INTEGRATION OF SUSTAINABILITY ISSUES WITHIN CONSTRUCTION PROCESSES

S. Asad1 and M.M.A. Khalfan2

1Amey plc, The Sherard Building, Edmund Halley Road, Oxford, Oxfordshire, OX4 4DQ, UK
2Salford Centre for Research and Innovation (SCRI), University of Salford, Greater Manchester, UK

m.m.a.khalfan@salford.ac.uk

(Received April 2006 and accepted December 2006)

There has been growing awareness of the importance of sustainability in the built environment as it can improve the quality of life. Sustainable construction, which is the application of sustainable development practices to construction, can have a big impact on the quest for a sustainable built environment. Efforts investigating ways of achieving sustainable construction targets recognised the importance of capturing and managing the knowledge required to improve sustainability in construction. This was investigated within the C-SanD Project (Creating, Sustaining, And Disseminating Knowledge For Sustainable Construction: Tools, Methods And Architectures), which was conducted in the UK by University of Salford in collaboration with the London School of Economics, Loughborough University and a number of industry partners[1]. The aim of the project was to develop, test, and implement software tools which enable the capture and retrieval of relevant knowledge, and to embed these tools in working methods that enable the creation of new knowledge particularly in the area of sustainable construction. This paper discusses the issues identified during the field work conducted with practitioners from the industry. It highlights that little has been done to create and retain knowledge on sustainable construction and the need for a structured framework to consider sustainability issues within the whole construction process. The paper then presents ‘sustainability management activity zone’ to support the implementation of sustainable construction practices integrated within a generic design and construction process map (Process Protocol)[2]. It concludes that there is much yet to be done in order to better manage sustainable construction processes during construction projects within the industry.

Keywords: Sustainable Construction, Process Protocol, Construction Processes.
1. INTRODUCTION

Awareness and significance of sustainable development has been growing around the world for the last few decades. Many international and national initiatives (which are discussed later in this section) that show the increasing concern for protecting the environment for future generations by adopting sustainable development principles. The construction industry remains one of the most critical sectors for the adoption of sustainable development principles because of its size, activities, number for people employed, services provided, waste generated, etc. Taking waste generation further, Cameron[3] reported that roughly 17% of the total waste production in the UK comes from the construction industry processes with an annual waste bill of as much as £800 million.

The Sustainable Development agenda within the UK is driven by the Department of Environment, Food and Rural Affairs (DEFRA). Securing the Future[4] is an expansive overarching document which covers not only the domestic issues of waste and energy use, but also wider issues of global poverty. The strategy approaches the issue of sustainable development through the triple bottom line approach[5] which addresses environmental, social and economic issues as a whole.

This is supported by a raft of policy guidance which addresses the key individual issues of sustainable development such as energy[6], waste and recycling[7], biodiversity[8] and community issues[9]. This is supported by policy statements from both regional development agencies and local authorities as they try to make sense of the issues of sustainable development at a local level.

Construction has a huge impact on these issues in terms on not only how a product is delivered[10], but also the performance of buildings in the longer term. For example buildings use 46% of all energy, rising to 70% in some urban areas[11]. This is being tackled through advisory and policy documents, but also through legislation[12], such as recent implementation of revised Part L of the Building Regulations in the UK. While from a social perspective the role of construction in regeneration projects such as the Housing Market Renewal Pathfinders or Schools for the Future where there is considerable emphasis on social issues such as community inclusion, crime and local labour issues.

A need has been highlighted to manage construction activities in such a way that from the outset of the construction process to the end of the life of the facility including the demolition or refurbishment, all processes are carried out in more sustainable manner[13]. To do this the construction industry needs to re-engineer the whole process of development with sustainability considerations for each and every activity in the process. This paper presents the development of a ‘Sustainability Management Activity Zone (SMAZ)’ to support project teams in critically reviewing sustainability issues during each phase of the whole construction process and implementing sustainable construction practices at the project level. The paper also gives an overview on sustainable development and sustainable construction, based on a comprehensive literature review in following sections.

2. SUSTAINABLE DEVELOPMENT

There are several definitions of sustainable development. According to Sage[14], sustainable development refers to the fulfilment of human needs through simultaneous socio-economic and technological progress and conservation of the earth’s natural systems. Report by DETR[15] states that sustainable development is about ensuring a better quality of life for everyone, now and for generations to come, through:

- Social progress which recognises the needs of everyone;
- Effective protection of the environment;
- Prudent use of natural resources; and
- Maintenance of high and stable levels of economic growth and employment.

The World Commission on Environment and Development (WCED), led by the Norwegian Prime Minister Gro Harlem Brundtland, in 1983, formulated the most common definition for sustainable development. It states that “Sustainable development is a development which meets the needs of the present without compromising the ability of future generations to meet their own needs”[16]. Sustainable development includes three broad components; social equity, environmental protection, and economic growth; often known as the ‘triple bottom line’[17].

3. SUSTAINABLE CONSTRUCTION

Sustainable construction can be defined as a construction process which is carried out by incorporating the basic objectives of sustainable development[14,16,18]. Such construction processes would thus bring environmental responsibility, social awareness, and economic profitability to new built environment and facilities for the wider community. The UK Government’s strategy for more sustainable construction DETR (2000) suggests ten key factors for action by the construction industry by widening these basic objectives. These include; design for minimum waste; applying lean construction principles; minimising energy in construction and use; pollution reduction; preservation and enhancement of biodiversity; conservation of water resources; respect for people and local environment; and setting targets, monitoring and reporting, in order to benchmark performance[19].

Construction has a significant effect on people’s quality of life; construction outputs affect the nature, function and appearance of the towns and countryside in which people live and work. The construction, use,
repair, maintenance and demolition of this infrastructure consumes resources and energy and generates waste. The UK construction industry employs 1.5 million people, which is approximately 8% of GDP and the amount of construction materials used annually is equivalent to six tonnes per capita[20]. The UK government has undertaken initiatives to improve sustainability within the construction industry to meet its sustainable development targets. Recent research programmes such as ‘Partners in Innovation (PII)[21] and others have been funded to support sustainability improvements within the construction industry[22]. The ‘Government Const-ruction Clients Panel’ (consisting of representatives with responsibility for procurement from most government bodies) also has a target to improve sustainability in all projects to make the government take a lead in sustainable construction[23]. The next section will introduce Process Protocol to the readers, which is then followed by development of Sustainability Management Activity Zone (SMAZ) within the Protocol to incorporate sustainability within the construction projects.

4. THE GENERIC DESIGN AND CONSTRUCTION PROCESS PROTOCOL

The Generic Design and Construction Process Protocol (Process Protocol) provides a framework with a common set of definitions, documentation and procedures to facilitate more effective co-operation between organisations involved in the construction process[24]. The Process Protocol is a product of a research project undertaken at the University of Salford[25], which involved a wide range of collaborating companies from the construction industry, including clients, contractors, subcontractors, architects and suppliers. The primary aim of the research was to develop a means of streamlining design and construction activities by applying a process viewpoint. Lessons were drawn from best practices implemented in the manufacturing industry; in particular, the area of New Product Development (NPD) provided significant input as it most closely resembles the nature of the building process[26]. Consequently, the Process Protocol can be defined as a way in which the design and construction processes are re-arranged to produce a more efficient, effective and economical delivery of construction projects. Tangible benefits of implementing the Process Protocol include wastage reduction, the shortening of project duration and improved communication methods and channels, among others[27].

4.1 Principles of the Process Protocol

The Process Protocol is based on six principles that are fundamental to an improved construction process[25]. According to Kagioglou et al[26], these principles can best describe a “new process paradigm” underlying the Process Protocol. These principles are briefly discussed in the following sections.

4.1.1 Whole project view

Addressing a whole project view in construction is a necessary precondition as the definition of a project has traditionally been synonymous to the actual construction works[25]. As a result, the pre- and post-construction activities have been sidelined and often accelerated to reach the construction stage or to move on to a new job[25]. This has resulted in the poor identification of client requirements and an ineffective project brief with limited involvement of internal and external specialists. By conceptualising design and construction process from the recognition of a project need through to the operation stage (preferably including the demolition/deconstruction works) ensures informed decision-making at the front-end of the design and construction development process. This has consequent benefits for the on-site activities. Most importantly, taking a whole project view provides opportunity to identify potential interdependencies of tasks within the process[26].

4.1.2 Consistent process

Ensuring process consistency is also a critical aspect of the Process Protocol. This entails the adoption of a standardised approach to performance measurement, evaluation and control. Consistent processes facilitate continual improvement in design and construction[25].

4.1.3 Progressive design fixity

The principle of progressive design fixity is operationalised using a stage-gate approach drawn from the manufacturing industry. It requires that a consistent planning and review procedure be applied at each stage of the process[25]. In the Process Protocol, phase reviews provide an opportunity to examine the work executed in a particular phase. The progress needs to be approved before the planning, resourcing and execution of a new phase are possible. This allows for a progressive fixing and/or approval of design information throughout the process, resulting in increased predictability of construction works[24].

4.1.4 Co-ordination

For all stakeholders involved in the building process to work seamlessly together, it is necessary to provide a mechanism of co-ordinating their participation and project activities throughout the process. In the Process Protocol, the co-ordination of the process falls under the responsibility of the Process and Change Management Activity Zones. The actions of the Process Manager are supported by the Change Manager, through which all information related to the project is passed[25].

4.1.5 Stakeholder involvement and team work

Following the practice of establishing multi-functional project teams in the manufacturing industry, the Process Protocol introduces the concept of the Activity Zone. This means that process participants are
described in terms of the activities that need to be undertaken in order to achieve a successful project and process execution[26]. This is a major change in the identification of roles in the building processes from the historically labelled roles of architects, engineers, contractors, whose scope of work constantly vary at the margins from project to project. Proactive resourcing of information from key stakeholders during phase reviews ensures that crucial design and production information is gathered early in the process. Working in multi-functional teams can also foster team environment and encourage appropriate and timely communication and decision-making[25].

4.1.6 Feedback
Learning from experience is imperative to the continual improvement of construction practice. The introduction of phase reviews in the Process Protocol provides an opportunity to record project experience throughout the process. This information can be utilised in later phases of the construction process or on future projects[25].

Through these phase reviews, the Project Protocol establishes the Legacy Archive. This is a mechanism for recording, storing and retrieving project/process information[24]. The Legacy Archive is meant to be used by project participants in current and future projects.

4.2 Organising the Construction Process in the Process Protocol
The Process Protocol uses process maps to build up a framework for delivering any construction project. The building process is divided into 10 phases, which constitute the Pre-project, Pre-construction, Construction and Post-construction stages of a project’s lifecycle. The process sequence in time and the relevant process functions represented by Activity Zones are depicted in Figure 1.

The process begins with the pre-project stage, which entails strategic business considerations of any potential project[25]. During this stage the client’s need is progressively defined and assessed. The statement of need is developed into a structural brief and all key stakeholders identified. Subsequently, core teams which will form the Activity Zones are appointed. In addition, the early feasibility study allows for the screening of potential design solutions and the selection of those solutions which will be considered further. It is also necessary to secure the outline financial authority before proceeding to the pre-construction stage[27].

During the pre-construction phases the client’s need is developed into appropriate design solutions according to the project brief[25]. This activity might involve many members of the construction supply chain, such as suppliers, specialist contractors as well as the traditional design consultants (e.g. an architect and engineer).

The design details are determined and reviewed to enable the planning of the construction (including the assembly and enabling works)[26]. The phase review process adds the potential for the progressive fixing of design information, together with its concurrent development. The major advantage of the progressive fixity is the potential for improved communication and co-ordination between the project’s participants as they pass through each phase[25]. The pre-construction phase ends with the securing of the full financial authority necessary to proceed with the actual construction works. This key decision-point requires a full understanding of the extent of the construction works and associated risks.

The construction stage entails the production of the project solution[25]. During this stage, the construction process is managed and information and resource flows controlled[24]. The benefits of the enhanced communication and co-ordination of activities during the design development are predominantly evident during this stage[26].

The post-construction stage consists of managing the monitoring and maintenance of the constructed facility[25]. As the facility management specialists will have been involved in the earlier stages of the building process, these activities will be delivered more efficiently. In addition, all records of the development of the facility are stored in the project’s Legacy Archive. A post-project review can help identify any areas that need to be given more attention in future projects[24].

4.3 Phase Reviews and the Concept of Soft and Hard Gates
The stage/gate approach sourced from the NPD[27] is a vital feature of the Process Protocol (see Figure 1). During the phase review meetings the feasibility of the project is examined against certain project and process critical success factors. The aim of the phase review is to ensure high quality performance. It is perceived as a mistake avoidance mechanism[24]. The use of soft and hard gates at the phase review points helps reduce development times and facilitates the natural progression of the project lifecycle by imposing discipline on the project. Soft gates allow for concurrency in the process, while respecting key decision points in the process[25]. This means that the activities of a subsequent phase can be started before the current phase is finalised. However, hard gates require the completion of all activities and satisfying all criteria before a decision to proceed is made[24]. An example would be the decision to build at the end of the pre-project phase and also the commencement of on-site activities, and the hand-over of the facility. To some extent, existing practices of the industry reflect the existence of hard gates, e.g., standard forms and conditions of contract.
The stage/gate approach makes decision-points explicit and transparent to all stakeholders, other than those who are party to the construction contract.

During a phase review meeting a report is presented with all relevant deliverables for the particular phase (i.e. documented project and process information). The main outcomes of the phase reviews include the following[24]:
- A potential decision to pass/fail or postpone the phase review for a later stage;
- Critical decisions on (mainly) financial authority to proceed;
- Planning for next phase and setting a date for next phase review; and
- Phase review minutes distributed to all attendees.

All phase review reports and minutes are entered into the Legacy[24].

4.4 Stakeholder Involvement in the Process Protocol

Stakeholders in the Process Protocol are defined as individuals or organisations whose views, interests and needs can influence or are influenced by the proposed project (its initiation, formulation and/or implementation)[24]. The timely identification, prioritisation of stakeholders and their needs, and their involvement in the process can arguably lead to effective decision-making throughout the project lifecycle.

The Process Protocol groups project stakeholders into 9 Activity Zones: Development Management; Project Management; Resource Management; Design Management; Production Management; Facilities Management; Health and Safety Statutory and Legal Management; Process Management; and Change Management[24]. These are multi-functional and multi-disciplinary teams responsible for specific sets of tasks and processes within the design and construction process[25]. An Activity Zone may be carried out by a single person or a complex network of people depending on the project’s scale. The multi-functional nature of Activity Zones implies that their membership is determined by specific project task and/or process (e.g., design detailing, production, supply, or continuous client input).

Activity Zones may overlap and are interdependent[28]. For instance, Design Management often provides input for the Production Management and Facilities Management Activity Zones. These Zones may also provide input for Design Management[25]. However, each Activity Zone has a primary responsibility for certain deliverables in the project:

**Development Management**: Development Management is responsible for maintaining business focus throughout the project, and satisfying stakeholders’ needs and constraints. Therefore, the Development Management Zone can be conceptualised as the client/customer for the potential project. It is the only Activity Zone which has activities at every stage of the project cycle. Client’s needs are presented and interpreted via the project brief developed by this Activity Zone.

**Resources Management**: This Activity Zone is responsible for the planning, co-ordination, procurement and monitoring of all financial, human and material resources throughout the building process.

**Design Management**: Design Management translates the business case and the project brief into an appropriate design solution. This Zone also facilitates the integration of the design inputs from other Activity Zones.

**Facilities Management**: The Facilities Management Zone aims to secure the cost efficient management of the new asset, and the creation of an environment that strongly supports the primary objectives of the building owner and/or user.
Health & Safety, Statutory and Legal Management: This Zone identifies and manages all regulatory, statutory and environmental aspects of the project.

Project Management: The core responsibility of Project Management is the efficient and effective implementation of the project. A crucial deliverable of this Zone is the project execution plan, which guides the integration of all relevant inputs from other Activity Zones. It collaborates closely with Process Management to ensure that agreed performance criteria are met. These criteria are based on requirements specified in the business case and project brief. Moreover, it is an active agent of the Development Management Activity Zone.

Process Management: This Zone develops and operationalises the Process Protocol. It is responsible for planning and monitoring the activities of each phase and reviewing phase reports. Consequently, this Zone determines and examines process inputs and outputs at each phase. Process Management also provides recommendations to the Development Management Zone regarding the satisfactory delivery of the final product.

Production Management: Production Management ensures that the optimal solution for the buildability of the design is implemented. It is also responsible for the construction logistics.

Change Management: This Zone communicates any project changes to all relevant Activity Zones throughout the process. Change Management also develops and manages the Legacy Archive. Hence, Change Management acts as the interface between all Activity Zones and the Legacy Archive.

The use of Activity Zones helps harvest the optimal benefits from team work. The communication process is enhanced as the participants work towards common objectives. In addition, this approach prevents any domination of a particular category of building professionals over any project phase or decision. This is a significant improvement over traditional conceptualisations of the building process, when typically the distinction between project phases is determined by the entry of different parties (e.g. an architect or contractors)[26], and where the model reflects the viewpoint of a particular industry stakeholder, e.g., the RIBA Plan of Work.

4.5 Using Process Maps to Represent the Design and Construction Process

Process mapping is a valuable management tool used to illustrate flows of information and/or materials within an organisation[28]. Process maps are usually two-dimensional. The actors or functions responsible for each task are plotted on the vertical axis, whereas the horizontal axis shows project/process progression in time.

In the Process Protocol, the participants are represented on the Y axis of the process model. They are referred to in terms of their primary responsibilities, i.e., as Activity Zones[25]. The sequence of individual process activities or gates is represented on the X axis (see Figure 2). The generic model of the Process Protocol provides a visual representation of the construction project in terms of prime responsibilities/functions and activities that may be undertaken during each phase. The process map enhances the transparency of stakeholder participation in the project by clarifying their roles and involvement throughout the project cycle. It indicates the potential interrelation of activities, processes and sub-processes. The map also assists in the identification of critical decision-points. Most importantly, the visual representation of the process allows all organisations involved in the project to communicate using the lingua franca - the language of the Process Protocol. Each organisation can map their own internal processes against the generic process model allowing them to clearly understand their relationship to the project.

The second stage of the research on the Process Protocol (Process Protocol Level II) focused on the development of sub-process maps and produced the Process Protocol Toolkit. The toolkit provides an IT support for the creation of process maps based on the Process Protocol framework[29]. In this way, users can create and customise their specific process as well as manage the process and project information.

5. SUSTAINABILITY MANAGEMENT ACTIVITY ZONE (SMAZ)

Having indicated the range of sustainability issues that need to be addressed in construction, it is critical to devise a way of tackling these issues throughout the project lifecycle. This section presents how this challenge is addressed through the Process Protocol. Although indicators have previously been identified, checklists already prepared, and assessments have been carried out to check sustainability, and reported by Khalfan[13], there is a further need for a structured, phase by phase map of activities for the whole construction process from inception to the maintenance period, which would integrate the social, environmental and economic considerations into the construction project and guide the industry to use such indicators and checklists in a more effective and efficient manner. The need was acknowledged during the C-SanD research project[11], to have sustainability activities identified and built-in for different stages of the construction process, and to have a tool for incorporation of these issues and activities into the planning and management of construction projects.
This need was also identified as an important aspect in improving sustainability by the engineers working on the project called ‘The Engineer of the 21st Century’ inquiry, facilitated by The Forum for the Future in the UK. The inquiry also identified that there is a need to embed sustainability issues into all stages of the construction process. Furthermore, this has appeared as one of four change challenges in a report ‘Change Challenges for Sustainability’ by the Forum. All above are resulted into the development of the SMAZ.

Some of the potential advantages of adopting the Process Protocol as an industry standard, which were the main drivers for developing SMAZ to be part of the Process Protocol, are:

- It provides a whole project view;
- It recognises the interdependency of activities throughout the whole project;
- It focuses on the identification, definition, and evaluation of client’s requirements;
- It enables co-ordination of the participants and activities in construction projects and identifies the parties responsible;
- It encourages the establishment of multi-functional teams; and
- It encourages a team environment, and appropriate and timely communication and decision making.

5.1 Development of SMAZ

SMAZ was first developed in the form of a matrix and then further refined into a full activity zone within the Process Protocol (see Figure 3). The final version of SMAZ’s first and second level of activities is the outcome of the following: a literature review; analysis of C-SanD Project’s first and second round of interviews; participation in real project meetings of industrial partners; review of available sustainability checklists, indicators and assessment tools; in-house workshops with the C-SanD project team at Loughborough University; and further validation with 20 construction related organisations.

Once the basic framework was developed and checked in-house workshops, it was validated within the construction industry to check its relevance, practicality, and use. Organisations such as local councils, consultants, contractors, etc. took part in the validation process. The validation was done in two stages: the first stage involved about half of the organisations and resulted in an interim version of SMAZ; the second stage then involved the other half for further refinements. The selection of organisations was done on random basis.

5.2. Characteristic of SMAZ

SMAZ was developed in a format similar to the other activities within the Process Protocol including first and second level activities. Each phase of the Process Protocol contains one or more activities within SMAZ. The first level activities (see Figure 3) are generic with more specific tasks defined in the sub-activities (second level activities). The development of SMAZ was carried out in such a way that it can be used with or without the Process Protocol. Although it was prepared to be fully integrated with the Process Protocol, its activities have also been structured in line with RIBA Plan of Work, and also with the more generic design and construction phases (which includes pre-project, design, construction, and post-construction phases). This attribute makes SMAZ a generic tool which can be used not only within the UK but also outside the UK, with the possibility of being adopted in virtually any design and construction process framework.

At the project’s outset (Phase 0), generic sustainability issues are identified and prioritised during a scoping exercise. The environmental, social and economic aspects of the project are screened using a taxonomy checklist. As the client’s need is conceptualised, a sustainability mission statement is developed for the project. Moreover, a consultant would be appointed where the project team lacks the necessary expertise (Phase 1). Subsequently, the previously identified sustainability issues are listed according to their priority, in line with the sustainability mission statement, with the client’s participation. During the pre-feasibility study (Phase 2), a matrix is prepared with a refined list of sustainability issues that need to be addressed in the project. The matrix also includes performance goals/targets and a set of relevant indicators. Khalfan et al. argue that the project team needs to be practical in identifying sustainability issues, indicators and targets. Moreover, the established targets and indicators should be specific, measurable, achievable, realistic and time-bound (SMART).

A sustainability plan and a sustainability management strategy are established during the feasibility study (Phase 3). At this stage it is determined what sustainability issues are addressed at what point in time during the project’s progression. The decision-points are also determined and monitoring methods defined. In addition, the responsibilities are assigned to various Activity Zones. The sustainability plan is based on the previously defined mission and targets included in the matrix. The optimal design options that meet the sustainability requirements are selected for further development.

The full conceptual design is also assessed against the sustainability matrix, followed by the production of a sustainability report (Phase 5). It is suggested that an appropriate building assessment tools are used at this stage (e.g., BREEAM or LEED). This is an important stage during the process as recommendations are made for subsequent phases of the building process to ensure that the design and construction are aligned with the sustainability goals and targets.
As the design is finalised in the following phase 6, the sustainability assessment must be completed and a final check against recommendations made in the previous phase undertaken. Subsequently, the production information is reviewed against the pre-set goals and targets so that the production information developed is co-ordinated with the sustainability plan (Phase 7). In addition, the construction monitoring parameters are established. During the actual construction works (Phase 8), any changes from the construction plans need to be assessed against the sustainability matrix by Production Management, while Sustainability Management monitors the compliance of construction with the sustainability plan. Finally, a post-construction review is conducted (Phase 9) to assess if the sustainability targets and goals have been met.

5.3 Using SMAZ

The following are considerations which should be kept in mind while using SMAZ:
- SMAZ is developed specifically for use at construction project level, but some of its activities could be translated for use at organisation level.
- The project team needs to be practical in their vision when identifying issues, indicators and targets in the early phases.
- The targets set during the initial phases should be SMART Targets (i.e. Specific, Measurable, Achievable, Realistic, Time-bound).[35]
- SMAZ can also be used for demolition or refurbishment projects.
- The mission statement, sustainability matrix, checklist, strategy, etc. can form part of a sustainability plan, which could be documented into the project brief first and then could form part of overall project development plan.
- SMAZ is very simple to use, but needs one person (manager/champion) to oversee its implementation throughout the whole project.
- Using SMAZ is made easy, for example, Phase four of the Process Protocol framework, under pre-construction, covers Outline Conceptual Design, the different activities carried out during this phase should be conducted to include sustainability guidelines. Tasks such as reviewing different alternative designs should also include a sustainability assessment of each alternative by using the Matrix developed in phase 2. These activities are also integrated with other sub-activities carried out in other activity zones. For example the list of all the suppliers should be prepared and reviewed with respect to material’s quality, recycleability, etc. Cost plans and procurement plans should be prepared and reviewed considering sustainable construction criteria as identified. Design options should be assessed on the basis of their best matching the project’s sustainability goals.

6. CONCLUSION

A brief overview of sustainable development and sustainable construction was presented, followed by an introduction to the Process Protocol. The latter part of the paper discussed the need for incorporating sustainability within the whole construction process, which resulted in the incorporation of these issues within the Process Protocol, as a Sustainability Management Activity Zone (SMAZ). SMAZ was developed in such a way that it considered the whole supply chain within the construction industry to achieve a more sustainable project. An important aspect of SMAZ is that it ensures that those sustainability issues, which are sometimes ignored or overlooked during the whole process of project development, are properly taken into account by the project development team. The SMAZ will also be able to help the project team identify sustainability issues to consider for a specific project at the outset, enable them to consider sustainability as part of project development process, and help them to set practical targets and goals. Further work will include linking the supporting documents to SMAZ and the implementation of SMAZ to a live project within the industry to assess the full potential of the framework. The results, changes, and outcomes from the implementation of SMAZ within the industry would then show and map the relationship between the academic world and construction project site practices. Therefore, there is a potential for SMAZ to be used as a tool which could translate academic concepts to real practices on site, and at the same time extract underpinning ideas from current practices within the industry and inform further research areas. One of the top five construction organizations have now taken this task on board within the UK to use the SMAZ as part of Process Protocol on their projects. The future publications would present the findings from the above practical implementation of the SMAZ.

REFERENCES
1. http://www.c-sand.org.uk/
PHASE ONE

- Conceptual Design
- Revise
- Prepare

PHASE TWO

- Conceptual Design
- Revise
- Prepare

PHASE THREE

- Coordination Design
- Revise
- Prepare

PHASE FOUR

- Substantive Feasibility Study
- Revise
- Prepare

PHASE ZERO

- FEEDBACK FROM CURRENT & PAST PROJECTS VIA LEGACY ARCHIVE

PHASE ONE

- FEEDBACK TO OTHER PROJECTS VIA LEGACY ARCHIVE

PHASE FIVE

- Ongoing Undertake

PHASE SIX

- Undertake

Figure 2. The Process Map of the Process Protocol [26].
PHASE ONE

THE NEED

ANALYSIS

MANAGEMENT

Liaison

Business Case

DEVELOPMENT

Brief

SCOPE

Management

SOFT GATE...HARD GATE

USE & CREATION OF LEGACY ARCHIVE

MANAGEMENT

Figure 3. Sustainability Management Activity Zone inserted within the Process Proto.