Making non-energy benefits a real asset and changing professionals' habits: renew the partnership approach through the DECADIESE method

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Abstract

Meeting the European energy efficiency and carbon emissions targets requires ambitious building projects. Unfortunately a raw energy savings-based payback assessment approach is usually unable to underline the economic and financial relevance of such projects. Benefits beyond energy aspects must therefore be taken into account in an assessment method which estimates a monetized value for each benefit within a larger scope which includes additional stakeholders. Although many extended building assessment methodologies have been developed, they failed to address the following challenges: being considered legitimate by the professionals (contractors, building companies) involved in such projects as well as designing compliant business models which convert the non-energy benefits into original co-financing schemes.

The DECADIESE method was developed over a two-year period starting in 2012 within the framework of a project in part financed by the French research agency, *Agence Nationale de la Recherche*, involving leaders from the energy, real estate and construction sectors as well as research centres in economics, industrial engineering and sociology. Designed for commercial and social buildings, DECADIESE integrates the functional performance of buildings together with environmental and social externalities. This method also helps identify stakeholders likely to become relevant potential partners within a business model giving a financial value to these externalities. It explicitly deals with the challenge of endorsement by professionals in construction and other related sectors, leading to a major change in work routines and modes of cooperation.

This paper briefly presents the method and its supporting concepts and then describes how and when it could be used by professionals in real case studies. It eventually identifies the main barriers to overcome in order to establish this method as a widely used tool within the construction sector. Beyond raw economic figures and the direct outputs resulting from its application, one of the key added values of DECADIESE, based on feedback from first experience, is the dialogue and mutual understanding it triggers among professionals. The promoted partnership approach could support a tremendous change in cooperation habits within the construction sector and with the clients, which is a key to get energy efficient buildings.

Introduction

The European energy and climate policy has set three key objectives for 2030, which are (EC, 2015):

- a 40 % reduction in EU greenhouse gas emissions from 1990 levels;
- raising the share of EU energy consumption produced from renewable resources to 27 %; and
- a 27 % improvement in the EU's energy efficiency.

As the building sector accounts for approximately 40 % of the final energy consumption in Europe (Huntington, 2009) and for almost 25 % of global CO_2 emissions (Moriarty & Honnery, 2011), it is particularly concerned by these energy and climate objectives. Very ambitious building energy renovations or new low- or zero-energy building projects must be realised to help reach these energy and climate targets.

Moreover, the building sector generates economic activities and local employment (Tirrado Herreo et al., 2011). For example, Zorzi (2009) proved that a district[1]-wide ambitious energy retrofit program for middle and high schools in France could generate an increase of more than €60 Billion in the local domestic product between now and 2050, which stands at about 50 % of the local GDP. This very huge increase comes from:

- a decrease in CO_2-related social costs;
- macro-economic effects of local energy-efficiency investments (Green Investments) in buildings (local added value and employment); and
- learning processes due to students' education in the framework of such retrofits.

Today's assessment tools of energy-related building projects (construction or retrofit) focus mainly on the capital cost (investment), or sometimes on a Life Cycle Cost (LCC) calculated from investment costs, discounted operations (including energy) and maintenance costs as well as discounted deconstruction costs (ISO 15686-5). With this assessment approach, energy conservation investment costs might be balanced by a decrease in energy costs (and therefore by operations costs) occurring over the calculation period. For instance, in the framework of an energy conservation investment with a 10-year service life and enabling an annual 10 % energy gain, a building owner can calculate: 10 (years) × Energy initial consumption × Discount Factor – (Energy Conservation Investment costs + 10 (years) × Reduced energy consumption × Discount Factor). If the resulting figure is positive, the investment is considered to be worthwhile. The discount factor expresses a "preference for the present", otherwise known as the time value of money. Unfortunately, this method fails to provide an accurate valuation to solutions which may be compliant with the oncoming energy and social challenges.

For instance, when considering ambitious energy retrofits which deal with building facades (insulation, double glazing), the calculated payback is often longer than 15 years and sometimes as long as 30 years whatever the selected discount rate might be (although the selection of a higher discount rate impedes the competitiveness of such long-term investments). On the other hand, simple energy systems-related investments with limited (although positive) energy impacts end up yielding an acceptable return (3 to 10 year-payback). However, the proliferation of such limited energy savings investments is insufficient to meeting the aforementioned 2020 energy and climate targets.

However, the benefits of energy retrofits are not only related to the energy savings achieved but also to numerous other impacts with economic values (asset values, health and well-being, employment …) as it is pointed out by the International Energy Agency (IEA, 2014) or Ürge-Vosatz (2009). This organisation even suggests ignoring the distinction between energy savings and "non-energy benefits" (Amman 2006) and using the more homogeneous "multiple benefits" (of energy efficiency) phrasing (IEA, op. cit.).

In any case, in most instances in the commercial building sector, energy efficiency investments are not undertaken even if they have an acceptable payback, since they are not considered to be strategic (Cooremans, 2011). It is therefore necessary to consider a comprehensive set of energy investment-related benefits beyond energy savings in order to assess the competitiveness of investment in a more comprehensive manner which is more consistent with the hosted "activity". The word "activity" hints mainly at business in commercial and public buildings but may also be relevant for residential buildings. Such a comprehensive assessment approach is likely to ensure that the scope of energy conservation solutions is not solely restricted to the options which could be seemingly cost-effective but might turn out to generate less value than more ambitious ones (whereas "value" may be defined in a broader sense of the term which includes relevant externalities). An assessment method encompassing this set of benefits unrelated to energy will make more solutions seem cost-effective.

Several extended global cost tools have been developed more or less under the inspiration of ISO 15686-5 and generally resemble a Cost-Benefit Analysis, yet they end up failing along three principle axes:

- Valuing a non-market benefit or an externality is not enough to ensure that the corresponding value is converted into a monetary flow. A Cost-Benefit Analysis (CBA) relies on the assumption that the "winners" are able and liable to compensate the "losers" (Pearce & al., 2006). Unfortunately, no market structure really supports such a compensation scheme and the CBA is essentially relevant when designing a public policy, with the "State" internalizing both gains and losses (representing both winners and losers). However, is such an approach still relevant when the subject (building projects) essentially concerns single actors (either public or private bodies) and not a national or regional policy or program financed by public bodies (such as public transportation infrastructure)?
- A building is neither an "object" with a distinct cost to the owner, nor a simple financial asset (as it can be considered with the famous "green value" approach): according to the DECADIESE project partners, the building is a real value creation system, which must be taken into consideration when performing its economic assessment.
- These methods fail to be fully legitimized by industry professionals and used as real decision support tools (Vitt, 2014). Such methods seem to too theoretical and indeed offer little help in designing relevant business models which convert externality values into real economic flows (monetary or other) (Vitt, *op. cit.*).

The DECADIESE assessment method encompasses both the building-related economic impacts (as per EN 15643-4), some valuation of its externalities occurring during its life cycle and its use value (its functional performance). This integrated approach is able to overcome the aforementioned pitfalls of existing extended economic assessment yet it is nevertheless based on the assumption of a change in the professional habits

1. The considered district was the *Département de Seine et Marne* (Metropolitan area of Paris).

of building stakeholders (designers, client, occupiers …). This paper explores to what extent and under which conditions this methodology could support such desirable change.

In this paper, we will especially focus on the service sector building stock and the stock owned by local entities (schools for instance). However, the DECADIESE methodology is equally suitable for the social housing sector.

The following section briefly describes the DECADIESE method and its theoretical underlying concepts, while the third section depicts how, when (at which stage of the building life cycle, for what purpose, etc.) and by whom it could be used. The fourth section highlights the identified drawbacks to overcome so that this methodology may be widely used. Lastly, the conclusion sets a roadmap for future work to bring relevant change to this method, which was deemed to be promising by the professionals interviewed in this study.

The DECADIESE method and its underlying concepts

A CROSS-USE OF FUNCTIONAL ECONOMY AND VALUE ENGINEERING

As previously mentioned, the main objective of the DECADIESE project is the development of a decision-support tool for the choice of building-related investments (construction and refurbishment) in compliance with the key points of sustainability. The core focus of the project is the identification of ways to integrate sustainable development-related effects (e.g. job creation, CO_2 emissions) in the assessment of construction/retrofit investment, which justifies the use of the Functional Economy concept …

A Functional Economy (or Service Economy or Performance Economy) (Stahel, 1994, 1997, 2006) is based on the production and sale of a solution comprised of an integrated and compliant set of products and services realised by a service provider. The customer no longer buys goods but rather a service which provides the needed goods. The functional offer is implemented by both the service provider and the client in the framework of a co-constructed process. The service provider contracts with the customer to insure results and performance. The economic agreement deals with an assessable performance (for instance the energy performance of a building) rather than with the supply of disjoined products and services (Stahel, 2006; du Tertre, 2008).

The service economy theory offers several relevant and original ideas for the DECADIESE project (Nösperger et al., 2011, Guennec et al., 2009):

- **The incorporation of external factors (externalities) in meeting functional needs**. Unlike some assessment methods, which incorporate external factors (the "polluter pays" principle, carbon credits, and energy saving certificates) as "obligations" to be respected, the Functional Economy model considers externalities as value-creating opportunities in as much as they can be integrated in the functional offer process. For instance, the external effects of one stage in the process can be a resource for another stage: a global program for school energy retrofits might have an impact on local employment provided the selected solutions are consistent with the skill level of the local work force. This program is therefore a resource for the economic development program of the local authority. Another example is the impact of energy retrofit programs on indoor air quality, which has been proved to influence the health and productivity of building occupants.
- **The creation of value is distinct from the production of objects**. It constitutes a real break with current economic models. In the Service Economy theory, value depends, among other things, on gains achieved through integrating operations and valuing positive environmental and social external factors by adopting a broader performance assessment scope consistent with local territorial challenges (infrastructure development, local employment, attractiveness of the local region …). This creation of value of such projects depends therefore on a closer cooperation between private actors and local public bodies, the latter considering it relevant to contribute to (or to partially fund) them. In the Service Economy model, the creation of value is no longer related (or with a weaker link) with physical production, which is the basis of sustainable development.
- **A high level of interaction with the economic development of the local area**. Territories are not just seen as a "neutral" location where economic activities are developed: they are considered as service co-constructors and resource providers. In this perspective, the service provider has strong interactions with the territory during the response process, which can generate local economic value creation. In the case of a building-related project, this local economic value creation is likely to trigger potential co-funding opportunities for such an investment, therefore presenting a more attractive situation to the building's owner from a financial perspective.

In the DECADIESE project, we considered a building from the point of view of its functional service instead of a set of components and systems. Using existing studies (Gobin, 2011), we identified seven main functions provided by a building after the construction/renovation phase (see below). The building performance regarding these seven functions can be assessed through the use of physical, measurable or qualitative indicators in accordance with a client's brief. The building owner should define this specification brief with respect to his own expectations of course, as well as to other stakeholder's expectations: local authorities, local inhabitants and building occupants … Such a way helps prevent poor energy building performance due to misuse, user complaints, long-lasting bargaining with the local population once the construction phase is launched, etc. To summarize, such a co-design approach with local stakeholders on the one hand helps to avoid subsequent transaction costs and on the other hand helps to maximize the building use-value. The seven main functions are:

- **Providing space** ("space"). This function deals with a building's geometric and physical features. It consists of ensuring that there is sufficient space so that planned activities and the related people can be effectively hosted in the building. For instance, the space-to-employee ratio in a call centre (~10 m^2/employee) is different from that of a standard lawyer's office (>15 m^2/employee);

- **Providing comfort** ("comfort"). Seen as a combination of internal temperature, light level, acoustic level, or the volume of air circulated on an hourly basis so that people are able to perform their tasks effectively.
- **Providing protection** ("protection"). Protection may be defined as waterproofing protection and the safety and security of building occupants. Protection level depends strongly on the building's use (for example, a standard office building vs. a bank).
- **Providing suitable goods and tools for hosted activities** ("goods and tools"). This function expresses the ability to connect and use different equipment, provide various acoustic levels, and activity-supporting services.
- **Managing the relationship with outside & inside people** ("relationship"). This function refers to inside and outside access control as well as the level of outside noise. Like the protection function, it strongly depends on the confidentiality policy of the company(ies) occupying the building.
- **Interacting with the site, using its resources and minimizing any negative impact** ("site"). The building is supposed to use the available network facilities (telecommunication, energy), available natural resource use (wind, solar lighting), applied environmental rules.
- **Carrying a message and an image** ("semiotics"). The quality of the image projected to the economic and social environments as well as to employees.

Each function is further divided into several sub functions, each of which is assessed using specific indicators. For instance, the *comfort* function is split into *lightning*, *temperature and humidity*, *noise level*, *indoor air quality* and *visual comfort*; the *temperature and humidity* sub function is then assessed using the indicators *percentage of dissatisfied people* (PMV-VVD, qualitative indicator which depends inter alia on temperature and hygrometry; see ISO EN 7730), *temperature space zoning* and *equipment affordability* (both qualitative indicators). Quantitative and qualitative indicators are then aggregated and combined in a fuzzy logic-based functional performance assessment process which awards subjective scores (range 1–10) for each function.

A life-cycle analysis (LCA) is thereafter applied to the seven main functions which attempts to answer the following questions: how are the functions "implemented" (through which types of equipment and services), how are they used during the operating life stage and finally what are the social and environmental impacts of their performance level? For instance, a determined comfort level has environmental impacts such as CO_2 emissions (i.e. through heating systems) but also social impacts on employees' health and productivity through indoor temperature (Loftness & al., 2003). The relations between building functions and societal impacts therefore exist at the functional performance level as well as through the energy and water used in order to attain the functional performance. No Life Cycle Software is embodied in DECADIESE, but this method integrates the outputs of an LCA as they are expressed in the EN 15978 standard (i.e. eutrophication potential, acidification potential …). This LCA is performed separately. DECADIESE rather focuses on impacts linked with building performance levels.

Table 1 provides examples of such relationships between building functional performance and impacts or externalities, which are the key pillars of the DECADIESE method.

In the DECADIESE approach, the occupying company is distinguished from the occupants (or building users), i.e. the company's employees. The expectations of both are theoretically aligned, but it has often been observed that this was not the case. The DECADIESE approach is based on interviews with representatives of both the occupants and occupying company, which is likely to trigger such an alignment (because the DECADIESE assessor will ensure that the expectations of both are consistent when making recommendations for the building owner).

The economic estimation of these impacts and externalities is crucial. The selection of externalities to take into account and their assigned values must be done in accordance with the building owner's commitment and ethical values in sustainability and in accordance with each stakeholder's point of view.

In fact, the DECADIESE method does not aim to propose "universal" externality values to apply at any time. It is rather an investment decision-support not only through economic estimations but also through the questions it raises from the points of view of the investor and the stakeholder. The "Contingent valuation" approach through designed interviews is therefore widely preferred to the other ones; however, it is adapted in as much as it concerns a specific project for an identified investor. The economic values of external effects from existing studies (see above, for instance Ürge-Vorsatz, *op. cit.*) are proposed as a discussion basis with the building owner and other stakeholders.

This theoretical material has been embodied in a building extended assessment method and software, which are briefly described in the following subsection.

AN OVERVIEW OF THE DECADIESE ASSESSMENT METHOD

The DECADIESE assessment process is composed of five main stages:

- **Stage 1: Tender design and local context identification**. The assessor helps the client define the building's purpose, beyond the simple construction or renovation (for which purpose, within what political and environmental context …) and its expected functional performance levels. For instance, a school purpose may be "pupil education" or "pupil self-fulfilment". This stage is widely based on interviews with the client and with other stakeholders (local authorities, health insurance agencies …). It therefore fosters mutual understanding between the building owner and the occupying organisation and building users (organisation's employees), which is not a standard in today's professional practice (Gobin, *op. cit.*).
- **Stage 2: Functional performance assessment and identification of relevant externalities**. For each project (regardless of whichever phase it is currently in or even within the tendering process itself), building functional performance is assessed for each type of function and sub function as well as from an overall point of view. This assessment relies on subjective scores (1 to 10) which depend on several criteria. The relationships between criteria values (i.e. indoor temperature, thermal zoning …) and the resulting scores have

Table 1. Examples of an integrated analysis of building functions and impacts.

Impacts or externality category	Building function generating the impact	Impact Description	Stakeholder
Health	Comfort	Occupant health improvement thanks to comfort improvement	Occupier Occupying company
	Good and tools Site	Improved health thanks to facility (cycle boxes, shower facility, pedestrian paths …) allowing environment-friendly mobility (bicycling, walking)	Occupant
Productivity	Comfort	Occupant wellness related productivity improvement thanks to comfort improvement (temperature, natural lighting)	Occupying company
	Semiotics (image)	Occupant wellness related to productivity improvement thanks to building-related positive corporate communication	Occupying company
Asset value improvement (“green value”)	Space Goods and tools Relation	Improved asset value (reduced vacancy period) due to advanced building indoor flexibility and adaptability	Owner
	Semiotics	Improved asset value due to reduced vacancy period or improved nominal rents thanks to advanced energy and environment labeling	Owner
Territorial economic development	Almost all functions (especially comfort)	New industry creation or reinforcement through the selection of technical solutions involving local firms	Local authority Local firms Inhabitants
Territorial facilities support	Site	Building’s ability to store rainwater (avoiding the need for additional drainage facilities)	Territory
Potable water savings	Goods and tools	Improved potable water using equipment which optimizes the sizing of the waste water treatment facility)	Territory
Emissions and pollution	Comfort	Energy-related CO_2 emissions due to comfort equipment such space heating	Occupier Territory World population

been established by building experts during the research project. These relationship patterns have been embodied in fuzzy logic software. When a specific subfunctional performance is considered as being sufficient enough (for instance a score of 7 or above), related impacts and externalities are highlighted (thanks to the use of a table similar to Table 1). These highlighted externality items are subject to being assigned a non-zero economic valuation from the concerned stakeholders involved (and therefore from the building owner). This kind of “externality triggering threshold” (for instance, a score of 7 for a given subfunctional performance) is pre-programmed in the DECADIESE software and this assumption is clearly presented to the building owner who is then allowed to either validate or change it. The underlying challenge in using DECADIESE is not the accurate determination of relevant thresholds for externality estimations as it is the raising of questions about the impacts of a performing building beyond the limited scope of its users. The building assessment is considered in this case as an opportunity to foster dialogue.

- **Stage 3: Estimating externalities**. The pre-selected impacts identified in Stage 2 are evaluated through in-depth interviews with the stakeholders involved. Potential existing values can be used as discussion material, however these discussions aim at getting their specific Willingness to Pay (WTP) for contributing to the considered building projects (with “outstanding” performance concerning certain identified subfunctional items, see Stages 1 and 2). The corresponding economic flow must be defined (e.g. financial flow or non-financial help such as simplified building renovation planning permission). These WTPs are then collected and help the building owner to establish the corresponding values he would like to choose (generally less than or equal to the sum of the WTPs). This stage is essential both for estimating the economic value of relevant externalities as well as for designing the associated business model. Without this stage, any externality evaluation such as those proposed in conventional cost-benefits analyses is liable to be contested as being unrealistic by both building owner and stakeholder (although the types of WTPs studied relies on robust econometric analysis, they suffer from several biases such as the *anchorage bias*, the *hypothesis bias* … see Pearce & al., 2006).
- **Stage 4: Building value analysis**. Given the previous collected data, cost items (construction costs, building in-use related costs, emissions taxes, deconstruction costs) are allocated into seven functions. This exercise of separating the functions is based on dedicated spreadsheets which were developed in the DECADIESE project. Building Value Engineering was another key pillar of the DECADIESE project.

Table 2. Energy retrofit options for a poor energy & CO_2-graded school (Area 5,000 m²).

	Reference	Solution 1	Solution 2
Investment Cost €/m²	0	87	131
Energy Consumption (kwm²/m²) and EPC (Energy Performance Certificate) grade	208 (D)	131 (C)	126 (C)
Environmental Emissions (kg CO_2/m²) and EPC grade	26 (D)	17 (C)	16 (C)
Life Cycle Cost €/m²/year (LCC)	15.8	18,1	20,1
Overall functional performance (assessment based on school users expectations).score /10pts	4.0	4.2	5.4
Externality valuation (€/m².yr):	0.2	0.1	(7.9)
CO_2 emissions	*0.2*	*0.1*	*0.1*
Improved educational efficiency			*(2.9)*
Extra facilities use			*(5.1)*
Extended LCC €/m².yr.	16	18.2	12.2
Overall Building Economic Assessment €/m².yr.funct. Performance mark	4.0	4.3	2.3

- **Stage 5: Detailed and summarised outcomes**. The extended building life cycle costing is performed and delivers relevant decision-supporting outcomes such as functional costing, building functional performance, scores for each category of function as well as for the overall performance, standard and extended, life-cycle cost per overall functional performance score unit (€/m²/yr. functional performance score). The latter may be considered as a simplified and synthetic metric for a DECADIESE building assessment.

Applying the DECADIESE method in a specific case

We consider a case of an energy performance-oriented school refurbishment. The school was built in early 20th century and showed a rather poor energy and environment performance (no insulation, simple glazing …). In this case, we considered two refurbishment scenarios:

- Solution 1 (limited retrofit focused on some energy conservation measures): Building management system re-configuration, revamping of the lighting system, loft insulation, partial wall insulation (inside), thermostatic tap, efficient pumps, partial fan coil installation …
- Solution 2 (more ambitious energy retrofit): enhanced insulation, advanced building management system (with more accurate temperature zoning), more efficient and powerful lighting equipment with indirect energy impact (sensitization devices, more convenient doors easer to close and from cold outside temperature) (personal protection equipment, easy-to-push doors, information devices).

The LCC of both ambitious retrofit projects (solutions 1 and 2) are far higher than in the initial situation. Even the integration of white certificates revenues and CO_2 taxes (in a so-called "First extended LCC") does not help to justify ambitious retrofits.

Given the significant difference between solution 1 & 2 and the LCC of the reference situation, even a much higher increase in energy prices will not make up easily for the difference between investment costs related to these solutions and a public owner is therefore poorly encouraged to undertake such energy retrofits.

Table 2[2, 3] presents the DECADIESE assessment of the different options for the school renovation. The second solution is just theoretical and was not actually chosen (the renovation project was achieved before the development of the DECADIESE method: it is an ex-post assessment case). The DECADIESE assessment of this school refurbishment project is based on stakeholders' expectations which were expressed during an interview campaign. The application of this method in this case is for an illustrative purpose.

The first solution ("Solution 1") improves significantly energy efficiency aspects but barely changes the functional performance. The second solution slightly further improves the building energy and environmental performance and also deals with some building functional features:

- **Comfort**: improved thermal regulation and classroom lighting while the classroom temperature level is increased (21 °C instead of 19 °C I, the case in the solution 1). The common rooms near the outside recreational space are better insulated once the new doors are closed: the former ones could not be pushed by young pupils and they therefore staid open …
- **Goods and tools**: some common space and equipment can be used in winter because additional closure and insulation works have been made. Moreover, as it benefits form an ambitious and visible energy retrofit, the school itself can be used as illustrative material for the pupils' sensitization to energy and climate challenge.
- **Relations**: the installation of "easy-to-push" doors which can be closed or opened depending on the situation facilitates movement between rooms.
- **Semiotics**: refurbishment works do not focus only on energy savings but also addresses teachers and staff's expectation, who feel therefore better considered.

2. CO_2 emissions: Public bodies are invited to give a cost to CO_2 emissions when assessing their investment (Quinet, 2009). In 2014, this cost is estimated at €42/tCO_2.

3. Externality valuation, Solution 2: Positive externalities values as treated as "negative costs".

Two major benefits have been identified:

- Thanks to advanced comfort, the school learning efficiency is improved (Loftness et al. *op cit.*), which can be expressed in avoided "class-doubling" (*Redoublement*: a pupil with poor school results is invited to re-attend the same class), which is worth around €11,000 (based on public expenses for education). In a conservative approach, the half (€5,500) is taken into account in the assessment over a 15-year period. Anyway, the point is showing that public expense for education widely overcome energy related costs and a very conservative assumption on the positive impact of suitable retrofit on educational effectiveness is enough to balance the additional investment costs. This example underlines the magnitude discrepancy between energy costs and human resource-related costs.
- In as much as additional facilities are now available in winter, the school is used for extra events, saving the renting of a extra rooms (which is considered to worth €15,000 a year).

The extended economic assessment of the "Solution 2" is therefore much better than the reference situation whereas the "Solution 1" extended economic assessment is worse although the energy performance is improved. This seemingly paradox comes from the integration of the building use value in the economic assessment.

Figure 1 give an example of the DECADIESE software output. The figure pictures the building investment allocation among functions and the achieved functional performance (in each renovation scenario). DECADIESE points out how much it is invested on every building function.

The DECADIESE method offers an integrated extended economic assessment combining use value and economic, environmental and social impacts. It is aimed at supporting relevant business model. It assumes very close and integrated cooperation between the building owner, the contractor, the architects, the engineers, the occupying organizations and other stakeholders, over the whole (construction or renovation) project process. Inversely, using the DECADIESE method is supposed to help build a close cooperation between the actors, which has proved to be missing in most renovation projects (Gobin *op. cit*. WBCSD, 2007). That would mean a major change in building professional habits. To what extend and under what conditions is this change likely to happen? The first step to answering this question is to analyze what kind of support DECADIESE could bring to these actors. This is the topic of the following section.

Perceived DECADIESE added-value by the targeted actors

DECADIESE is intended to convince building owners that energy efficiency investments are worthwhile by engaging a range of stakeholders to value and present a range of benefits, which implies to convince a group of stakeholders to jointly fund building renovation work. This is a tremendous change in today's professional routines in the building sector where trust, co-design, dialogue are missing. DECADIESE is assumed to help diffuse the desired change in professional routines and therefore it is important to answer a key question: why will building professionals (building owners, contractors, architects, construction firms …) use DECADIESE? What could be the added-value of this tool and this approach to them?

The targeted DECADIESE user's community encompasses all the stakeholders of a building project throughout its life cycle:

- Design stage: client (building owner), landscaping companies, town planners, local authorities, administrations, political and regulation bodies, contacted occupying organisations, contractors, architects, engineering companies, specialised consultancy companies (e.g. for BREAM certification), Financing bodies, inhabitants;
- Work stage (construction or renovation): contractors, architects, engineering companies, specialised consultancy companies (e.g. for BREAM certification), commissioners, building companies and their subcontractors;

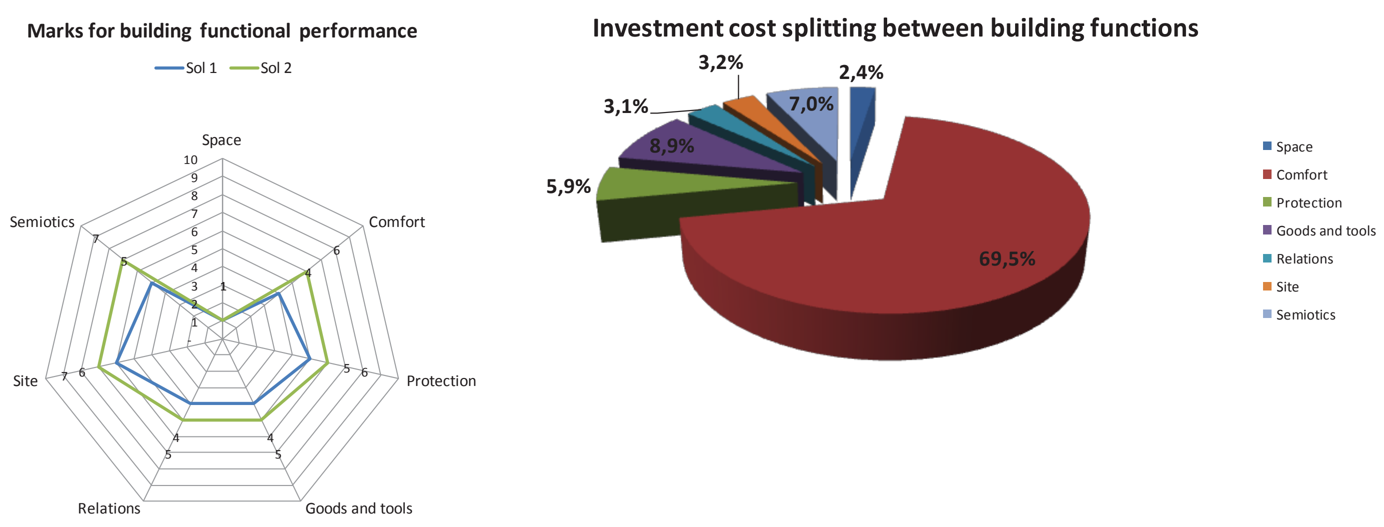

Figure 1. Overall charts provided by the DECADIESE method (and software) (Solution 2).

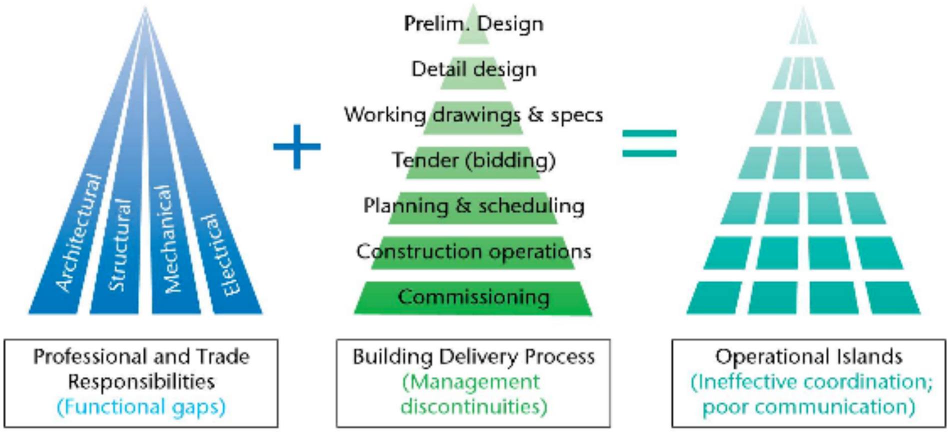

Figure 2. The complexity and the fragmentation of the building sector (WBCSD, 2007).

- Use stage: building users, associations, exploitation and maintenance companies, neighbouring inhabitants …

The following subsections describe the potential added value of the DECADIESE methodology perceived by these actors. The following sections are mainly based on an EDF-hosted Msc Research work in 2014 (Vitt, *op. cit.*). It relies on several in-depth interviews with several of the aforementioned actors to test to what extent they are ready to use DECADIESE and under what conditions. It is a preliminary work and it will be completed by further investigation (additional interviews, serious game …) in order to ensure the production of robust findings.

REINFORCING THE COOPERATION BETWEEN ACTORS

The building renovation industry is very fragmented and involves actors with potentially diverging objectives (WBCSD, *op. cit.*).

For instance, building energy Performance can be a priority for the building owner or the contractor (At least in order to get the work permit) but is very seldom a major concern for the building user or even the occupying organisation (employing the building user) given the huge discrepancy between energy costs and employees-related costs (Loftness & al., *op. cit.*). To give another example, exploitation and maintenance companies are integrated very late in the project process, which is likely to hamper a really consistent global approach of the building. The major challenge is not only providing project coordination (i.e. a consistent task scheduling) but rather establishing a deep cooperation within the project. That means that every project contributor is aware of how his task output will be integrated in the overall work and to what extent his job is going to interact with workers from other trades from the point of view of building functional and energy performance. Going beyond simple coordination routines to establish a real cooperative work will help to increase the use value of the building (assessed through the functional performance) and to ensure that its use costs (energy and maintain) will be limited.

As it is described in the previous section; the DECADIESE approach is not only a spreadsheet-based calculator but is mainly based on interviews with the project stakeholders. All asked building professionals acknowledged that such approach could help build up the desired cooperation throughout the project as long as project contributors are ready to take part in interview sessions and to act in accordance with what they declared during these interviews (Vitt, *op. cit.*).

SUPPORTING THE DESIGN PROCESS THANKS TO THE FUNCTIONAL APPROACH

Writing consistent and complete building specification is the first and most essential step of the design stage in as much as it conditions the different bids (Gobin, *op. cit.*). For instance, defining the “building functional equivalent” is essential when assessing the building economic performance (EN 15643-4). However, this stage is often overlooked by the building owner team, especially when there is little consideration for the expected users, which can hamper the efficient building use of the latter (appropriation) (Gobin, *op. cit.*). In other cases (especially small local authorities), the client might happen to lack relevant skills to establish such a consistent specifications brief (Vitt, *op. cit.*).

The building owner and the contractors interviewed during the research project acknowledged that The DECADIESE approach could be potentially used for assessing and challenging the specification brief. It could particularly help the client to make the building purpose clearer and to ensure that his functional specifications are consistent with this purpose. For instance, expected building functional performance is not the same in the case of a lawyer office or of a call centre (specific space/employee, equipment, semiotics …).

At a later stage of the design process, the DECADIESE tool could support the technical and functional assessment of the building alternative bids (in the frame of a construction or renovation projects) and ensure that such assessment is compliant with the client and other stakeholders’ expectations. Moreover, the rational aspect of the DECADIESE approach seemed to give client and contractors some confidence within a complex and multi-scope project (Vitt, *op. cit.*).

ENSURING DECISIONS DRIVEN BY LONG-TERM CONSIDERATION

The client is in charge of financing a building project, representing future building occupiers and anticipating long-term building use (and especially change in building use). This growing long-term concern is testified by the development of innovative financing scheme and contracts such as PFI or Energy

Performance Contracting (Vitt, *op. cit.*). However, these tools seem not to succeed completely in integrating fully the aspects of a long-term sight (for instance, because they are focused on a single main topic such as energy efficiency, ignoring the long-term use-value challenge beyond conventional modeling).

To accomplish this mission, building owners, contractors and engineering companies need structured decision-supporting tools taking into account technical, financial, social, economic and environmental criteria. Some multi-criteria methods have been developed but they remain yet hard to use and they do not really ensure a consistency integration of market and non market impacts (Vitt, *op. cit.*).

The DECADIESE method is perceived by the contacted professionals as potentially bringing such a structured and integrated decision support. The functional performance assessment considers both technical and use-value aspects, while life cycle costing brings a first technical & economic assessment. Social, economic and environmental external impacts integration ensure a consistent long-term reflection while a high interactivity degree of the assessment process make the client sure that he agreed the underlying parameters and criteria.

As this assessment process could be implemented as many times as necessary, it is likely to be used throughout the project cycle in an interactive way, from early design stage to bid selection and commissioning and even during use stage.

OVERCOMING ECONOMIC BARRIERS OF AMBITIOUS BUILDING PROJECTS WITH INNOVATIVE AND SUSTAINABLE BUSINESS MODELS

As energy savings seldom pay back extra investment costs of energy efficiency ambitious building projects, it is necessary to estimate the global added-value of such projects. As things stand, the consideration of future impacts-related costs hardly balance the overweighed investment cost which hampers the selection of the best compromise between limited initial cost and global building performance (Vitt, *op. cit.*). Especially there is a growing need for the consideration of intangible assets; i.e. assets which cannot be directly quantified (du Tertre, 2013) such as knowledge, organisation, social capital (whose approximate counterpart is known as "goodwill") (Fustec & al., 2012, Dumont, 2014).

Both clients and contractors on one hand as well as building companies on the other need a comprehensive economic assessment approach to estimate an appropriate value for "project smartness", whether it may be for selection or promoting such a project. This "project smartness" should be proven as ensuring asset value stability against future and still unknown social or legal change (Lützkendorf & al., 2010).

Overcoming this financial barrier to the completion of ambitious building project implies attracting additional and more or less unusual investors who could be interested in benefiting from positive externalities as well finding additional convincing arguments for the traditional ones. This is not such an utopia, in as much as this is exactly the underlying concept of crowd funding … However, designing the business model integrating this extra investment contributions remains a crucial question.

As it has already been underlined, the DECADIESE assessment approach deals with functional performance, that is use value. Building owner is invited to elicit his functional expectations (Stage 1 – Tender design) and to validate the building performance assessment according to each bid project (Stage 2 – Functional performance assessment). It could therefore help overcome the too simplest initial investment cost-based assessment or even energy savings-based investment by bringing to the first place the building use-value while it would encourage contractors and building companies to spend more time in research and development in order to propose innovative bids.

The impacts and externalities valuation approach helps specify additional convincing points for traditional investors and especially helps identify new potential contributors. Using the DECADIESE methodology would raise innovative financing scheme, however these new contributions are financial (e.g. incentives) or not. For instance, the built area to plot of land area ratio, which is an administrative construction threshold to abide by in France (*Coefficient d'Occupation des Sols*) could vary depending on the building's environmental performance and is a key input for a project's financial equation. As a counterpart, dealing with external stakeholders asks new business habits such as multi-stake contracting.

DECADIESE provides innovative tools for economic value elicitation, deepened cooperation and innovative financing and contracting practice, which are the key components of a business models. Such business models are likely to help overcome this so crucial financing barrier.

DECADIESE is therefore likely to be used by all the aforementioned actors, yet at different building project stages. It can be noticed, the acknowledged DECADIESE added value is not limited to the quantitative economic outputs. The originality of the assessment process itself seems to potentially bring valuable support, especially by raising right questions and constructive dialogue and mutual understanding. These additional elements will help to improve the likeness of the quantitative outputs, whose calculation always relies on assumptions (use scenarios, rent level, vacancy period …). Improving the dialogue and the cooperation throughout the building project is likely to ensure that these assumptions are consistent with the actual building use and rental conditions. However, this method is still at the experimental stage and several key drawbacks need to be removed before being used widely as a state-of-the-art decision support tools. These limitations are explored in the following section.

Identified barriers to a wide use of the DECADIESE method

However promising the DECADIESE method may seem, its widespread use beyond research and academic circles depends on many factors which must be carefully identified and taken into account. They refer to technical, professional and legal challenges.

GETTING FAMILIAR WITH DECADIESE UNDERLYING CONCEPTS AND ITS OUTPUT FORM

As things stand, the current DECADIESE version seems too "theoretical" to be used among local authorities or even building developers, as the Life Cycle Analysis software "ELODIE" looks like in France (with the same non-use consequence). This asks for simplification, adaptation and education work (Vitt, *op. cit.*).

Like every research outcome, DECADIESE needs to be simplified when being developed in a professional version. However, the simplification work should be adapted to targeted user-community and its current skills and professional wordings. For instance, "functional performance" is clearly intelligible for engineering staff but was judged excessively technical by architects, who are likely to have a more artistic approach, although the underlying concept of "functional performance" has not been questioned. It seems to be really a matter of vocabulary, for instance "building user wellness aspects" instead of "building comfort functional performance" … This simplification and rewording work needs in depth interviews with representative panels of the different targeted professions. That will probably lead to specific professional versions (DECADIESE for building owners, for architects, for external stakeholders, for technical contractors …).

An identified key point is ensuring that traditionally used indicators belong to the set of DECADIESE output indicators, for instance specific energy consumption (kWh/m²) or cost (€/m²). Respecting this condition will give DECADIESE a "familiar" aspect (although it will be an innovative tool) from the target-users 'point of view.

SMOOTHENING THE DECADIESE USE-RELATED CHANGE IN PROFESSIONAL PRACTICES

Until now, certain stakeholders might be purposely excluded from the decision making process, for instance when a company division changes location without first consulting with its employees (Vitt, *op. cit.*). Such building-external considerations must be taken into account while deploying the DECADIESE approach. More generally, building occupiers' needs are generally modelled instead of being defined through interviews, because most of the time the tenant company is not even known by the building owner when considering a construction or renovation project.

DECADIESE diffusion might have therefore to be integrated in a more global change management process. This methodology has to be first partially applied (for instance, establishing a functional brief) or focused to a single project (niche building project) to experiment the whole. It important to select consciously the impacts identified by the DECADIESE approach which have to be underlined, depending on the nature of the actor to convince. For instance, insisting on productivity or health impact from the tenant company point of view might be essential to make the latter contribute to the project and take part in the decision process. From the building owner's point of view, impact on building asset value must be clearly pointed out. Selecting carefully such impacts-related argument leads to make "strategic" the decision of selecting a sustainable building alternative to use Cooremans' wording (Cooremans 2009, Cooremans 2011).

This task is especially difficult when bringing around the table external actors who do not traditionally feel concerned by the building decision process (neighbourhood, insurance companies …). Such actors may prefer to follow the well know "free rider" strategy and refuse to contribute, expecting that the more ambitious project alternative generating the greatest beneficial impact on them will be chosen anyway. That is the strategic bias of zero- WTP statement which can occur in a contingent valuation enquiry (Pearce & al., 2006). Convincing them that their involvement is essential to make the most desirable alternative chosen is a key factor and not the easiest one … In this case either, the main challenge is to make this involvement strategic. On the opposite, these actors must be convinced that the decision process will be at least partially acted on their viewpoint, so that the necessary trust between building owner and other stakeholders could be built up. This is essential for a non-zero WTP statement.

Another key success factor related to the endorsement of the DECADIESE approach is the handling of the time consumption challenge raised by this method. On the one hand, all professionals are under pressure and seem unable to afford spending time in numerous in-depth interviews, which is necessary to follow the DECADIESE process. Some simplification – especially concerning the data collecting process – should be certainly made. On the other hand, it is highlighted in previous section that "project smartness" deserves tangible valuation, which mean that extra time spent to improve the designed building sustainability must be acknowledged as necessary and therefore paid. Every actor could theoretically agree with this point but the main challenge is ensuring that professional practice at every level is altered to give more time to suppliers. This tremendous change can be first applied in specific projects before being integrated in dominant practices.

A NEED FOR FAVOURABLE LEGAL CONTEXT

The use of the DECADIESE approach could be incompliant with public purchase regulation, as it could impose that tender stay anonymous in the frame of standard purchase processes[4]. In this case, tender is not allowed to have an in-depth interview with the (public) building owner, which is yet necessary to understand his functional expectations and to bid accordingly. Additional interviews with other stakeholders (occupying organisation, employees …) are not allowed either. Such a legal context is likely to deprive DECADIESE of a great share of its added value, which mainly come from the dialogue and mutual understanding it triggers. DECADIESE should be therefore dedicated to specific public purchase processes such Private Finance Initiative (PFI) or any kind of specific partnership between public and private sector. Such special process allows more flexibility and more opportunities for a dialogue between the public building owner and tenders but it is restricted to exceptional situations (technical complexity, short deadline …).

Actually, DECADIESE will not be able to be widely used in the public sector as long as the purchase regulation stays unchanged. There is however some hope, in as much as complex challenges such public building energy performance are poorly handled by traditional processes. It is one explicit justification for the use of Energy Performance Contracting but local authorities are still reluctant to use this arrangement (Ortega, 2011).

Conclusion and perspective

DECADIESE is at the crossroad between three different time-scaled visions. The short term one ignores long term risks and is based on immediate rationale (such as investment cost-based decision), the middle-term takes risks into account in the well know economic calculation. The long term vision integrates structural and societal change and great threats (e.g. global

4. Such a legal barrier does not exist in private purchase process.

warning) (Grubb, *op. cit.*). DECADIESE does use investment costs data to propose a value engineering approach and a link between building functions-related investments and its actual functional performance. DECADIESE looks like a standard Cost-Benefit Analysis, especially designed for mid-term decisions. However, this calculation aspect actually aims at triggering mutual understanding and dialogue among professionals to make the building sector contribute to the climate change mitigation (and adaptation) thanks the selection of energy-ambitious building (construction or renovation) projects due to a right valuation of their multiple benefits. Interviewed people clearly felt that beyond raw economic figures and direct outputs resulting from its application, key added value of DECADIESE is the dialogue and mutual understanding it triggers among professionals. The promoted partnership approach could support a tremendous change in cooperation habits within the construction sector and with the clients, which is a key to get really energy efficient buildings.

The identified barriers confirm this conclusion: it is important for professionals to understand DECADIESE's underlying concepts, vocabulary and process organization.. However, far deeper conditions related to the socio-technical regime (policy, culture, market preference) and the manner in which niche experiments may help change the dominant regime have been identified. Moreover, the development of DECADIESE was triggered by the apparent inability of the building sector to rightly deal with the challenges of climate change and energy efficiency, which can be considered "exogenous context". Such a conclusion justifies deepening this first professional change management study through the DECADIESE method using the Multi-Level Perspective pattern (exogenous context, socio-technical regime and niches) developed by Geels et al (2007).

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