a European country would have the same value as the certification attributed in another European country provided that the standard are defined on a European level
- The certification process would be recognized by an accreditation body that is a member of the EA (European co-operation for Accreditation) which ensures harmonisation of the practices of national accreditation bodies (European Accreditation 2015)

3.5 State of the art insurances schemes and transition paths

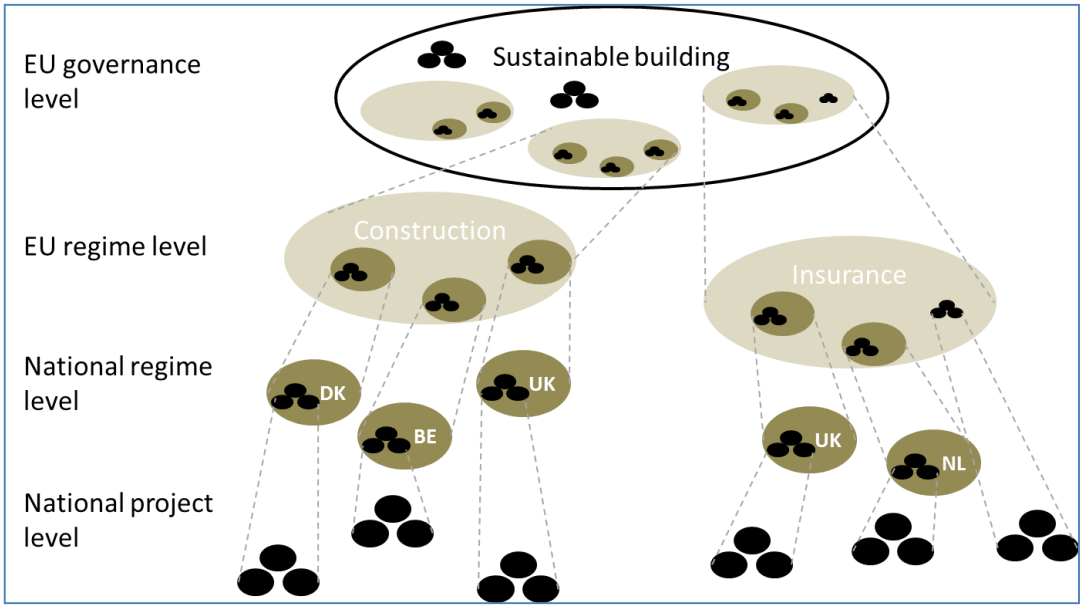
3.5.1 Construction and insurance regimes

An overall objective of the project is to achieve concerted change on construction insurance regimes and sustainable innovation in Europe.

A transition towards increased levels of sustainable innovation in construction is, however, not only a question of aligning national interests, but also a question of aligning highly discrete and durable systems of construction, sustainability and insurance within the individual member states.

Applying a socio-technical approach, combining contributions from transition theory and institutional theory, the analysis will be conducted as two distinct yet interrelated analyses; a horizontal respectively vertical analysis of regimes development and transformation as illustrated in Figure 19 below.

Figure 19: Levels of analysis (adapted after Seyfang and Longhurst, 2012)



The horizontal analysis aims at providing an understanding of the interplay and co-development of national regimes of insurance, sustainability and construction within the individual national context.

The analysis will result in a typology of various national construction regimes based on their technological, historical, social, political, cultural and economic characteristics. The analysis will be conducted in order to identify main similarities and differences between the various national construction regimes that may function as drivers or barriers towards a common European insurance policy implementation, which is the focus of the vertical analysis.

The vertical analysis, thus, will focus on the interplay between national and supra-national regulation and on the dynamics of adaption and circulation of insurance schemes in Europe.

3.5.1.1 From Construction Business Systems to Regimes

The preliminary findings indicate that national regimes of construction vary markedly from country to country in the EU. Winch (2000, 90) has distinguished between three types of systems / regimes:

- The Anglo-Saxon system is characterised by "a greater reliance upon liberal market values, relatively low levels of state regulations…."
- The corporatist system depends more on "…negotiated coordination between the 'social partners', greater willingness to intervene in the market to protect social values… "
- "The 'étatique' system has more extensive coordination of the economy by the state relatively high level of worker protection … and a desire to promote national champions in various industrial sectors"

Not only do these national regimes of construction and insurance differ on some dimensions, they might also be contradictory and even detrimental in terms of their functioning. In addition, the preliminary findings also indicate that the distinctiveness or idiosyncrasies of the different national construction regimes have impact on the actual uptake of new technologies and policies. In essence, this entails that policy and technology implementation follow different transition pathways dependent on the regime level characteristics.

Winch's (2000) typology of Construction Business Systems (CBS) constitutes, however, quite a broad framing and conceptualisation for understanding different cultural and systemic factors that are important to understand when discussing issues of how actors and structures are interrelated and not least, how change can be brought about in highly institutionalised organisation fields. Thus, for the purpose of the following analysis, we intend to describe the Danish corporatist construction business system drawing on concepts from institutional and transition theory to enable a richer understanding of these issues.

Thus, the following section constitutes a description of the Danish construction and insurance regime based on Gottlieb (2010), Jensen et al. (2011), Thuesen (2011) and Brahe et al. (2013). The objective is to describe the characteristics and modus operandi of the Danish construction and insurance regime as a starting point for the further analysis of differences of regimes in the EU and hence the challenges of harmonizing insurance and liability schemes across member states.

3.5.1.2 The Danish construction system

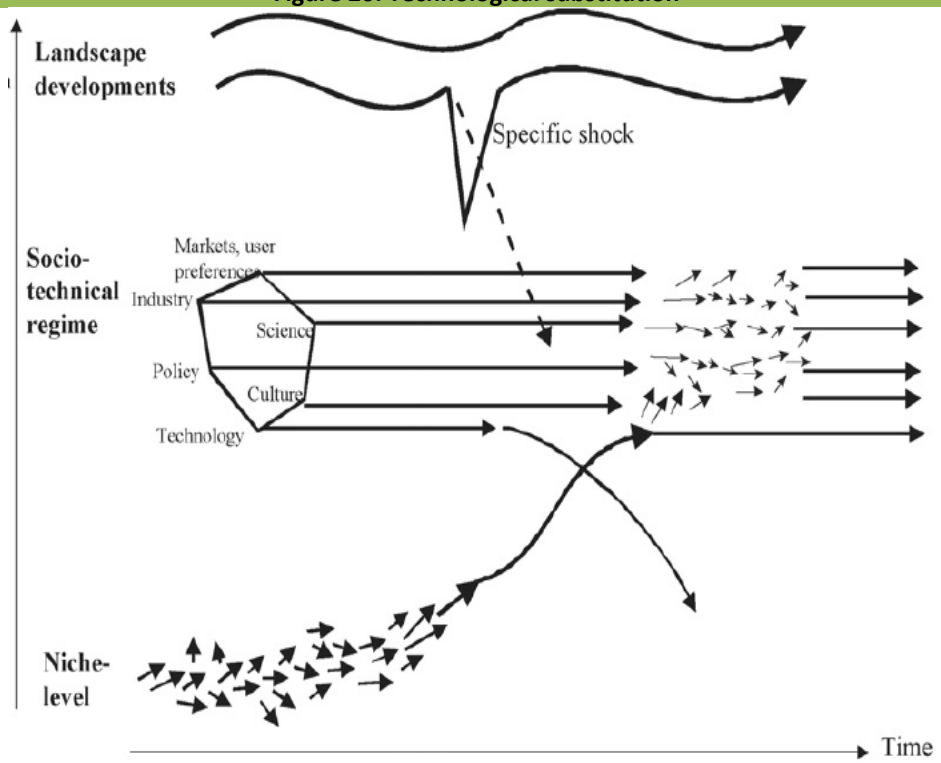
In a historical analysis on the constitution of the Danish construction sector, Gottlieb (2010) argued for the need to understand the current practices and systemic configuration of the sector in a historical perspective, i.e. as a result of a development process that have taken place over generations. This type of historical awareness is crucial in understanding the conditions for how new technologies or practices can gain prominence, including the role of existing systemic factors in promoting or resisting institutional change.

In essence, Gottlieb (2010) argued that the current Danish construction regime can be seen as the result of a development process taking place in the intersection between three highly institutionalised regimes or systems of interaction (see also Gottlieb and Haugbølle, 2013) and that the introduction of new technologies or practices depends on the ability to understand and manage contradictions in and between these regimes.

The three regimes comprise: Building customs and practices; Rationalisation; Negotiation. Further explanations and information can be found in Appendix 3.5.

Despite recent developments we would argue that the current Danish construction regime to great extent is moulded in the image of the rationalised construction industry that was formed the 1940s onwards. Thus, observed in the light of the MLP model and Geels' typology of transition pathways we get the following picture of the different transition pathways and the dynamics of change between these three epochs or systems of construction.

Figure 20: Technological substitution

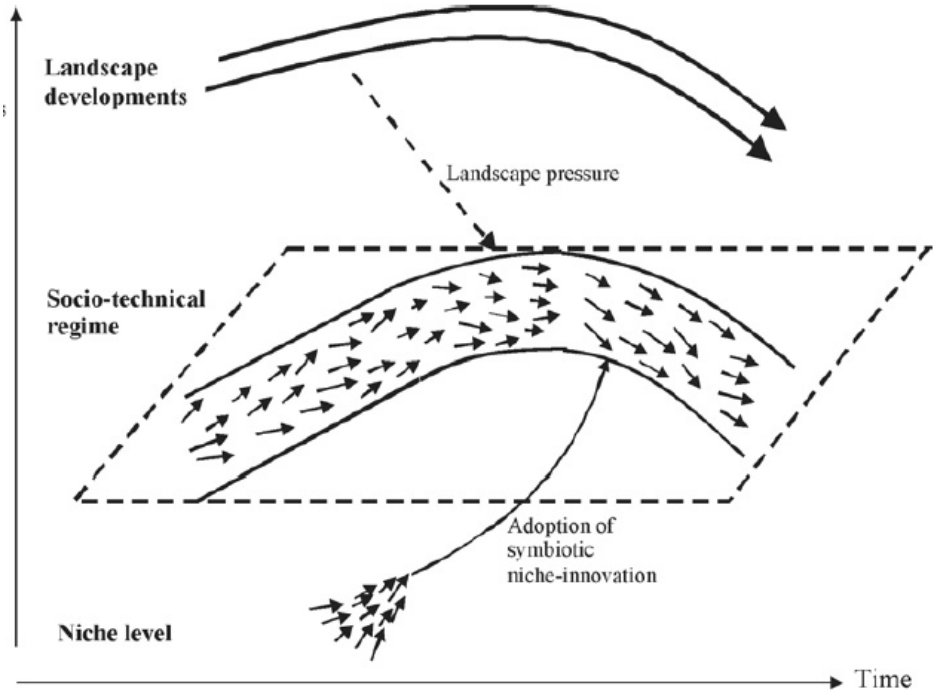


Reiterating, Geels and Schot (2007: 409) claimed that: "*If there is much landscape pressure […] at a moment when niche innovations have developed sufficiently, the latter will break through and replace the existing regime. This pathway assumes that radical innovations have developed in niches, but remain stuck because the regime is stable and entrenched.*" Further: "*Without landscape pressure, this remains a reproduction process. It becomes a technological substitution path when a 'specific shock' 'avalanche change' or 'disruptive change' exerts much landscape pressure on the regime. This pressure leads to major regime tensions, and windows of opportunity for niche-innovations. Niche-innovations can use these windows, because they have stabilised and gathered internal momentum*" (Ibid. 2007: 409-410).

In contrast, the developments that took place from the 1990s onwards can much better be seen as following a so-called transformation pathway, in which a moderate landscape pressure, not least prompted by the abolishment of the Ministry of Housing, lead to a continuous process of *modifying the direction* of development paths and innovation activities in the sector.

This is illustrated e.g. by Jensen et al. (2011: 671) who argued that "*From the early 1990s the industry was once again problematized from a sectoral point of view. This sectoral problematization was [however] radically different from the sector problematization of the immediate post-Second World War years and it generated a set of very different theorization dynamics*."

Figure 21: Transformation pathway



Most notably, Jensen et al. (2011) demonstrated that in the 1990's, the sector was no longer framed as the means to cope with a critical societal need but rather as an inefficient economic entity with an unsatisfactory high consumption of societal resources due to a series of interconnected weaknesses such as low productivity, poor innovation, poor collaboration and organizational fragmentation.

Rather, we have seen that the most radical of the proposed niches (e.g. system deliveries) have had the most difficulties in gaining wide support and uptake in the industry, whereas the more "symbiotic niche-innovations" that do not offer a whole new conceptualisation of what it means to do construction but rather offer to supplement and existing practices and sort out the worst of the current inexpediences (such as e.g. partnering and the local Danish version of LEAN (LPS)) have been able to gain industry-wide accept.

Therefore, it is much more difficult to observe the direct or deduced effects of these niche-innovations on a sectorial scale.

3.5.1.3 Insurance as a regime internal response

What is interesting in the above description of the historical constitution and development of the Danish construction industry is that insurance, more than representing a vehicle or mechanism of change emerges as a consequence of regime internal dynamics.

Thus at a niche level it is the proliferation of new production technologies breaking into the regime level that propels the need for insurance schemes to evolve and adapt to newfound needs.

This is also argued by Bunni (2003: 7) who suggests that "*Insurance developed and spread as a result of society's needs and demands*".

3.5.2 International comparisons

Based on the above description of the Danish construction regime and the co-development of construction and insurance, we will highlight some of the main characteristics of the French and UK regimes in order to contrast the findings and point to some general observations and issues that have to be taken into account in the development of recommendations for policy convergence of insurance schemes in the EU.

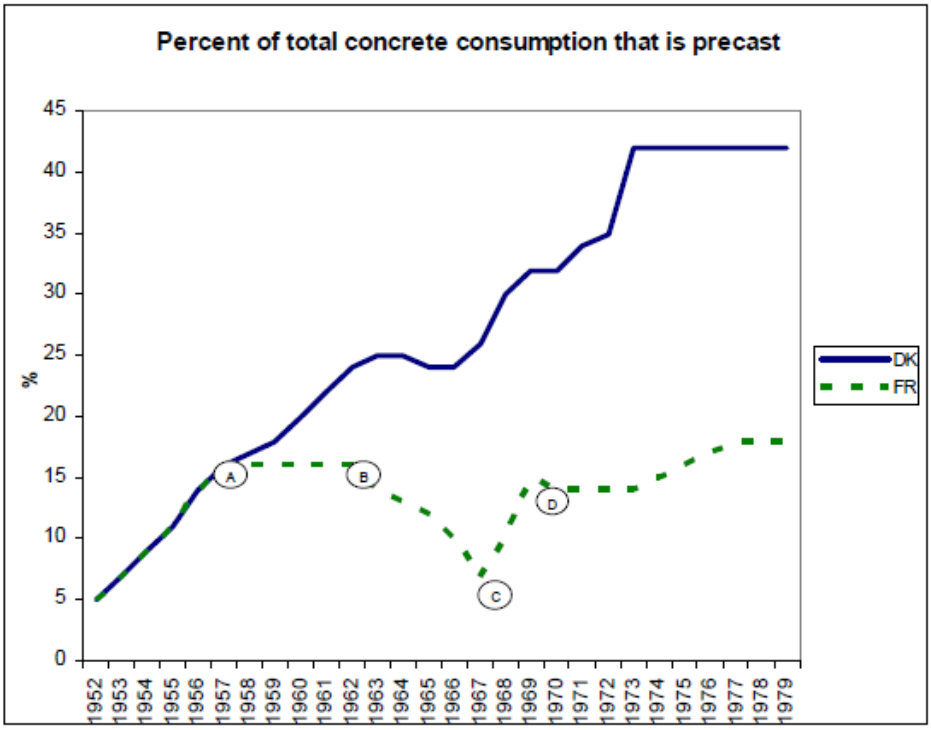
3.5.2.1 France

Whereas we could claim the hegemony of a rationalised concrete regime in Denmark, the situation in France is somewhat different. In a comparative analysis of the diffusion and institutionalization of prefabricated concrete elements, in France and Denmark during the post-war construction period, Boxenbaum and Daudigeos (2010) demonstrate two things in particular.

First, that "*…the relative pace of diffusion was determinant for institutionalization*" (Ibid., 2010: 1) of prefabricated concrete elements as a new dominant technology rather than other competing technologies at that time. In the foregoing analysis of the Danish construction regime, we have demonstrated how the diffusion was supported by various legislative and market changes.

Second, Boxenbaum and Daudigoes (2010) demonstrate that there is a marked difference in the diffusion of prefabrication between Denmark and France, where prefabrication, in the period between 1958 and 1967, gained prevalence in Denmark while it first stabilized and then lost prevalence in France. This is illustrated in the figure below.

Figure 22: The prevalence of prefabrication in Denmark and France, 1952-1979 (Boxenbaum and Daudigeos, 2010: 8)

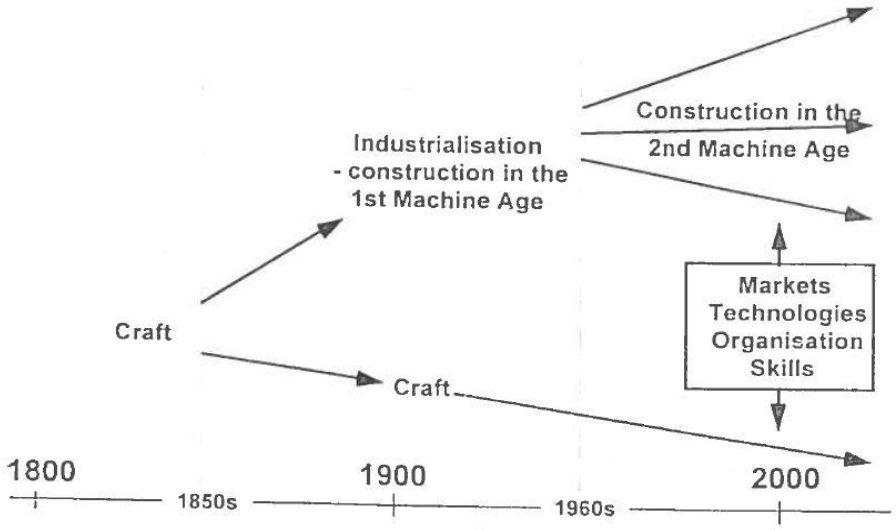


What we however in conclusion can learn from this short comparative analysis is that even though the same new technology is introduced and initially diffuses in a similar fashion in two different countries, the cultural socio-technical and the climatic context of the diffusion environment plays a crucial role in determining the relative success (i.e. institutionalization) of the said innovation.

3.5.2.2 United Kingdom

In a thorough historical account, Gann (1993) has analysed UK attempts to modernize the construction industry and the production of buildings. Gann used this historical account to illustrate different distinct trajectories of development in the industry, which each operates with its own systemic rationale and entails different and distinct modes of technology diffusion and innovation dynamics.

Figure 23: Industrial divides in construction (Gann, 1993: 76)



Gann operated with two stages in the industrialization of construction, the so-called first and second machine age.

The first was concerned mainly with the development of new technologies for structural element, for facades and for the fabric of buildings.

In the second era, the trajectory of industrialization divided into several paths, due to the circumstance that construction was influenced by alternative approaches to raising productivity and expanding markets adopted by firms in other sector.

According to Gann (1993: 76) each path of development is characterised by differences in markets, technologies, organisation of production and skills, such that the industries operating within the craft trajectory are distinct from those in the industrialised trajectory. The characteristics of these different technological trajectories are illustrated in Figure 23.

Thus, according to Gann (1993) today we have in the UK at least three different forms of organising work: those based on traditional craft practices, those associated with the industrial techniques used in the first machine age, and those emerging after the latest boom in construction activity.

3.5.2.3 Insurance in UK and the role of NHBC

An important player in the industrialised paths of development in the UK, has been NHBC, the National House Builders Registration Council, which was incorporated on 17 November 1936 and *"…created to combat unsatisfactory building practices prevalent in UK housebuilding in the aftermath of inter-war government slum clearances*" (Howard, 2011: 25).

Beyond its role as Latent Defect insurer, NHBC also plays an important role as certifier. Historically, NHBC was created to increase quality in the construction through the establishment of a set of "requirements" in order to get their certification, which is needed to be insured.
Of course those requirements focus on "workmanship" and "installation" problems, but also filled some gaps in design codes.

According to Howard (2011) NHBC represented an important voluntary venture into self-regulation and consumer protection by the industry. Thus, as well as inspecting and certifying new homes as being fit for purpose, the council also operated a register of approved house-builders prepared to build in accordance with a model specification.

In terms of consumer protection, registration with NHBC included a warranty: "*…for buyers of certified homes that required builders to rectify defects arising from non-compliance with specifications during a two year period from date of purchase*." (Ibid. 2011: 25). In 1965, this evolved into the ten year concept of the Buildmark warranty, which covers over 80 % of new UK houses, giving home owners assurance and redress if things go wrong (Howard, 2011: 26).

3.5.3 Summary

This brief description of the evolution and configuration of the Danish, French and UK construction industries has two important lessons to convey.

First, that transitions from one regime or 'machine age' to another is prompted by different precipitating jolts (Greenwood et al., 2002) and vehicles of transformation. Thus, the transition from craft to industrialisation in the first machine age was prompted by more or less the same overall landscape changes and processes as in Denmark, whereas the transition to industrialisation in the second machine age in the UK according to Gann (1993: 63-70) was marked especially by a construction boom in the start of the 1970s and the Ronan Point collapse, which prompted designers and architects to criticise the use of standardised heavy concrete systems and search for alternative paths for industrialised construction.

Second, the cases also illustrate that it is difficult to talk about regimes in the singular form even within individual member states. A regime is thus not a homogenous entity, as the preliminary analysis of the Danish and UK construction industries. It has been shown that even though we can speak about evolutionary dynamics and technological trajectories, there are still competing sector socio-technical configurations present, and that in order to implement new policies or technologies, these competing representations have to be taken into account. This is essentially a question of governance and strategic niche management that will be addressed in the following work in WP3.

In the end, this description of the organization of the different existing consumer protection systems, through incentives toward quality of the construction, has highlighted the importance of differences, and most important, that those differences are market/culture specific, and the result of an evolution. It is shown that some systems are based on a legal framework others on a market driven trend, some systems offer very few protections while others are extensive (Table 27).

Insurance can be viewed only as an element (systemic approach), maybe the final one, in the consumer protection framework. It is closely linked to the other elements involved in the construction quality chain and cannot be considered alone.

Table 27: Overview of construction and insurance regimes in three European countries

Level	Denmark	France	UK
EU Landscape	Policy convergence or harmonized insurance regimes?		
National construction regime	Corporatist system	Étatique system	Anglo-Saxon system
Techno-scientific knowledge	Strong administrative and technical continuity surrounding concrete technologies in DK. The adoption of standard measures, modules, planning techniques and specialized engineering education have played an important role in institutionalizing concrete as the de facto standard building technology in Denmark	Prevalent development of concrete technologies in the theoretical corpus, disseminated through "Engineering Schools" (e.g. invention of prestressed concrete by Freyssinet). Historical know-how of various craft skills with developments of new techniques (narrow join bricks). Absence of planned management techniques, with implementation plans carried out during construction.	Mixed. Comprising application of scientific knowledge as well as of short formal training. Specialised, narrow technical skills. Fragmentation of old craft skills, growth of new skills associated with new materials and techniques
Industry/Infrastructure	Complete existing infrastructure for the use of concrete in construction comprised of quarries, cement plants, concrete elements factories, transport and on-site production facilities.	Concentration of activity on large international companies, with lots of subsidiaries, whether for contractor activity (Vinci, Bouygues, Eiffage) or manufacturing (Lafarge)	Large number of privately owned companies, driven by a relatively high proportion of self-employment and number of small and micro businesses.
Policy and regulation	The national construction policy conducted in DK favours extent concrete construction principles, through a strict legislation pertaining requirements for acoustics, climate, fire and structural safety.	Complex set of regulations, now largely harmonized under Eurocodes. Regulation doesn't need to be strictly enforced as the different responsibilities (of contractors or designers) are regulated by the insurance sector through the compulsory liability guarantees.	A great reliance upon liberal market values, relatively low levels of state regulations.

Insurance	Legally compulsory Building Defect Insurance for original owners of dwellings with a purpose of sale or rental, and for cooperative housing associations	Legally compulsory decennial insurance of all construction works, and of all companies taking part in the construction process.	Market driven widespread decennial insurance of construction works, requested by investors.
Technology	Well-anchored network of proven roles and technologies to support and sustain pre-fabricated concrete as the dominant construction principle, including: norms, standards, element fitters, masons concrete production engineers, factory workers, etc.	Historical predominant use of concrete in the form of blocks (breezeblock / cinderblock), regional use of bricks and more recently increased use of aerated concrete (Siporex) and wood under the pressure of Thermal Regulation evolutions (RT2005 and RT2012)	Mainly pre-cast as dominant technology until Ronon Point collapse, with an increasing move towards the use of complex products made from internationally sourced components.
Culture and markets	Strong cultural-cognitive legitimacy surrounding the use of concrete technologies among both professionals and end-users. More than 70 years of continued development have constituted concrete as the dominant construction principle in Denmark. Eco-technologies such as e.g. wood is almost non-existent in multi-story buildings and there is a marked reluctance among home owners to reside in a wooden detached house.	Segmented markets: • Individual Housing: built by specific entrepreneurs (CMI) in blocks, bricks, wood or aerated concrete • Multiple dwellings: made in concrete by local contractor (subsidiaries of large companies or SMEs) • Large projects: other construction works built by few large contractors	Three types of markets: • Small scale traditional markets: residential and repair and maintenance • Large scale projects – new markets: construction of infrastructures, mass-housing, schools, hospitals, slum clearance • Mainly large projects: new sophisticated buildings
Niche level	Sustainable eco-technologies		

3.6 Conditions for greater mutual recognition of construction insurances regimes

This section analyses the conditions for a greater mutual recognition of construction insurance regimes, and possible convergence paths, basis for the development of a set of guidelines for a policy formulation.

Following previous sections, we will first extend the analysis on recognition paths toward its "vertical", regime integration, point of view.

We will then briefly see how mutual recognition may concern a wide range of stakeholders and how regulation, and more specifically "freedom to provide service" regulation impacts the organization of the insurance market.

Finally, we will see how "policy convergence" literature could clarify possible pathways toward better market practices.

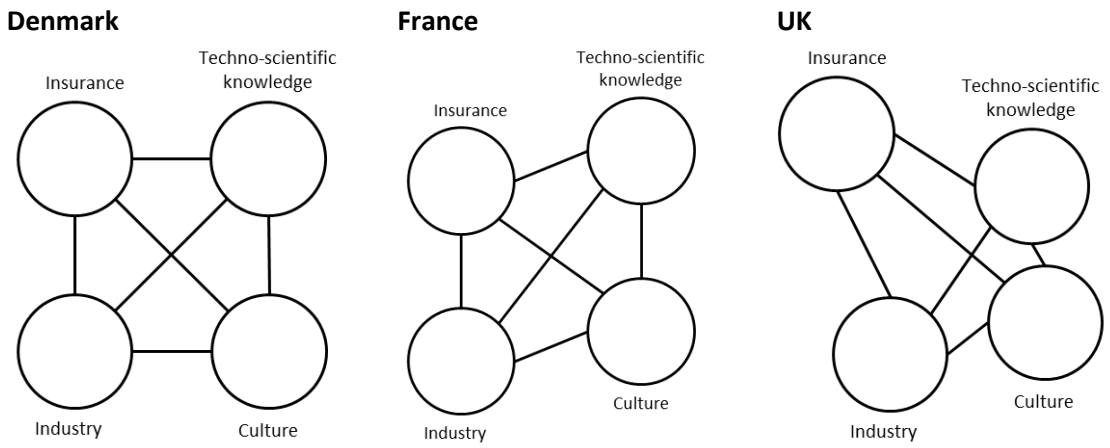
3.6.1 Impacts of national strategies on construction insurance

The previous regime development and transformation analysis illustrates that it is not conducive to talk about an insurance regime respectively a construction regime, as these elements are intertwined to a wide extent and have co-developed over time. This is illustrated by the Great Fire in Copenhagen in the 18th century leading to the implementation of fire insurance of buildings in Denmark as well as the more recent initiation of the Danish Building Defects Funds as a result of the quality assurance and liability reform in 1986 of construction activities.

In UK, the establishment of NHBC in 1936 as both an insurer and a certifier demonstrate the close co-development of insurance and construction for house building. In France, the construction industry has co-evolved with extensive and widespread use of insurance and technical inspection services (notably the Bureau de contrôle). Furthermore, we have also seen that national regimes are homologous but not homogenous entities.

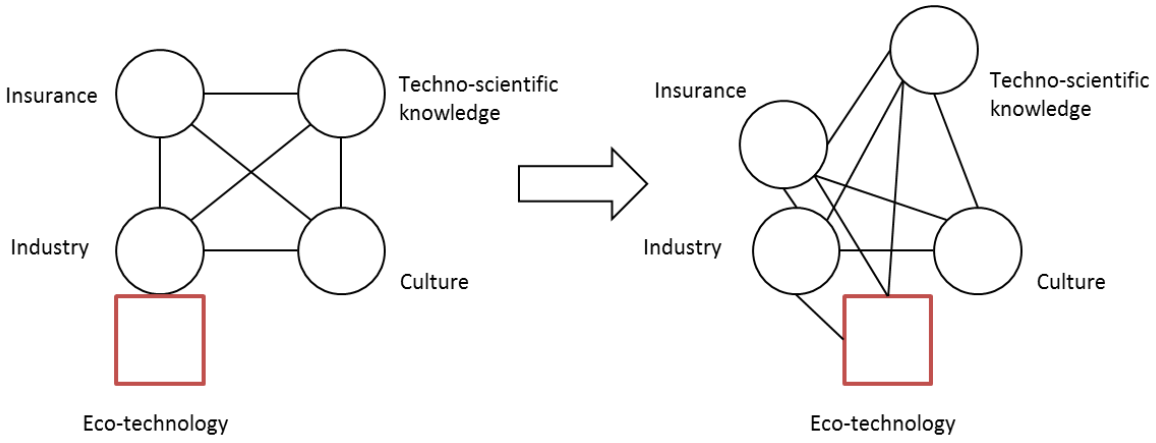
Thus, following the previous sections' analyses of construction and insurance regimes, and as illustrated in Figure 24, when discussing the impacts of national strategies on construction insurance and the possibilities for convergence of insurance schemes across national boundaries, we have to take into consideration the idiosyncrasies of each national regime.

Figure 24: National construction and insurance regimes



While each regime is composed of the same elements, the distinct contents and not least linkages between the elements vary from country to country. What this means is that the successful introduction of a new element (such as an eco-technology) in an otherwise stable socio-technical configuration (i.e. a transition) relies on a number of regime-dependent processes and translations according to the specific socio-technical context. Thus, as illustrated in Figure 255, depending on the existing regime configuration, a new technology will be implemented differently in different contexts and give rise to different reconfigurations of the existing socio-technical regime in which it is introduced.

Figure 25 : Two examples of socio-technical configuring and reconfiguring



The consequence such local transition dynamics is that the governance of policy implementation, e.g. in relation to EU legislation on the topic of sustainable building, emerges as a prime unit of analysis in the further project progress. The reason for this being that it is very difficult under varying and even contradictory circumstances to implement and enforce a single solution or governance scheme across all nations. Instead, new policy (insurance) schemes have to be designed and applied differently in different nations acknowledging that a single, uniform solution might not be possible to implement. This will be discussed further in the next section.

3.6.2 Governing transition pathways and convergence

Acknowledging the contingent nature of national construction and insurance regimes, the question then remains how not only to initiate a transition within a single regime, but also to ensure convergence between several distinct regimes at a supranational level.

To address the first question, we turn to Geels and Schot (2007) who have developed a typology of transition pathways based on different multi-level interactions. Transition pathways provide a relevant framework for understanding the dynamics and processes that are involved in shaping of new structures and systems.

In order to distinguish between different transition pathways, Geels and Schot (2007) combine two criteria, being (i) the timing of interactions; and (ii) the nature of interaction. With this they attempt to counter an assumed bottom–up, niche-driven bias in the understanding of transitions.

On the timing of interactions, the argument is that different timings of multi-level interactions have different outcomes. And particularly important is the timing of landscape pressure on regimes with regard to the state of niche-developments (Geels and Schot, 2007: 405). Thus if landscape pressure occurs at a time when niche-innovations are not yet fully developed, the transition path will be different than when they are fully developed.

Furthermore, on the nature of interaction, Geels and Schot (2007) pose the question, whether niche-innovations and landscape developments have reinforcing relationships with the regime or disruptive relationships through pressure or competition. The essence of the argument is that reinforcing landscape developments have stabilizing effects on regime and form no driver for transitions. On the other hand, disruptive landscape developments exert pressure on the regime, creating impulses for change.

Moreover, Geels and Schot (2007: 406) suggest that niche-innovations have a competitive relationship with the existing regime, when they aim to replace it, whereas a symbiotic relationship exists if the niche-innovations can be adopted as competence-enhancing add-on in the existing regime to solve problems and improve performance.

Within this framework, Geels and Schot (2007) distinguish between four different transition pathways: (i) transformation, (ii) reconfiguration, (iii) technological substitution; and (iv) de-alignment and re-alignment. In essence they entail (Table 28):

Table 28: Transitions pathways (Geels and Schot, 2007)

Transition pathway	Description
Transformation path	If there is moderate landscape pressure ('disruptive change') at a moment when niche-innovations have not yet been sufficiently developed, then regime actors will respond by modifying the direction of development paths and innovation activities.
De-alignment and re-alignment path	If landscape change is divergent, large and sudden ('avalanche change'), then increasing regime problems may cause regime actors to lose faith. This leads to de-alignment and erosion of the regime. If niche-innovations are not sufficiently developed, then there is no clear substitute. This creates space for the emergence of multiple niche-innovations that co-exist and compete for attention and resources. Eventually, one niche-innovation becomes dominant, forming the core for re-alignment of a new regime.
Technological substitution	If there is much landscape pressure ('specific shock', 'avalanche change', 'disruptive change') at a moment when niche innovations have developed sufficiently, the latter will break through and replace the existing regime.
Reconfiguration pathway	Symbiotic innovations, which developed in niches, are initially adopted in the regime to solve local problems. They subsequently trigger further adjustments in the basic architecture of the regime.

In the case analysis of the historical development of the Danish construction regime the implementation of a national Quality Assurance and Liability Reform in 1986 is argued to be the result of a so-called transformation pathway process, in which a moderate landscape pressure, coupled with a strongly rising number of defects in buildings of only 15 - 25 years of age, led to an increased focus on new measures being taken to assure a sufficient level of quality in construction.

From a transition management perspective such dynamics are important to understand when making decisions on strategic action or policy planning (Voß et al., 2009). An intimate understanding of historical socio-technical transitions and contemporary interactions across different co-evolving levels (niches, regimes and landscapes) forms a key organizing input for transition management (Voß et al., 2009: 283). In other words, the actual multi-level configuration determines the most likely transition pathway that can be taken, which in turn impact on the choice of governance processes that can help fulfil the aspirations.

In the present study, we have empirically demonstrated the existence of a variety of distinct construction and insurance regimes. We have also illustrated the well-established insight that the introduction of e.g. a new technology into an existing socio-technical system does not follow linear or well-defined trajectories and that the uptake of such technologies is a dialectical process in that the technology is configured by existing systems or structures – at the same time as it reconfigures the very system it is a part of.

Thus, when attempting to ensure convergence of insurance schemes at a supra-national level across different highly institutionalized construction regimes, a careful governance approach has to be decided. Voß et al. (2009) suggest that long-term policy design, i.e. the development and implementation of policy strategies that seek to change radically key societal structures, such as the case we are facing in the present study, has evolved over several generations. Classical approaches address policy design in a comprehensive rationalist perspective as 'planning' –based on a belief in the possibility of progress by the use of forecasting, analysis and bureaucracy (Voß et al., 2009: 279.)

In contrast, and acknowledging the messiness of bottom-up implementation and need for 'modulating' ongoing co-evolutionary processes, recent long-term policy concepts have been grouped under the label of 'reflexive governance' (Voß et al., 2009: 279-280).

In a reflexive perspective, governing processes are seen as shaping, interlinked with and open to feedback from broader social, technological and ecological chances. Such governance processes are described as messy and controversial as each of the actors involved only has a limited view of the whole. According to Voß et al. (2009: 281) all reflexive planning approaches face a dilemma. On the one hand, the requirement is not to suppress diversity, but to nurture developments that are open to contestation, and to retain adaptability towards the complex dynamics of change. On the other hand, there still remains a requirement to achieve coordination and to fix long-term goals for orientation and mobilization. In order to deal with this dilemma, Voß et al. (2009: 281) argue that reflexive planning pragmatically combine top-down and bottom-up elements into so-called procedural design for social learning. What this entails is that the focus of reflexive approaches to policy is towards creating options and exploring paths of development rather than towards planning and then implementation.

Based on the these insights, and using a framework of factors of policy convergence, the next sections will explore and analyze different policy mechanisms that can be employed when seeking a convergence of insurance schemes across different highly institutionalized construction regimes. This analysis will present different possible actions that could improve mutual recognition and stimulate insurance solutions, and will further outline the pros and cons of those actions in relation to the previous discussions of construction regimes, the multi-level perspective and pathways towards convergence.

3.6.3 General financial protection requirements and regulatory framework influence

Depending on the type of stakeholder the answer to the question "what are the expectations or fears that are implied or understood behind the idea of recognition?" may be regarded very differently.

Considering feedback from insurers, we will see how Freedom to Provide Services (FPS) raises questions about the cross-border activities.

3.6.3.1 Financial protection requirements

We previously noted that the necessity of information on financial protection touches all the actors of the market:

- The insured, regarding the risk of default of his insurer, notably the owner, who must ask for information on his insurer. Note that this category also includes contractors and designers in general.
- The insurance broker who bears a "duty to advise" and is liable according to European Directive 2002/92 on insurance mediation (European Parliament and of the Council 2003).
- The insurer regarding its own "financial exposure". This is notably the case for an insurer which is used to work on an unfunded / pay as you go basis and wants to deliver guarantees on a funded / capitalized basis like decennial covers.
- The reinsurer, also regarding its own exposure. This is the case for example if he participates to the cover on a quota-share basis. The asymmetry of information between the parties may also lead to an inadequate use of the treaties (for example use of a general liability treaty instead of specific decennial treaty).

- The financial public authorities which deliver the FPS authorizations, which may not have the knowledge on the financial exposure of foreign guarantees (such as decennial covers). In order to verify and validate the financial security of an insurance activity, the authority must have a thorough knowledge on the insurance product structure.

Once again it appears that access to information is a key element in the global financial protection requirements hence in insurance underwriting process.

3.6.3.2 Regulatory framework influence

Among insurers interviewed, cross-border activity of insurance seems to raise a concern of equal treatment for all European actors in terms of application of the regulatory framework. In other words, what are the applicable rules in terms of financial protection in case of cross border insurance and who is supposed to verify their compliance?

Regarding insurance undertakings, the Interpretative Communication on "freedom to provide services and the general good in the insurance sector" (European Commission - Commission Interpretative Communication 2000) states:

> *"The Third Council Directives 92/49/EEC and 92/96/EEC(1) completed the establishment of the single market in the insurance sector. They introduced a single system for the authorisation and financial supervision of insurance undertakings by the Member State in which they have their head office (the home Member State). Such authorisation issued by the home Member State enables an insurance undertaking to carry on its insurance business anywhere in the European Community, either on the rules on establishment, i.e. by opening agencies or branches in all the Member States, or under the rules on the freedom to provide services. Where it carries on business in another Member State, the insurance undertaking must comply with the conditions in which,* ***for reasons of the general good, such business must be conducted in the host Member State****. Under the system set up by the Directives, the financial supervision of the business carried on by the insurance undertaking, including business carried on under the rules on establishment or on the freedom to provide services, is always a matter only for that insurance undertaking's home Member State".*
>
> Where the concept of the general good is expressed as:
> *"The concept of the general good is based in the Court's case law. […] However, the Court has never given a definition of "the general good", preferring to maintain its evolving nature. […]****The Court requires that a national provision must satisfy the following requirements if it is validly to obstruct or limit exercise of the right of establishment and the freedom to provide services:***
> *- it must come within a field which has not been harmonised,*
> *- it must pursue an objective of the general good,*
> *- it must be non-discriminatory,*
> *- it must by objectively necessary,*
> *- it must be proportionate to the objective pursued,*
> *- it is also necessary for the general-good objective not to be safeguarded by rules to which the provider of services is already subject in the Member State where he is established.*

These conditions are cumulative. A national measure which is claimed to be compatible with the principle of the freedom of movement must satisfy all the conditions. If a national measure does not meet one or other condition, it is not compatible with Community law.[…]
The harmonisation directives define the minimum level of the general good within the Community. Measures relating, for example, to the calculation of technical provisions and the solvency margin, ***the conditions for taking up insurance business, and financial and prudential supervision may no longer be covered by the general good of a Member State****.[…]*
The Court has so far acknowledged that, in the absence of harmonisation, the following areas could fall within the scope of the interest of the general good: the professional rules designed to protect the recipient of services, protection of workers, consumer protection, etc."

Therefore, since harmonized minimum provision rules exist at European level, and that financial and prudential supervision do not fall under "the general good" concept, a Member State that decides to impose, on its own, insurance undertakings stricter enforcement rules than those laid down in the Directives, cannot impose those standards to a foreign State.
In other words, the directive establishes a framework for cross border competition, with different prudential supervision rules, and therefore consumer protection, depending on the insurer's home Member State.

As a consequence, insurers are apparently taking a competitive advantage from providing insurance from Member States with less restrictive prudential rules. This situation seems to be especially the case for Inherent Defect Insurance, which implies financial protection up to construction costs, for periods of up to 14 years according to prudential regulations of the countries where the risks are located.

3.6.4 Conditions for handling incompatibility of national insurance regimes

Considering the previously exposed inter-connection of elements that makes up the construction regime systems and the variability of situations, we will further develop the possible theoretical paths toward "policy convergence" at a European level.

While various and numerous literature explore the topic of policy convergence, the following discussion will be essentially based on the framework presented by Christoph Knill in his synthetic, nonetheless very complete, comparative articles (Knill 2005 ; Holzinger and Knill 2005). The overview made in this article encompasses all policy convergence mechanisms we could find in literature.

3.6.4.1 What causes policy convergence

Even though causal factors of policy convergence vary among authors, Knill identifies five main categories of causes. As summarized in the following table, each mechanism combines a stimulus and a corresponding response, i.e. the behaviour leading to convergence.

Table 29 : **Mechanisms of policy convergence** :

Mechanism	Stimulus	Response
Imposition	Political demand or pressure	Submission
International harmonization	Legal obligation through international law	Compliance
Regulatory competition	Competitive pressure	Mutual adjustment
Transnational communication		
- Lesson-drawing	Problem pressure	Transfer of model found elsewhere
- Transnational problem-solving	Parallel problem pressure	Adoption of commonly developed model
- Emulation	Desire for conformity	Copying of widely used model
- International policy promotion	Legitimacy pressure	Adoption of recommended model
Independent problem-solving	Parallel problem pressure	Independent similar response

Overview of the different mechanisms:

- Imposition

  "Convergence through imposition occurs whenever an external political actor forces a government to adopt a certain policy". We can regard this coercive mechanism as not desirable considering the variety and complexity of the systems and situations described in the previous discussion. It also faces two major critic: legal systems differ from one country to another, and insurers are free actors on the insurance market. Firstly, common imposed legislation as to suit both common law and civil code legal systems. Secondly, if legal requirements are to be imposed, it cannot be on insurance legislation but only on liabilities, leaving the adequacy of the insurance and financial associated protections unclear.

- International harmonization

  International harmonization occurs when the different countries involved in the process comply with uniform legal obligations defined in supranational law. It is a voluntary co-operative process. We can in our case categorize it as a *"negotiated"* imposition. It therefore faces the same hurdles.

- Regulatory competition

  In this mechanism*, "countries facing competitive pressure, mutually adjust their policies, [...] they redesign their market regulations in order to avoid regulatory burdens restricting the competitiveness of domestic industries"*. In summary it is a race to bottom mechanism that is not desirable in our case, considering once again the importance of level of protection existing in the different countries.

- Transnational communication

  This category includes different related mechanisms: lesson drawing, transnational problem solving, emulation and transnational promotion of policy models.

  "In contrast to other mechanisms, they are purely based on communication among countries."

  In summary:

  - Lesson drawing utilize available experience elsewhere, it is an experience-based policy learning.
  - Transnational problem learning is a rational joint development of common solutions to similar domestic problems.
  - Emulation of policies is driven by a desire of conformity with other countries. It is function of the number of countries that already adopted a certain policy, trying to increase social legitimacy, and not being left behind. Its adoption also depends on the perception of its urgency. Considering the increasing number of countries carrying out IDI covers and the general sustainable development trend this mechanism seems to fit greatly to our problematic.
  - International policy promotion is a comparable rational learning mechanism but driven by the active role of international institutions promoting the spread of distinctive policy approaches they consider particularly promising. It is here again a definition that corresponds to our situation, the European Commission being the promoting institution.

- Independent problem solving

  In this mechanism, the convergence of policies between several countries arise as a result of similar but independent responses to parallel problem pressures. Actors do not behave in response to each other's actions. Therefore, this mechanism is out of the scope of our means.

A preliminary conclusion of the description of those mechanisms is that "transnational communication" seems to be a preferable path to follow as it allows convergence by pulling upwards the standards without interfering in national regulations and construction systems' balance.

3.6.4.2 When does policy convergence occur

For each casual mechanism Knill further develops theoretical framework of conditions of their operation. As summarized in Table 30 he shows that *"the conditions and effects of convergence vary strongly across the different convergence mechanisms".* He also states that "*it is hardly surprising that empirical findings on policy convergence and on races to the top or bottom are rather ambiguous."*

Table 30: Theoretical expectations on scope, degree and direction of convergence

Mechanism	Factors affecting convergence scope	Factors affecting convergence degree	Expected convergence direction
Imposition	Reach of the imposing actor (individual country vs. international institution)	(by definition full convergence to imposed model)	No prediction possible
International harmonization	Number of member countries	Degree of legal specification	Upward shift for minimum harmonization
Regulatory competition	Market economy Trade-related policies	Capacity to enforce compliance	Persistence for total harmonization
		Trade dependence	Upward or downward shift for product standards
			Downward shift for process standards
Transnational communication	Apart from information about policy choices of other countries no particular restrictions apply	Degree of existing similarity (number of adopters)	Upward shift in case of policy promotion For other mechanisms no prediction possible
		Cultural linkages	
		Degree of model specification	
		Similarity of policy legacies	
		Degree of inter-linkage into transnational networks	
Independent problem-solving	Number of countries that recognize similar problem	Degree of existing similarity across countries	No prediction possible

Consequently, if the theoretical framework may clarify the mechanisms of convergence, it doesn't give any simple answer to the efficiency of those mechanisms. Nonetheless, we can already conclude from our previous discussion, that policy convergence of construction insurance regimes seems preferable through "transnational communication" mechanisms, in order to improve voluntary dissemination of the insurance offer, adapted to each specific sociologic, economic, technic, cultural and regulatory context of the construction systems.

3.7 Recommendations for policy formulation

This section provides the presentation of different possible actions that could improve mutual recognition and stimulate insurance solutions, based on previous section findings. It will further outline the pros and cons of those actions, supporting final section conclusions and recommendations for the whole Elios2 study.

We hereby remind that, as already indicated in ELIOS, and developed in previous sections, national legal and insurance construction frameworks are the result of long historical developments of, among others: local culture regarding construction methods and techniques (adapted to local environment specificities, including climate, soil conditions or construction materials availability and cost), legal history, insurance role in the construction quality chain, or general economic wealth.

Therefore, and considering firstly states' legal sovereignty and secondly freedom of activity of private construction insurance players, legal and insurance frameworks throughout Europe can essentially evolve and change through internal national mechanisms, involving the stakeholders being part of the national markets themselves.

Consequently, improvements in both constructions market accessibility and protection of consumer through easier access to insurance and better coverage appear to be mainly achievable through "transnational communication" mechanisms. In other words, our main lever to promote insurance is information. Whether it be through incentives in order to stimulate the market or through sharing out the knowledge to the different actors involved.

Based on previous sections results, this section will nonetheless present all possible actions to improve the accessibility to construction insurance, grouped in two main categories:

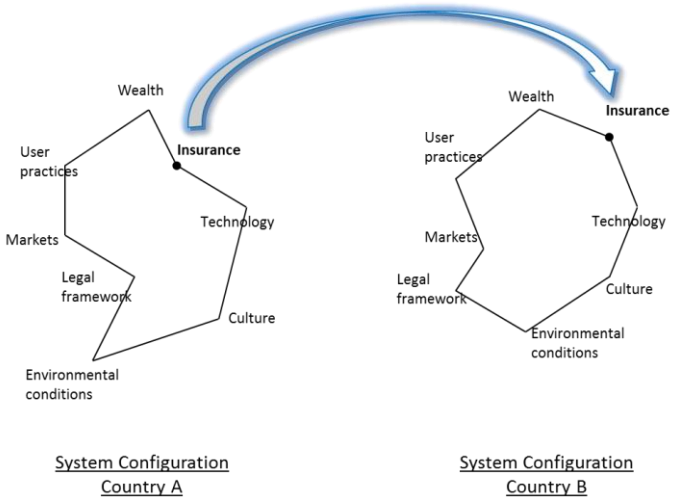
- Improving the access process to the existing "construction systems" through transnational communication
- Modifying the "construction systems" themselves through harmonization

A third independent sub-section will also stress out specific recommendations regarding Energy Performance Guarantees.

3.7.1 Improving the access process through transnational communication

Considering two different construction system configurations, corresponding to two countries, the transnational communication set of recommendations focuses on improving the accessibility process between two systems (see Figure 26). It doesn't affect the systems themselves.

Figure 26: Improving the accessibility process through transnational



Following paragraphs will present the different recommendations comprised in "transnational communication".

3.7.1.1 Increasing Insurance offer

This sub-set of recommendations is aimed at increasing the insurance offer, i.e. the capacity of construction insurers whether to accompany a contractor abroad or to meet a foreign request.

3.7.1.1.1 Improve failure forecast

One efficient incentive to improve insurance availability would be to give some help to the insurers in their risk assessment of unknown or innovative technologies or carried out in an unknown environment. Being able to make a reliable forecast of failure is the key element in order to do the pricing of a cover and propose guarantees. And as previously indicated, without claim history and statistical data this forecast can only be done through a specific qualitative analysis of the risk.

Results of our discussions with insurers indicate that:

- The technical classification of claims is a problem: it has to be done by experienced staff that can classify the claims from a technical point of view, and it is unlikely that most insurers have the computational systems to differentiate "eco-technological" claims
- Insurers are not interested in participating to a pure open statistical database, which would mean sharing information on the spread of claims, since it touches their internal pricing know-how, which is confidential. They seem to be more interested by an exchange on technical information on systems' failures, without any claim numbering or cost consideration

- Nonetheless insurers are interested in obtaining information, and sometimes opened in exchanging technical information on specific technical systems, that are innovative on their market

Consequently, our main recommendation to improve failure forecast consists in sharing information through the EQEO as discussed and detailed in WP2 “Pathology work-package”.

Another form of exchange of information about pathology could be the creation of a “hazard notification procedure” for eco-technologies.

3.7.1.1.2 Quality signs information sharing

As detailed hereafter, sharing information carried by QS should improve accessibility at different levels. Specific details regarding the implementation of the means to provide this information is presented in WP1 “Directory of quality signs”.

QS as an insurance underwriting tool

One way of helping insurers who want to cover a foreign company is to give them the means to appraise the competence of this company and improve its risk assessment, through a better knowledge and understanding of its local QS. Note that the given information must be sufficiently relevant and discriminatory in terms of risk assessment to have an added value for the insurer.

Reminder: the technical information that will be provided by the insurer’s IT system has to be sufficiently valuable for the insurer in order to help them assess the risks and consequently set up new insurance products to seize new market opportunities.

Improve relevancy of QS

As mentioned in previous paragraphs, in order to be useful assessment criteria, QS have to be relevant in terms of risk characterization. In conjunction with Work Package 1, we tried to identify those signs in regard of their use by insurers in their risk assessment process.

One of the conclusions of this work is that few QS are recognized as valuable by insurers. In order to improve this situation, we feel that some interesting developments could be pursued specifically on the ETA (European Technical Approval).

Suggested improvements for ETA:

- Take into account local climatic conditions in the ETA in accordance with national annexes of Eurocode 1. This is especially necessary for all envelope elements (roofs, joinery, insulation) regarding weather conditions or temperature actions (e.g. possible material fatigue under thaw-freeze cycles in some locations), but also for “sustainable” materials with regard to humidity, insects attacks, mildew or fungi.
- Take into account in the ETA site implementation and installation issues.

QS as a promotion tool

On the other hand the directory of QS should allow enterprises to know what signs are used locally by the insurers on their homeland to appraise their risks, notably if they want to set up business or engage in a long term activity.

3.7.1.1.3 Technical Inspection Service (TIS) recognition

As expressed in a previous section, TIS is a core contributor to construction insurance. Therefore, improving TIS recognition should help insurance activity.

Share information on existing TIS

As already made for a set of countries through the mapping update, information sharing on existing national TIS should help insurers identify possible TIS partners in order to control their risks.

In order to provide valuable information, it is important to underline the difference between existing independent “risk analysis” TIS and “conformity” TIS.

TIS European Accreditation / Certification

One way of increasing TIS recognition throughout Europe would be to create a European harmonized TIS accreditation or certification. As expressed before this accreditation should be based on “risk analysis” competences and independence, as valued by insurers. Nonetheless, the implementation of such accreditation through national existing TIS federations face a problem of trust by the insurers.

Even though it seem more complex, a Certification process by the service providers themselves, through their representatives (such as CEBC) may seem a more promising avenue.

3.7.1.1.4 Promote a European IDI cover

Considering the lack of knowledge of companies regarding insurance, especially in countries with lesser insurance offer, another way of increasing insurance accessibility would be by clarifying the subscribing process and improve the transparency of the existing insurance products and existing financial offer, and notably promote the standard international IDI covers toward enterprises.

Considering the difficulty of sharing insurance companies’ contracts, the information could be given through examples of usual covers included in those contracts.

3.7.1.2 Facilitating subscribing procedures

This sub-set of recommendations is aimed at facilitating the insurer's subscribing procedures, and consequently coverage providing.

3.7.1.2.1 Communication through the Points of Single Contact (PSC)

As indicated previously, "single points of contact" should be provided by governments as requested by the Service directive. As they are largely implemented and their access centralized (European Commission 2015), Points of Single Contact (PSC) were identified as the best existing and functioning information sharing tool to meet our needs of transnational communication at a European Level.

Add an Insurance Access Procedure Guide

Beyond sometimes existing information on legal obligations, the PSCs should answer very pragmatic questions asked by insurance non-professionals. Therefore, an "administrative procedure guide" should be easily accessible by the general public. This guide should be an idiot proof comprehensive construction insurance access guide, giving a detailed answer to the general question: how do I get insured?

Could be notably indicated:

1) Who are the insurance providers that I can contact, including:

- Complete and detailed contact information
- Home Office and Regional branches information (a lot of contractors work just the other side of the border)
- What are the available foreign languages of communication?

Note: This information should obviously be provided by the insurers. Considering the increasing cross border construction activity, and the already existing foreign enterprises insurance activity, it seems that regional insurers could see this communication tool as an expansion opportunity.

2) What information is required by the insurer? Including:

- Is there an insurance "construction activity" classification to which I can rely on to identify my activity?
- Complete and detailed list of information needed (e.g.: turn over, list of works done in the past, claim history if existing, workers qualifications …)

3) What is the local technical and normative framework that I should comply with (Including the on-site health and security regulation)? Therefore companies should get a better knowledge of:

- Local design codes and general normative framework, including local climatic or live loads (according to national appendix of Eurocode)

- Local construction techniques for different type of construction elements. For example existing types of roofs and terrace sealants techniques for a company installing photovoltaic panels

This information should help the companies demonstrate that they comply with local design requirements, and are taking into consideration the local environmental construction context and therefore should help them find insurance.

Specifications of the information to provide could take for example the guide written by the French insurance federation (FFSA) in an attempt to help foreign companies understand the French legal framework and how to comply with it. This guide notably gives:

- Description of how insurance works locally (Fédération Française des Sociétés d'Assurances 2015)
- Description of the administrative documents needed to be insured (Fédération Française des Sociétés d'Assurances 2015)

Standardize the information presentation

Considering the present difficulties to find insurance information on the PSC sites, their presentations should be standardized in order to effectively make it accessible. Actions that could be conducted are:

- Add an English version. Language being the most common hurdle to accessibility problems, and even though a language cannot be imposed under current European law, it should be recommended to offer an English version of the site.
- Within the PSC internet sites, harmonize the form factor, i.e. its format: impose specifications regarding the location of the information on the site (site architecture), and the way it is displayed (position of the fields, font, boxes, colors …). Not only format harmonization should help navigation, but it would greatly improve the accessibility in case the site is only available in national language: it then becomes quite easy to compare the foreign site with its national version to locate the information and translate its content with tools such as Google Translate.
- Add ELIOS mappings to the PSCs. Work done in the ELIOS and Elios2 studies should logically be shared on the PSC sites. One of the important set of information that could be shared should be the Mapping of Insurance Regimes for each country. Therefore, it would be possible to assess the insurance requirements and/or legal risks for each country.

  Beyond the pure description on the Legal framework / requirements or insurance possibilities / obligations, as expressed in the mapping, the site could also point out the associated risks for the "builder". In addition, considering the presumed incompetence of the users in legal terminology (SME), the text should also be edited in order to be accessible by non-legal speaking audiences.

  As a result, the reader should be able to know easily what are the risks incurred in a selected country, notably financial, and consequently what insurance protection is needed.

- Require a regular update of the Mapping by the Member States. It seems irrelevant to launch new European studies to update the construction insurance regimes description while sharing this information falls under the PSCs objectives. The mapping update should be included in the PSC specifications.

3.7.1.2.2 Enterprises prequalification

Enterprises prequalification at a European level could be a way to standardize procedures and give a common European framework to access insurance.

Even though this mechanism is successful in Germany (Bauindustrie Bayern 2015) it was abandoned at community level (FIEC - European Construction Industry Federation 2011), apparently because it was to the advantage of bigger companies (compared to SMEs), that have the means to satisfy this additional administrative burden.

Nonetheless, it would be interesting to further investigate how Germany managed to trim its disadvantages for SMEs, and reinitiate the CEN TC-330 dealing with "qualification of construction enterprises", maybe with narrower objectives.

Some concurrent solutions were also found on parallel topics, for example for sub-contractors in the UK (Turner 2015).

3.7.1.2.3 "Insurance accessibility" complaint procedures

Add to PSCs a national complaint submission procedure

Even though the Elios2 project notably tries to improve accessibility to insurance, the real extent of the accessibility problem is unclear. In order to objectify this problem, and at least standardize the means to retrieve factual and quantitative information (number of cases), a simple complaint submission mailbox could be added to the different PSC Sites, with copy to European bodies, so that national authorities would get a clear view on the extent of the difficulties faced by foreign companies willing to fulfill local insurance practices.

Create an EU level complaint submission procedure

In the same way Solvit internet site centralizes complaints about obstacles regarding EU law application by authorities, a comparable internet site could be dedicated to retrieving the complaints regarding insurance at the EU level. Taking advantage of the Solvit site, a link could be made between them.

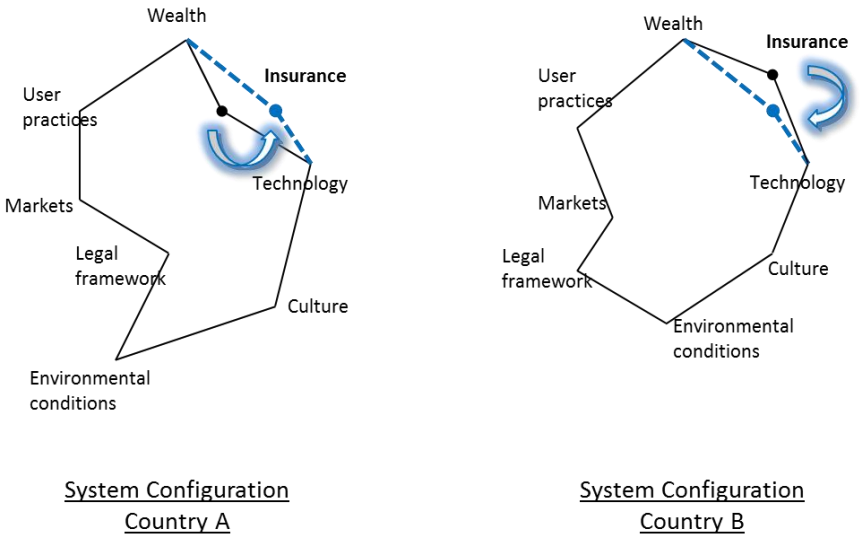
Implement an European construction insurance obstacle mediator

The most effective mean of retrieving information about complaints, analyze those complaints, find solutions, and report about the problematic would be to dedicate a body to this task. This Mediator solution can be carried out jointly with previous proposals.

3.7.2 Modifying the "systems"

In comparison to the "international communication" set of recommendations, this one doesn't aim the accessibility process per se but the system configurations themselves, in order to diminish the differences between systems and consecutively ease the accessibility (Figure 27).

Figure 27 : Construction insurance regimes harmonization



System Configuration Country A

System Configuration Country B

This harmonization solution can only be carried out by setting new EU regulation or modifying the existing ones. Two main domains could be concerned.

3.7.2.1 Setting a minimum level of guarantee

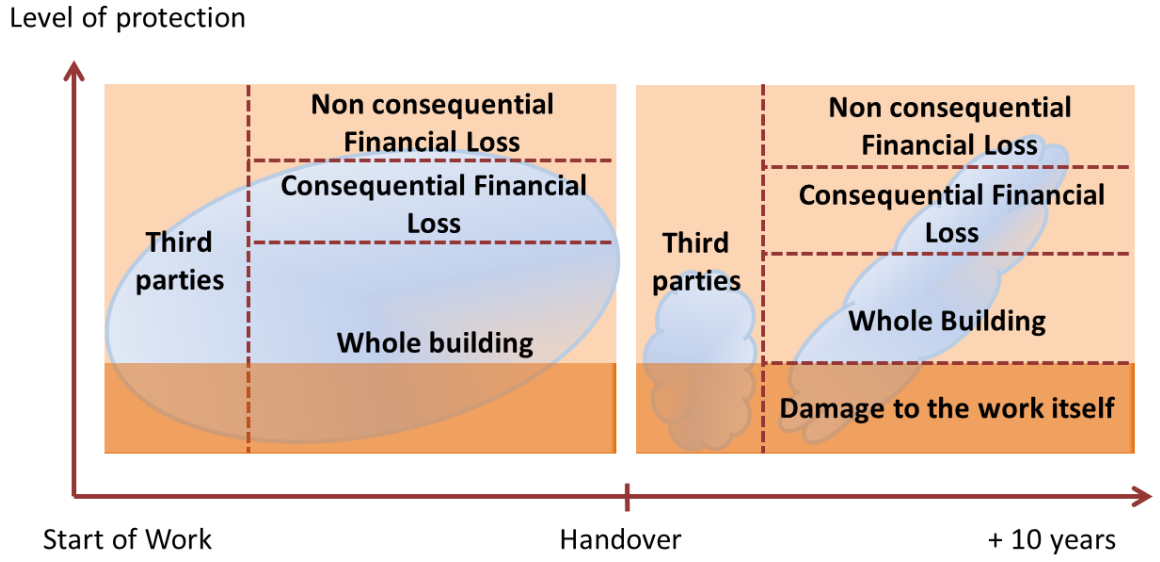
Under this new law, it would be required from all EU Members a common minimum level of guarantee of the contractors, architects, engineers and inspectors' liability on solidity / stability of the built work. The guarantee could be legal or contractual, on a liability or property basis.

This level of guarantee could be the construction work value for contractors, and a percentage of the Total Construction Value (TCV) for "designers" (architects, engineers, inspectors) (Figure 28).

As previously analysed, the principle of levelling up the requirements, departing from lowest common denominator is the only possible convergence path to harmonization. Nonetheless, once again this solution faces the general problem of the "systems" complexity.

If we look in detail in the insurance functioning, we see that under for example Third Party Liability, insurers combine different underlying types of insurance coverage, without detailed distinction, in order to spread out the risks. This aggregation principle is the main reason why construction TPL premium values are never available; they cannot be distinguished from other types of TPL.

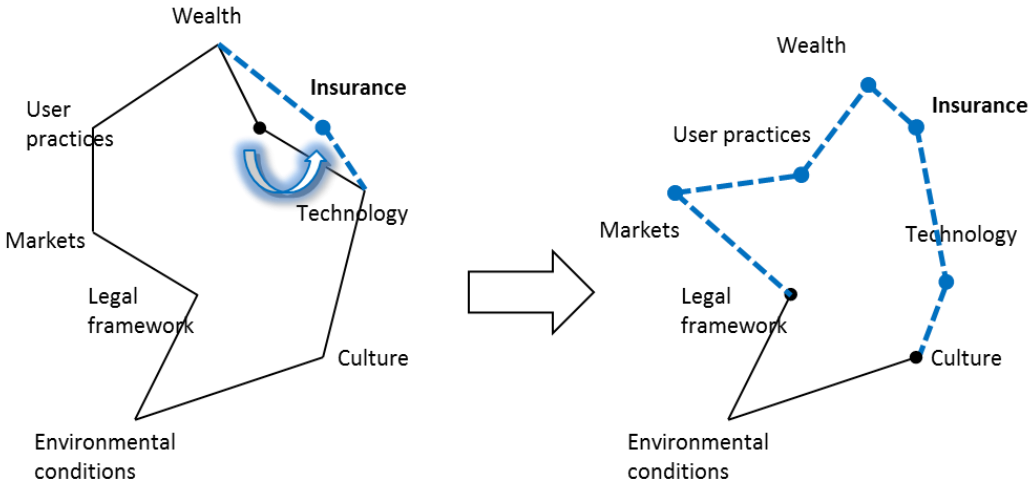
Figure 28: Setting a common minimum level of guarantee



Consequently, modifying regulations on construction TPL cannot be done alone, independently from other domains covered, that would be impacted by any modification.

From a systemic approach point of view it seems that pure harmonization induce a system reconfiguration process; that not only affects insurance but all components of the systems. Pursuing this solution would mean disrupting the systems globally, forcing them to globally reconfigure (Figure 29).

Figure 29 : System reconfiguration as a consequence of harmonization



3.7.2.2 Adapt the Freedom to Provide Service law

Based on differences between national financial regulation laws (Solvency II) and on the application of Home Member State's provisions, current Freedom to Provide Service law (for insurance) seems to lead to distorted competition between insurers since they don't have to comply to the same prudential rules. Consequently protection of the consumer is also at stake. The current FPS application raises doubts and even suspicion from some actors, especially in the French Market.

The FPS law could in theory be modified in two ways:

- Change the obligation to satisfy the "host Member" State's regulation instead of the "home Member" state's regulations
- Require the communication of existing local financial regulations (and notably provision rules) associated to specific guarantees (and notably IDI), from "host Member" state's regulatory authority toward the "home member" state's regulatory authority, through the EIOPA (European Insurance and Occupational Pensions Authority). Doing so, the authorities of the "home member" state of the insurer would be fully aware of the financial requirements the companies operating from its territory should comply with and of the associated risks. Therefore, being informed of the risks, the local authorities couldn't deny their responsibility in protecting the consumer from a possible failure of a domestic insurer.

However, a suitable answer to this situation could be to find ways in order to improve the exchange of information between the competent supervising Authorities.

3.7.3 Energy Performance Guarantees

As previously mentioned, coverage of performance guarantees faces many challenges. Pure "energy consumption performance" coverage, i.e. coverage of the level of energy consumed by the house or dwelling, or produced in order to suit the consumer demand, faces huge hurdles:

- Its dependency on the consumers' behaviour makes it hard to assess, particularly if the users are individuals (compared to enterprises). It is particularly true regarding the perceived individual "comfort temperature level" and ventilation habits (opened windows)
- In order to determine the inherent performance of the building, the consumption of appliances need to be separated from the building one. If it can be easily done by installing smart meters, even though it should increase in the coming years, few of them are currently installed (Financial Times 2014) in order to let the occupant evaluate its consumption
- Modern high performance buildings rely on equipment that needs maintenance, especially ventilation (recovery dual flow ventilation). In case of "home" occupants, this maintenance will likely be ignored. Real performance will therefore highly depend on the behaviour of the occupant.

In order to improve the insurability of true energy performance, following actions could be carried out:

- Include in European standards a common conventional performance definition and calculation in order to facilitate cross border emergence of ESCo type energy covers as they exist in USA. These “guarantees” consist of recovering the investment made in the energy consumption improvement through future energy bill savings. They are usually directly delivered by ESCo in case of rehabilitation or by developers for new constructions, without implication of insurers. The risk is directly borne by the builder or investor.
- Restrict the energy performance guarantees to inherent energy performance guarantees, as it is attempted by French authorities (Le Moniteur 2013). Inherent Performance is the theoretical performance of the construction work in place, hence consisting of material / design / workmanship.
- Promote smart meters which permits “inherent performance” measurement
- Even if it is not pure performance coverage, where they exist, existing IDI covers can be extended to malfunctioning, within the existing inherent defect covers. This trend is for example followed by Spain.
- Aim development of office building energy saving guarantees, for which on the one hand consuming framework is better foreseen (not individual dependent), and therefore construction more adapted at the design level, and on the other hand maintenance is carried out flawlessly.
- Take advantage of the feed-back given by current experiences held by the various national publicly financed projects. In those cases while the governments substitute for the insurers, the covers are widen to a broader range of buildings and situations.

CONCLUSION

Firstly the key results of the Pilot Project (4.1) are summarized before presenting the main transversal recommendations (4.2).

4.1 Overview of some key findings

Amongst the main trends we have observed during the Pilot Project Elios2, some are "in line" with the conclusions of Elios1, they confirm or enhance the description within this feasibility study (4.1.1), the other ones are somewhat new or different (4.1.2).

4.1.1 Confirmed trends

4.1.1.1 Diversity of national systems

As mentioned in the final report of Elios1 (2008-2010), "the first observation with respect to the general framework of construction regimes in Europe is the existence of an extreme diversity of construction liability and insurance regimes across the EU Member States".

Today, the diversity of the national regimes has not been reduced at all, no measure stimulating some forms of convergence in this sector has been adopted and the landscape of construction insurance in Europe can still be described as a "patchwork of 28 insurance systems" (see the updated mapping, appendix 3.1).

There are also deep differences between national practices for quality signs (WP1) and for building pathology (WP2). These differences manly lie in the level of development of both QS and pathology records. Nevertheless, where developed, QS and pathology records refer to similar principles.

There is indeed a distinction to be made between the factual reality of pathology (leaks or cracks for instance) and the qualification it will receive according to the national rules, the way the legal system will take the physical reality into account, in terms of both liability and insurance (the first question being simply: is it a claim?).

When a failure or a defect occurs, the duty to repair falls to different actors depending on the national frameworks. Typically, numerous defects affecting houses in the UK will be managed by NHBC, whereas the German contractors will generally be asked to take charge of the same kind of damage and, in France, a similar situation will mobilise the compulsory insurance system.

4.1.1.2 Inter-connection between construction insurance and its national context

It has already been highlighted during Elios1 that insurance can play a regulatory role in construction activities. The research done by WP 3 underlines the strong inter-connection of elements that make up the construction regime systems (see Figure 29).

For this reason, examining the conditions for greater mutual recognition of construction insurance regimes, we propose to give priority to an improvement in the access process through transnational communication rather than modifying the systems and try to harmonize them.
In parallel, the use of QS by the insurance sector is also linked to the realities of each national market. This use differs depending on the guarantees delivered and these guarantees are largely in accordance with the legal frameworks and the national customs.

In this regard, it has to be noted that, generally and historically, existing QS have not been meant to explicitly produce information for insurers.

4.1.1.3 Despite the diversity, some similar concerns and common general trends of evolution

As was done during Elios1, a functional approach of comparison between the different national regimes of construction insurance allows underlining important common concerns and trends of evolution.

Through the diversity of the national regimes, a growing need for security and guarantees, a will to protect consumers, exists throughout Europe

Some QS, initially dedicated to be “signs on the basis of which construction stakeholders rely on or give credit to when decision has to be made” are more and more taken into account by the insurance sector in the underwriting process. This is for instance the case for QS on competences, construction systems and performances of works.

The concern about the considerable cost of non-quality in the construction sector and the interest to disseminate information about pathology in order to promote better practices are also widespread throughout Europe.

Unfortunately, the data on pathology are often seen as confidential and some actors are not eager - or are even reluctant - to provide their data in order to contribute to an exchange of information. Despite a large consensus on the theoretical and practical interests of such a process of exchange, only few organisations have succeeded in collecting and disseminating data on building defects in a systematic manner.

It is noticeable that, amongst the existing national observatories on pathology, two of the main references, AQC in France and BYG-ERFA in Denmark, were initially created with the support of governmental measures. It seems that, in this regard, the addition of the individual interests does not lead automatically to measures favourable to the general good: public support, at least temporary, can be useful.

Note: Established in 1982, l'Agence Qualité Construction (AQC) is an association that gathers the professional organisations of the construction sector in order to prevent building defects and to improve the quality in construction. The activities of the Agency are organised around 3 axes: observation, prevention and communication. The AQC was created and financed by the French Government. Since 2005, the professionals of the sector found it. The financial contributions are collected by the insurers in the framework of a 5-year agreement. The third agreement (2015/2019) has been signed the 5th of June 2014.

BYG-ERFA was established in Denmark in 1977 to disseminate knowledge and experience on building pathology information sheets. Partners/board members include the Building Danish Defects Fund (BSF), the Building Damage Fund for Urban Renewal (BvB), the Danish Building Research Institute (SBi), the trade association of insurance companies Forsikring & Pension, the ministry etc.

BYG-ERFA was partly financed until 2001 by public funding. Since 2001, BYG-ERFA is fully self-financed through its activities, in particular sale of publications. Moreover, BSF and BvB are established by decree.

The financing stems from a 1/1.5 % fee of the construction cost to be paid to either of the two building Danish Funds) were initially created with the support of governmental measures

4.1.2 New developments

4.1.2.1 A break in the tendency to implement mandatory insurances

The mapping established during Elios1 in 2008 highlighted a tendency to implement ten-year post completion insurance for housing, mainly in the Western part of Europe. Apart from 6 States with a compulsory legal framework: France (1978), Sweden (1993), Finland (1994), Spain (1999), Italy (2004) and Denmark (2008) and 3 with a widespread insurance scheme (the UK, Ireland and the Netherlands), there was a project to implement such an insurance scheme in 5 other European States (Belgium, Czech Republic, Greece, Luxembourg and Portugal).

What is the situation today? It seems to have changed radically since none of these projects has been implemented. On the contrary, the Swedish compulsory IDI cover was cancelled during the summer of 2014 and Spain's insurance is still expecting the extension of its compulsory IDI with a 3-year cover for housing (see chapter 3.4.2).

It underlines the link between compulsory insurance and economic conditions. The reason for this change, even this reversal of trend, seems clear: the economic crisis. In other words, a compulsory or widespread insurance presents a lot of advantages, but has a cost. And, for many Governments today, the implementation of such a mandatory system is not a priority.

4.1.2.2 Scepticism on the part of some national actors and stakeholders about the European initiatives regarding construction insurance

We have to take note that, during the process of our Pilot Project, we had to face some reactions from professional actors and stakeholders translating a kind of scepticism about a European project in this sector.

This was the case for WP 3 with the fear of a project of harmonization, as happened during the 90's with the "Mathurin Report" (C. Mathurin, *Étude des responsabilités des garanties et des assurances en vue d'une harmonisation au niveau communautaire*, 1989) and the works of the "GAIPEC" (*Liability and insurance regimes in the construction sector*, 1992; http://ec.europa.eu/enterprise/construction/info/study_liability_insur_regimes_sect_construct.pdf), especially expressed by actors of the insurance sector.

But it is also the case for WP 1, with some reluctance to populate the Directory of QS coming from the sign providers, in spite of intense efforts, or for the WP 2 with the questioning of national bodies about the pros and cons of an exchange of information about pathology at the European level.

4.1.2.3 A kind of contradiction between the European legal framework and the national markets realities

Consequently, there appears to be a kind of contradiction between, on the one hand, the European rules, especially the Freedom to Provide Services and the statement of a Single Market, and, on the other hand, the national markets realities.

One of the manifestations of this contradiction is the question of access to insurance by the actors of the construction sector, especially SMEs, when providing their services in another Member State. Is this access to insurance an obstacle to cross-border activities and the development of the Single Market?

A question that seems to be somewhat "resilient": several initiatives have been taken since 2008 at the national and at the European levels, but has the problem really been solved?

The answer could be negative according to the Staff Working Document issued by the EC the 31st of March 2014 and entitled "Access to insurance for services provided in another Member State" (http://ec.europa.eu/internal_market/services/docs/services-dir/implementation/140331-staff-working-document-access-to-insurance_en.pdf). This document points out that the provision of services still faces significant obstacles due to disparities in insurance obligations, especially in the construction sector.

Another question linked to this contradiction is the lack of confidence sometimes expressed about the exercise of the Freedom to provide services by insurers. Do they offer the same level of guarantee in terms of solvency as the national actors? According to the Home Country control principle, their national Authorities control these insurers and an efficient control assumes a good knowledge of the specificities of the host country (see the report of the Scientific Committee).

As a general conclusion, these different trends fully justify, from our point of view, the main orientations of the Pilot Project Elios2. It is crucial, especially for cross border activities, to attempt to better manage the diversity of the existing construction insurance regimes.

It needs to stimulate a better circulation of information at the European level. We have to imagine tools in this perspective.

Additional remark about the freedom to provide services (FPS) for the actors of the insurance sector

As mentioned during the course of the Pilot Project (see Progress Reports), different stakeholders have addressed the question of the conditions, rules and information needed when an insurer acts in the framework of the Freedom to Provide Services.

The current functioning of the Home Country control principle raises doubts and even suspicion from some actors, especially in the French Market: are the insurers who are operating from another Member State -and their Control Authorities- always correctly informed about the specificities of the Host Country national regime, especially when a long tail guarantee is required? The Scientific Committee has acknowledged this question as a serious concern (see appendix).

It seems important, at least, to improve the confidence of the public and of the professional actors in the control exercised by the different national Authorities according to the system of the Home Country control.

In our opinion, it means finding ways to improve the exchange of information between the different national Authorities in charge of this control.

And it seems to be necessary and urgent since, according to the information we have collected, some actors could make unfair use of the current situation: the risk of occurrence of financial difficulties for the insurers involved, and consequently the risk of a flaw in consumers protection, cannot be ignored.

4.2 Main transversal recommendations

4.2.1 An observatory allowing an exchange of information about the crucial topic of pathology: the EQEO Project

As explained and justified in the second part of this report, we recommend the creation of an Observatory at the European level in order to organise an exchange of information between national actors.

Even if there appears to be a widespread and even systematic willingness to collect information on pathology in the different member states and even if the collection and analysis of data are officially organised and managed in some of these (under various forms and by different types of actors), there is no exchange of information today at the European level.

Considering the difficulties in gathering reliable and exhaustive information on pathology and the few organisations collecting data systematically at the national level, the observatory could be, at least as a first step, limited to some member States and to some eco-technologies.

The technologies are expected to be clearly identifiable, mature enough, available on the market and commonly applied in most EU-countries.

According to the findings of the work done by WP 2, in particular through the Pilot Database, we propose to select the 3 following eco-technologies:

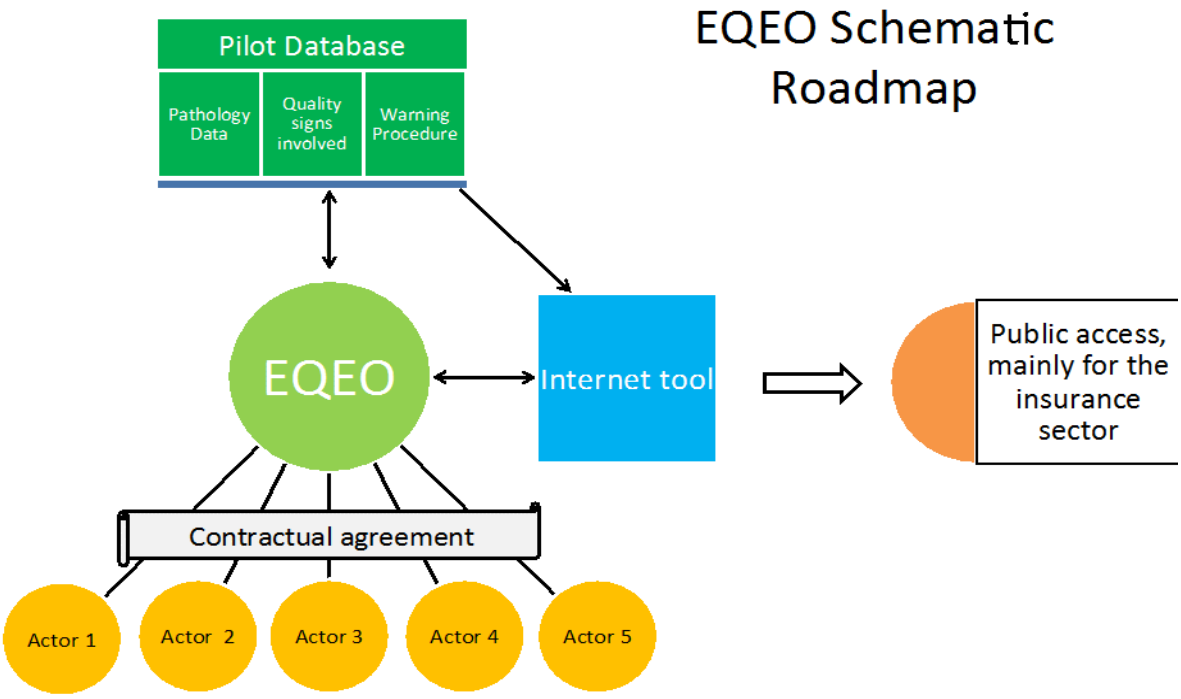
- Photovoltaic Panels (PV's)
- Ground source heat pumps
- Bio material based insulation

As a result of our discussions with the main stakeholders, the insurance industry, and more generally all the actors of the construction and insurance sectors, would be interested in having information about the quality of these 3 eco-technologies at a European level.

The tool to be developed would be called: Eco-technologies Quality European Observatory (EQEO).

It should have at least three functionalities}:

1) A database with pathology records that provides qualitative technical information on the pathology of eco-technologies (without any statistical data disclosure of claims).
2) A 'Warning procedure' (or hazard notification procedure), where interlocutors in each country can report issues/defects.
3) An overview of quality signs for these eco-technologies (as an extract from the quality signs directory developed in WP1).



This Observatory would obviously be a way to stimulate the quality in the Single Market for construction and to improve the confidence of the different categories of actors, especially the insurers.

The main goals of the EQEO Project are thus:

- To promote the quality of eco-technologies used in the construction sector
- To support insurers in their risk assessment and, consequently, to facilitate access to insurance, especially for SME's

Amongst the 4 possible business models (see 2.6.11), a non-profit basis tool with free public access seems clearly to be the most appropriate for the objectives.

In order to imagine a possible roadmap for the creation of a European tool, we have tried to summarise the pros and cons of the different solutions suggested at point 2.7.2

Possible solutions (chapter 2.7.2)	Relevance and opportunity (critical view)
1. Setting up a European Working Group	In a long-term perspective, a European Working group could be useful to manage the exchange of information at the European level. However, initially, due to the difficulties to gather comprehensive and reliable information on pathology, creating *ex nihilo* such a group would risk to be an expensive solution without real efficiency
2. Organizing meetings between some key national actors holding information on pathology	Even if the simple organisation of meetings is a temporary solution, it is certainly a good starting point. These first meetings could be an efficient and not too expensive way to validate the possibility to build an observatory (EQEO project).
3. Exploiting the results from EU research projects on construction materials and eco-technologies	The use of the existing European data is a necessity. The question is more to know who is going to exploit the information bases and how this work will be remunerated. In any case, according to our investigations, the available information today is not sufficient and has to be completed.
4. Making information available through a web-portal of the European Commission	The Elios2 pilot pathology database is a first step making information available at the European level. This experience confirms the interest of such a tool, but also the difficulties to set it up, feed it and manage it.
5. Setting up the Eco-technologies Quality European Observatory (EQEO)	Several stakeholders have already expressed their interest or their support for the EQEO project. As explained in the present report, we are convinced of the pertinence of this model. Nevertheless, before launching such an observatory, it is crucial to make sure that the key actors holding information at a national level are ready to actively participate.

Taking into account the relevance and the opportunity of the different possibilities summarised above, the best solution would be, from our point of view, to start with a set of meetings gathering some key actors holding information for their national markets. The different exchanges during Elios2 lead to think that the following members, for instance, could compose an efficient and representative pilot group:

State	Actor
Belgium	SECO
Check Republic	TZUS
Denmark	Danish Building Defects Fund
France	AQC
UK	NHBC

This pilot group would have all the competences and knowledge to define the following steps in order to progress toward a European Observatory.

The project of an Eco-technologies Quality European Observatory (EQEO) was presented and discussed during several forum meetings (see progress reports and minutes of forum meetings).

A broad consensus exists on the theoretical and practical interests of such an observatory, but the key question to be addressed today has to do with what kind of support can be expected.

4.2.2 A way to fix the delicate question of access to insurance for cross border activities: a European Facilitator for the Access to Construction Insurance (EFACI)

4.2.2.1 The question to be addressed

Some remaining problems seem to be hampering a fully functioning Single Market for services (see the Staff Working Document of the 31st March 2014 entitled "Access to insurance for services provided in another Member State") (http://ec.europa.eu/internal_market/services/docs/services-dir/implementation/140331-staff-working-document-access-to-insurance_en.pdf).

This document points out that the provision of services still faces important obstacles due to disparities in insurance obligations, and it refers to the Elios2 project: “The developments in this context should be monitored with a view to determine whether the experience gained from this pilot project in the construction sector could be valuable for other sectors dealing with the issue of insurance in a cross-border context”. It also reminds that – according to article 23 of the Services Directive – the Commission may decide on common criteria for defining when an insurance requirement is appropriate or not to the risk covered.

In the same perspective, the European Commission has launched a new survey to better analyse the problems faced by the providers of services and to assess the role of insurance in the subsistent obstacles (http://ec.europa.eu/eusurvey/runner/internal-market-services-businesses).

4.2.2.2 Options

When dealing with difficulties encountered by cross-border service providers in order to access to insurance, five broad non-exclusive options of guidelines seem imaginable:

- Organise a system of equivalence between insurances issued in the various States as defined under Article 23.2 of the Services Directive of 12 December 2006.

Insurance issued in the State of origin is thus recognised as equivalent, fully or partially, to this requirement in the Host State. In some cases additional (“top up”) guarantees are contemplated.

Nonetheless, the details of some legal regimes in the matter of construction limit the prospect of such equivalencies.

- Reduce the diversity of national construction insurance systems, a diversity that is at the origin of the difficulties encountered.

This option may itself take various forms, since an attempt to harmonise the legal rules (but see the drawbacks of such an option in chapter 3 of this report) until common insurance contracts or good practices.

In every case, it is plain to see that this all remains fairly theoretical. And that levelling "down" the guarantee requirements is not desirable, especially as regards to the protection of consumers

- Encourage better information on existing systems and the possibilities of subscribing to guarantees adapted to the constraints of the Host State.

The difficulty of obtaining enough information explains certainly to a great extent the current situation (position defended in Elios1).

The possibility of relying on the network of Points of Single Contacts (PSC) falls within the framework of this option, one of the most interesting. In this perspective the *mapping* of the current Pilot Project could be useful.

However, it seems very complicated to concretely provide efficient information to the different national actors, especially SME's. The consultation of the PSC demonstrates this difficulty.

- The inadequacy of this latter option, or at least the risk that it would be inadequate for resolving observed difficulties, leads to another possibility, i.e. to imagine a tool in order to fix the difficulties on a tailored and consensual basis.

It could be the setting up of a **European Facilitator for the Access to Construction Insurance (EFACI)** in the construction sector.

The role of this Mediator would be to advise and to help services providers in the construction sector in order to facilitate access to insurance for their cross border activities.

- Finally, if soft solutions are not enough, a mechanism should be considered that obliges an insurer to issue the guarantee, where necessary.

Nevertheless, the idea of a European "Bureau Central de Tarification" (Authority existing in France), is admittedly heavy and complex to implement.

In view of the above, the preferred option is the proposal of a facilitator, which is developed below.

4.2.2.3 Missions of the Facilitator

The Facilitator, independent Authority appointed by the European Commission, would be in charge of advising and helping the service providers of the construction sector in order to facilitate the access to insurance for their cross border activities.

He would have to:

- Gather and update data on the 28 Host States insurance construction systems. The facilitator could use the Elios2 *mapping*, keep it up to date and improve it based on feedback.

- Deliver to the service providers information as appropriate and as efficient as possible about the existing constraints and possible solutions.

- Set up links with national mediators, stakeholders and actors of the insurance market, the points of single contacts (PSC)…
- Handle residual difficulties through negotiation.
- Centralise demands concerning cross border activities in the construction sector, being able to make a reliable assessment of the (potentially) hindrance of access to insurance for the Single Market.

From our point of view, in order to avoid any confusion or uncertainty, the role of the Facilitator has to be clearly delimited and defined in accordance with the difficulties to be fixed and the principle of subsidiarity.

Thus, the Facilitator, consulted only if a problem in the normal functioning of the market appears, will not be in charge of:

- Making it compulsory for an insurer to cover a risk,
- Managing the contractual process (guarantees, premium, claims…)

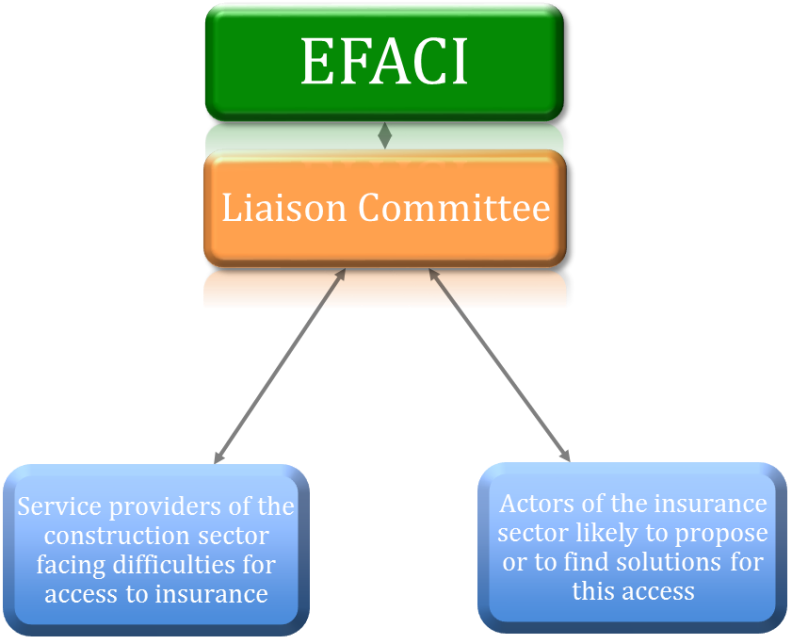
This solution would have a number of advantages. These include:

- Allowing anyone concerned to know to whom claims might be submitted (complaints bureau),
- Fixing on a tailored and consensual basis a certainly large part of the existing difficulties
- Giving a real census of these difficulties.

In order to contribute to the "visibility" of the EFACI and to help him to fix the difficulties, a Liaison Committee would be set up. This Committee has to be composed by a small and efficient team:

- 1 representative of the EC
- 1 (or 2) experts
- 2 (or 3) representatives of the construction sector
- 2 (or 3) representatives of the insurance sector

This solution, which presents the considerable advantage of being not expansive, could be in a first time tested during a limited period of time (3 years for instance).



A large part of the stakeholders have already expressed their interest for this recommendation and we are currently collecting letters of support coming from the representatives of the different key actors of the insurance and construction sectors.

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Appendixes

Introduction

Appendix Intro.1

Work Package 1

Appendix 1.1 : Directory of quality signs: scope and structure
Appendix 1.2: Directory of quality signs: specifications of the web tool
Appendix 1.3: Rationale and relevance of the information provided by quality signs
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Work Package 2

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Work Package 3

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