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Waste Management and Sustainability during the Design Phase of a Construction Project: A Qualitative Review

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Abstract: Waste management and sustainability are two core underlying philosophies that the construction sector must acknowledge and implement; however, this can prove difficult and time consuming. To this end, the aim of this paper is to examine waste management strategies and the possible benefits, advantages and disadvantages to their introduction and use, while also to examine any inter-relationship with sustainability, particularly at the design stage. The purpose of this paper is to gather, examine and review published works and investigate factors which influence economic decisions at the design phase of a construction project. In addressing this aim, a three tiered sequential research approach is adopted; in-depth literature review, interviews/focus groups and qualitative analysis. The resulting data is analyzed, discussed, with potential conclusions identified; paying particular attention to implications for practice within architectural firms. This research is of importance, particularly to the architectural sector, as it can add to the industry's understanding of the design process, while also considering the application and integration of waste management into the design procedure. Results indicate that the researched topic had many advantages but also had inherent disadvantages. It was found that the potential advantages outweighed disadvantages, but uptake within industry was still slow and that better promotion and their benefits to; sustainability, the environment, society and the industry were required.

Key words: Architectural design, qualitative methodology, sustainability, waste management.

1. Introduction

The concept of sustainability applied to development establishes a relationship between the natural environment's ability to support development, with social and economic challenges. Therefore an integrated methodology to design, construction, and operation is required. This can enhance; design quality, sustainability, build ability, materials management, reduce waste, reduce maintenance needs and consequently reduce whole-life costs. The purpose of this research is to; gather, examine and review published papers and investigate factors which influence economic decisions at the design phase of a construction project regardless of project size. This paper will concentrate on Waste Management Systems and Site Waste Management Plans (SWMP's). It will also examine through these topics, if sustainability is given consideration. The objectives of sustainable

design are to minimize pollution, reduce the consumption of natural resources, reduce energy during material production, construction and use [1]. It should also be with these ideals in mind to create a healthy comfortable space to work and live. Research and experience of the construction industry has shown that it is slow and resistant to change [2, 3].

The aim of this research is to investigate factors which influence economic decisions at the design phase of a construction project, with regard to the topics as discussed and present the findings as a cohesive logical argument. To achieve this aim the objective will be; to examine relevant literature from as wide a variety of sources as possible and undertake interviews. To see if there is any correlation between the results obtained from the; literature review, interviews/focus group. Investigate any links between the areas to be researched. To examine if the stated hypothesis confirmed or has to be restated. This

research is important because it can add to the industry's understanding of the design process and to its body of knowledge on the researched topics. It will also highlight reasons for the success or failure of a construction project, in terms of sustainability, at the design stage and to identify any areas in which gaps in our knowledge exist, bridge those gaps.

For sustainability to work effectively it should be considered as early as possible in a construction project and should be considered across all processes, from inception to handover but the current economic climate is detrimental to sustainability and while it may be considered the cost of inclusion will be too high and due to this and the lack of demand, will therefore be discarded. It is proposed that going "green" is now more about corporate image than any real concern about the environment or sustainability.

So that a comprehensive understanding of waste management is achieved it is necessary to undertake some investigative procedures. These included; an in-depth literature review, interviews/focus group and qualitative analysis. Firstly, a comprehensive critical review of the available literature is undertaken to gain a understanding of the subject matter and provide a foundation for the semi structured interviews/focus group which were held with industry professionals and practitioners, the information gathered is then collated for the final stage of qualitative analysis.

A thorough critique of the literature from primary and secondary is undertaken including, but not limited to, conference papers, government papers, industry reports, peer reviewed journal articles, published research papers, text books and web pages. This provides the researchers with a wide-ranging knowledge foundation on the subject; from which to build a frame work to assess the interviewees/focus group and their knowledge on the subject matter.

The information gathered through the literature review will be enhanced by gathering further results from Qualitative analysis. There are about as many definitions of qualitative research as there are books

on the subject [4]. This form of research refers to non-statistical methods and generally involves discussions with interviewees to gather data on particular research questions or explores a central phenomenon. A qualitative approach therefore looks to gather insights into and understand people's perceptions and experiences of the environment in which they operate [5, 6]. Interviews are a means of providing in-depth information relating to the interviewees' experiences, knowledge and viewpoints of a particular topic. Turner III [7] stated that often, interviews are coupled with other means of data collection in order to provide the researcher with a more rounded collection of information for analysis. Qualitative interviewing is a flexible and powerful tool which can open up many new areas for research [8]. The format for the interviews chosen for this research is semi structured and guided where appropriate to ensure that information gathered in the literature review was covered, This form of interview uses "open" and "closed-ended" questioning but the questions are not asked in a specific order and no schedule is used [9]. This technique was selected as it was judged to be the best way to extract as much relevant information as possible as one question may lead to another and affords the interviewee an opportunity to impart as much information as possible and freely express their thoughts and opinions. The unstructured interview technique was discounted as there are specific topics to be broached and specific questions to be asked and does not meet research needs. The structured interview was also discounted as it may stem or inhibit the flow of information. During the interviews, the researcher asked no leading questions or questions that could elicit a particular response and that all responses were entirely those of the interviewees this is because in a qualitative interview, the aim is to uncover the interviewee's own framework of understanding of the research topics and the researchers task is then to avoid imposing the researcher's framework, theories and assumptions on

the interviewee's narrative as far as possible and to ensure that no bias is introduced. The researcher needs to remain open to the possibility that the concepts and variables that emerge may be very different from those that might have been predicted at the outset [10].

2. Site Waste Management Plans (SWMP's)

It is generally recommended that contractors produce a "Materials Resource Management Plan". Under legislation passed in England, the requirements for this will generally be covered by the Site Waste Management Plan. Best practices indicate that the plan be used as more than an instrument for meeting legal requirements and that it is beneficial when utilized from the design process onwards. The Royal Institute of Chartered Surveyors, [11] states; this can minimize the generation of waste and materials usage in the construction process and goes on to say that materials procurement and use, includes the impact of packaging and that this needs to be considered. Expenditure on materials form huge proportions of the contract value and therefore proper control of; scheduling, purchasing, delivery and handling of the materials is vital. Generated waste has a detrimental effect on profitability. Historically waste has always been an on-cost' in construction but new thinking suggests that waste should be seen as a resource [12].

According to DEFRA [13], as illustrated in Fig. 1, waste from construction and demolition amounts to approximately 100 million tonnes per year and waste removal accounting for approximately 4.5% of a construction company's profit. It further estimated that approximately 13% of all solid materials delivered to site are wasted and up to one-third ends as landfill. The materials management system attempts to insure that the right quality and quantity of materials are appropriately selected, purchased, delivered and handled on site in a timely manner and at a reasonable cost [14]. This was echoed by the CIOB [15], who state that material management plans are therefore intrinsically linked to and are an integral mechanism

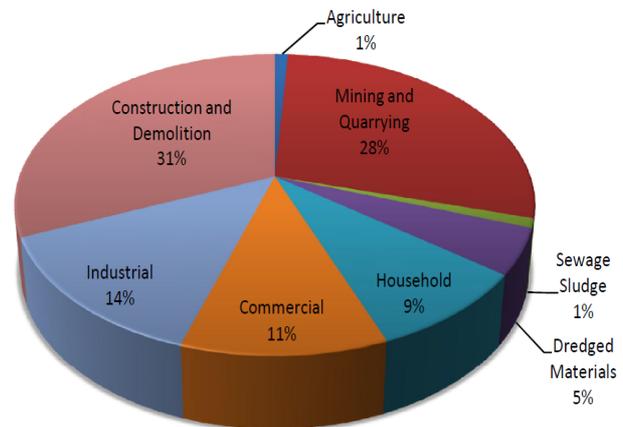


Fig. 1 Estimated total annual waste by sector UK [13].

in the production of a SWMP. As stated in the introduction a SWMP is a plan that details the amount and type of waste that will be produced during construction and how it will be reused, recycled or disposed of. Under legislation in England and current best practice in the devolved administrations, there existed a requirement for the production of a SWMP for all projects in excess of £300,000. It should be noted, when there is a requirement for a SWMP, in England, the client and principal contractor sign a joint declaration of commitment to the SWMP.

2.1 SWMP's at the Design Stage

A designer may use or adapt a published template for use. CIRIA [16] recommended that such an initiative should be introduced at the procurement and design stages; a view echoed by the RICS [11] which stated in minimising materials usage there is a need to address this issue at design stage. It went on to say it needs to start at the concept design stage. CIRIA [17] identified that the most beneficial waste reduction opportunities should be recognized by design team members. At design stage a SWMP can be used in the design of the site layout. Areas for the secure and correct storage of materials must be designated, preventing damage to materials wastage and loss through theft and vandalism. Designers are therefore responsible for ensuring environmental aspects are considered and incorporated into the design.

2.2 Barriers to Effective use SWMP's

Research shows that the formation of these plans can be a complicated process and this could be seen as a barrier to their implementation. This was found to be the case on a WRAP case study [9] on the fit out of an HSBC branch in 2009, they found The Project Managers and Principal Contractors within HSBC were daunted by the size and perceived complexity of completing a good practice SWMP [18], this was echoed by Zero Waste Scotland, [19] who in conjunction with Clarks, a local contractor, implementing a SWMP and established that a lack of understanding by staff had to be overcome. In both cases the difficulties were overcome by staff training and on-going development for the duration of the project. Clarks also found that the use of generic templates hindered their successful use and had to be tailored to suit their needs. When SWMP's became compulsory in England in 2008, a major barrier was again a lack of knowledge, tools such as; Net waste and SMARTWaste, were developed to supplement the SWMP templates. Legislation, its interpretation and use can be a barrier to its proper and wide spread use. All EU countries are governed by waste legislation. SI 314 in England, which came into effect on the 6th April 2008, states in section 5 Any client who intends to carry out a project on any one construction site with an estimated cost greater than £300,000 excluding VAT must prepare a site waste management plan conforming to these Regulations before construction work begins. but this can be misleading, DEFRA, [20] state on page 5 in their guidance note, There is no legal requirement for a project of contract value greater than £300,000 but undertaken over multiple sites (clearly geographically separate) to undertake a SWMP. Only England, at present is affected by this regulation, in Wales, the Welsh Assembly has yet to pass legislation in respect to production and use of a SWMP, in the meantime and in the absence of formal legislation, Local Authority planning departments are

also promoting resource efficiency and recycling in the form of guidance [21]. The Scottish Executive have stated that SWMP's, though not a legal requirement, are good practice and their use is to be recommended. In Northern Ireland there is yet to be legal requirement for SWMP's but they are encouraged and are planned to be introduced the department of the environment has consulted on proposals to make SWMP's a legal requirement for construction and demolition projects in Northern Ireland in the near future [22]. In Ireland, neither SWMP's nor enforceable legislation for construction and demolition waste is in place. However the Government DoECLG [23] introduced guidelines in 2006 for the preparation of waste management plans designed to promote sustainable development, environmental protection and optimise the use of resources and introduces the idea of a waste management system for construction projects above a certain threshold. These legislative geographical variations could be a barrier to successful implementation of a SWMP and a company working in different regions would need to be aware of these differences, if not they may be open to possible prosecution for non-compliance. Implementation costs may possibly be considered a barrier to the execution of a SWMP, especially for those below the legislative ceiling but virtually no data could be gathered on this area to definitively say if this is the case. Ref. [20] highlighted this, stating Although users of SWMP's in general agree that their introduction has brought significant cost savings and benefits of different types, there is very little data available regarding the specific costs and savings attributed to the different activities associated with the introduction of the plans. They also state assumptions had to be made for their study. SWMP's highlight the need for recycling but in some cases it may also be a barrier to the success of a SWMP. In the UK, there has been a growth in the number of recycling centers, from less than 100 in 1994 [24] up to an estimated 400 plus in 2000 [25] but

not all are ideally located, the BRE report goes on to say that some centres experienced shortages in materials and customers. Some contractors may send waste to landfill if closer or if landfill costs outweigh transport costs to the recycling centre. Fandrich et al [26] also highlighted this by stating b resource recovery facilities will need to be strategically placed by taking account of feedstock availability and that Awareness and availability of cost-effective recycling services and lack of storage for recyclable waste have proved to be major barriers for businesses to get involved in recycling but Howard Humphries and Partners [24] indicate that planning permission may be problematic for these centres and they may not be placed where needed and greater investment in plant is required. Similar problems in Ireland were found to exist [27]. There, the same growth in the number of recycling facilities has not been seen and those that exist are geographically spread out and need regular, good quality supplies of feedstock. In Ireland, FÁS [28] also indicated problems with feedstock. Clearly a wide geographical spread may make it difficult for some contractors to recycle. The quality of recycling materials can also become a barrier to the success of a SWMP. The NHBC [29], in a guidance note state A SWMP will work best if it is embedded into company policy and site procedures e.g. within existing environmental management or quality system.

WRAP [30] developed protocols for waste management to help guarantee the quality of recycled materials, they state a quality protocol gives guidance on how to recover waste, remove it from the regulatory regime and unnecessary regulations. This means materials such as aggregates can return to the supply chain and attract a higher premium the resultant aggregate in this example is classified as a recovered non-waste product [17], but only if they are certified free from contaminants The recycling of materials begins on site by correctly segregating materials. If this is not done it may be refused at the recycling centre. The Symonds Group [31] noted that a large volume of good quality

construction materials goes to landfill as mixed waste. Duran et al [27] further highlighted that quality recycled products would be more readily accepted and used by the construction industry but only if quality was consistent and the same as products already on offer. Research shows a rise in the price of aggregates would encourage the purchase of recycled aggregates. Under the “polluter pays principle”, the producer of C&DW and the user of primary aggregates must incur the environmental costs of their actions [19] and a higher landfill charge would encourage more recycling, A similar approach has been advocated in china where Yuan et al [32] revealed that higher landfill charges would lead to higher net benefits. These ideas are corroborated by Lawson et al [33] who state that Research at the UK Building Research Establishment and the University of Manchester has shown that new taxes are making disposal of C&D waste to landfill uneconomical.

2.3 Benefits derived from SWMP's

There are also many benefits to having a site waste management plan in place. CIRIA [17] identifies four main areas which benefit from the use of SWMP's.

They are:

Environmental;

Economic;

Social;

Corporate or Project;

Environmental benefits are largely well known; less damage caused to the environment, less dependence on natural resources, increased use of recycled or sustainably sourced materials, a reduced production of greenhouse gases, a reduced need for landfill and landfill sites and less fly tipping. The social and corporate benefits, whilst not as apparent include; a heightened corporate and environmental image, better skilled workforce etc.

Economic benefits identified [17] include:

Improved opportunities to tender through demonstration of sound environmental performance and effective risk management;

Less money wasted on fines for non-compliance with legislation and associated costs of clean-up, legal fees and management time ;

Fewer delays to the project by fully characterizing the site before works start, reducing costs incurred by delayed surveys;

Better cost certainty through improved materials resource management cost savings through improved energy efficiency and carbon management;

Other economic benefits include: The creation of markets for recycled construction and demolition waste [27]. This then leads to lower waste disposal costs and lower prices for certified recycled materials.

Table 1 was prepared from data supplied by BRE (2008) but used in the Department of the Environment-Northern Ireland [34] consultation report of 2010. The table shows that estimated savings or returns can be made on a sliding scale but these are only from a break-even point of £250,000. Those involved in projects below this break-even point must reap the non-financial benefits.

2.4 Sustainability and SWMP's

Other than the environmental benefits as discussed, the research has uncovered no direct link between sustainability and SWMP, though it could be argued that their use encourages sustainable procurement, production and materials handling. Graighill and Powell [35] state an estimated 80% of all energy required to produce a building is used in the production and transport of materials. The data produced by an SWMP can be used in WLC/LCC. The construction industry has, by improving practices

Table 1 SWMP's estimated costs and benefits [34].

Project value (Band)	Assumed average value	project implementing A	Estimated cost of writing and implementing A	Estimated benefit of writing and implementing A
< £100,000	£70,000	£350	£210	
> £100,000	£150,000	£500	£450	
> £200,000	£250,000	£750	£750	
> £300,000	£450,000	£1,000	£1,200	
> £500,000	£1,600,000	£1,600	£4,800	
Weight average	£1,300,000	£1,400	£3,900	

on site, an opportunity to benefit the environment, improve performance and its' profit margins.

3. Qualitative Analysis

The interviews and focus group took place over a number of days with Architects in Belfast and in the Republic of Ireland. A software package called "Decision Explorer" version 3.3.2, by Banxia was used. This software allows researchers to map and link concepts from the interviews/focus group, allowing the unstructured information gathered to be mapped and structured. The concepts were then linked to show the relationship between them and then the software can run different outputs for analyses.

The three types chosen for this report are:

Domain Analysis-This shows concepts which may have several links;

Central Analysis-This shows those concepts which will have the greatest effect;

Cluster Analysis-This shows the groupings of concepts which are strongly linked.

3.1 Domain Analysis

Using the Decision Explorer software, a Domain Analysis was run using the same model of mapped concepts. This analysis method determines the concepts that possess the most links, shown in red between the concepts. It should be noted that like the central analysis only the top five were used for this report but more exist in the actual results produced by Decision Explorer. This form of analysis highlights concepts that the interviewees and focus group found interesting and discussed, also how these topics or

concepts as discussed or answers to the questions posed, are linked.

The analysis shows that there are more benefits or advantages to be derived from the inclusion of waste management plans at the design stage rather than the disadvantages of including or using them. Of the 23 concepts ranked in the top five in the domain analysis only one was a disadvantage, or 4% of the top five ranked concepts. This may illustrate that the interviewees are clearly aware of the possible benefits and are more interested in them and therefore talked more about them.

3.2 Central Analysis

As discussed the main concepts extracted from the interview are modelled onto a cognitive map and then central analysis is run. This identifies and orders each concept according to its effect or impact on the mapped model. The higher the score in the central analysis, the more of an effect that concept has on the map.

Only the top five concepts are discussed.

The first disadvantage was ranked 16th in interview A and this concept was then ranked 25th and 24th in interview B and in the focus group, respectively. This could be said to prove the importance of waste management to the design process. Whilst there are disadvantages to waste management reported, such as the cost and time spent on calculations and plans and their complexity, these are far outweighed by the reported benefits. It is interesting to note that within central analysis that sustainability ranked higher than project cost savings for all three groups. However so did “improved corporate image” and promotion of “green credentials”. These were also higher than concepts such as; less “materials wasted”, “sustainable design”, “collaboration between stakeholders”, “client satisfaction” etc. Does this mean further cost savings are being sacrificed to promote CSR or the portrayed image of sustainability or “green” corporate image is

more important than the issues that could provide effective sustainability?

3.3 Cluster Analysis

The cluster analysis was run next on Decision Explorer. This breaks the large down into smaller maps which are less complex, easier to understand and analyze.

3.4 Identified Advantages

Table 2 is comprised of the benefits or advantages identified by interviewees. It also shows which advantages are held in common to different interviewees.

3.6 Identified Disadvantages

Table 3 is comprised of the disadvantages identified by the interviewees. It also shows which disadvantages are held in common to different interviewees.

3.7 Identified Advantages of Waste Management Plans

The research undertaken had identified many advantages to the use of site waste management plans and the need to implement a waste management strategy. There were many advantages identified through the literature review and by the interviewees and they are listed under the following headings.

3.7.1. Economic Advantages

Many cost advantages or activities leading to savings that are linked to waste management were recognized within the research. The main problem was in identifying actual costs. In the literature review, DEFRA [20] acknowledged that although users agreed that savings are made, there is inadequate information regarding specific savings. DEFRA have produced figures which show the savings that can be achieved but again acknowledge that certain assumptions had to be made. It also shows that savings are only made on larger projects. This does not mean that savings are not made on smaller projects but the overall saving decreases the smaller

Table 2 Identified advantages.

Advantages identified	Interview A	Interview B	Focus Group
Asset management			✓
Better informed team and client	✓		✓
Better materials handling procedures	✓	✓	✓
Better materials management	✓	✓	✓
Better scheduling procedures	✓	✓	✓
Cost control		✓	✓
Efficient use of manpower and resources	✓	✓	✓
Encourages sustainable design	✓	✓	✓
Enhanced tendering	✓		
Environmental issues considered earlier	✓		✓
Grants to promote sustainability		✓	
Improved Company image (CSR)	✓	✓	✓
Improved construction management	✓		✓
Improved corporate image	✓		✓
Improved Corporate Social Responsibility	✓		
Increase value for money	✓	✓	
Increased client satisfaction & relationship	✓	✓	✓
Increased savings	✓		✓
Less materials wasted	✓	✓	✓
Less materials wasted through incorrect storage		✓	
Less rework	✓	✓	✓
Less Waste to landfill			
Marketing opportunities	✓		✓
Open and transparent procedures			✓
Project cost savings	✓	✓	✓
Promotion of green credentials		✓	
Re use of waste		✓	
Sustainable procurement		✓	
Use of recycled products		✓	
Waste can be designed out	✓	✓	
Waste designed out	✓		✓
Waste segregated on site for re-cycling		✓	

the project and on these, companies are more dependent on the other benefits to be gained.

The main cost benefit identified in both types of research, was reduced materials wastage and was achieved by:

- Better materials management and ordering systems;
- Improved materials handling;
- Improved materials storage;
- Just in Time Deliveries;
- Better design procedures;
- Early contractor involvement.

The reuse of materials on site has also shown to be a cost saving as the more materials that customarily would have been disposed of, were reused, meaning less replacements to be ordered.

Less apparent cost saving were also identified, CIRIA [17] stated that money was not wasted on fines through non-compliance with legislation or on costs related with clean-up or legal fees. Other identified savings included; savings made on not sending waste to landfill. Duran et al. [27] and Lawson et al. [33] stated that higher landfill charges would encourage more recycling; this cost benefit then migrates to

Table 3 Identified disadvantages.

Disadvantages identified	Interview A	Interview B	Focus Group
Contractual problems	✓		✓
Early data may not exist	✓		
Incorrect reports / models produced	✓		✓
Legislation	✓		
Mistakes easily made by inexperienced staff	✓		✓
Reduced productivity during training	✓	✓	
Specialist waste contractors required	✓		
Staff training	✓		
Technology expensive (renewables)		✓	✓
Time required to compile plans (SWMP)		✓	

environmental benefits. This was also identified by Graighill and Powell [35] where it was estimated that 80% of all energy required in constructing a building was in the production and transport of materials.

3.7.2 Sustainability and Environmental Advantages

The environmental benefits of recycling are universally acknowledged. The recycling of waste from all sectors has established benefits. The recycling of construction waste has, been growing over the past number of years. As was highlighted in the literature review site waste such as masonry can be recycled into aggregates, and can then be returned to the supply chain and can attract a higher premium. CIRIA [17] stated this aggregate can then be classified as a recovered non-waste product.

The environmental benefits identified in the research are:

- Sustainability;
- Improved recycling procedures;
- Less waste to landfill;
- Re-use of waste products;
- Reduced pressure on resources.

Environmental benefits also expand into other benefits, as discussed reusing materials reduces the need for new materials and the increase in recycling creates demand for new recycling centres, Duran et al. [27] indicated this creates markets for waste from construction and demolition, which leads to lower costs for waste disposal and lower prices for certified recycled materials. Both the research and analysis has

shown that these benefits are linked throughout the researched processes, Waste can be designed out and increased environmental awareness can lead to improved corporate social responsibility.

3.7.3 Corporate Advantages

Throughout the research corporate benefits were identified and linked directly to waste management. They were described as being a marketing tool or a means of promoting company image during discussions with industry professionals. CIRIA [17] identified corporate benefits as one of the four main areas which benefit from the use of SWMP's. For many companies image is understandably important and being able to market their 'green' credentials is very important, the research has shown, when little or no financial benefits are gained, companies will still use a SWMP to acquire and promote corporate benefits. Some corporate benefits are not readily identified. The literature review identified that better materials management led to enhanced health and safety and consequently a lower accident rate, which is good for a company image.

The main corporate benefits identified are:

- Enhanced corporate image and Improved corporate social responsibility;
- Increased tendering success;
- Improved management systems;
- Improved quality systems;
- Improved site conditions.

3.8 Identified Barriers and Disadvantages of Waste Management Plans

There are more barriers to the success of a waste management plan than actual disadvantages, which in itself is a disadvantage. These barriers can be real and perceived. Many using them for the first time perceive them as being difficult to implement as was shown by WRAP [18] on the refurbishment of an HSBC branch, and by Zero Waste Scotland [19], who found that a lack of understanding by staff had to be overcome. The contractor also found that the use of generic templates was a barrier to their successful use and had to adapt them. This also highlights the need for culture change within an industry that is, by tradition slow and resistant to change.

3.8.1 Legislation

Countries within the EU are governed by waste legislation but in England, SI 314 came into effect on the 6th April 2008, this was the introduction of the SWMP. A project only had to conform to the regulations once it has an estimated cost greater than £300,000 excluding VAT. They have now been rescinded. Though encouraged, in Wales, Scotland, Northern Ireland and Ireland none exists and draft papers for consultation on their introduction have been produced. Companies operating in one or more of these locations need to ensure compliance with local legislation or face legal liabilities. Geographical differences in law send a mixed message to the construction industry.

3.8.2 Location

Site location is a factor in many ways. Site size is important as a restricted urban site may not have the space for the number of skips required for waste segregation, whereas a large rural site may not have this problem. As discussed under the legislation section, the geographical location can determine the requirement for a SWMP. As discussed in the literature review, there has been an increase in the number of recycling facilities and but they have a wide geographic spread. This may make it difficult for

some contractors to recycle. A site located too far from a centre, may prohibit sending waste there, this is especially true if a landfill site is closer and transport costs and increased costs for landfill are less costly than transporting for recycling.

3.8.3 Costs

The implementation of a SWMP does incur costs. It was found that as a percentage of project costs, the smaller the project, the larger SWMP costs. Costs identified included:

Staff training;

Promotion and awareness of the SWMP;

Transport;

The use of certified waste contractors;

Re cycling costs;

The use of a dedicated person;

Cost of time spent on, implementing, using and reviewing SWMP.

The research has shown that the realized savings on larger projects outweigh the negative cost impacts but that the opposite is true for smaller projects.

3.8.4 Manpower

Cost, administration, time, training and awareness are found to have negative impacts on a SWMP. This was also highlighted by WRAP and Zero Waste Scotland, [18, 19]. There is also the cost of time management spent on overseeing the process.

3.8.5 Culture

Historically the construction industry is slow and resistant to change [2, 3] and therefore there needs to be a shift in this attitude to make SWMP's more successful. When SWMP's were introduced they met with resistance and since their introduction in 2008 there have been calls from within the construction industry for their abolishment as there are those who feel that they are; costly, time consuming and should not be foisted upon the construction industry by government.

4. Implications for Practice

From the research it is evident that there exists a lack of knowledge or awareness on how a SWMP is

implemented. This inhibits their full and accepted use. When using them initially, users were intimidated by them and their perceived difficulty. This is an issue that needs to be addressed whilst it was overcome by training, the burden of training was left to individual companies, this is something the industry as a whole needs to get involved in. A culture or attitude change in the construction industry as a whole to SWMP's is needed. Many companies have incorporated and fully utilize them at project level, whilst others are hesitant and slow to change. This may change as new, better informed individuals graduate through the industry but this is a slow process and better promotion and awareness is needed from the industry. Many benefits and barriers that have been identified and through the research it seems many companies only focus on the negative aspects. Though it has been shown that smaller projects gain little financial benefits; they, society and the environment still gain in other ways. This needs to be emphasized. The construction industry needs to adopt the ethos of waste management, to make it successful. Many trade on and advertise "green" credentials as part of the corporate image and this is an acceptable advantage but for WMPs to be successful industry wide, the awareness of environmental benefits has to increase, as this advantage leads to an increase in the other benefits. As the use of SWMP's increases, so does the demand for recycled products, this then leads to a stimulus in growth for recycling centers, which then creates more construction projects and jobs, which then benefits; the construction industry, society and the environment.

5. Conclusions and Recommendations

The evidence from this research clearly shows that there are many advantages to be gained from the use of Site Waste Management Plans and the control of waste, these include; environmental, financial, corporate and social. It was reported that the construction industry uses an estimated 400 million

tonnes of resources every year, with 100 million tonnes ending as waste. This practice is clearly uneconomical and unsustainable in terms of natural resources and the effect on a company's profit margin. Their use means a lot less construction waste is going to landfill and more materials are being recycled on site for reuse or going to recycling centers, some firms have reported generating a revenue stream from selling waste metal produced on site. There has been a growing demand for recycling centers and their products, such as aggregates, which has led to job creation and new markets being opened up. The use of waste management plans at the design stage has highlighted areas in the design that could be altered to make use of onsite materials, an example of this was seen during the refurbishment of the Ark building in west London, ceiling tiles were re-used, saving £490,000, re use of the raised floor saved a further £505,000 and £18,254 from diverting waste from landfill. The research has shown these savings are made on medium to large projects only but smaller projects can reap the; organizational, social and environmental benefits. HSBC bank was so impressed by the savings that the SWMP was implemented for all their fit out and refurbishment works. Companies are also finding that their corporate image is improved by correct waste management procedures and as a consequence has helped in the procurement process and their ability to tender effectively increases. There are many barriers or disadvantages, some only perceived, to their use as the research has highlighted but the advantages, not just to the industry but to society far outweigh these.

To overcome some of these barriers, more emphasis on their use needs to be made. There needs to be a better understanding of waste management plans and a cultural change in the industry in relation to their implementation and use. The construction industry needs to better promote and improve knowledge of and in waste management practices. However, despite the highlighted advantages there are those in the

construction industry that feel that SWMP's are; too time consuming; create more paperwork, prolong the design stage and that the companies could be utilizing time and money more effectively to reduce waste. DEFRA [36] stated in their published report that they are proposing to remove Site Waste Management Plans from the Regulations because evidence and feedback suggest these regulations are ineffective: no prosecutions have been made; enforcement is inconsistent and often poor. Final submissions were in October of 2013 and following a government review of 21,000 regulations on different themes, Site Waste Management Plans are no longer compulsory for construction projects in England (from 1st December 2013). They may still be required for BREEAM assessments or by a local planning authority and may be considered an environmentally responsible initiative by the main contractor or by the client. There is currently no legislation for their use in Northern Ireland, Scotland or Wales but their use has been encouraged by Local Authorities and in Ireland as in Northern Ireland draft proposals have been published for a consultation process.

Construction projects are currently wasteful with unsustainable amounts of materials being sent to landfill, which in itself is a costly process. Current economic climate and environmental concerns highlight the need to reduce costs and waste. A culture change within the industry is needed for the furthering of waste management plans. Waste management plans are perceived to be complicated and this inhibits their use. Waste management plans not only control waste but also promote better materials management. Their use has many socio-economic and environmental benefits and advantages which need to be promoted by the industry and Government.

The research that has been undertaken has led this researcher to make the following recommendations.

A culture change within the industry is needed for the furthering of waste management plans. The benefits and advantages derived from the

implementation and use of SWMP needs to be promoted. Waste management plans, their socio-economic and environmental advantages need to be fully researched and promoted by the industry and Government.

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