Conservation Plan and ‘Green Maintenance’
from Sustainable Repair Perspectives

1. Introduction

Conservation Plan is not new in historic buildings conservation. It has been widely adopted in Australia, New Zealand, and United Kingdom and globally recognised. Despite its inception since 1990’s, there is no well-established study to ascertain whether a Conservation Plan is workable or vice versa, particularly on its integration with ‘Green Maintenance’ concept and methodology and sustainable repair approach. A significant number of authorities, experts and researchers claimed it is not. Moreover, some of their important links are still missing, particularly lacking in terms of achieving sustainable historic environment.

2. Conservation Plan: A Review

Definition
A considerable number of authors have defined Conservation Plan through various interpretations. Kerr (2000) defines Conservation Plan as “a document that explains what is significant in a site (also referred to as a ‘place’) or building and reasoning why they are important and how their significance can be retained” (Kerr, 2000, p. 1). Conservation Plan is formulated to conserve the “significance” of a building, site or place (Worthing and Bond, 2008, p. 47), either for “potential use” (Smith, 2005, p. 101) or for “future development” (Gard'ner, 2007, p. 156). In ‘Conservation Plans: A Guide to the Preparation of Conservation Plans’, Historic Scotland defines Conservation Plan as reference document used to identify relevant needs to achieve effective building maintenance (Historic Scotland, 2000). Meanwhile, ‘Conservation Plans for Historic Places’ by Heritage Lottery Fund (1998) defines a Conservation Plan as policies used to understand the processes in maintaining and protecting buildings significance. Generally, a Conservation Plan is a well-developed policy to protect a building’s significance without jeopardising their future development. However, the relation of its definition with ‘Green Maintenance’ concept and methodology, particularly in achieving sustainable repair for historic buildings remain unclear.

The emergence and virtues of Conservation Plan
Chronologically, Conservation Plan was developed in response to both the initiatives of leading conservation bodies and support from building conservation charters. Initially, Conservation Plan was introduced by James Semple Kerr under The Burra Charter (Worthing and Bond, 2008). ‘Burra Charter Process' has set a logical sequence of investigations, decisions and actions upon buildings’ significance (Pearce, 2000, p. 15; Worthing and Bond, 2008, p. 110) and this makes it “very similar” (O’Connor, 2000; Hudson and James, 2007) and “well resonance” with Conservation Plan (Whitbourn, 2007).
While Burra Charter and Conservation Plan are significantly similar, recognition gained by the latter however is achieved only at a very late stage. The Heritage Lottery Fund (HLF) was the first public body to promote and adopt conservation plan (see Clark, 1991a). In the UK context, Conservation Plan is widely recognised by national committees of International Council on Monuments and Sites (ICOMOS) (Gard'ner, 2007) and strongly supported by ‘Conservation Plans for Historic Places’ documents (Smith, 2005).

Various supplementary documents have been widely published to support Conservation Plan. But, they are published with different emphases. Worthing and Gwilliams (2002) have had highlighted these different emphases including consideration on contribution of all relevant parties as suggested in “‘Sustaining the Historic Environment: New Perspectives on the Future’ by English in 1997, the needs for constructive debate to determine building’s importance in Power of Place’ by Historic Environment Review Steering Group (English Heritage) in 2000 and the efforts to promotes integration and changes between long term maintenance and management as in ‘The Historic Environment: A Force for Our Future’ by the Department for Culture, Media and Sports (DCMS) in 2002 (Worthing and Gwilliams, 2002, p. 564).


Conservation Plan may encompass many attached values connected to places, sites or buildings-cultural, historical, scientific, educational, aesthetic, social, economic and ecological values. These “values” need to be considered in the production, components and structures of conservation plan (Australasian Legal Information Institute, 2008, Heritage Council of Kilkenny, 2008). It must emphasise however that in this paper a Conservation Plan is a policy to protect a building’s significance, through well developed standard components, structures and processes.

Components, structures and processes of Conservation Plan

As suggested by Clark (2000), Miele (2005), Gard’ner (2007) and (Worthing & Bond, 2008), a Conservation Plan should include an understanding of buildings, sites or place and their cultural significance. Additionally, a Conservation Plan also needs to have “good written policy” (Atkins, 1999) and fair “judgement” on vulnerability of site significance (Worthing and Bond, 2008). Clearly, a Conservation Plan is developed based on its fundamental association with the significance of heritage properties.
However, its distinct components, structures and processes for historic buildings conservation, particularly in achieving integration with ‘Green Maintenance’ concept and methodology and sustainable repair approach remained unclear and relatively compromised.

Prior to its implementation, a Conservation Plan should and be able to identify all the contradictory elements affecting buildings (English Heritage, 2005). These include any small cumulative alterations, loss of fabric, problems with mixed ownership, conflicts between different types of heritage, pressure from visitors or users and the need for better access (Stenning and Evans, 2007). Due to its complex implementation processes, it is difficult to ascertain the requirements of a Conservation Plan for historic buildings conservation, particularly in determining the requirement of works essential for ‘Green Maintenance’ concept and methodology and sustainable repair approach.

Additionally, Conservation Plan needs to be more authoritative, accessible and easy to read (Clark 1999a; Clark 1999b; Clark 2000), representing a good degree of consensus (Pendlebury and Townshend, 1997), thoroughly debated (Historic Scotland, 2000; Dann and Wood, 2004) and clearly explaining future use of buildings (Clark 1999a; Clark 2000; English Heritage, 2005). Worthing and Bond, (2008) asserts that a Conservation Plan needs to “provide ready advice necessary, appropriate requirements and opportunities, basis for assessing change, reassurance of projects right direction for appointed heritage and funding agencies” (Worthing and Bond, 2008, p. 108). Clarks (1999a and 2000) suggests that a Conservation Plan needs to explain building’s maintenance regimes (including sustainable repair approaches) and legislative influence (Clark 1999a; Clark, 2000). From the above statements, unique components, structures and processes of a Conservation Plan are caused by their very own non-flexible requirements. This posed possible risks to its relation with ‘Green Maintenance’ from sustainable repair perspectives, particularly upon its own benefits.

**Benefits of Conservation Plan**

On behalf of the grant or fund providers, in Clark’s opinion, Conservation Plan is useful in applying for grant from the funding organisations (Clark 1999b). Consequently, Worthing and Bond (2008) asserts that “in many cases, the reason that conservation plans are produced is to fulfil the requirement of either a funding body (such as Heritage Lottery Fund in UK), or a statutory consent authority within the context of a development proposal” (Worthing and Bond, 2008, p. 109). But, is a Conservation Plan only prepared for the sake of applying for grant? Are there any possibilities for them to be produced beyond this ultimate reason, particularly with regards to scope of works stipulated in achieving ‘Green Maintenance’ and sustainable repair?

As a professional himself in the building conservation industry, Miele (2005) points out that the reason for a Conservation Plan preparation is beyond grant, as he said: “Conservation Plan is helpful for a full understanding of an historic building and protects certain areas within a building by setting parameters for further investigative or design works” (Miele, 2005, p. 31). Conservation Plan acts as a “practical document” (Smith, 2005, p. 101) and a “useful tool” in dealing with political, resource, economic and community issues surrounding the conservation of heritage properties (Tavernor,
It can be concluded that the simple concept behind a Conservation Plan masks a potentially powerful management tool in maintaining built heritage properties in more sustainable ways.

Utilisation of a Conservation Plan helps to achieve informed decision upon heritage properties. Atkins (1999) and Worthing and Gwilliams, (2002) suggest that by utilising a Conservation Plan, heritage property managers will be more explicit, transparent, and open about their assumptions (Atkins 1999; Worthing and Gwilliams, 2002). Conservation Plan is always seen as a downscaled version of “rescue operation” for heritage properties, a tool to prevent negative outcome either from new development or threats and a cost budgeting instrument to minimise major expenditure for conservation works (Clark, 1999b; Smith, 2005; Stenning and Evans, 2007).

A series of very effective implementation of a Conservation Plan can notably be observed from a significant number of cases. They include projects commissioned by English National Trust (done by Inskip + Jenkins for Stowe and Mogerhanger), Historic Scotland, Allies and Morrison, HLF (Royal Festival Hall, London, St. George's Hall, Liverpool and for Somerset House in London) and The Heritage Council of New South Wales (NSW), Australia (Clark, 1999b). Conservation Plan is an essential tool for those who are facing difficulties in making major decision either on new development or resolving conflicting types of building significance. But, there is still no clear indication on how it can provides reference point of strategic thinking of well-developed maintenance plan and sustainable repair approach for historic buildings.

Commonly, benefits of a Conservation Plan have been highlighted by the majority of professionals who are involved directly in building conservation. Conservation Plan is important guidance for avoiding a dispute case reaching a court (Preston, 1999), reference that brings together all the related issues (Clark, 1999a), resolution for conflict (such ‘Sheffield Template’ by English Heritage) (Clark, 1999b), mechanism to achieve consensus (Kerr, 2000). In addition, a Conservation Plan is a holistic view of the development of the place, site or building encompassing a variety of disciplines; archaeology, architectural history, landscape history, ecology, science and technology and the social perspective (Clark, 2000).

Historic Scotland (1998), claims that “Conservation Plan did not harm the special interest of the listed building and provided a huge opportunity as well as guidance for any legal dispute in conservation” (Historic Scotland, 1998, p. 66). Moreover, Conservation Plan identifies the opportunities for building development (Cambridge Architectural Research Limited, 1999) and provides feedbacks from stakeholders before any conservation work commences (Victoria Baths Trust, 2003). In addition, a Conservation Plan is able to address sustainable development as it pointed out buildings future threats, vulnerability, issues and concerns (Worthing and Bond, 2008).

Generally, the aforementioned statements suggest that a Conservation Plan could act as a tool that provides a good mechanism to attained sustainable historic environment. However, all of these statements are emphatically made by professionals who are directly involved in the management and maintenance of historic buildings (see example from Forster and Kayan, 2009). Therefore, there is the element of biased judgement and strong preference on Conservation Plan’s advantages. This leads to a
question: “Is there any contradicting views or significant concern raised particularly on the deficiencies of a Conservation Plan and its relation with ‘Green Maintenance’ concept and methodology, particularly from sustainable repair perspectives?”

Deficiencies of Conservation Plan

From previous discussion, Conservation Plan has gained recognition from the majority of building conservation professionals due to its theoretical advantages. While evaluating this recognition, it leads to some major questions, “is a Conservation Plan workable without any deficiencies or completely perfect, particularly on how well it associated with ‘Green Maintenance’ concept and methodology from sustainable repair perspectives?” In fact, deficiencies of a Conservation Plan have also been consistently under close scrutiny. Despite being promoted in UK since 1990s, there are claims that there is no research to ascertain the workability of a Conservation Plan. In 2005, Miele has said: “Conservation Plan has been promoted in the United Kingdom for more than a decade (since early 1990s), but there is no research to establish whether they are working as intended” (Miele, 2005, p. 23). In Malaysian context, the practicality of a Conservation Plan is prone to cynical views from academic sectors and industry alike despite establishment of similar kind of ‘conservation management plan’ (CMP) of Section 97 of National Heritage Act 2005 (Act 645) (Kayan, 2006) and ‘conservation framework’ (Ahmad, 2006).

Conservation Plan adoption may face various constraints as it is too prescriptive, particularly in its components, structures and processes. A good Conservation Plan should specifically describe the scope, intensity, circumstances, issues and details of the conservation work (such as building conservation works coordination) required (Kerr, 2000; Worthing and Gwilliams, 2002). Conservation Plan which is too complex however may no longer appropriate for adoption in achieving integration of ‘Green Maintenance’ and sustainable repair because a wide range of skills is required in its implementation.

With regard to the skills needed to implement a Conservation Plan, there is the question of who should prepare them and the criteria in the selection of the right person. A study by Preston (2006) in ‘Journal of Architectural Conservation, Special Issue’ finds that “legislation is only able to work well when the necessary skills exist” (Preston 2006, p. 35). But, there is a lack of expertise (Preston, 2006) and a disappointing number of professionals (Historic Scotland, 2008) in this area. Skills needed to write a Conservation Plan may vary as it is very much determined by “characteristic and complexity” of sites (Wise, 1993, p. 229). In practice, the writing team preparing a Conservation Plan should reflect on the details and qualities of the building, place or site and their maintenance and repair needs. Yet, this leads to the question: “is a good writing team always available for a Conservation Plan preparation” and “whether or not they are in-house team or a group of consultants or practitioners who will put ‘Green Maintenance’ and sustainable repair approach above all other needs”?

At its best, the Conservation Plan preparation processes should be a creative integration of efforts and skills by both client and practitioner. Marquis-Kyle (1998) said in ‘Study of the East Brisbane State School, Queensland, Australia’, that a
Conservation Plan needs a thorough process in its preparation (Marquis-Kyle, 1998). While in Preston’s opinion, the setback is that, there are stages and procedures to be followed (Preston, 2006). During the stage of writing a Conservation Plan, Horne (1993) suggests that it is essential to engage consultants who have a wide “broadened knowledge” (Horne, 1993, p. 375), equipped with “skills and motivation to engage” (Worthing and Bond, 2008, p. 114) and possessed good “coordination ability” (Weaver, 1995, p. 30; Drewer and Steel, 1996: 53).

Regarding a Conservation Plan preparation, Wood (1999) suggests that a team-based approach should be adopted (Wood, 1999). In line with these opinions, the more “viewpoints” (Drury, 1999) and “cast of fresh eye” (Clark, 1999a) included, the higher the possibility of achieving the desired result of a Conservation Plan. But, Worthing and Gwilliams (2002) argues that the more disciplines and people involved however, the more difficult for a coherent Conservation Plan to evolve (Worthing and Gwilliams, 2002). Based on the above statements, it can be concluded that there is no clear indication on how to ascertain whether a team or an individual efforts can achieve the best end results of a Conservation Plan, particularly in adopting ‘Green Maintenance’ concept and methodology. Therefore, the influence of the end results of a Conservation Plan on historic buildings conservation from sustainable repair perspectives is remained difficult to determine.

Despite the logic behind the establishment of Conservation Plan (at least methodologically), however, there is anecdotal evidence suggesting that it has not been comprehensively implemented, particularly in achieving ‘Green Maintenance’ and sustainable repair. John (2007b) asserts that the UK government has defined the role of a Conservation Plan in statutory regulations back in 2004 (John 2007b). But, Miele (2005) argues that “Unfortunately, the role of Conservation Plan may not, of course, being actually adopted and materialized to this day” (Miele, 2005, p. 23). Clark (1999a) asserts that “Conservation Plan is easy to fall into bad practice...there is room for abuse if the related parties fail to manage the process” (Clark, 1999a, p. 37). When the relevant parties are unable to manage the implementation of a Conservation Plan (Forster and Kayan, 2009, p. 214), it can cause historic buildings be left to dereliction or subjected to controversy (example from Adam Smith’s Edinburgh home) (Ferguson, 2011a & 2011b). Conservation Plan might also become a money-spinning exercise (Inskip, 1999; Forster and Kayan, 2009), undermined by heritage sectors and exploited by the clients (example of Skye Castle Ross) (Ross, 2004).

As the application for building conservation grants using a Conservation Plan is consistently facing stiff competition, it is arguable that it may not be ethically and inclusively implemented. In the case of English Heritage, nearly £33 million per annum has been expended on grants over the past five years (from 2005 to 2010) which spread over 800-900 offers per year (depending on demands and projects financial commitment) (English Heritage, 2011). In addition, HLF has handed over £1.5billion to conserve 12,800 historic buildings and £305 million for religious buildings and monuments in UK until 2011 (HLF, 2011a). By and large however, HLF’s funds are always overwhelmed by grant applications (HLF 2011b). Based on these trends, a Conservation Plan may merely be produced to fulfil the satisfaction of grant funding requirements rather than be used as a decisive tool for maintaining heritage properties.
including historic buildings in more sustainable ways. This is contradicting with the claims and compliments made by professionals in the management and maintenance of historic buildings, who are accepting a Conservation Plan as a beneficial tools in attaining sustainable development (see example from Forster and Kayan, 2009).

Chronologically however, there is a lack of understanding, support and negative perception towards building conservation itself. Hubbard (1993) claims that “there is still very little certain knowledge of people’s conscious or unconscious commitment to buildings from the past...as such, conservation remains shackled by the stigma of subjectivity and accusation of elitism” (Hubbard, 1993). Conservation Plan considered as “didactic process” (Worthing and Bond, 2008, p. 71), with “considerable amount of gaps” (Pendlebury and Townshend, 1997, p. 9) and has “no ability to check maintenance works” (Forster and Kayan, 2009, p. 214). Professionals working within legislation are guided by their own philosophy and they are rarely involved in seeking people’s view (Mansfield, 2004), ignored community perceptions (e.g. Hendry, 1993; Moore, 1993; Turnpenny, 2004) and perceived merely as a developer’s charter (Worthing and Gwilliams, 2002). From the above statements, a great number of parties in historic buildings maintenance believed that a Conservation Plan is exclusive for certain sectors and not comprehensively applicable to all groups alike, such as sustainable development experts.

As stated by English Heritage and the Department of the Environment and Department of National Heritage in Larkham (2000), it is widely accepted that the success of any conservation policy is a result of strong support (e.g. Maguire, 1997; Taylor, 1997, p. 78; Clark, 2000; Kayan and Zuraini, 2003, p. 42; Dann and Wood, 2004, p. 138; Kayan, 2006, p. 41; Orbaşlı, 2008), active attention (Watt, 1999, p. 225; Earl, 2003; Mansfield, 2004; Chung, 2005) and a high level of awareness (Rodwell 2007, p. 88; Forsyth, 2008) of the public at large. Pendlebury and Townshend reports as reviewed by Johns, warns that “…communities and individuals will continue to need to take a leading role” (Johns, 2007b, p. 144). Rodwell (2007, p.14) argues that “If there is any deficiency in public support, therefore, linkage and strategic roles of conservation seemed to be very loose, unsound and might be missing at some critical points.” Based on the above arguments, there are scepticisms and low level of confidence regarding the practicality and sustainability envisions of a Conservation Plan by the public at large, particularly on how well it will integrates with ‘Green Maintenance’ concept and methodology and sustainable repair approach.

A considerable number of past authors have suggested that the use of Conservation Plan has contributed to unnecessary constraints, particularly for historic building protection. Implementation of a Conservation Plan by local government is firmly based on the “stick rather than carrot” (Taylor, 2004) and only able to be seen as a “punishment rather than a beneficial process” (Historic Scotland, 1998). From these statements, heritage organisations have been penalised for their inability to conform with Conservation Plan. This may have sent a wrong message that a Conservation Plan is an instrument of ‘punishment’ and ‘pressure’ rather than a tool that provides maintenance solutions and reference for ‘Green Maintenance’ concept and methodology and sustainable repair approach decision for historic buildings.
Maguire (1997) and Earl (2003) claim that heritage organisations are often under political pressure (Maguire, 1997, p. 17; Earl, 2003, p. 47). Kerr (2000) suggests that Conservation Plan should be implemented away from extraneous pressures (Kerr, 2000). Efforts to express its benefits for historic buildings conservation are essentially paramount. But, it should be allowed to evolve in an independent manner, particularly in achieving integration with ‘Green Maintenance’ concept and methodology and sustainable repair approach.

There are efforts between related parties in the conservation of historic buildings to the implementation of Conservation Plan in historic buildings. But, their success in the legal context is still very much questionable as there is “loophole” (English Heritage, 2008), “poor” (Dann, Worthing and Bond, 1999, p. 147), “inherent” (Fairclough, 1999, p. 127) enhancement of its principles. In agreement with the statement, Johnson (1999), points out that, “it takes far too long for grant provider to realise why Conservation Plan is needed” (Johnson, 1999, p. 21). Clark (2000) claims that some practitioners in building conservation industry are still unclear about conservation plan terminology (Clark, 2000). Conservation bodies and authorities are, more often than not, able to work collaboratively in implementing a Conservation Plan (Larkham and Jones, 1993, p. 395; Kayan, 2005, p.15; Shacklock, 2006, p. 7). As evidence, English Heritage’s views on planning applications for new development are always in conflict with the opinions of local planning authorities (e.g. Mansfield, 2004). In addition, Miele (2005) claims that very few of a Conservation Plan summary shows any understanding of the statutory planning process and the status of the plan in development control or statutory policy (Miele, 2005). It could be summarised that the needs for legal support and enforcement for Conservation Plan, particularly in adopting ‘Green Maintenance’ concept and methodology from sustainable repair perspectives is remained insufficient.

From the previous discussion, the extent of the influence of deficiencies in a Conservation Plan remains in terms of ‘Green Maintenance’ concept and methodology and sustainable repair perspectives remained unclear and difficult to determine. It can be said that, there is a strong stand on the need to understand the strategic roles that can be played by a Conservation Plan in historic building conservation with regards to ‘Green Maintenance’ and sustainable repair perspectives, particularly in the legislative context.

Conservation legislation and its influence on Conservation Plan

Various documents recognised the importance of Conservation Plan in protecting building’s or place’s significance in legislation in a very specific manner. ‘Building in Context: New Development in Historic Areas’ (by English Heritage and the Commission for Architecture and the Built Environment (CABE), Johns, 2007b), ‘Summaries of Importance’ (by Department for Culture, Media and Sport (DCMS) (Department for Culture, Media and Sport, 2004) and adoption of Scotland’s ‘Conservation Plans: A Guide to the Preparation of Conservation Plans’ in Scotland (Johns, 2007a) have supported the structures, consultation process, implementation, distribution, and presentation of a Conservation Plan. In addition, from April 2005
onwards, each new designation of buildings, sites or places for conservation in UK is required to have a Conservation Plan (e.g. Johns, 2007b).

There is a varying degree of results in the enforcement of legislation and its influence on focus and consistency of a Conservation Plan. Previously, Conservation Plan focused more on buildings that were likely to fall out of use (schools, hospitals, town hall and etc.) and properties listed in Buildings at Risk Register (used by English Heritage and Heritage Lottery Fund) (English Heritage, 1992; Atkins 1999). On behalf of the conservation grants providers, Clark (2000) asserts that Conservation Plan needs to demonstrate the consistency. Consistency of legislation that supports Conservation Plan in sustainable more ways however, is very difficult to be determined as there is no comprehensive procedures and protocols to check their practicality. Pam Alexander, Chief Executive of English Heritage, as cited by Worthing and Gwilliams (2002) said that:

“Management of historic environment has to be done with great sensitivity, and in a sustainable way, to meet today’s needs without compromising the ability of future generations to meet theirs. This will only be possible with widespread support and understanding. However, “legislation alone, even with funding support to support it, would not be sufficient.” (Worthing and Gwilliams, 2002, p. 564).

In the present situation, Conservation Plan seems well-accepted and being promoted in the legislative context by the involvement of a wide-range of conservation organisations. Conversely, it is also clear that there are contradicting views signifying the implementation of a Conservation Plan in more sustainable ways. Therefore, it could be summarise that the rationale for the implementation of a Conservation Plan will only be holistically justified by focusing on all sorts of relevant contexts including well integration with ‘Green Maintenance’ concept and methodology.

3. ‘Green Maintenance’: The Concept and Methodology

Principally, the tenets associated with building conservation philosophy include: least intervention; like for like material replacement; honesty and distinguishability; integrity; reversibility; respect for historic patina; and respect for traditional craft skills (Bell, 1997). The success of maintenance intervention for historic buildings is therefore not only evaluated on the quality of the repair, but also conformity to aforementioned principles. Philosophically, this also specified both in a Conservation Plan and sustainable repair approach.

That being said, interventions that fit within the philosophical context, are generally high quality, have better compatibility with the fabric, highly defensible and have greater longevity than insensitive, often inappropriate repairs. Meanwhile, costs associated with maintaining a building can be contributed to retaining or increasing its value in economic context. Adding to the complexity of prioritisation within the philosophical and economic context, a third and emerging factor in the evaluation of maintenance is environmental sustainability.
The Venn diagram in Figure 1 represents the traditionally accepted conceptual model of sustainability with environmental, societal and economic factors, overlaid with the three factors that influence maintenance for historic buildings, namely; environment, cost and philosophy. Those interventions that intersect with all three contexts would potentially be considered as being the most sustainable concept and methodology for maintenance i.e. ‘Green Maintenance’.

![Figure 1: ‘Green Maintenance’ conceptual model. Source: Forster, et al., 2011 and 2013; Kayan, 2013.]

There is clearly a relationship between the number, type as well as longevity of repair, with embodied energy and CO$_2$ expenditure in repairs. A durable repair requiring fewer repeat interventions and this will incur less CO$_2$ expenditure over the lifespan of the building than a less durable alternative. For example, although replacing natural stone is a significantly more durable than plastic repair, the energy associated is a great deal higher.

Figure 2 shows that there are implications for undertaking maintenance interventions on the service condition of buildings over time. Over the longevity of repair, the downward sloping lines signify the steady decline in building condition. Each maintenance intervention is undertaken largely to bring the building’s existing structure back to its optimal service condition. However, the deterioration rate depends mainly on the repair techniques undertaken. Maintenance intervention is assumed to be taking place when the minimum acceptable condition for the building is reached; the saw tooth profile results from successive interventions, each extending the life of the existing structure.

With regards to historic masonry buildings, a steep gradient denotes a repair technique with a short life expectancy (lower longevity of repair, such for pinning and consolidation techniques in stone masonry wall), which can lengthen the service condition by 20 years. Comparatively, a shallow gradient equates to a durable long...
lasting intervention (higher longevity of repair), such as the natural stone replacement repair technique, which lasts for at least 100 years.

Figure 2: Impact of maintenance interventions on the service condition over the whole life of buildings.
Source: Adapted from Forster, et al., 2011.

Apparently, for the ‘Green Maintenance’ concept and methodology to be of rational use, the embodied carbon expenditure of the repairs must be evaluated using comparable, reproducible methods. For examples, process analysis assessment methods of Life Cycle Assessment (process analysis (P-LCA) can be adopted for the ‘Green Maintenance’ model in order to evaluate carbon expenditure for stone masonry walls of historic masonry buildings within the ‘cradle-to-site’ boundary (Kayan, 2013). Using this methodology, the influences of maintenance intervention (n), total wall repaired area (m$^2$) and longevity of repair on embodied carbon expenditure can be quantified based on Environmental Maintenance Impact (EMI). In the case of historic buildings, the frequency of their maintenance interventions obviously affects their embodied carbon expenditure. It must be emphasised however that the time between interventions is influenced by many variables; longevity of repair, resourcing and geographical location, technological development, mode of transportation, degree of exposure, building detailing, quality of initial work and specification.

‘Green Maintenance’ concept and methodology will be positively welcomed as our society moves towards a low carbon economy and materials and ‘green’ procurement. The level of awareness in our society upon the importance of selection and prioritises low embodied carbon materials is increasing steadily. While low carbon trading in building industry becomes more prevalent, ‘Green Maintenance’ concept and methodology is so important in general as it can be converted into a supplementary financial cost in maintenance decision making process as envisioned in a Conservation Plan as well as in sustainable repair approach.

Based on the EMI ‘Green Maintenance’ has ability to provide guidance for the flexible selection of maintenance options that minimise embodied carbon expenditure.
This promotes sustainable solutions for the repair of existing buildings. The concept and methodology of ‘Green Maintenance’ complements the growth in ‘green procurement’ that is now being accepted as a tangible developing market area. It must be emphasised that Conservation Plan and ‘Green Maintenance’ would benefit from agreed cross party definitions for all organisations responsible for the maintenance of buildings including, particularly in achieving an emerging sustainable repair approach.

4. Sustainable Repair: An Emerging Approach

The Burra Charter suggests that maintenance should be the first priority and must “be distinguished from repair because repair involves restoration or reconstruction” (International Council on Monuments and Sites, 1999, p. 2). This important distinction has been discussed by Worthing et al. (2002), who suggest that repair work is effective at “prolonging the life of the element and the building the fabric (Worthing et al., 2002, p. 296).

Figure 3 overlay the embodied carbon expenditure (CO₂ emission) for each maintenance intervention on the service condition graph. Each maintenance intervention (repairs) is characterised by its longevity and embodied carbon expenditure. Under sustainable repair perspectives, the ‘Green Maintenance’ concept and methodology distinguishes between ‘brown’ and ‘green’ maintenance: namely, those repairs of high and low carbon impact respectively. The cumulative effect of ‘brown’ maintenance increases the total embodied carbon expended far more quickly than ‘green’ maintenance. Conversely, the former is synonymous with less efficient repairs, which have lower longevity and higher embodied carbon (more CO₂ emission).

Figure 3: Relationship between longevity of repair and embodied carbon expenditure.
Conceptually, the higher the embodied carbon expenditure (more CO\textsubscript{2} emissions) is due to more frequent maintenance intervention. In the case of historic buildings repair, however, various mechanisms may exist to attain total CO\textsubscript{2} emissions reduction. These include usage of locally sourced repair materials, engagement of regional companies to undertake repair work and selection low embodied carbon materials. Commonly, in order to attain low embodied carbon expenditure for repair materials, preference is given to repair techniques with higher longevity. Theoretically, the higher the longevity of repair, the less number of maintenance intervention to be undertaken (lower embodied carbon expenditure and less CO\textsubscript{2} emissions). This should clearly emphasise in a Conservation Plan document preparation and adoption of ‘Green Maintenance’ concept and methodology.

For example, natural stone replacement is more ‘greener’ in terms of embodied carbon expenditure as opposed to plastic repair (lower longevity, high embodied carbon expenditure and more CO\textsubscript{2} emissions). It must be emphasised that the complexity of repair longevity, using either single or combined repair techniques in different repair scenarios within the selected boundary of LCA and the maintenance period, requires an appropriate approach for determining ‘brown’ and ‘green’ maintenance in historic buildings.

Meanwhile, a precedent Energy Modelling in Traditional Scottish Houses (EMITSH) in 2008 and LCA report of Technology Assessment for Radically Improving the Built Asset Base (TARBASE) in 2009 show that historic buildings have capability to attained optimum performance (EMITSH, 2008: 1; Historic Scotland, 2008: 1, 2; TARBASE, 2009: 1). For instance, EMITSH successfully identified a generic hierarchy of interventions for all traditional dwellings in Scotland by developing general rules-of-thumb for an informed selection of technologies and measures to reduce the carbon dioxide emissions. Moreover, EMITSH has adopted the measures with high probability of user-acceptance, such as improving of lighting and appliance which carried out first, followed by basic insulation such as roof insulation. Subsequently, technology-replacing measures, such as more advanced appliance options (e.g. improving refrigeration) and boiler upgrades were the other adopted measures. Meanwhile, TARBASE had effectively delivered technological solutions which will allow a radical, visible, step change input to policies and programmes designed to reduce the carbon footprint of the UK building stock (Carbon Vision target of a 50% reduction in carbon emissions by 2030 on the UK’s existing built assets), since at least 75% of the building stock that will be present in 2030 is already in existence. With regards to UK’s existing buildings, TARBASE primary aims is to assess the potential of present and future technologies available for carbon intensity reduction under three headings namely- (i) building fabric and installed heating, ventilating, and air conditioning (HVAC), (ii) energy production and storage, and (iii) end-use equipment. It must be noted however that, both of the works are conversely attempted to make historic buildings more energy efficient using retrofitting approach and not by means of adopting sustainable repair approach in reducing CO\textsubscript{2} emissions.

Comparatively, if we can evaluate the efficacy of repair in terms of its embodied carbon expenditure (CO\textsubscript{2} emissions) based on ‘Green Maintenance’ concept and
methodology, it could then be tailored to suit the EMI aspects rather than the longevity of repair alone. It must be noted that, to fully appreciate the EMI of the repair, the boundary of LCA and maintenance profile period must be set appropriately.

Figure 4 shows how EMI of repair builds up. In the case of historic masonry buildings, this is the cumulative effect of maintenance interventions over the stone masonry walls’ life, denoted by $n_1$, $n_2$ and $n_3$. Each intervention (repair) has embodied carbon expenditure ($ce$) and a longevity of repair ($l$).

![Figure 4: Determination of theoretical ‘Environmental Maintenance Impact’ (EMI) of maintenance interventions. Source: Adapted from Forster, et al., 2011.](image)

The total embodied carbon expended by maintenance interventions through repair is illustrated by the following equation:

$$\text{Carbon expenditure on maintenance} = \sum_{i=1}^{n} ce_i$$

where;

- $n =$ number of interventions
- $ce_i =$ embodied carbon expenditure for the $i$th maintenance intervention [evaluated by within ‘cradle-to-site’ tools of LCA] [kgCO$_2$/kg/m$^2$]

Based on the ‘Green Maintenance’ concept and methodology, the efficiency of single or combined repair techniques undertaken in different repair scenarios can be tested based on their EMI. The following section discussing on how well a Conservation Plan’s components, structures and processes associated with ‘Green Maintenance’ from sustainable repair perspectives.
5. Conservation Plan and ‘Green Maintenance’ from Sustainable Repair Perspectives: The Integration

As previously discussed, a Conservation Plan plays a crucial role to pull all the building conservation issues together in a balanced way. With regards to historic buildings maintenance, well prepared Conservation Plan provides a good approach, protection, legislative control (Yeomans, 2007), promotes active involvement (Fairclough and Taylor, 2001), contributes resolutions (Drury, 1999; Worthing and Bond, 2008), enhances the cultural significance (Kerr, 2000; Worthing and Dann, 2008) and enlightens the clarity of historic buildings (Simpson, 1999). It must be noted that, a Conservation Plan as referred in this paper is related to historic building repair and not associated with the planning of the conservation areas. Additionally, the paper also focused mainly on ‘Green Maintenance’ concept and methodology as a measure of achieving sustainable repair.

However, other professionals in the industry suggested that there is a need to develop a Conservation Plan in a more comprehensive, vigorous and robust manner. Miele (2005) argues that: “...Conservation Plan succeeds not because the statement of significance or policy section is well worded (although this helps); the critical factor has in every case been whether or not the plan shows an awareness of the wider development process affecting the site” (Miele, 2005, p. 25). Wood (1999) highlights that, “the promoters of Conservation Plan should seek to introduce greater flexibility into their conceptual model, addressing the different circumstances commissioned by the different types of clients” (Wood, 1999, p. 83).

On the other hand, Miele (2005) points out that“...there is no technical planning reason why an authority could not give a Conservation Plan some status, encouraging or even requiring them in respect of certain sites or areas...and to allow for the possibility of Conservation Plan in certain circumstances” (Miele, 2005, p. 32). Considering the above statements, it is clear that an opportunity exists now to give Conservation Plan a stronger statutory basis tailored to suit building conservation needs and context, particularly in achieving ‘Green Maintenance’ concept and methodology and sustainable repair approach for historic buildings.

Clarks (1999b) strongly believed that a Conservation Plan seems able to avoid various layers of legislative system-bureaucratic policies (Clark, 1999b). However, Miele (2005) raises his concern on overlapping issues as he points out:

“One could argue that local planning policies which reproduce accepted guidance and principles are superfluous and should not be repeated in Conservation Plan...therefore, evidence-based analysis is essential to the effectiveness of conservation plans” (Miele, 2005, p. 25).

Therefore, if a Conservation Plan is really good and practical in the building conservation industry, then more than a simple semantic shift is needed. This includes
evidence-based analysis on its implementation, particularly in adopting ‘Green Maintenance’ concept and methodology as well as attaining sustainable repair approach for historic buildings.

Conservation Plan can act as a “bridge” for all the expertise involved in the protection of heritage properties. But, in reality, this is not seen as a common practice. In enhancing the workability and values of a Conservation Plan however, contributions of other professionals may be overlooked. Worthing and Gwilliams (2002) quoted:

“The National Trust has admitted as it has not always happened in practice. The National Trust has placed particular emphasis on surveys which reflect specialist views of archaeologist, nature conservationists, and architectural historians. Yet, it has tended to place less emphasis on local people’s judgments of what is significant and must now consider how to restore the balance” (Worthing & Gwilliams, 2002, p. 20).

The question is, apart from owners and occupiers who should be consulted in developing a Conservation Plan? Glover (2003) articulates that building surveyors’ expertise is required to enhance the value of A Conservation Plan as they possessed the competency necessary in producing maintenance schedule, conducting dilapidation survey and preparing building repair works proposal (Glover, 2003). To encapsulate this articulation, ideally, a Conservation Plan should be prepared by a wide and balanced range of experts. It should also be prepared without heavily relies on the influence of certain expertise. This will help a Conservation Plan to be well integrated with ‘Green Maintenance’ concept and methodology and sustainable repair approach.

It is also important for the people who are commissioned to carry out a Conservation Plan to show their awareness on relevant influencing factors and needs of ‘Green Maintenance’ and sustainable repair for historic buildings. As has been highlighted, a Conservation Plan is affected by relevant factors such as building’s information and conservation policies (see for example, Christchurch City Council, 2004), therefore, they are likely to be implemented with more integrity and competently (Clark, 1999b) using a rigorous approach yet in a transparent way (Worthing and Bond, 2008). According to Worthing and Bond (2008):

“three categories of stakeholders who need to be consulted and actively involved including interested parties who might be affected or might have an impact on conservation plans delivery and individuals and groups that may have evidence in significance establishment. Individuals or groups involved and have memories and insight into the place should also be consulted as well”. (Worthing and Bond, 2008, p. 20).

It is clear that Conservation Plan should not be confidential to those who share the common grounds, issues and benefits from their heritage properties such as the stakeholders and public at large.

Conservation Plan can be seen as a driver that contributes to a sustainable historic environment. Clark (1999a) suggests that implementation of conservation plan is
another aspects of achieving sustainability (Clark, 1999a). English Heritage echoed that Conservation Plan achieves a good understanding and set a high level of appreciation of the historic environment values, forces of change and resources (English Heritage, 1992 and 1997). Apparently, when a Conservation Plan provides guidelines to achieve a balance either in cultural, aesthetic, economic, environment and etc. for historic buildings (including integration with ‘Green Maintenance’ concept and methodology and sustainable repair), only then heritage conservation and sustainable historic environment goals is likely to be achieved (see example from Forster, et al., 2011).

Conceptually, the integration between a Conservation Plan and ‘Green Maintenance’ concept and methodology and sustainable repair approach in historic buildings conservation must also be implemented within a framework based on ethics and principles, including least intervention; like-for-like material replacement; distinguishability; integrity and reversibility. Success is evaluated against these principles. For example, ‘Green Maintenance’ concept and methodology has illustrates that the importance of transportation of repair materials with regional sourcing playing and ever increasing role in the significance of CO\(_2\) reduction. The concept and methodology has also shown that the local sourcing of regional materials is often environmentally the best option (Kayan, 2013, p. 223).

The use of locally sourced materials compared against imported materials can significantly minimise CO\(_2\) associated with transportation. Clearly, resourcing next to the proposed project location will yield greater results in terms of lower CO\(_2\) emissions. In general, the shorter the transportation distance, the lower the embodied carbon expended on the locally sourced materials delivery.

In 2008, a preliminary study was been undertaken by Venkitachalam (2008) to evaluate the carbon footprint for stone in the Scottish context. This study highlighted the fact that a high proportion of the carbon footprint (within ‘cradle-to-gate’ LCA) for sandstone is contributed by transportation. This study also found that transportation emissions were between 31% and 90% of total represented embodied emissions associated with local and imported stone respectively (Venkitachalam, 2008). In addition, Crishna et al., 2011 discovered that a massive increment of 90% to 550% (over six times more) was noted in relation to transportation of stones imported mainly from China and India when compared to equivalent material sourced locally (Crishna et al., 2011).

Due to the integration of the three concepts, the appointment of regional companies to undertake the repair work would also be beneficial. This has the simultaneous benefit of stimulating the local economy and repair of hard to treat buildings (including historic buildings) with generally speaking, the most historically accurate materials available by implementing sustainable repair approach. Under the sustainable repair approach, these materials are also often the most physically and aesthetically compatible.

The use of local craft skills also pay dividends in terms of reducing carbon and would hopefully, in the longer term embed the concept of local sourcing and procurement from management tendering for projects through the operatives undertaking the sustainable repairs. Based on the aforementioned discussion, the
integration between the Conservation Plan, ‘Green Maintenance’ concept and methodology and sustainable repair approach is essential to the emergence and virtues of sustainable historic environment.

6. Conclusion

Conservation Plan can be seen as a rigorous tool to comprehensively understand building, place or site and making informed historic building conservation decision and repair options. Despite widely promoted and broadly recognised, Conservation Plan often mitigates against its integration with ‘Green Maintenance’ concept and methodology and sustainable repair approach for historic buildings. This paper shows that, significant reductions in CO₂ can be achieved by ‘Green Maintenance’ and this could be of value to decision-makers, including all parties preparing and implementing a Conservation Plan and operative undertaking sustainable repair. The concept and methodology of ‘Green Maintenance’ facilitates a deeper analysis of the tension between philosophies of repair as envisioned in a Conservation Plan and sustainable repair perspectives, set against carbon emissions and cost, making initially difficult decisions easier to defend. More importantly, the integration between the three concepts have had contributed significantly in achieving sustainable development. This could be utilised to form the basis of a primary decision making process for attaining sustainable historic environment.

Acknowledgements

The author would like to thank Dr. Alan M. Forster (Tenured Assistant Professor) and Professor Philip F.G. Banfill of School of the Built Environment, Heriot-Watt University, Riccarton, Edinburgh, UK for their valuable inputs throughout the completion of this paper.
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