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Citation:

LOWE, Jack and WATTS, Norman (2011). An evaluation of a Breeam case study project. Sheffield Hallam University Built Environment Research Transactions, 3 (1), 42-53. [Article]

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AN EVALUATION OF A BREEAM CASE STUDY PROJECT

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ABSTRACT

The purpose of this paper is to ascertain though a case study, the financial benefits in a Building Research Establishment Environmental Assessment Method (BREEAM) healthcare construction project. It uses a mixed primary data collection methodology through a case study approach. The aim is to provide a discussion on BREEAM: Healthcare and its application with regards to the credit scoring scheme and to analyse the financial benefits of implementing BREEAM on a construction project.

Keywords: BREEAM, Health Care, Construction Projects.

INTRODUCTION

The Construction Industry's contribution to climate change and resource depletion presents two of the greatest challenges facing building professionals today' (Dye and McEvoy, 2008).
To reduce the negative effect imposed by the Construction Industry on the environment the most common and widely used Environmental Assessment Tool in the UK is BREEAM (Building Research Establishment Environmental Assessment Method).
This paper investigates BREEAM and its application in the Construction Industry through the means of primary and secondary data collection methods, consisting of a case study, interviews, questionnaire and review of the existing information.

IMPLEMENTATION OF A BREEAM SCHEME

BRE Group (2010, p8) states that the main aims of BREEAM are *'...to mitigate the impacts of buildings on the environment; to enable buildings to be recognised according to their environmental benefits; to provide a credible, environmental label for buildings; [and finally] to stimulate demand for sustainable buildings.'*
The BREEAM assessment of a project is carried out by a licensed independent assessor, who is usually involved throughout the development and carries out a final assessment of the project, ultimately giving the building a final BREEAM score and rating.

A summary of the BREEAM assessment process carried out by the assessor is shown in Figure 1 provided by Grace and MacFayden (2006). Once the scores for each category have been finalised they will be combined to give an overall rating. This is done by applying the BREEAM environmental weightings shown in figure 2, provided by BRE Group (2010, p27). To assist the BREEAM assessors 'BREEAM Scheme Documents' are implemented. These technical guidance documents are created for specific building types and contain information that is used to aid the assessor in their duties (BRE Group, 2010, p12).

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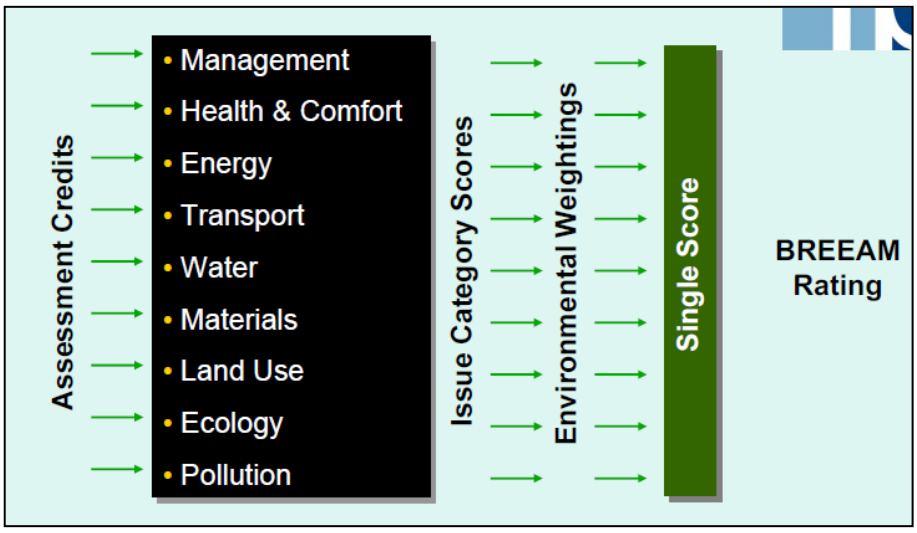

Figure 1: Process of BREEAM Rating Calculation (Grace and MacFayden, 2006)

BREEAM Section	Weighting (%)	
	New builds, extensions & major refurbishments	Building fit-out only (where applicable to scheme)
Management	12	13
Health & Wellbeing	15	17
Energy	19	21
Transport	8	9
Water	6	7
Materials	12.5	14
Waste	7.5	8
Land Use & Ecology	10	N/A
Pollution	10	11
Innovation	10	10

Figure 2: BREEAM Environmental Weighting (BRE Group, 2010, p27)

Advantages	Disadvantages
Robust	Complicated
Detailed	Inflexible
Well Known	Poorly Understood
Easy to Specify	Often Poorly Specified
Independent	Extra Cost
Tailored to each building type	Comparing apples and pears?

Table 1: Advantages and Disadvantages of BREEAM (Grace and MacFayden 2006)

Benefits of BREEAM

BREEAM can be used in a number of ways across various professions ranging from clients, developers and design teams and all the way to the building managers (BREEAM, 2010). All operations aim to

help achieve a sustainable building that is friendly to the environment. Grace and MacFayden (2006) show advantages and disadvantages of BREEAM summarised in Table 1.

There are indirect benefits of BREEAM as described in research carried out by Holmes and Hudson (2001, p68) found that *'...one of the important indirect effects of assessments [in this case BREEAM] has been the encouragement of teamwork and dialogue between various sectors in the building industry.'*
There is a debate surrounding the cost effectiveness of the implementation of BREEAM. Case study research carried out by Holmes and Hudson (2001) found that the building costs would increase by 1% in order to obtain an 'excellent' BREEAM rating, contradicting previous research by others.
Cartlidge (2006) comments that 'it is commonly assumed that consideration of sustainable issues will rack up building costs, but this may not necessarily be the case' this view is reaffirmed by Cyril Sweett (2005, p1) who states *'...that significant improvements in building sustainability performance can be achieved at very little additional cost.'*
In contrast NAO (2007, p12) shows that *'...even though the BREEAM assessment process is not in itself expensive (except as a proportion of the costs of very small projects), the cost premium associated with designing a building to achieve a BREEAM rating can be prohibitive.'*
The associated costs are increased due to the introduction of green building materials '...which often cost substantially more than the materials they replace' (Kibert, 2008, p12). There are however, ways of achieving BREEAM credits without introducing costly green building materials (NAO 2007, p12).
BREEAM is becoming the most implemented environmental assessment tool in the UK.

RESEARCH METHODOLOGY AND DATA COLLECTION

CASE STUDY METHOD

Woodside (2010, p1) describes case study research as '...an inquiry that focuses on describing, understanding, predicting, and/or controlling the individual) i.e., process, animal, person, household, organization, group, industry, culture, or nationality).' The study involved the investigation of a construction project in Driffield of a Primary Care Centre.
The use of a case study was advantageous to the research project as it offered an in-depth view, provided a clearer insight and enabled the researcher to obtain primary data.
The qualitative data provided draws on 'individuals' experiences of events, processes and systems' (McMillan & Weyers , 2010 p127) The interview questions were open which meant that the primary data collected was opinion based.

QUESTIONNAIRES

To gather a professional opinion on BREEAM and its application in the construction industry the researcher conducted a questionnaire and distributed it amongst members of the construction industry working within various professions. Further, it was felt to be the most efficient way to gain a wide spectrum of information.
A 5-point Likert scale was utilised and worded response categories used as it made it easier for respondents to clearly establish their opinions, distributed via Google Docs. The questionnaire link was e-mailed to all participants.

DATA RESULTS AND ANALYSIS

A total of 45 questionnaires were distributed, from the distribution there were n=20 responses, representing a 44% response rate. Table 2 shows the responses from the various professions. All of the respondents were anonymous, to protect their interests. The results were analysed using mean descriptive statistics including the calculation of mean and standard deviation.

Respondent's Roles	Number of Responses	% of Responses	Cumulative Responses
Quantity Surveyor / Assistant Quantity Surveyor	13	65.00%	65.00%
Construction Manager / Site Manager	3	15.00%	80.00%
Engineer / Assistant Engineer	1	5.00%	85.00%
Estimator / Buyers	2	10.00%	95.00%
Architect		0.00%	95.00%
Other	1	5.00%	100.00%
Total	20	100.00%	

Table 2: Questionnaire Responses

The case study project

The focus of the case study was a two storey medical centre development (See Figure 3). With a foot print of 680m^2 and a gross internal floor area of 1377m^2, the development involved the demolishment of unutilised buildings to facilitate the proposed development.

Figure 3: Two Storey Medical Centre - Driffield

The development was designed to fit within the foot print of the previous building so as to '...maintain the characteristics of the conservation area and therefore the general foot print, mass and height of proposals replace existing structures that require demolition to facilitate this development'(HDP, 2009, p11). The new Primary Care Centre is based on East Gate North Road in Driffield and accommodates a GP surgery facilities to serve the general community.

BREEAM RATING OF THE CASE STUDY PROJECT

The case study project had to be BREEAM rated excellent so it was necessary for a licensed BREEAM assessor to be employed to carry out a BREEAM assessment to ascertain where the credits were achieved and what needed to be improved upon to achieve the credits needed to attain the Excellent rating. Table 3 shows a summary of the credits that were available and the credits that were achieved along with the overall rating that was achieved.

Section	Credits Available	Credits Achieved	Weighted Section Score
Management	18	17	11.33
Health & Wellbeing	17	13	11.47
Energy	26	17	12.42
Transport	13	10	6.15
Water	9	9	6.00
Materials	15	10	8.33
Waste	6	5	6.25
Land use and Ecology	10	5	5.00
Pollution	12	8	6.67
Total	**126**	**94**	**73.63**

	Credits Available	Achieved Credits
Total Credits	126	94
Weighted Score	73.63	
Rating	Excellent	

Table 3: Summary of BREEAM Credits Breakdown & Overall Rating

CASE STUDY INTERVIEWS

Interviews were based on the case study project and its relation to the BREEAM scheme. Opinions on the following subjects were sought:

- Green Materials,
- Construction Programme,
- Construction Costs,
- Quick Win BREEAM credits,
- Overall Opinion of BREEAM

THE USE OF GREEN MATERIALS

Kibert (2008) notes that there are increased costs associated with the introduction of green materials to construction project. In a similar study, Holmes & Hudson (2001, p72) reaffirms this view. Did the use of green materials, (Materials rated A), have any effect on the build of the Medical Centre?
To achieve the BREEAM Healthcare 2008 credit waste2 there had to be the use of recycled materials on the project in excess of 25% of the total material use. Using the recycled hardcore resulted in 1 BREEAM credit being awarded, according to Hare (2011) there was no effect on the quality of that build. The material used on the case study project was sourced over 70 miles away from the project, in total there was 720 tonnes of 6F2 (recycled crushed brick / concrete hardcore) used, which equates to 36 wagon loads. There is an inherent difficulty in sourcing materials to meet the BREEAM constraints' Further, the introduction of green materials resulted in a negative impact on the construction programme due to long lead-in times for materials which where a requirement of BREEAM. The green

materials resulted in increased costs an example would be the type of insulation used (Celotex) which is considerably more expensive than the traditional insulation available.

THE CONSTRUCTION PROGRAMME

One of the effects of the use of Green Materials Rated 'A' was an increased construction programme mainly due to M&E installations, in particular the Heat Recovery System and Solar Photo Voltaic Cells.
The Solar Photo Voltaic Cells a roof mounted system used to provide the power for low and zero carbon technologies achieved the BREEAM Ene5 credit, installed at a cost of £18,135.00.
Squrbo Xbox Horizontal Ecosmart Heat Recovery System installed to recover energy from the exhaust air system (Fig. 4) at a cost of £54,250. The system had a long lead-in time resulting in a detrimental impact on the construction programme.

Figure 4: Squrbo Xbox Horizontal Ecosmart Heat Recovery Unit, Nuaire (2010)

It was found that the introduction of BREEAM did have an effect on the construction programme, but according to Jackson (2011) who stated that 'these effects can be limited or even reduced' However, some of the subcontractors did face a steep learning curve, but did eventually overcome the problems they faced and were able to complete their works, has observed by Hare (2011)

CONSTRUCTION COSTS

Holmes & Hudson (2001) found that the introduction of BREEAM results in increased construction costs. To attain a BREEAM Material6 credit specialist insulation had to be used which offered the same thermal values as other insulations but had lower embodied energy this came with an increased cost. Table 4 shows the comparison between a typical insulation and the low embodied energy insulation.
Table 4 further shows that the insulation with the low embodied energy provides the same thermal conductivity as the insulation with the higher embodied energy but costs 43% more. Despite the extra cost of the insulation it was utilised as it was a requirement of the specification to achieve Materal6 (Insulation) credit.
To achieve other credits there was a requirement to carry out surveys on the existing site and the new development. The surveys consisted of a BREEAM assessment, Thermal Model, Ecology Report and Acoustic report & testing. All of the reports came with a consultancy cost which added to the overall construction costs.
The introduction of BREEAM to the case study project resulted in an increased construction programme which according to Meredith (2011) does have effect on the construction costs as the running costs are increased, an example would be site preliminaries.

Insulation Type	Embodied Energy	Thermal Conductivity (W/mK)	£/m2	Qty in BofQ (m2)	Total Cost	Cost Difference
*Knauf Earthwool Loft Roll 44	Low	0.044	£4.60	445	£2,047.00	£1,161.45
**Superglass Multi Roll 44	High	0.044	£1.99	445	£885.55	

**Costs / Information as per Driffield Medical Centre B of Q (2010)*

***Costs / Information as per www.tradingdepot.co.uk (2011)*

Table 4: Roof Insulation Comparison

QUICK WIN CREDITS

Quick win BREEAM credits are credits that are relatively easy to achieve. Interviewees were asked if any 'quick win' BREEAM credits were achieved on the case study project.
The responses show that 'quick win' credits were achieved and that actions required to achieve them were relatively easy to implement. For example, the requirement to carry out surveys (Acoustic, Air Test, Ecology etc) are classed as quick wins.
Meredith (2011) showed that acoustic tests before and after the development was relatively easy to implement, carrying out the survey gained the BREEAM Pollution8 credit and has little impact upon on the programme.
To achieve the BREEAM Transport3 credit there was the requirement to install a cycle shelter, figure 5, installed at a cost of £2,833.00.

Figure 5: Circo Cycle Shelter, JJM Building Supplies (2011)

However, the cycle shelter was oversized for the case study project. Designed to house 16 bicycles, based on the number of people occupying the completed development, this ratio is stipulated by BREEAM.
Hare (2011) believed that a cycle shelter half the size of the one installed would have sufficed. This demonstrates one area of BREEAM that has no benefit to the client as a cost is outlaid for something that will not be fully utilised by the occupants.
Other quick wins include bird & bat boxes (Scarborough 2009, p8). The ecology survey carried out prior to the demolition of the existing buildings found that there were no bats or signs of use by bats were noted during the external inspection.'
Despite this result bat boxes were incorporated into the project as a stipulation of BREEAM. Although a BREEAM credit was achieved the incorporation of the bat boxes was not necessary or even utilised.

The introduction of a suitable landscaping scheme is a relatively easy method of attaining a BREEAM Material2 credit. The total cost of the landscaping scheme was £4,335.00.
A similar case study carried out by Holmes & Hudson (2001, p72) found that in relation to its BREEAM credits '...the redesign of landscaping to encourage bio-diversity was of minimal cost and was implemented.' In this scenario BREEAM was easily implemented and utilised.

SUMMARY OF THE INTERVIEW FINDINGS

- The process found that the introduction of BREEAM had an effect on the case study project in terms of the construction costs and programme. It was found that both were increased because of the introduction of BREEAM.
- The application of A-rated materials (green materials) did not have any effect on the quality of the build of the case study building, but it did however have an effect on the construction programme and construction costs.
- The introduction of environmentally friendly insulation offered the same thermal insulation qualities as that of traditional insulation but had increased the total cost of the roof insulation by 43%.
- The interview process found that due to the introduction of BREEAM the design of mechanical and electrical installations had a significant impact on the construction programme, Due to the required 'lead-in' times.
- Subcontractors faced a steep learning curve because of the introduction mechanical and electrical installations that had to be highly energy efficient as stipulated by BREEAM which resulted in longer installation periods and increased the construction programme.
- Increased construction costs due to the introduction of BREEAM. However, with the correct planning at tender stage allowances could be made, this reaffirms the findings of Sweett (2005, p1) that '...cost consultants, [estimators], can add a significant margin of as much as 10% to capital costs to allow for more sustainable solutions.'
- Quick win credits were relatively easy to implement, but not always necessary to meet the correct design criteria.

QUESTIONNAIRE RESULTS

Table 5 shows a summary of the responses gathered from the questionnaires.
The data collected has been analysed as previously discussed in this report and the mean responses along with the standard deviation are shown in figure 6.

- Based upon the findings of Kibert (2008) and NAO (2007) participants were asked whether the introduction of materials rated A in the Green Guide to Specification improved the quality of a new construction development. 55% agreed. The mean response value 3.30, with a STDev 0.91 showing that although 55% of the respondents agreed the mean score suggests that there was neither a positive or negative effect on the quality of construction development.
- Participants were asked to respond to the statement 'The use of BREEAM can result in a construction project having increased costs', the mean response value was 4.40, with a STDev of 1.02. The mean response showed that a large percentage of the respondents agreed, with 65% in strong agreement.
- Participants were asked to respond to the statement that quick wins do benefit the client and developer, the mean response value 3.35, with the STDev 1.06. It was the opinion of 55% of the participants that quick wins are beneficial.
- Participants were asked to respond to the statement 'The use of BREEAM can result in an increased construction programme', the mean response value3.35, with a STDev 1.15. It was the opinion of 55% of the participants that the construction programme was increased, reaffirming the interview findings.
- Research carried out by Holmes and Hudson (2001) suggested that an indirect effect of BREEAM was the encouragement of teamwork and dialogue between various sectors of projects. Opinions of the participants differed as it was found that the mean response was

2.75, with the STDev 1.18. Suggesting participants thought that there was no increased communication between different sectors.

- Participants were asked if BREEAM was robust and easily applied to any project. The mean response 3.00, with the STDev 0.95 was found to be inconclusive as the majority of the response was neutral.
- The participants of the questionnaire were asked to respond to the following statement: 'The introduction of BREEAM results in increased pre-contract design work.' This statement was created based on the findings made during the interview and thus participants' opinion was requested. It was found that 90% agreed. The mean response was 4.30, with the STDev 0.95.
- Research by Holmes & Hudson, (2001) found that the introduction of BREEAM results in increased construction costs. The questionnaire asked for the opinion of participants on BREEAM's value for money, this is considered a low percentage.
- The mean response was 2.50, with the STDev 1.02. The study found that 20% of the participants believed that BREEAM helped to provide the client with a building that was value for money.

	Number of Responses					
Statements	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**Total**
The use of materials rated A in the Green Guide to Specification as prescribed by BREEAM improves the quality of a new construction development.		11	5	3	1	20
The use of BREEAM can result in a construction project having increased costs.	13	4	2		1	20
Quick Win' credits on a BREEAM scoring scheme can benefit both the client and developer of a construction project.	1	11	4	3	1	20
The implementation of BREEAM results in an increased construction programme	3	8	3	5	1	20
BREEAM helps to provide the Client with a building that is value for money		4	6	6	4	20
BREEAM is robust and easily applied to any construction project	2	2	11	4	1	20
BREEAM helps to stimulate the demand for sustainable buildings		12	4	3	1	20
BREEAM helps to encourage teamwork and dialogue between various sectors in the construction industry		7	4	5	4	20
The introduction of BREEAM results in increased pre-contract design work	10	8	1		1	20

Table 5: Questionnaire Results

THE APPLICATION OF BREEAM RATING SCHEME

Hare (2011) explained that actual BREEAM rating will not be known until 6 months after its completion.

There is a growing acceptance that environmentally sustainable construction is where the construction industry is headed with BREEAM being the main driving force behind it. With time the true impact of greener construction will be evident in the future. The introduction of green buildings help to reduce the negative effect the construction industry has on the environment.

If the BREEAM 'excellent' rating is not achieved the case study project will not be given a completion certificate by the contract administrator, which will result in the main contractor not receiving their final payment and release of retention. So it will be in the main contractor's interest (the main contractor will have to go back to site and retrofit equipment) to achieve the excellent rating in order to receive final payment.

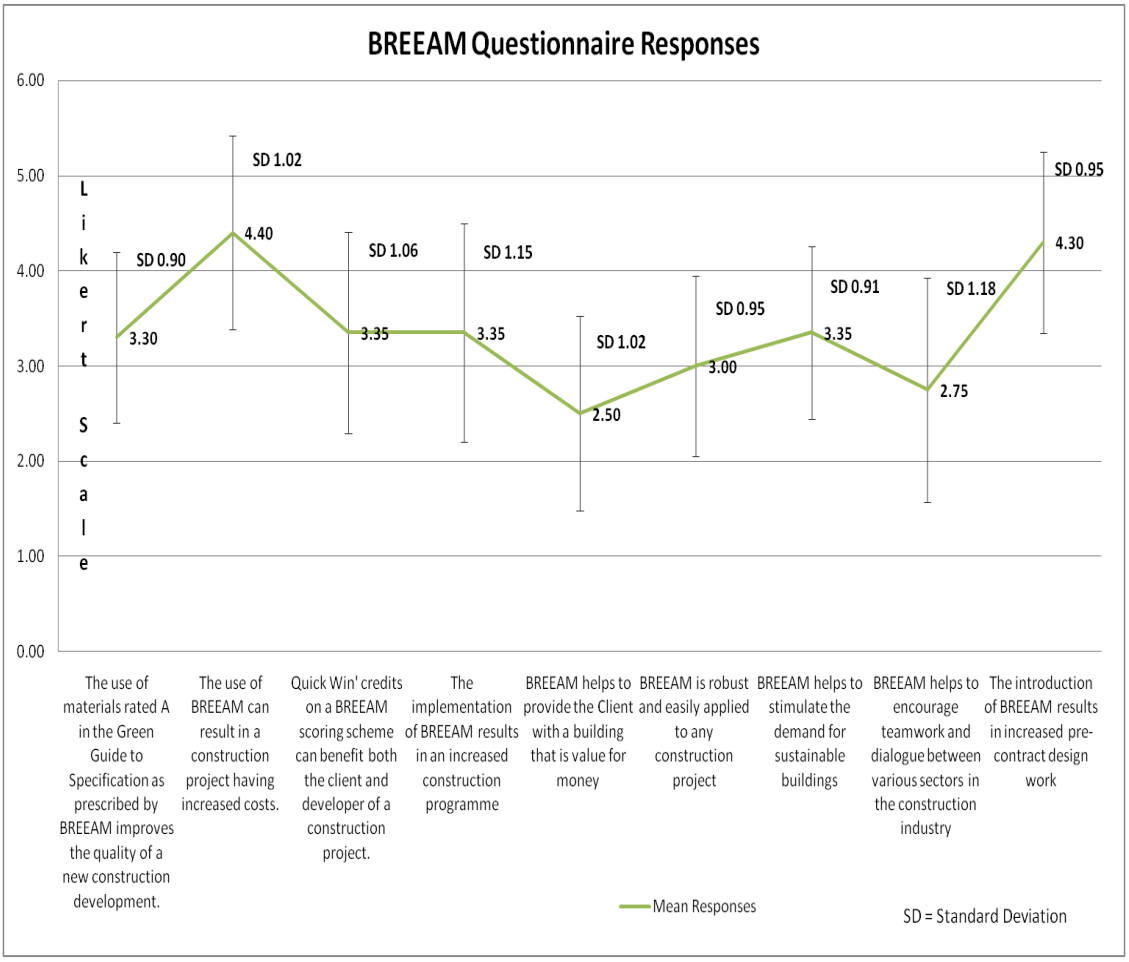

Figure 6: Mean Analysis of Questionnaire Responses

DISCUSSION AND CONCLUSION

The report discussed the findings researchers such as Kibert (2008) who believes that there are increased costs associated with the introduction of green materials to construction project. It was found that the construction costs were increased.

The primary data collected found that the introduction of green materials did not affect the quality of the case study project although Kibert (2008) explained that green materials can cost significantly more

than traditional materials, and NAO (2007) discusses that the BREEAM rating system is malleable, meaning that a rating can be achieved at minimum cost.
It was interesting to see that the introduction of green materials has a positive effect on the environment but has no affect on the quality of a construction development. There is however the negative impact on construction costs in that they are increased as proven by the findings made during the interview process and the findings of other researchers.
The report discussed the findings of Holmes & Hudson (2001) who found that the building service engineers found it difficult to source equipment required that was a requirement of BREEAM. The case study primary data showed that the application of mechanical & electrical installations had a negative impact on the construction programme due to long lead-in times.
Both the data collected from the interview process and the secondary data collection shows that the introduction of BREEAM on a construction development resulted in an increased work-load for the Mechanical & Electrical sub-contractors / engineers, with most of the work being in the design of the systems.
It was found that the introduction of BREEAM resulted in increased pre-contract design work, which corroborated with the both primary data collected and the secondary data collection.
One of the reasons for the increased pre-contract design work maybe due to the fact that the design and installation of the mechanical and electrical systems came under the energy section of BREEAM which has a high weighting percentage.
The increased construction costs was due to the introduction of BREEAM, but with the appropriate planning at tender stage allowances could be made for these costs which reaffirmed the findings of Sweett (2005) explaining that cost consultants / estimators could add an allowance to capital costs of up to 10% to allow for BREEAM related installations and solutions.
This report has discussed the case study research carried out by Holmes and Hudson (2001) who found that the building costs would increase by 1% in order to obtain an ‘excellent’ BREEAM rating, which was found to be contradictory to previous findings by others.
The findings of the interview process and secondary data collection show that the client will be provided with a building at an additional cost due to the introduction of BREEAM. The primary data collected reaffirmed this view.
The research by Holmes and Hudson (2001) found that an indirect effect of BREEAM was that it encouraged teamwork and dialogue between various sectors of the construction industry. The primary data showed that this was not truly accurate, as participants did not declare increased communication between varying sectors during the process to obtain BREEAM accreditation.
The research aim was to examine the BREEAM credit scheme with particular attention to credits which are so called 'Quick Wins' to ascertain the financial benefit to the Client. The questionnaire results found that the opinion of 55% of the participants that quick wins are beneficial, which was contradictory to the findings of the interviews.
The interview procedure found that quick wins were achieved on the case study project with an example being the incorporation of bat boxes. Although, it was found that there was no evidence to prove the presence of bats at the existing site of the case study project bat boxes were incorporated into the project as was a stipulation of BREEAM, this shows that the incorporation of the bat boxes was a unnecessary cost to the client.
The report further identified the research method used that to gather the information required and a literature review has been carried out to investigate BREEAM methodology.
An overview of BREEAM has shown how it is implemented in the Construction Industry in terms of the scoring and credit scheme. The advantages and disadvantages of BREEAM have been outlined, the robustness of scheme being the main advantage and cost being one of the potential disadvantages. Design and lead-in times of M&E services have to be adequately monitored in order to bring the project within budget and on time.
The report recognises that BREEAM has a very important standing in the Construction Industry and has a very positive effect on a building’s environmental impact. There are however associated costs of scheme implementation, highlighted through the primary data mixed-methodology through the means of a case study.
The primary data collected has shown that the introduction of BREEAM lead to an increased construction programme and increased construction costs. However the client takes ownership of a building which is environmentally friendly that costs more than a building that is not BREEAM rated.

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