Chapter 24

Sustainable Design, Innovation and Competitiveness in Construction Firms

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1. Introduction

Construction firms are experiencing greater demands for reducing their carbon footprint due to sustainability. There is gradual shift away from traditional methods to environmentally friendly design and construction processes. This chapter examines the challenges faced by construction firms as a result of sustainability and its impact on innovation and competitiveness. Using a case study strategy, the sustainability challenges and strategy of five organizations in various positions of the construction supply chain are discussed. The chapter also explored how sustainability in construction firms is driving changes in their strategy, which has triggered process, design and product innovation influencing competitiveness and profitability both in the short and long term. Following this introduction, the concept of sustainable development, key drivers influencing sustainability strategies of construction firms are reviewed. The case study findings, analysis and discussion of the key issues based on the experience of five construction firms are presented. The lessons learned and the implications for construction firms are also discussed.

2. Background and Context

The construction industry uses a significant amount of energy and generates an astounding amount of waste both from excess materials, which cannot be re-used, and from new materials not stored properly on site resulting in wastage. Construction firms have been put under increasing pressure in recent years as a result of sustainable development driven by international agreements such as Kyoto protocol, EU Emission Treaty and various UK government legislation and initiatives aimed at reducing environmental impact and carbon emission. These agreements have led to profound changes in the behaviour of construction firms such as changes in design, project processes creating challenges as well as opportunities for the construction supply chain. However, for sustainable design to be effective a balance between addressing the environmental concerns about design and construction (environmental objectives), needs of society (social objectives) and profitability and competitiveness (economic objectives) is required. If firms are not competitive and profitable then their sustainability efforts would fail as firms exist to maximise profits. Innovation in design and construction is therefore necessary to respond to the increasing pressure to adopt sustainable development. Previous studies have not adequately addressed the impact of sustainability on design, process and product innovation, competitiveness and profitability.

2.1 Concept of Sustainable Development

Sustainable development based on the seminal Bruntland Report is *defined as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs"* (Cited in Atkinson, 2008). In any sustainable development strategy, three important dimensions have to be addressed. These are the environmental (the planet), social (the people) and economic (profit) aspect. Cooper (1999) and many researchers recognised this tension between protecting the environment, social obligations and economic development, and the difficulties in operationalising the concept of sustainable development

(Kaatz et al 2005). Edum-Fotwe and Price (2008) used a model called the *"Triple Bottom Link Sustainability Model"* to demonstrate that sustainability lies at the core of the three dimensions, when they are combined. The Forum for the Future (2009) argued for sustainable development to be incorporated through an organization's strategy. Responding to the challenge of sustainable development is important to ensure the survival of construction firms in the market. There is now a greater demand for adopting a sustainable development strategy increasingly driven by government legislation, clients and other stakeholders affected by construction activities.

2.2 Key Drivers of Sustainability in Design and Construction

There are a number of drivers influencing the rate of adoption of sustainable development strategy in UK construction. First there are the legislative requirements. To support the government's sustainable development policy there are a number of legal instruments, directives and Acts passed to address various environmental issues such as energy usage, water, waste, wildlife and land use and carbon emissions (Ministry of Defence, 2009). The Climate Change Bill, which became law on 26th November 2008 serves as a legally binding target to reduce the UK's carbon emission by at least 26 percent in 2020 and at least 60 per cent in 2050" (DEFRA, 2008). The Government is required to publish five yearly carbon budgets from 2008 onwards, and have formed a Committee on Climate Change. The Committee is expected to advise the Government on the levels of carbon budgets to be set, the balance between domestic emission reductions and the use of carbon credits, and whether the 2050 target should be increased. In a recent article, the *Secretary of State for Climate Change* for the *UK Government sets out low-carbon plan for 2050 (*Huhne, 2010).

Second, there are specific planning and building regulations such as the 'Merton Rule', energy performance certificates, BREEAM assessment and Code for Sustainable Homes, which affects design and construction activities. The planning rules, building regulations and assessment tools are aimed at protecting the environment by providing guidance on design approaches and construction procedures which obviously affects the activities of construction firms. For example, the 'Merton Rule' originally introduced by the London Borough of Merton has been adopted by other boroughs throughout Britain (Merton Council, 2008). This rule is a prescriptive planning policy that requires new developments to generate at least 10% of their energy needs from on-site renewable energy equipment. An Energy Performance Certificate (EPC) is also required when a building is constructed, sold or rented. The EPC gives home owners, tenants and buyers information on energy efficiency of properties using a standard energy and carbon emission efficiency grade from 'A' to 'G', where 'A' is the most efficient (Directgov, 2008). The BREEAM assessment process was introduced in 1990 and there are various versions updated regularly to comply with UK Building Regulations. BREEAM looks at a broad range of environmental impacts from management, health and wellbeing, energy, transport, water, material and waste, land use and ecology and pollution (BREAAM, 2007a and b). Credits are awarded in each of the above areas according to performance and a set of environmental weightings then enables the credits to be added together to produce a single overall score. A Code for Sustainable Homes was also introduced and from May 2008 it became mandatory for all new homes to have a rating against the Code.

Third, there are the economic arguments as one of the most powerful triggers for changing the behaviour of construction firms and their clients. The Stern review focused on the economic costs of the impact of climate change, and the cost benefits of action to reduce the emissions of greenhouse gases (HM Treasury, 2009). Carbon Trust developed carbon management to help companies including construction firms to recognise the business opportunities associated with climate change (Carbon Trust, 2006). A major economic driver of sustainable construction is

improving building performance and reducing maintenance and operational costs (Khalfan, 2001). An argument sometimes put forward is that the 'least sustainable is the more profitable' as it avoids the environmental cost'. Sir Jonathon Porritt, Chair of Sustainable Development Commission was quoted as saying.

> '*You have occupiers saying we want to live in green buildings, but there aren't any. So the contractors say we can build them but developers don't want them. Developers say we want them but investors won't pay for them. Then the investors say we would pay for them but there is no consumer demand" (Financial Times, 2007).*

The misconception of increased costs of sustainability and lack of a market value discourages both developers and contractors (Cole 2000). Johnson (2000) found that sustainable buildings could produce more economical benefits for their owners/operators than more traditional designs. Yates, (2001), explored the business benefits of sustainable construction and concluded that the benefits are diverse and potentially significant. He identified the business benefits such as capital cost savings, reduced running costs, increased investment returns and image/ marketing spin-offs. There are various other economic incentives or disincentives to adopt sustainable solutions such as capital allowances scheme, landfill tax, climate change levy and aggregate levy (ICE, 2009).

These legislative and planning instruments affect construction firms in a number of ways. The construction industry draw materials from natural resources, use highly energy intensive processes, remove land from other uses and is responsible for designing and making products that have lasting effects on the environment and users (CIOB, 2008). Materials extraction, production and recycling interfere with complex ecological and socio-economic systems (Steen, 2005). Construction firms also contribute to pollution of water, dust, noise and toxicity. Chartered Institute of Building argued that construction firms' account for a third of the nation's waste through demolition and excavation processes (CIOB, 2008). Clients, both public and private, are demanding changes and expressing preference for construction firms that are up-to-date with their design and construction procedures. Changing design and construction processes to adhere to legislation and planning requirements and to avoid potential economic and environmental costs as a result of non-compliance or to benefit from economic incentives such as enhanced capital allowances or tax allowances can drive an organisation to become innovative and steer away from traditional practices. There are significant opportunities for innovation to respond to the challenges of sustainable development. However, design and construction firms often invest relatively little in research and development (R& D) to drive innovation compared to other sectors. Ivory (2005) noted that due to a client-focused construction industry the innovation process may be in jeopardy as clients are in general not keen on taking any risks with new designs or ideas as their main concerns are budget and time completion. Reichstein *et al*, (2005) argued that "construction firms have become inherently risk averse and many construction firms do not need to innovate to remain successful". Innovation can be delivered through change of processes or creation of new products, often referred to as process or product innovation (Jiménez and Lorente, 2001). However, if successful, innovation can reduce cost and increase revenue for an organisation thus increasing competitiveness and profitability.

3. Case Studies

Case Study A: Managing Consultant

Case A is a managing consultant firm, which serves the public and private sectors worldwide from over 152 offices. They currently operate in all sectors and specialises in building, environmental, health, communication, water, energy, transport, oil and gas, tunnels, bridges and power stations. They have an annual turnover of £800million with about 13,500 employees worldwide. The corporate responsibility for sustainability is driven through their QES (Quality, Environmental and Safety) teams, which are spilt, into various management units operating in different sectors of the business.

Case Study B: Main Contractor

Case study B is an international company that operates in all sectors besides property and residential. They have an annual turnover of about £800 million and employ approximately1500 to 2000 people. Sustainability has always been a key part of what the organization does and is driven through a Corporate Responsibility (CR) team, which consists of 15-20 members, who constantly measure the organisations' sustainability performance.

Case Study C: Main Contractor

Case study C is an international company that was formed from an acquisition, with an annual turnover of £3.24 billion and about 30,850 employees. The sectors in which they operate are diverse and include lifestyle, social infrastructure, business and transport. They have a specific department (Corporate Responsibility team) which deals with sustainability and it is a key part of the responsibilities of the Procurement Director, Human Resources Director, the Design Management team, the Environmental Manager and Community Managers.

Case Study D: Specialist Contractor

Case study D operates in both the rail and highways sectors locally in the UK and internationally with an annual turnover of £240m. The company's sustainability commitment is directly linked to the requirements set out in their section 61 documents, issued by their environmental team. Section 61 is a legal document which comes from the Control of Pollutions Act (COPA) 1974 issued by the local council to construction companies to govern and control interface works with the public.

Case Study E: Subcontractor

Case study E forms part of a group company, which operates internationally. They have an annual turnover of £1.2 billion worldwide and employ just over 500 engineers in the UK and 8000 worldwide. Sustainability is relatively new on the agenda for case study E and is currently being progressed through the quality and environmental side of the business. The appointed department so far consists of 10 key personnel with an additional 5 in the peripheral.

4. Findings and Discussion

Key findings from all the five case studies are summarised in Tables 1, 2, 3, 4 and 5 and discussed in relations to their sustainability strategy and the key drivers, effects of sustainability on processes, types and nature of innovation and competitiveness.

4.1 Profile of Companies

Case studies A, B, C and E operate in all sectors, with specialities in a number of areas while Case D being a specialist contractor only operates in two sectors - rail and highways (see Table 1 below and Table 2 for their sustainability strategy).

TABLE 1: COMPANY BACKGROUND

	Case Study A	**Case Study B**	**Case Study C**	**Case Study D**	**Case Study E**
Type of Firm	Managing Consultant	Main Contractor	Main Contractor	Specialist Contractor	Subcontractor
Geographical focus	National – UK-based & International with over 152 offices	National – UK-based & International	National – UK-based & International	National – UK-based & International	National – UK-based & International
Operational Sectors	All sectors	All sectors besides property and residential	All sectors	Rail and highways	All sectors
Annual Turnover	£800 million	£800 million	£3.24 billion (March 2008)	£240m (for 2008)	£110m in the UK and £1.2 billion world wide
No. of Employees	13,500 worldwide	1500 - 2000	30, 847 - 11,482 in Europe, 17, 326 in Middle East/Asia and 2039 in Australia	1350	8000 world wide (include 500 engineers in UK) operating out of 60 different countries

Insert Table 2 here

4.2 Key Drivers of Sustainable Development Strategy

Case studies A and B have both adopted a personal stance on sustainable development and the need for it (Table 3). Fergusson and Langford (2006) noted that companies, who willingly show environmental concern, command a strong market position because they are driven by more than just legislation and client requirements. Case study B is currently in the top 20 based on the Construction News top 100 contractors, which shows that they are among the industry leaders in terms of their market position. Case A, was ranked in the top 5 by the Sunday Times in the 20 'Best Big' Companies to work for**.** Both Case studies C and D (specialising in rail and highway sectors) views profit as their main driver. However, Case study C recognises that while sustainable development may cost more at the beginning they can benefit from long-term profits if they invest in it. The Project leader for Case C (main contractor) argued that on projects where they are building and operating, they are most willing to invest in sustainability costs from the up-front. Case D (rail division) does not see the need for sustainable development if there are no profits whilst Case study D (highways section) views it as an environmental responsibility. Case E's (subcontractor) main drive for sustainability stems from the client's requirements. Case study C approach is to implement sustainable development as long-term objective (i.e. paying up front costs for long term benefits).

Insert TABLE 3: KEY DRIVERS OF SUSTAINABILITY STRATEGY

Cases A, B, C and D (highways) are aware of BREEAM and all its requirements and have implemented it on a number of projects. They however did not express knowledge of the key legislative requirements such as the Climate Change Bill, Clean Air Act and others as well as major reports such as Stern review. Case D (rail) and Case E had little or no knowledge of BREEAM. Unlike the others, Case B was the only organisation voluntarily signed up to a sustainable development programme that does not carry any legislative requirements. This further emphasises their view of sustainable development as an important entity within the construction industry and to the future of their business.

4.3 Effects on Processes

Cases B and C experienced changes at the tendering stage and believed that clients are now seeking contractors who show commitment to sustainability. As a result, they have changed their procedures for tendering to facilitate this (see Table 4 below).

Insert TABLE 4: EFFECTS ON PROCESSES

Case B also reported that the number of sustainability related questions have increased at tender stage, especially with public sector clients reporting directly to the government. Cases A, D (rail) and E changed their procedures based solely on clients' requirements. For case D (highways), no change was made to their procedures because they have always offered sustainability as part of their package. The tendering process for a main contractor is usually more stringent than for the others along the supply chain, upstream and downstream. For this reason, case studies B and C as main contractors have experienced increased pressure at tender stage to adjust their procedures to facilitate this.

Cases B, C, D (highways) and E have changed their processes to incorporate sustainable development. Cases B and C both changed some of their key account and management plans and adjusted the way they manage their supply chain. Case D (highways) experienced change as they now have to manage their carbon footprint. Case E incorporated changes in their construction processes such as their procurement and waste disposal methods. In Cases A and D (rail) changes were directly driven by client requirements (Table 4).

4.4 Nature and Types of Innovation

Each organisation reported increased innovation due to sustainable development, except for case study D (specialist contractor, rail division) who argued that sustainability has had no effect on innovation within that sector of their organisation (see Table 5). Case E (subcontractor) argued that innovation directly related to sustainable development is now on the increase within their organisation. However, they have always viewed innovation as an important part of the organisation's development and a way to increase their profitability.

Insert TABLE 4: NATURE AND TYPES OF INNOVATION

The results in table 4 suggest that sustainability has played a positive role in increasing innovation. Cases B and C cited examples of innovation in processes, product and design. Cases D and E only reported innovation in processes whilst Case A cited examples in both processes and product. They all argued that the key driver for innovation was profit. However, case studies A and B argued that innovation is a way to increase their competitive advantage and competitiveness. Jiménez and Lorente (2001) noted that firms can contribute individually

towards sustainable development by innovation in products and processes during design and construction.

There were a variety of examples of process, design and product innovation to respond to the challenges of sustainability. This includes the use of polystyrene instead of piling in hard stone for constructing railways embankment (Case A), use of timber from more sustainable sources for design solutions (Case B), use of new materials for cement replacement, recycling by-products and development of "Waste Tracker" to quantify waste generated, recycled, reused or disposed of. (Case C). Case D (highways) provided an example of the use of a surfacing product, which was used on a South African project. Case E also developed "*Screwso"* which reduces the amount of spoil that comes up when a pile is dug and use a lot of replacement mixes including GGBS and PFA to reduce their cement content.
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4.5 Effects on Competitiveness and Profitability

Case A (consultant) as one of the major suppliers of oil and gas has experienced no effect in competing for work. They argued that they have filled a niche in this market and do foresee some competitive benefits. However, in other sectors where there are strong key players tendering, they have experienced some effects (Table 6).

Insert TABLE 6: EFFECTS ON COMPETITIVENESS AND PROFITABILITY

Case B reported that the change in their level of competitiveness was project specific. They argued that in sectors such as highways where the clients (Highways Agency) are more sophisticated compared to the retail sector the requirements are different and thus will have to show more commitment at tender stage. Case C reported an effect on their level of competitiveness in all sectors, because of the increasing demand to construct more sustainably from all sectors. Case D experienced no effects in both their highways and rail sector business whilst case E only noted a minimal effect.

The ICE (2009) stated that the active management of sustainability performance can deliver significant improvements in business, efficiency and profitability (ICE, 2009).However, some organisations (Case A, B and C) found it difficult to quantify the impact of such changes in their profits at the organisational level but argued that any change positive or negative in profitability was more project specific. Case D experienced no change in their profitability in both their rail and highways divisions. Case E had taken no steps to quantify the effects on profitability at a project or organisational level. The direct impact of sustainability for construction organisations would be in the form of increased cost or savings due to changes in processes, procedures and methods in complying with sustainability strategy. For example, Case A has implemented a multi-phase pumping for oil, gas and water from an Abu Dhabi project. The usual process for pumping involves separating the oil, gas and water, pumping the oil and water and compressing the gas, which involves the use of three different pieces of equipment (a separator, two pumps and a compressor). With multi-phase pumping however, one piece of equipment is used which carries out all the processes. Using this method of pumping rather than the traditional method provided savings in their capital and manufacturing costs. These savings can be aggregated for each type of innovation and assessed at the project level, which can directly improve profitability.

5. Concluding Remarks

There are several key findings. First, main contractors, higher up in the construction supply chain need to demonstrate their commitment to sustainability during the tender and bidding stages more than those in lower part of the supply chain. Subcontractors in the lower end of the supply chain do not necessarily have to demonstrate the same level of commitment unless they are involved in major projects where sustainability is top of the client's agenda. Second, whilst sustainability is deemed important there are still questions about the level of awareness in the construction industry. Requirements for sustainability set out in BREEAM was the most common source for increasing awareness. Action on sustainable development should be taken or required at the tender stages, especially when bidding for work with public sector clients. Third, as a result of the pressure of sustainability, some organisations adopted new processes in the tender phase resulting in changes in design, construction and different types of process, design and product innovation. The innovative ideas were not limited to UK projects as there were examples of innovation adopted for international projects. Specific examples included innovative ideas to reduce their waste, energy consumption and carbon footprint. In many instances such innovative ideas have had a direct positive impact on competitiveness and/or savings due to a reduction in for example, the higher fees associated with waste disposal at landfills.

Whilst there were obvious examples of how innovations can lead to savings in the cost of processes, design and products, the level of profitability from innovation at a project or organisational level have not been assessed. Sustainability is more than just complying with legislative or planning requirements requirement but provides the opportunity for increased innovation, competitiveness, and more significantly, profitability which can be quantified to strengthen an organisation's market position. For an organisation to effectively manage sustainability, a specific department, dedicated team and resources are required with clear leadership and authority. A quality driven agenda allows for easier quantification of the benefits and savings resulting directly from innovation. Monitoring of sustainability progress is also crucial to identify areas for innovation to facilitate continuous improvement in design and construction processes. Construction firms should seek to adopt sustainability, increase awareness, and develop a strategy as it can have a positive effect on innovation in processes, design and products and their level of competitiveness and profitability.

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TABLE 2: SUSTAINABILITY STRATEGY

	Case Study A	Case Study B	Case Study C	Case Study D	Case Study E
Organizational ethos towards sustainable development	Committed to promoting a strong culture of corporate sustainability through their values, practices and projects	Sustainability has always been a key part of what the organization does and is driven by different departments and committees	Sustainability within the organizations is dependent on who is responsible for the long-term cost of operating asset. If they are building and operating, they are happy to invest upfront to gain long term savings	highways division is driven by being "Environmentally Responsible in all activities" rail division's commitment stemmed from, requirements set out in Section 61 documentation but if there is no profit involved then there is no point in doing it	Important – seeking to gai better understanding
Corporate Strategy and Department Responsible	Integrated into company's culture through QES (Quality, Environmental and Safety) teams	Managed by a specific department (Corporate Responsibility (CR) department/ team) for reporting and e collation of data on sustainability, i.e. CR KPIs KPIs set by the highways agency.	Managed by specific department with belief that there is no point in pricing something in if Client is not willing to pay Central Corporate Responsibility (CR) cross functional team of Champions ensures that sustainability is intertwined in the business	Highways -Integrated into company's culture, focus on management of their carbon footprint through energy, fuel and waste projects to deliver their strategic aims Rail – no specific department that dealt with sustainability, as there was no budget. Highways - Not specified Rail – Environmental team	Implementation stage - rel new on the agenda, and as they are now in the proces developing their strategy f Also seeking to gain a bett understanding of what eac within the sector requires i of sustainability Developed a sustainability statement as part of their management strategy
Members in team	QES split into various management units with representative for each division	15 to 20 (from across different sectors of the business)	- thousands directly involved in sustainability strategy - champions within each business unit meet regularly with Central Sustainability team to discuss action plans	10 people in highways division whose main focus is sustainable development with resources and budget	Consists of 10 key people an additional 5 in the perip
Leadership	Leaders of various management units from different sectors of the business consisting of 200-300 people	Two corporate responsibility managers specially appointed and one is a member of the Executive Board.	Project Leader reports to the Director responsible for sustainability, supported by the team of CR Champions from functions and business units - HSE Director - Procurement Director, HR Director - Design Management teams Environmental and Community Managers etc.	Not specified	Currently being managed t the environmental departm

TABLE 3: KEY DRIVERS OF SUSTAINABLE DEVELOPMENT

	Case Study A	**Case Study B**	**Case Study C**	**Case Study D**	**Case Study E**
Key Drivers	Driven by the "if it can be done, then it would be attitude" not only on local but international projects as well Always seeking new ways to do things but believes that innovation is difficult in traditional sectors Profit and increasing competitive advantage are key factors	Recognizes the need for climate change and reduction in carbon footprint Increased innovation from sustainable development e.g. innovation on health and safety has increased significantly. The SHE newsletter highlights innovations at project level. Profit and increasing competitive advantage are key factors as they see a direct link between innovation and competitiveness	Increased innovation as a result of pressure from sustainable development Profit – investments in upfront to gain long-term savings. Profit is therefore a key factor	Different drivers. For Rail its profit and for Highways its environmental responsibilities In Highways, there is increased innovation from sustainable development but none in Rail. "Innovation Scheme" Introduced to stimulate and encourage innovation or improvement of ideas by providing an approach that ensures proper examination, approval, recognition and award Profit is a key factor	Client requirements Major drive to increase inno As piling contractors their bi spend is on concrete and stee constantly looking for ways reduce cost and improve effi Profit is therefore a key fact Monetary prizes are awarded employees who come up wit ideas, which consist of its of well as site based, so if some comes up with an idea as sin printing on both sides of a pa would be awarded.
Awareness of tools, reports, legislative instruments and implementation	Aware of Bruntland Report and BREEAM adopted on all projects to improve design and management process	Adopted BREEAM on some building projects and signed up to voluntary requirements of CEEQA (Civil Engineering Environmental Quality Assessment) - specific to rail and road projects Client's approach differs greatly. For example highways - highways agency would expect greater resources, reports on waste KPIs every month and energy consumptions KPIs, and they also look at carbon accounting	Adopted BREEAM and often build to its requirements. However, the Project Leader believes the system does not always encourage most sustainable solution. For example, a contractor does not receive BREEAM credits for cement replacement in concrete.	Highways - Aware of BREEAM but has not specified Sustainable development implemented in all highway projects Rail – none	Limited knowledge of BREE and its requirements. Felt BREEAM is not very clear a which requirements are statu and voluntary Main contribution to the environmental aspect of sustainability at the moment adhering to all the requireme their Section 61 documentati

TABLE 4: EFFECTS ON PROCESSES

	Case Study A	**Case Study B**	**Case Study C**	**Case Study D**	**Case Study E**
Procedures and Methods	Change is influenced by client requirements when tendering for projects but difficult to achieve in sectors such as oil and gas Generally seek solutions that will not have an adverse impact on natural environment e.g. rely on local manufacturing and locally sourced materials rather than importing.	Experienced change when tendering - more questions asked on sustainability and how it is dealt with in project Changes in their design / construction methods. Required to check credentials at the design stage using BREEAM Use of local labour is a now a mandatory requirement on all international projects. Projects employ a percentage of local labour	Change their methods and procedures for tendering, particularly for public sector clients to meet government targets Design / construction methods have also been affected. Product selection to drive down long term energy costs, locally sourced materials to reduce transport miles and costs Procurement team working with suppliers to reduce packaging delivered to sites, buy-back unused materials, support local business etc.	Promote sustainable solutions where specification and client approval has allowed it Highways – no changes required as it has always been part of culture for the highway sector Rail – changes introduced based on client requirements at tender stage	Currently have not changed methods but will in future de on clients' requirements. No requirements for sustainabili increasing. All offices are video linked a meetings are carried out via videoconference, which redu transportation costs, and mal more efficient because they to travel long distances. Changed their design / const methods mainly in the procu section and on site in terms waste disposal methods.

TABLE 5: NATURE AND EXAMPLES OF PROCESS, PRODUCT AND DESIGN INNOVATION

	Case Study A	Case Study B	Case Study C	Case Study D	Case Study E
Process Innovation	Seek to implement BREEAM in business processes Key processes introduced focusing on - Minimization of power and maximization of their products, - Minimizing pollution to the local environment and emissions (oil and gas engineering)	Key account plans introduced and appointed specific key managers to manage this process. - Changes in downstream supply chain management - PPA (project performance assessment) on projects. Audit carried out by business systems - Sustainability KPIs. Introduced new site waste management process and plans to cut landfill waste, encourage recycling aggregate and recycling on site.	Changed management processes to incorporate sustainability. E.g. there is a system called "Waste Tracker" to quantify waste generated, recycled, reused or disposed of. Introduced new business code of conduct and supplier code. Changed business process - each business unit and business function has an action plan. Introduced effective downstream supply chain management Lean construction techniques (Design for Manufacture (DfMa), offsite construction, local sourcing of materials and resources and waste management	Highways introduced new process for management of carbon footprint through energy Rail – None	Use a lot of replacement mix including GGBS and PFA t reduce there cementitious co Concrete and steel represent of their material spend, and a limited in their use of timber plastic products. They are constantly looking at ways th save on concrete. If they can the concrete volume by 20% still have it carry the same lo then, it's more feasible to do well as it would save on 20% material taken out of the gro Developed *Screwso*, which r the amount of spoil that com when a pile is dug. Introduce CSM, which is better known remix soil to reduce a wall.
Product and Design Innovation	Use of polystyrene instead of piling in hard stone for constructing railways embankment. Polystyrene able to take the same loading as piles	Use renewable energy as part of their energy mix for a School project. Use of timber from more FSC and sustainable sources for design solutions Use of natural ventilation instead of air condition units. Taking a more in depth look at the design stage to show whole life costing	Use new materials for cement replacement, recycling by-products. Pre-manufactured units, use of recycled materials, Carbon Management DfMa, Specification of sustainable materials, Design out waste, Reduce, Reuse and Recycle	Rail – not specified Highways – not specified	None specified
Innovation influence from international projects	Yes. Innovations highlighted in company newsletter. Use multi-phase pumping, adopted from an Abu Dhabi project	None	No influenced known	Highways –Yes, Use of surfacing product, adopted from project in South Africa Rail – no	Yes nut no examples given

TABLE 6: EFFECTS ON COMPETITIVENESS AND PROFITABILITY

	Case Study A	**Case Study B**	**Case Study C**	**Case Study D**	**Case Study E**
Competitiveness	No effect in niche markets/ sectors (e.g. oil and gas) Experienced more competition at tender stage in other sectors such as rail and building projects	Change in competitiveness is sector specific	Change affected all sectors and their competitiveness when tendering. They believe that it can provide a competitive advantage where it can be demonstrated in their offering clients	Experienced no change in level of competitiveness, as they have always had sustainability at the heart of their business. Believe that effects on competitiveness would be different for each sector. Highways and Rail not affected	Minimum effect. Noticed a s difference in their level of competitiveness and wasn't report any noticeable effects believe that the level of competitiveness in each sect different and they are curren involved with innovations to and improve their sustainabi although predominantly the innovations are mainly there increase their profit margin r than improve sustainability.
Impact on Profitability	Not affected at organizational level, benefits are more project specific	Difficult to quantify at organizational level. Profitability is more project specific. For example, in a demolished building - able to use / recycle materials on site saving on lorry journeys and material costs	Not quantified at organizational level Sustainable development affects short-term profitability but it is for ÷long-term gain. Profit margin is the same for a construct only project as they build what is specified and charge a percentage on top of the costs. It is only when they go onto operating a building or asset that they see the payback on investment.	Profitability for each sector is different and it is believed that sustainable development has affected their profitability due to improved management of their carbon emissions, Highways - Not affected Rail – not affected	Has not been quantified but an impact on their profitabili although very small. For exa they have not seen paramoun benefits as winning a job bec they were showing commitm sustainability. The difference in profit le each sector has not been qu to date, but the Project Ma convinced that it would exi particularly in the housing where there are requireme builders to produce more e and carbon neutral properties