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Management of sustainability issues in construction works processes

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2010

[Link to publication](#)

Citation for published version (APA):

Persson, U. (2010). *Management of sustainability issues in construction works processes*. Paper presented at SB10 , Sustainable Community – buildingSMART, Espoo, Finland.

Total number of authors:

1

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Management of sustainability issues in construction works processes

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Keywords: Management, Sustainability, Construction works, Assessment model

1. Introduction and method approach

The implementation of sustainability in the construction sector depends to varying extents at global, national, regional, local, corporate and individual levels. It also depends on the cultural and social context of the society in question. Many industrial countries have already set national strategies for sustainable development in order to measure their national or regional share of global depletion of resources. For the construction sector, these national strategies imply policies for sustainable buildings and sustainable construction. The policies and objectives as formulated are, from the public's perspective, directed towards the single client in the form of different kinds of incentives. Yet, the impact on 'typical' construction projects and their stakeholders (e.g. the client, project management team and end users) remains unclear. In addition, it appears to be a lack of knowledge transfer to local construction project management according to managing the process towards sustainability.

Referring to the view of Swedish environmental legislation, it is the part which performs an activity that is responsible for the environmental impact consequences. Accordingly, it should be equivalent regarding sustainability impact consequences. Concerning construction works, it is no doubt that it is the client/owner/developer that is the responsibility part, performing activities as owner and administrator of construction works.

The aim of this paper is to apply a model for enabling a client or a construction project manager to deal with significant aspects of sustainability during construction works and to validate this model by input from real cases, with a well-defined context of sustainability in construction works. The research is conducted by literature studies, development of a management model focusing on sustainability in construction works suited to clients and project managers, validated by case studies with a well-defined sustainability context and generalized to be used in projects covering construction works entire life-cycle.

2. Result

Various interpretations of sustainability in construction works have been adapted and are defined in an ISO standard applied to construction works: the international standard "Sustainability in building construction – General principles", ISO 15392: 2008.

An assessment model, the Stakeholder-Urban Evaluation model (STURE) has been developed. STURE could be described as an objectives-led integrated assessment applied at the project level. The model is a way of systematizing the issues of sustainability in construction works in accordance with principles of ISO 14001 combined with empirical studies of stakeholder management. The model optimizes the sustainability objectives and targets of a client's management organization and the specific conditions of an actual project and the particular site of the project. ISO 14001 is the basis of the structure of the model.

To do the validation practically, a set of case studies were used reflecting different stages of a construction works life-cycle and also different phases in the process of a construction project. The cases were not in the forefront of environmental or sustainability adapted construction work. Even if some of them had some higher ambition than average by addressing, especially, the environmental part of the triple bottom-line, were the cases overall quite standard and common project performed during the last ten years and reflecting different stages in a facility's life-cycle during different phases of the process of a facility development. The case studies cover a quite broad spectrum addressing construction works. The case studies were evaluated by, and in some cases also converted to, STURE. The outcome from this were validated with the nine principles of ISO 15392 to see if the use of the STURE model could be a tool to make sustainability estimations and if the cases with help by the model could possibly be estimated as:

- Sustainable construction works,
- Partly sustainable construction works, or
- Non-sustainable construction works

Following six principles of ISO 15392 were fulfilled when using STURE with the case studies:

1. The principle of continual improvement
2. Global thinking and local action.
3. The holistic approach.
4. By stakeholder analysis of influence importance and defining internal and external stakeholders, the principle of involvement of interested parties is covered.
5. The principle of long-term consideration
6. The transparency principle

There are missing references in the model to the principles of equity, responsibility and precaution / risk management. Equity and responsibility should be included and highlighted by the social aspects during assessments and objective settings. The principle of precaution and risk management should become a new input, especially as the latter is a common part in project management and compulsory in quality or environmental management systems. The precaution principle was already stated in the Rio meeting 1992 and is legislated in Sweden by the Environmental Code, so it is already a compulsory part concerning environmental and sustainability issues.

3. Conclusions

The validation of STURE shows there is a possibility to use such models, with minor compliments as above and with an environmental management system in use of the client, to assess a construction work or works to determine whether it is heading towards being a sustainable, a partly sustainable or non- sustainable development. This is an example of an objective-led assessment, avoiding the snap-shot statements.

To use the STURE model also promotes continual improvement in project performance and basic organizational activities. Thus, this is a 'many-small-steps' approach depending on the client's ability, level of knowledge and inclination. The aim should not be to become a world leader, but to recognize that improvements comes through successive small steps and thus an ability to measure improvement along the path of sustainability in the field of construction works can be achieved. It is the client/owner/developer, as the responsible performer of activities concerning construction works who has the main responsibility concerning construction works and the obligation to commit sustainability. At the same time there is an opportunity and challenge for make the built environment more sustainable and begin a regenerative development in the earnest.

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Summary

The implementation of sustainability in the construction sector depends to varying extents at global, national, regional, local, corporate and individual levels. In addition, it appears to be a lack of knowledge transfer to local construction project management according to managing the process towards sustainability. Accordantly to environmental legislation, it is the client that is the responsibility part, performing activities as owner and developer. By the standard ISO 15392: "Sustainability in building construction – General principles", it is possible to interpret sustainability for construction works accordantly, despite different backgrounds of stakeholders.

A model was developed that optimizes the sustainability demands and abilities of a client, stakeholders and authorities relevant to a single or multiple construction works. Five cases were used as input to validate the model with the principles of the ISO 15392 standard. The cases studies were from different phases in the life-cycle of construction works and in different stages of construction project process. Furthermore, the cases represented buildings with various functions. The result of the validation implies a possibility to use the model to assess building construction processes to determine whether it is heading towards being a sustainable, partly sustainable or non-sustainable development.

Keywords: Management, Sustainability, Construction works, Assessment model

1. Introduction

The implementation of sustainability in the construction sector depends to varying extents at global, national, regional, local, corporate and individual levels. It also depends on the cultural and social context of the society in question [1]. Many industrial countries have already set national strategies for sustainable development in order to measure their national or regional share of global depletion of resources [2]. For the construction sector, these national strategies imply policies for sustainable buildings and sustainable construction. The policies and objectives as formulated are, from the public's perspective, directed towards the single client in the form of different kinds of incentives, e.g. taxation subsidies, direct investment subsidies, public procurement advantages and allowance of specific investment funds [3]. It could also be a matter of sector agreements on common sustainability objectives and targets as in the case of Sweden's construction sector [4].

All these differences have somehow the same meaning in the end because the concern is how current decisions are going to affect future well-being, i.e. changes in real asset values [2]. Yet, the impact on 'typical' construction projects and their stakeholders (e.g. the client, project management team and end users) remains unclear. In addition, it appears to be a lack of knowledge transfer to local construction project management according to managing the process towards sustainability. Wasley [5] comments the importance of local cultural context in challenging and reforming the normative expectations of both construction professionals and end users.

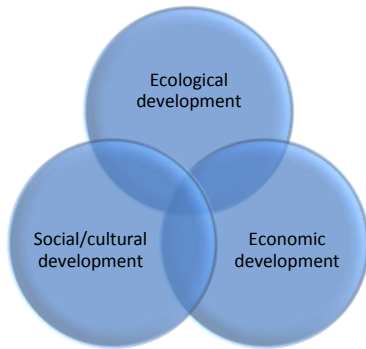


Fig. 1.1 The triple bottom-line of sustainable development , adapted from [10]

Deeper interpretations of sustainability using the Brundtland Report [6] as a basis have been generated and involve issues of balancing economy and social development with ecological considerations. This is called the 'triple bottom-line' and is an expression of these three complementary parts of sustainability [7], [8], [9]. These parts can be considered on an equal level as in Fig. 1.1.

But sustainability is adapted and defined to construction works in the international standard of sustainability in building construction, ISO 15392 [10]. There are various tools, many tailor-made for a particular region, for assessing the result of a construction project's level of sustainability [11]. But there are fewer tools or methods to manage the process towards a client desired level of sustainability. However, are these tools or levels of sustainability corresponding to the definitions and principles of ISO15392?

Referring to the view of Swedish environmental legislation, it is the part which performs an activity that is responsible for the environmental impact consequences [12]. Accordantly, it should be equivalent regarding sustainability impact consequences. Concerning construction works, it is no doubt that it is the client/owner/developer that is the responsibility part, performing activities as owner and administrator of construction works.

According to Rees, Foliente, Lutzkendorf and Larsson in their introductory comments at the SB08 conference in Melbourne, 2008, they claimed that irreversible damage concerning the global environment has already reached the tipping point and it is probably too late to sustain the conditions of today for future generations: it is just a matter of minimizing the damage. The timeframe for action is very limited and the extent of necessary action is fast becoming extensive. Moreover, and with reference to the precautionary principle, playing a waiting game is no alternative.

2. Method approach

The aim of this paper is to apply a model for enabling a client or a construction project manager to deal with significant aspects of sustainability during construction works and to validate this model by input from real cases, with a well-defined context of sustainability in construction works. The research is conducted by literature studies, development of a management model focusing on sustainability in construction works suited to clients and project managers, validated by case studies with a well-defined sustainability context and generalized to be used in projects covering construction works entire life-cycle.

Some limitations are made: It is important to note that sustainability is the result of the activities related to the concept of sustainable development. When using the term of construction works, defined as "everything that is constructed or results from construction operations" [10], it only concerns buildings. When activities of a client are in question; solely applying during the process of construction works.

3. Result

Various interpretations of sustainability in construction works have been adapted and are defined in an ISO standard applied to construction works: the international standard "Sustainability in building construction – General principles", ISO 15392: 2008 [10]. This is the result of a validation of a

process-oriented assessment model suited to construction works projects with a well-defined context of sustainability such as ISO 15392.

3.1 An ISO-standard of sustainability in construction works

The standard of ISO 15392 is linked to the international standard for environmental management system, EMS, ISO 14001:2004 [13] and it refers to the concept of sustainable development defined in the Brundtland Report [6] adapted to the triple bottom-line. The standard is applicable to one or more buildings' whole life-cycle from the very beginning to the end of their life including the related materials, products, services and processes.

The internal relationship of the triple bottom-line is set to as being of equal importance, see Fig. 1.1, and each of these should be addressed systematically and then prioritized as protection goals derived from the needs of the triple bottom-line.

According to ISO 15392, following six objectives are in the promotion of sustainable development when applied to construction works: Improvement of the construction sector, reduction of adverse impacts while improving value, proactive approach, innovation, decoupling of economic growth from increasing adverse impacts, and reconciliation of contradictory interests between short-term and long-term decision making.

To meet these objectives there are nine principles in ISO 15392 to be fulfilled (without prioritization):

1. Continual improvement – improvement of all sustainability aspects over time adapted to construction works including performances and processes. It addresses methods or means of assessment, verifications, monitoring and communication,
2. Equity – includes the consideration of intergenerational, interregional and intra-societal ethics including the triple bottom-lines,
3. Global thinking and local action – when acting locally consider global consequences and when applying global strategies consider local implications,
4. Holistic approach – includes all aspects of sustainability when considering or assessing sustainability in construction works and regarding the whole life-cycle,
5. Involvement of interested parties – involvement of stakeholders in relation to their importance, responsibility and timing,
6. Long-term consideration – taking in account of short-, medium-, and long-term implications in decision making, including performance over time, life-cycle thinking and legacy impacts (the impacts as a result of a development),
7. Precaution and risk management – the precautionary principle adapted to construction works such as avoidance of risks through risk management, i.e. risk assessment, risk treatment, risk acceptance and risk communication,
8. Responsibility – comprises the moral responsibility for actions carried out, and
9. Transparency – information in an open, comprehensive and understandable way with traceable underlying data and verifiable credibility, e.g. information about products and decision-making processes.

3.2 An assessment model

An assessment model, the Stakeholder-Urban Evaluation model (STURE) has been developed. It began as a purely environmental construction work project management model [14], then

improved with additions such as considering the triple bottom-line of sustainability, the sustainability construction works concept, considering stakeholder influences and demands, considering usefulness of environmental or sustainability assessment tools, and links to other facility developments or processes [15], [16], [17], [18] and [19]. All these additions were made by using and adapting the model in different real construction works projects.

STURE could be described as an objectives-led integrated assessment [7] applied at the project level. The model is a way of systematizing the issues of sustainability in construction works in accordance with principles of ISO 14001 combined with empirical studies of stakeholder management [20]. The model optimizes the sustainability objectives and targets of a client's management organization and the specific conditions of an actual project and the particular site of the project. ISO 14001 is the basis of the structure of the model and with terms of environmental (sustainability) objectives and environmental (sustainability) targets defined by the standard. Other terms used are also similar to the standard

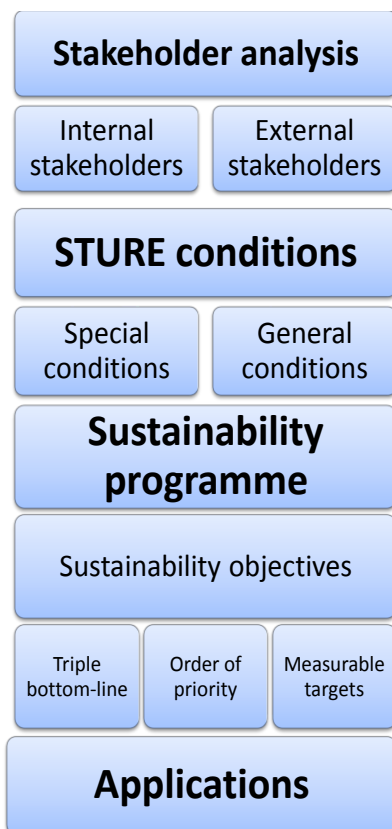


Fig. 3.2 The STURE model [21]

ISO 15392. The connection to the client's environmental management system and the standard of ISO 14001 adds the facility development to the client's commitment of continual improvement, i.e. each client starts on its own level of ability and improves continually towards more and more sustainability.

3.3 The process of validation

The aim is to apply on-going construction works to the STURE model and if the result of STURE assessment could be validated with arguments of sustainability described by ISO 15392

The principle of STURE (Fig. 3.2) can be described by four steps: *stakeholder analysis*, STURE conditions by *special conditions* for the actual application, *general conditions* that need to be addressed and the *sustainability programme*. The last step acts as a synthesis of the other three and the concept corresponds to ISO 14001. The information gathered in these steps is then used as input to a relevant application, e.g. plan of operation and maintenance for a real estate company or an analysis of alternative solutions in the design and location of a new facility.

The STURE model enables the client of a facility development to gain an insight into relevant sustainability concerns and needs of different stakeholders. It also clarifies significant sustainability aspects of the actual application's dependence on planning, operation, maintenance, recycling, site, system and components. By translating these significant aspects into objectives and prioritising them according to the client's environmental management system, the STURE method intends to assess the process of sustainable development and to fulfill the principles of

Table 3.1 Chosen case studies. [21]

Case Study	Art of case study	Construction works stage
A	Residence buildings and student flats	Exploitation phase
B	A new office building	Design and construction phase
C	Residence and commercial buildings	Maintenance planning project for a real estate company
D	Residence buildings	Maintenance and refurbishment project with construction work during tenants use.
E	A coal and oil based power factory	Dismantling project in the procurement phase

To do the validation practically, a set of case studies were used, see Table 3.1, reflecting different stages of a construction works life-cycle and also different phases in the process of a construction project. The cases were not in the forefront of environmental or sustainability adapted construction work. Even if some of them had some higher ambition than average by addressing, especially, the environmental part of the triple bottom-line, were the cases overall quite standard and common project performed during the last ten years and reflecting different stages in a facility's life-cycle during different phases of the process of a facility development. The case studies cover a quite broad spectrum addressing construction works. The case studies were evaluated by, and in some cases also converted to, STURE. The outcome from this were validated with the nine principles of ISO 15392 to see if the use of the STURE model could be a tool to make sustainability estimations and if the cases with help by the model could possibly be estimated as sustainable or not, see Fig. 3.3.

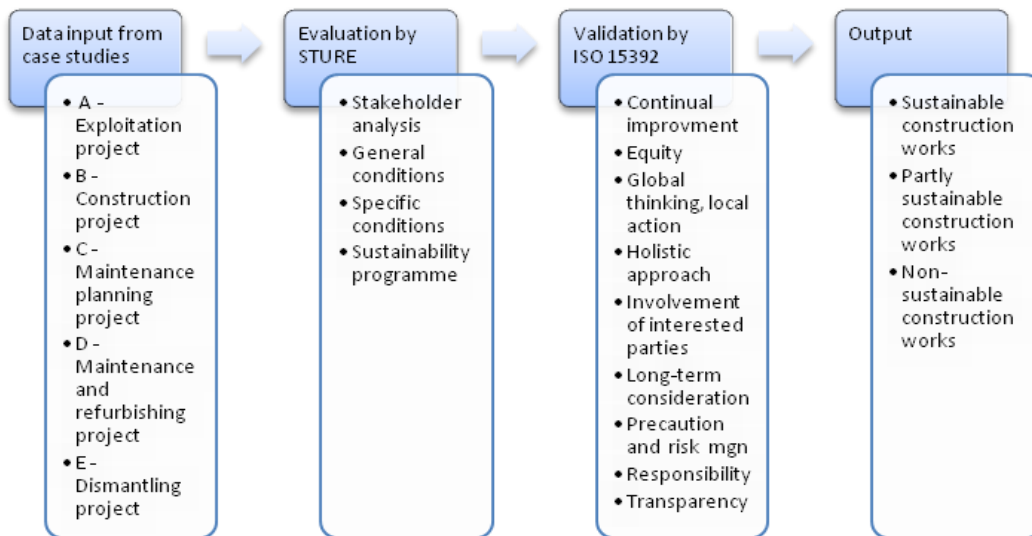


Fig.3.3 The process of validation [21]

The first stage of the process focuses on evaluation of each case study based on the STURE model and is summarized in Persson [21] Table 8.1. The next stage is concentrated on the validation of each case study with ISO 15392 nine principles of sustainability and the results are summarized in Persson [21], Table 8.2. The expected results will either meet the following level of sustainability:

- Sustainable construction works,
- Partly sustainable construction works, or
- Non-sustainable construction works

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3.4 Integrating STURE and ISO 15392

3.4.1 Evaluation by STURE

The stakeholder analysis done in the cases shows the importance to crystallize that or those of the stakeholders, external and internal, who has significant impact on the facility development and, consequently, should attract more attention by the client during the development process. This part in the STURE method ensures identification of the interested parties and decrees an involvement with the most important of these stakeholders.

The general conditions set the platform of the facility development regarding the clients' business and environmental policy, management systems, organization and standard procedures. By this part, the client's ability and knowledge of sustainability are formulated and is also the starting point of the client's commitment of continual improvement regarding the particular facility development.

The specific conditions are the base of the facility development's site related aspects. This implies to carry sustainability site and product assessments through to gain aspects of sustainability for the facility development. It also implies to take decisions made by the client and other important stakeholders in to account during the development process to compare the impact on relevant aspects produced hitherto. These procedures have to take the whole triple bottom-line in account to fulfill the holistic approach regarding the state-of-the-art circumstances of the facility development.

When evaluating and formulating the sustainability objectives, it is necessary to compare all the aspects and facts from the parts of general conditions and specific conditions qualitatively or, if it is possibly, quantitatively. To produce significant aspects it is important to take both general commitments (e.g. sector mutual agreements) and corporate commitments (e.g. business policy, environmental policy or other commitment made by the individual company) in account. The objective formulating is depending on the most significant aspects adapted to and evaluated by the client. During this evaluation procedure, aspects from the whole triple bottom-line are to be considered. The final objectives also reflect the triple bottom-line by cross-references with each main aspect. Sustainable objectives along with added targets address long-term consideration, global thinking and local action. The measurable and verifiable targets meet the principle of transparency, where the targets are traceable with underlying data and comprehensive by the condition of standardized verifications.

3.4.2 Validation by ISO 15392

Following six principles of ISO 15392 were fulfilled when using STURE with the case studies [21]:

1. The principle of continual improvement is a condition stated by a client's environmental management system in its environmental policy and accordingly included in the general conditions of STURE. It is of course very important that this aspect is covered in a STURE application.
2. Global thinking and local action is covered by the STURE method during the evaluation process of general conditions and specific conditions. In general conditions there are aspects from global, regional and governmental perspectives by recommendations, sector agreements or legislation. In specific conditions there are aspects on a local level, especially from the actual site of the facility development.
3. The holistic approach is obvious by STURE's objective setting and the underlying sustainability assessments of supposed aspects.
4. By stakeholder analysis of influence importance and defining internal and external stakeholders, the principle of involvement of interested parties is covered.

5. The principle of long-term consideration is fundamental in STURE, particular in the objective and target setting. But this depends of what kind of client is involved in the facility development. Is it a short-termed thinking client with focus only on putting the developed property on sale could this principle fail, even if using the STURE model.
6. The transparency principle covers by the model's condition of verified targets and the condition of including project decisions during the process for comparison of hitherto significant aspects. A limitation of this principle occurs when to transfer the facility developments knowledge after a project finish to an operation organization, internal or external, or when a shift of corporation culture occurs, especially the case of new owners.

3.4.3 Output

The case studies of **A** and **B** had missing parts of STURE conditions in input [21]. These had to be re-worked to replenish the missing parts and, consequently, these are non-sustainable construction works.

The maintenance planning project, case **C**, had all the opportunity to gain success in sustainability, the company's management had to decide of a permanent environmental policy, replenish with an equity commitment and perform a risk management system. It was not completely partly sustainable as above, but yet not fully non-sustainable. But all its intention of sustainability failed when the management transferred the company and its properties to a new owner and no conditions or knowledge transfers of the work carried out so far was made during the transaction of the company because of no interest of such matters from the new owner.

According to Persson [21] could the cases of **D** and **E** be considered not to fulfill all the principles of ISO 15932, but if some former STURE conditions was fulfilled and therefore six of nine principles, these could be considered as partly sustainable construction works, especially the refurbishing project, case **D**, that carried out its intention all the way out of the project.

Looking at the time aspect shows that little have happened concerning re-thinking and improvement of how to perform the process of a construction project. The refurbishing project **D** performed almost ten years ago was, according to Persson [21], quite close to fulfill the ISO 15932 principles of sustainable construction works.

The dismantling project, case **E**, could be considered as a sustainable building construction work by the procurement phase. It had to be verified during the rest of the project performance to be a sustainable construction works.

From a client's perspective and ability to deal with sustainability issues, the result of the validation of using this model is an approach to evaluate and manage the most important sustainability aspects according to the principles of sustainable construction works, the client's activity and its stakeholder's demands during a facility development. From a business perspective is this very important step in the process of sustainable development.

3.4.4 Re-modeling STURE

The six principles mentioned above are quite possible to fulfill when using the STURE model. If the client also uses an environmental management system as ISO 14001 or similar it is most certain to control and maintain these six in the long run. But there are missing references in the model to the principles of equity, responsibility and precaution / risk management

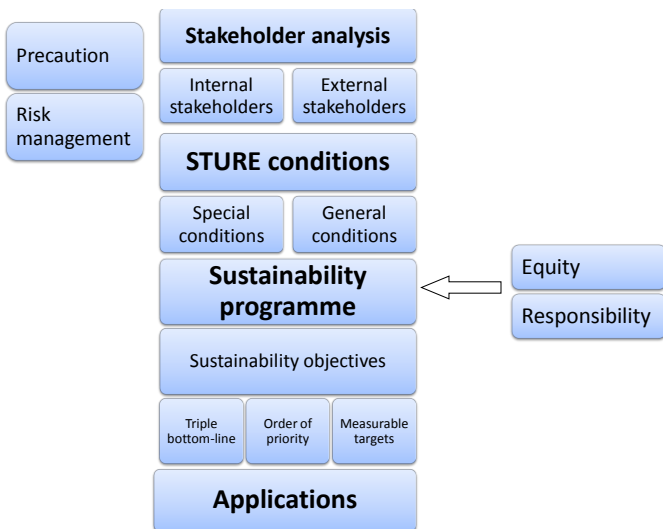


Fig. 3.4 Re-modeled structure of STURE model.[21]

Equity and responsibility should be included and highlighted by the social aspects during assessments and objective settings. The principle of precaution and risk management should become a new input, especially as the latter is a common part in project management and compulsory in quality or environmental management systems. The precaution principle was already stated in the Rio meeting 1992 and is legislated in Sweden by the Environmental Code [12], so it is already a compulsory part concerning environmental and sustainability issues. Fig. 3.4 shows a re-modeled structure by the findings from the validation of the STURE model with the case studies.

4. Discussion and Conclusions

4.1 Discussion

It is clear that initiatives at the governmental level such as legislation and regulations for a better environment exist in many countries and even some countries have formulated an agenda for sustainability. This is also the case on regional and community levels; some objectives are already formulated in different agendas. The work of formulating sustainability objectives on national and regional levels is in progress. A major threat is severe consequences for our built environment related to the climate change, and this is already evident. A risk assessment regarding the consequences of climate change is becoming mandatory. Another consequence is the demand for zero carbon or negative carbon solutions, i.e. regenerative constructed buildings instead of sustaining the pressure of our environment. To make such a paradigm shift is urgent and it needs both top-down and down-up knowledge transfer. From the latter perspective, many small steps on the corporate level are in the pipeline. One milestone is the international standard ISO 15392 which deals with general principles of sustainability in construction works. This standard defines the main terms of sustainability concerning the built environment and construction works; there are no obstacles in the form of confusing interpretations. All is a matter of knowledge transfer, to promote value to clients or facility managers acting on their behalf for the mainstream projects.

On the corporate level it is very important to formulate objectives of sustainability that suits the company's activity, ability and business policy and to let these objectives permeate the activities and projects of the company. The construction industry is very fragmented; a majority of companies are very small. The knowledge and ability to deal with sustainability is on quite different levels. Transferring knowledge internally and between organizations as well as from global, national, regional, and local levels and from ad hoc or empirical levels is crucial if these differences is to decrease.

A good start might be to systematize the activities according to the environmental management system of ISO 14001 without necessarily prioritizing certification. Certification only shows if the company is aware of its activities' environmental impact, not if it is a "good" environmental company. By these means, the formulation of proper objectives suited to the company's activities should not be difficult, especially if sector agreement is provided (as in the case of Sweden). A way of dealing and prioritizing the objectives of the organization and to break them down into a single project together with project-specific objectives is to use the STURE model.

To measure if a company is committed to continual improvement requires assessment. Many different assessment methods are available, but they are mostly regionally or nationally adopted. When assessing the targets or indicators of sustainability objectives it is important to change the direction of assessment tools from solely EIA-driven or “*snap-shot*” tools to objective-led assessment methods as for example STURE. Here, the client’s organizational objective is measured together with the assessment outcome of the actual project or facility combined with the assessment for sustainability with defined sustainability criteria.

The validation of STURE shows there is a possibility to use such models, with minor compliments as in Figure 3.4 and with an environmental management system in use of the client, to assess a construction work or works to determine whether it is heading towards being a sustainable, a partly sustainable or non- sustainable development. This is an example of an objective-led assessment, avoiding the snap-shot statements.

4.2 Conclusions

It is time to prioritize the objectives to make it easy for mainstream property developers, clients and project managers to obtain information on how to act and formulate procedures or opportunities to motivate the mainstream construction work and works towards sustainability. It is obvious that a general global agenda of sustainable construction has to be complemented with the specific conditions of the actual site, the specific project or facility, the ability or knowledge of the client, design and project management team and, of course, regional and local conditions and the context of the triple bottom-line of sustainability. It is, in fact, a question of knowledge transfer from locally adapted bottom-up and top-down perspectives. The challenge is to adapt this to a simplified and user-friendly method that suits the needs and abilities of a mainstream construction project management team. This research may be a step in the right direction of this challenge. The timeframe is very limited; our planet is already suffering from irreversible damage. The construction sector’s and especially the property developer’s responsibility to minimize this damage are huge.

To use the STURE model also promotes continual improvement in project performance and basic organizational activities. Thus, this is a ‘many-small-steps’ approach depending on the client’s ability, level of knowledge and inclination. The aim should not be to become a world leader, but to recognize that improvements comes through successive small steps and thus an ability to measure improvement along the path of sustainability in the field of construction works can be achieved. It is the client/owner/developer, as the responsible performer of activities concerning construction works who has the main responsibility concerning construction works and the obligation to commit sustainability. At the same time there is an opportunity and challenge for make the built environment more sustainable and begin a regenerative development in the earnest.

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