ENGAGING CONSTRUCTION PROFESSIONALS IN A TWO STAGE TRAINING INITIATIVE TO IMPROVE KNOWLEDGE ON RENEWABLE ENERGY TECHNOLOGIES

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Abstract
Renewable Energy Technologies (RETs) have been identified as one of the possible solutions to the built environment's energy crisis. However, the construction industry to date has limited experience in the use of these new technologies and it is essential that the confidence of the industry is grown as regards the future routine incorporation of RETs in construction projects. Current training approaches used in the construction profession can act as a barrier towards delivering and receiving training. Traditionally, construction projects are often viewed as isolated silos of knowledge within contracting organisations. This makes training for non-trade specialist professionals limited to ad hoc tuition delivered by third party or specialist consultants which removes them from valuable construction project time and at considerable cost to the organisation. It is proposed that a new method of training should be implemented to improve industry knowledge and experience with RETs. Contractors need to be made aware of the advantages of RETs in the built environment. Construction projects involve multiple disciplines and individuals to collectively solve problems within a team environment. Therefore the management of these multidiscipline construction teams across the industry requires an increased level of knowledge in areas not previously associated with contractors.
The aim of this paper is to showcase a method of introducing RETs to an audience that is traditionally cautious when it comes to new technologies and difficult to train within a fragmented industry context. This paper reports on research undertaken within a major UK construction contractor to develop and implement a training package that blends engagement and education on the role of RETs in the construction industry and facilitate feedback on experiences within the organisation. The study shows the first phase of the new training initiative and the perceptions towards the use of RETs in the built environment. It presents the initial results of a training initiative that has been developed within a contracting organisation. The findings are likely to be of interest to designers and those involved in construction, sustainability, Renewable Energy Technologies (RETs), knowledge management, trainers and those involved with training construction professionals.

Keywords: Contractor, Training, Renewable Energy, Knowledge, UK

1. INTRODUCTION

The construction industry is notoriously slow to change existing practices (Egan 1998, Latham 1994 and Wolstenholme 2009) and as a result there is a need to provide training and support to a generation of construction professionals with limited experience of working with RETs in order to overcome organisational barriers. The construction industry accounts for 8% of the UK's GDP and employs directly and indirectly over 2 million people across 300,000 firms. For this reason, the government uses it as an economic regulator (BIS 2012). The industry relies on information and knowledge (Ribeiro 2009) which is often lacking within organisations due to the fragmented nature of what is essentially a project based industry, preventing the transfer of knowledge from one project to the other. Supporting construction professionals to contribute to the generation and dissemination of knowledge through a training initiative to enhance the effectiveness of the business is a challenge facing many organisations in the current economic climate (Obaide and Alshawi, 2005). It is widely accepted that knowledge can offer a competitive advantage (Matusik and Hill 1998, Vakola and Rezgui 2000, Tallman *et al* 2004). In order to achieve this transfer of knowledge, organisations have to take advantage of their most useful asset – People. The collective learning of a construction organisation suffers from limited knowledge sharing which is associated with a conservative culture and existing practices within construction companies. Ingrained practices and organisation barriers have been identified as a major barrier to innovative change (RfP report, 2000) which was further supported by the findings of Vakola and Rezgui (2000), Robinson *et al* (2005) on resistance to change.

Traditionally, the construction industry has been depicted as an industry that is mostly populated by skilled manual labour, is slow to innovate and produce poor quality end products to the disappointment of clients (Dainty *et al* 2002, Egan 1998, Latham 1994, Kululanga and McCaffer 2001, Wolstenholme 2009). It has since attempted to improve its reputation and its performance but not nearly enough as hoped (Wolstenholme 2009). Training within the construction industry has been well documented, from traditional apprentice on-the-job training which is still relevant for contractors but more prevalent in SMEs (Beaver and Hutchings 2005, Latham 1994) to part-time degree courses at universities. Site based construction projects utilise "toolbox talks" to disseminate essential information to the labour force to improve performance and comply with rules and regulations established by the principal contractor. Beaver and Hutchings (2005) identified that during heightened exposure to market pressures larger construction organisations have an advantage over small medium enterprises (SMEs) regarding the motivation and retention of human resources. The nature of construction projects does not facilitate cross knowledge sharing outside of the project environment. Abdel-Waham *et al* (2008) states that construction companies should actively address the "skills shortage" within the industry and deliver the required training for the workforce. Large contracting organisations have an opportunity to greatly improve professional's skills through new training methods.

2.0 LEARNING FROM PAST PROJECTS

Construction projects are rarely reviewed post-completion of the building. Contractors in particular fail to conduct adequate reviews of the end product and the process with a view to improve performance and learn from past experiences (Kululanga and Kuotcha 2008). The emphasis of regular team meetings throughout the building process is primarily focussed on the cost and timescale of the project. Contractors, in particular, appear to repeat the same problem on multiple projects despite procedures in place to avoid this. This could be related to the nature of the industry and to the variety and temporary nature of team relationships that develop to complete a project. At the end of a project, the team disperses within the organisation to form new teams on different projects. Failure to capture the lessons learnt on projects was identified by Vakola and Rezgui (2000) as a significant limitation of managing corporate knowledge.

Whilst designers specify products for new build construction projects, little knowledge on performance is relayed back to them by the end users or contractors. This further highlights the lack of continued learning, communication of information and knowledge management within organisations in the construction industry which was also identified by Robinson *et al* (2005). This is an important element overlooked on nearly all construction projects; the in-use performance of, and end-user satisfaction with, the built product.

Williams *et al* (2010a) highlighted the benefits for contractors of conducting post occupancy evaluation (POE) and included lessons learnt from failure and successful projects, and these can be quickly identified by the end-users of a building. This information can be used to benefit contractors, designers and future projects by identifying problematic areas and to prevent "reinventing the wheel" in each project. Foy (1994) identified that when employees are engaged through using their experiences to plan and make decisions, the whole organisation can benefit. Knowledge capture sessions can be used to engage with the contractor workforce when particular technologies, for example RETs are integrated during the construction phase. This will prevent the knowledge being lost due to inadequate record keeping processes within an organisation at the end of a project (Vakola and Rezgui 2000) whilst ensuring that employees perceive their input as a positive contribution for the organisation's learning. The use of POE data can also support the credibility of any future training initiatives.

3. METHODOLOGY

This research forms part of a wider research project on the integration of Renewable Energy Technologies in the built environment as part of an Engineering Doctorate programme in partnership with Loughborough University and the Engineering and Physical Sciences Research Council (EPSRC). The work presented is the first phase of the development and deployment of a larger research programme into RETs in construction undertaken between industry and academia. The research investigated the impact of a training initiative implemented within the sponsoring organisation. A case

study methodology was used to enable the researcher to gather detailed information on the implementation of the training initiative within a major UK contractor.
A pre-intervention structured survey was distributed to all site-based construction professionals (circa 500 people) to establish levels of knowledge on RETs and current practice regarding training and development within the sponsoring organisation. The most prevalent technologies identified were investigated further through a comprehensive literature review in order to provide background knowledge to each technology. Literature was cross-referenced to the sponsoring organisation's experience through interviews with key personnel, from senior project managers and building services managers to office-based business development managers. This was carried out in order to produce "handbooks" for each technology that could be circulated within the company (Williams *et al* 2010a) whilst identifying the current status of RET within a construction contractor organisation and highlight barriers to its potential penetration into the built environment.
The main findings from the review (Williams *et al* 2010b, Williams *et al* 2011) highlighted the need for training on RETs within contracting organisations. This enabled the authors to develop a practical training programme tailored specifically to the needs of a UK contracting organisation. By improving the quality of training available to staff on RETs, the research could offer a real commercial benefit to a company in a time of economic uncertainty and pressure of increased competition through engaging with staff to aid organisational learning. Interviews with the pilot study group were conducted using best practice in addition to a post-intervention self-assessment survey to evaluate the impact of the training initiative within the organisation and were triangulated with existing literature on training.

4. CASE STUDY

BAM Construct UK Ltd (where the training package is being developed and implemented) is one of the largest contractors operating in the UK construction industry with an annual turnover of £1bn and is a key member of the United Kingdom Contractors Group (UKCG – Formerly the Major Contractors Group MCG). The company operates within an ever challenging construction market across the UK are in an uncertain economic climate. The underlying objective for implementing the training initiative within the sponsoring company was to enable efficient learning and knowledge dissemination. To deploy the initiative across multiple contractors would involve significant time requirements in the research programme, therefore it was decided that the pilot study would be limited to the sponsoring organisation, and hence act as a typical example.

4.1 FINDINGS FROM THE PRE-INTERVENTION SURVEY

Prior to implementing any training component, it was important that the research identifies the current state of the sponsoring organisation's operation regarding RETs and the sharing of knowledge. A structured questionnaire survey was distributed to construction professionals across the disciplines of design and construction. The response

rate was 44% (220) and was deemed acceptable and represented a cross section of different disciplines, as shown in Figure 1.

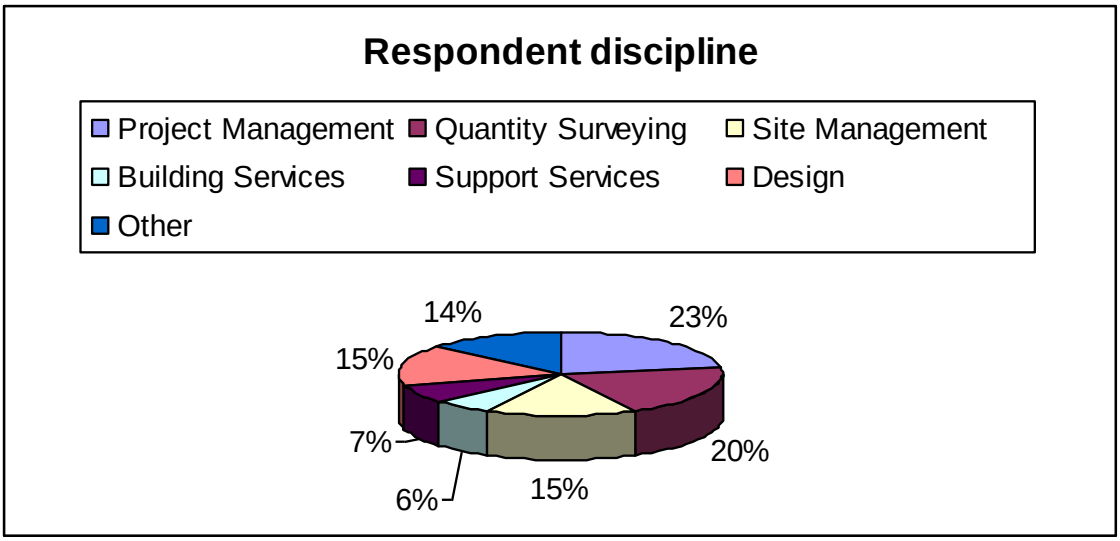

Figure 1. Respondent disciplines

The survey established the levels of training offered to the organisation's employees. An overwhelming 93.52% (n= 202) of respondents had not received any training on the use of RETs in the built environment. Of those that had received training (4.63%, n=10), this was within a University degree or external course not affiliated with a contractor, which further highlighted the need for structured training across all disciplines within the organisation.

The respondents were asked to identify how contractors can overcome barriers to the uptake of RETs in construction. The results are shown in Figure 2 and clearly identify training, learning from previous experience, reduced cost of technologies and increase knowledge sharing within the company as key elements. It was decided that the research conducted could potentially have an influence on internal barriers to RETs relating to contractors, and therefore training and knowledge share were targeted as an area for further research. Reducing the capital cost of RETs was outside the scope of this research project.

Regarding knowledge sharing practices within the organisation, it was important to establish the existing lines of communication. The organisation is formed from three separate business units within the UK: Design, Construction and Facilities Management (FM). The findings show minimal communication between business units and sectors within the organisation; this is of particular relevance to the FM unit which is responsible for operating buildings completed by the other two business units. The FM business unit has a wealth of experience regarding the operation of buildings and could share this knowledge to prevent future problems re-occurring; however the lines of communication are limited to a small fraction of the surveyed population, with over 80% (n= 149) having no contact with the FM business unit.

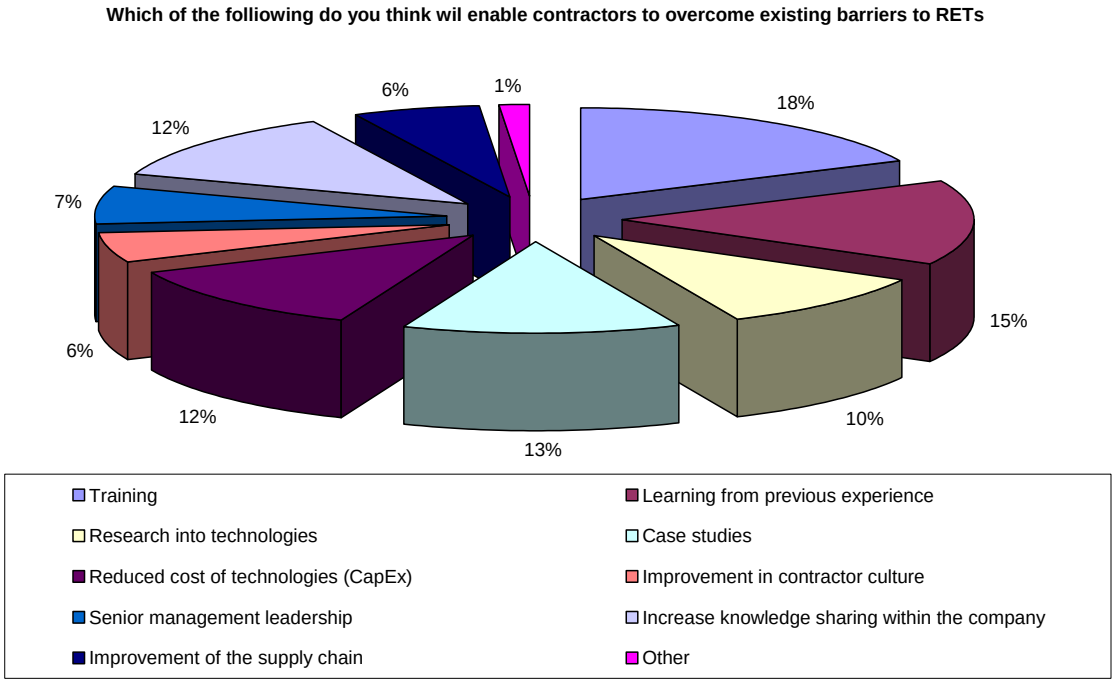

Figure 2 Overcoming existing barriers to RETs

The vast majority of respondents believed that knowledge share within the company would be beneficial. However, when the respondents were asked to indicate their level of interaction with other sectors or business units, the results showed a lack of communication. Only three participants said that knowledge share was "very good" within the company. It was expected that respondents based "on-site" would have less awareness of knowledge sharing systems within the company due to working in project-based environments compared to office workers. The results indicated that senior management (Project Managers) believe knowledge share was good within the company. Upon further questioning, it was discovered that project management have an increased opportunity to participate in knowledge share with colleagues during a bi-monthly management meeting.

5. DEVELOPMENT OF THE TRAINING MATERIAL

The results of the pre-intervention survey provided the benchmarks that will be used for comparison following a post-intervention survey to be completed by a sample group of trainees. The training initiative was developed with key stakeholders within the company, including Heads of departments in central support services through to site-based disciplines. Of the barriers identified by the participants, the only indicator within the scope of the organisation, and that guided the training initiative, is to provide construction professionals with further resources (including experience and guidance on innovative technologies (RETs) as little is currently available within the organisation) and to promote the exchange of knowledge. Egbu (2004) believes that "an organisation's

capacity to innovate depends to a very considerable extent upon the knowledge and expertise possessed by its staff". For example, contractors within the UK construction industry have moved from skilled labour and trade professionals to the management of the construction process. Contractors add value to the project and client through the management of the building process and through effective use of their collective knowledge and experience. Robinson *et al* (2005) states that larger construction organisations see knowledge management as a "contributory factor to business improvement" which further demonstrates the impact potential of research within the sponsoring company.

With the business shift to a service industry, changes occurred amongst the workforce. The O'Donnell *et al* (2008) review of previous literature shows the change to include:

- "A workplace that is more diverse culturally and in terms of gender
- Trade barriers and tariffs have reduced
- Competition and achieving through people
- Recognition that processes, techniques and designs from the past will not meet the challenges of the future."

All of the above indicators of change in the workplace highlight the need for a review of training methods within contracting organisations. Within the sponsoring company, the learning and development team have been involved with the development of the training material to be deployed nationwide to all construction professionals, totalling over 1000 employees. In order to gain 'buy-in' from employees, it was important that the corporate style was used to highlight that the research project was an integral part of the future business learning and development strategy of the company, and an important element of the e-learning and workshop training packages. This was to ensure that it could be fully integrated into the sponsoring organisation and would be viewed as being professional and credible amongst the targeted audience. Williams *et al* (2011) discussed the development of training material suitable for contractor employees.

5.1 RET HANDBOOK

As part of the on-going research by the author, a number of RET handbooks were previously produced and are discussed in Williams *et al* (2010; 2011). Existing literature and best practice were utilised to guide a structure and content for the handbooks that is familiar to construction professionals. The RET handbooks provided a number of benefits to the development of the training initiative. Firstly, they assisted the on-going objectives through identification of the most prevalent technologies within the sponsoring organisation, as well as providing information for on-going research into the barriers to RETs in the construction industry. Secondly, through data collection using in-depth POE case study projects, as well as interviews and focus groups with key personnel within the industry, it facilitated an informal cross-sector line of communication between projects using similar technologies. The handbooks were also made available through the e-learning training and were hyperlinked within the sponsoring company's intranet to enable dissemination into the wider organisation, and as a permanent reference resource for all employees if required.

5.2 THE E-LEARNING TOOL

The first stage of the training initiative involved the development of an online e-learning course. This course introduced the topic of RETs to be built upon in a one hour workshop event. The role of E-learning in construction organisations is currently under- researched; however, research within the Information Technology (IT) industry and academia offers an insight into deployment mechanisms. The authors utilised e-learning as a method for disseminating RET knowledge throughout the business, with a view to make it available to all employees as both a learning and development tool and as a reference guide. Welsh *et al* (2003) state that the technological advances will dramatically alter the training and development, in addition to identifying the following benefits of e-learning:

"1 Provide consistent, worldwide training
2 Reduce delivery cycle time
3 Increase learner convenience
4 Reduce information overload
5 Improve tracking
6 Lower expenses"

The e-learning training package comprises six modules each covering a number of RETs (Photovoltaics, Biomass Boilers, Solar Thermal, Ground Source Heat Pumps, Wind Turbines and Combined Heat and Power). The e-learning course requires the learners to complete all six modules and sub-modules within the RET training suite. There is no particular order in which the modules must be completed; however, to complete the training courses, all modules must be finished to receive a Continued Professional Development (CPD) certificate.

The target provision of the e-learning modules was not constrained by geographical and logistical issues and is therefore due to be deployed to 1500 construction professionals employed by the sponsoring company nationally across the UK with a pilot group of 30 individuals to test the usability and aesthetics of each module. DeRouin *et al* (2005) state that engagement with e-learning can be affected by high drop-out rates. A solution to overcome this is through customisation and personalisation of the e-learning experience.

Features of the e-learning tool include the following:

- Review questions at the end of a module and intermediate knowledge checks. The purpose of the questions is to support and focus the attention of the learners.
- Assessment sections whereby the individuals can obtain feedback, and identify areas of weakness. Examples are given to support the theoretical principals for each RET in the learning management system (LMS).
- Supporting information included case studies' RET handbooks, and Corporate Reports. The length of the e-learning module for each technology was limited to 20-30 minutes in order to maintain the concentration of the learner. Whilst it was not possible to include all the information associated with a technology in 30 minutes, additional supporting information was made available through the e-learning software and through hyperlinks to company based information.
- Enabling users to locate information relevant to RETs within the company.

5.2.1 INTERFACE DESIGN

As stated earlier in the paper, for the e-learning training to be viewed by the target audience as an integral, corporate component of the organisation, it had to incorporate the company's preferred style. Figure 3 shows the main menu screen for the RET training, with each of the six identified technology modules available. The e-learning modules used a combination of bullet points, visual images, "hot-spot" images and activities to ensure interaction with the users, hyperlinks to external information located on the company's intranet and a voice over to ensure all learning styles were recognised and accommodated.

Figure 3 Interface design for E-learning main screen

5.3 TRAINING/ KNOWLEDGE EXCHANGE WORKSHOP

As noted earlier in the paper, individuals within organisations are in general resistant to change, and thus their attitude to education and development within the organisation is likely to be no different. It was important to include a more traditional method of training in order to help overcome any such resistance from individuals; therefore, a face-to-face workshop was included in the training initiative. The purpose of the course was to further provide case study examples of RET installations based on the company's own experience. The workshops were designed to be delivered in a formal training session that construction professionals are familiar with, in order to gain 'buy-in' from site based employees and senior management.

The workshop facilitated knowledge share within the organisation and enabled cross-discipline dissemination of information and experiences, in addition to supporting the introduction of RETs. Attendees were invited to discuss and analyse the case study examples provided in the half-day training session. From the initial pilot study with a selected group of construction professionals through to full company roll out, the workshop offered a unique insight to issues that prevented RETs from being efficiently integrated within projects. The interaction between the researcher and the participants in the workshops also helped to refine the training material for future training sessions. The

sponsoring company's decision to include the RET training within a continuing training package on a wider topic of "sustainability" showed high level commitment to improving the company's performance regarding training and development which has been identified as key to the success of a training initiative.

6. DEPLOYMENT WITHIN THE COMPANY

From the initial stages of the research project through to developmental workshops and dissemination of practical experiences, these were fundamental to the effectiveness of the training initiative and were highlighted by the interviewees and focus groups as a key component to promote the technologies within the organisation. Real world POE case studies of RETs were incorporated into both the e-learning and workshop training sessions with data made available via the e-learning and intranet and through social media groups.

6.1 INITIAL POST-INTERVENTION FINDINGS

Initial results from the post-intervention survey distributed to the pilot study group shows a positive impact on perceptions towards RETs. Figure 4 shows the respondents' opinions on the content, graphics, voice-over, pace, flexibility, user-engagement and knowledge checks for the e-learning component of the training initiative. The majority of responses were in the categories 'very satisfied' – 'satisfied' with the overall e-learning. However, the voice-over on one module was highlighted as a potential area to improve upon. This has been addressed within the company and will be revised following the company's updating procedures for the LMS. Figure 5 show that 100% of respondents believe that the e-learning component has had a positive effect on their perceptions towards RETs. This is an encouraging finding from the initial review of the e-learning component. In addition to impact of the training initiative, 100% of respondents indicated that POE data improved the content of the training.

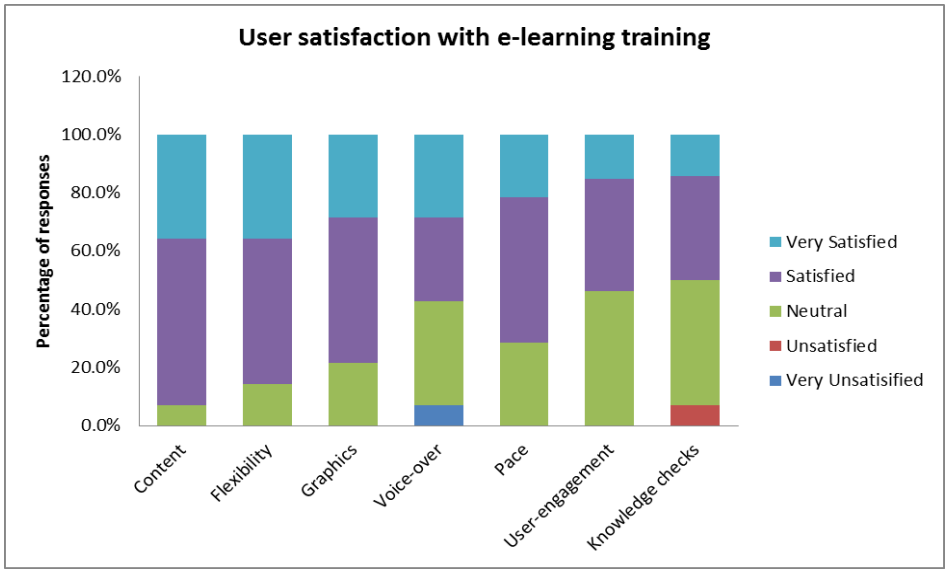

Figure 4 User satisfactions with e-learning training component

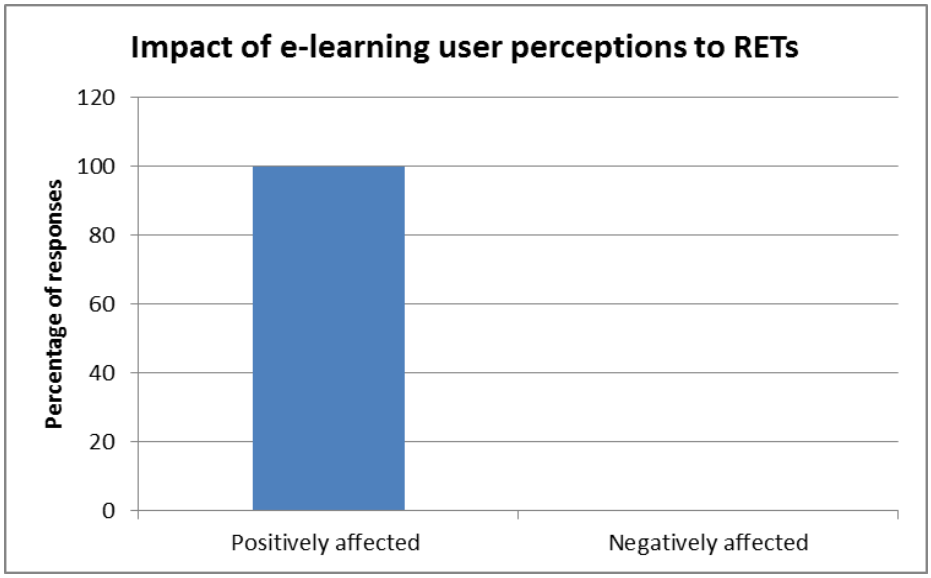

Figure 5 Impact on e-learning user perceptions to RETs

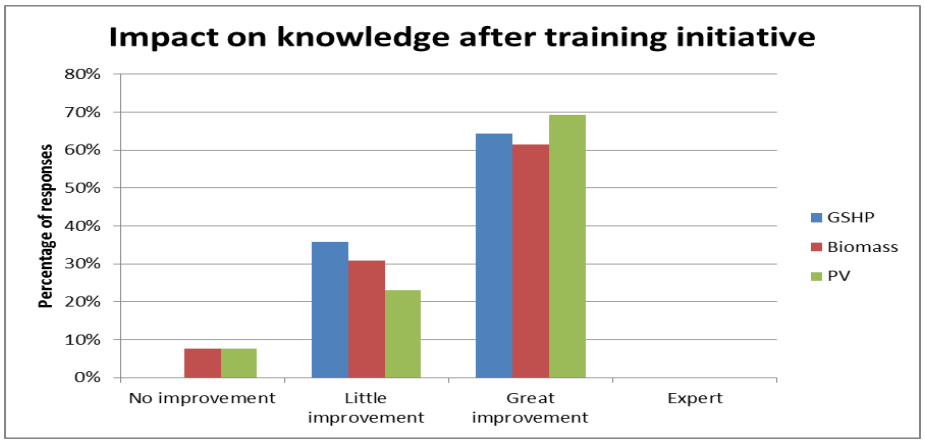

Figure 6. Impact on knowledge after training initiative

The respondents from the pilot study have shown that the training initiative has positively- impacted on their knowledge of RETs. The post-intervention survey with the pilot study allowed the participants to self-assess their own level of improvement. This was also supported through a set of randomised knowledge-check questions administered throughout the e-learning modules. Participants also completed an evaluation form upon completion of the CPD workshop and discuss their opinions on the training initiative. The findings indicate that the combination of e-learning and workshop events have increased respondent knowledge (figure 6) and have improved perceptions across a range of construction disciplines. The results suggest that the use of e-learning to disseminate organisational learning on a particular subject, in the form of concise modules, is of real benefit to organisations distributed across a large geographical area, as it overcomes multiple barriers towards delivering training.

7. BENEFITS

The benefits of the training initiative will be of interest to the wider industry (particularly contractors) as it tackles a key barrier to traditional methods and distance learning with the introduction of e-learning. The e-learning component offers a degree of flexibility to the training, facilitating engagement with the project-based construction professionals who need to complete continued professional development (CPD). Cross knowledge sharing between and within the separate business units had a secondary benefit to the research as it also encouraged participation in the training development, and offered useful company-specific ideas for future e-learning initiatives on other topics, including health and safety and environmental awareness.

The ability for users to leave and return to the e-learning module(s), the integration of attachments to more detailed background information, in addition to learning at a flexible pace and content has succeeded in disseminating information learnt from completed and "live" projects. The successful roll-out of the RET training package will encourage future training needs to be met through development of bespoke courses following the methodology conducted in this research project.

The long-term benefits associated with the training initiative will be to create a change in culture by promoting good experience within the organisation, critique case study projects and offer a medium for knowledge exchange within the company. This has been possible through the integration of Post-Occupancy Evaluation (POE) within the contracting organisation in order to capture valuable information and data on RETs. Furthermore, in order to create a continual learning cycle with real world benefit, the adoption of in-use building reviews will be critical to improve the knowledge of RETs during the occupation of a building.

8. LIMITATIONS

The authors acknowledge that the results of this paper are limited to a single case-study company; however, it is a typical UK contracting organisation and is one of the largest in the UK construction industry. However, the initial survey of 500 construction professionals across the UK identified a need for additional training and revealed a gap in knowledge within the organisation related to renewable energy technologies and knowledge sharing. The review of the e-learning component of the training initiative within the pilot study was limited by the software used to disseminate the training, which prevented access to the system by all employees. The company also required the pilot study to test the IT infrastructure of the organisation to ensure that it could manage a national roll-out for future e-learning modules. Due to this limitation it was not possible to complete a statistical paired t-test, as not all professionals have to date had access to the e-learning component on the training initiative. However, the focus groups with the pilot study group has initiated a change in perceptions to RETs and to knowledge share, and it is reasonable to assume that, with company-wide deployment, the training will have a positive effect on the culture within the contracting organisation.

9. CONCLUSIONS

This paper has presented the development and deployment of a training initiative into a leading UK construction contractor organisation through a combination of e-learning and interactive workshop sessions, aimed at improving perceptions towards RETs and knowledge share within the organisation.
The results of the initiative have all been positive from all participants, and have shown that the use of real world case studies is an effective method to engage with construction professionals. The integration of POE case study data within the training initiative was positively received by all participants in the workshop event, and by pilot study users of the e-learning software, and assisted in engaging with the trainees. Whilst information exists on the topic of e-learning, advances in IT and organisational learning there is little available on implementation of this type of initiative in a multi-national organisation operating in the UK construction industry.

Research into learning and teaching has highlighted the need for training to be engaging, fun, active and constructive in order for it to be successful. The e-learning and workshop sessions therefore built upon existing knowledge from employees within the organisation in order to achieve success in facilitating knowledge sharing and in increasing general knowledge on RETs.

The methodology adopted by this paper acknowledged that in order to affect a culture change within an organisation, it is necessary to overcome institutional barriers. These barriers were overcome through engaging with professionals during the development and knowledge capture sessions (site and office based) of the training initiative. It has highlighted the need for internal training on RETs but also identified underlying issues related to knowledge share and communication within the organisation. Despite the consensus that there is increased knowledge share and improvement since Latham (1994) and Egan (1998), this paper suggests that ingrained organisational barriers still need to be overcome to maximise efficiency within the industry. The developed training facilitated cross business unit knowledge sharing utilising POE case studies and in-situ construction experiences to fully engage with construction professionals. Culture change within construction organisations is a long-term process and is typically difficult within traditional industries like construction. Any attempt to initiate change is likely to be met at first with a degree of scepticism and cynicism; however, engaging all business units as part of the training initiative has shown the need for cross knowledge sharing to improve the organisation's delivery of projects. Construction projects utilise multiple actors during the building process and therefore any training must be engaging for a range of disciplines and available to both site and office based staff.

Additional comments obtained from interviews aimed at evaluating the research have identified that videos and streaming examples would improve the e-learning. There is scope for this to be included in a revised set of modules encompassing improvements that will be trialled before the national roll out of e-learning to the sponsoring organisation.

10. ACKNOWLEDGEMENTS

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