Implementing Environmental Management Systems in the Architecture, Engineering, and Construction Sectors of the UK

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Abstract

Environmental management systems (EMS) are a modern-day management tool available for various industries and sectors to adopt as part of their organisational strategies. They are designed to help an organisation guide and direct their environmental performance targets and, more recently, their sustainability targets too. Despite a worldwide increase in their uptake (particularly ISO14001), understanding the rationale and motivations why an organisation does or does not implement an EMS remains a complex topic. Based on a portfolio of peer-reviewed articles (n=12), which have a focus on the architecture, engineering, and construction (AEC) sectors, the aim of this doctorate study is to two-fold: to identify and examine the benefits and barriers to the implementation of EMS (particularly ISO14001) in the AEC sectors and to use these to create a roadmap that can indicate pathways for AEC organisations to support the delivery of the United Nation's Sustainable Development Goals (SDGs). Utilising a pragmatism stance, a mixed-methods approach of literature reviews, questionnaire surveys and interviews with environmental professionals based in the AEC sectors has been used to collect quantitative and qualitative data from national and international settings. Many of the case study findings presented herein support and align with those of previous studies. The need, however, to have an EMS to enable engagement with governments or for other tendering processes has come to the fore as a leading benefit, and the absence of an EMS is a substantial hurdle to successful trading. Importantly, many organisations are now working towards sustainability objectives but are not always seeing the opportunity to use their EMS as a tool for monitoring their targets. This may be because, traditionally, an EMS was mostly treated as a tool for waste management and legal compliance. It has also become clear that many of the organisations do not include client construction projects in their EMS, so while they may have a system, it is often limited to their offices and transport rather than the design and construction of buildings, which are the revenue generators of their operations. Further, whilst there is worldwide interest in the adoption of sustainable practices within the AEC sectors, it is proposed herein that a need exists for an amalgamated approach that is relevant for the sectors and all organisations working within them. Therefore, a roadmap has been created as part of the work that can enable AEC organisations to use the EMS to accord with the SDGs. In summary, the work has highlighted that some organisations have moved-on from using an EMS solely to support their environmental management ambitions and are now working towards sustainability-focused aspirations too. Not all of them, however, are monitoring these targets. Therefore, it is proposed that future research should ascertain why all organisations are not yet using ISO14001 to deliver both their environmental and sustainability objectives.

Acknowledgements

Thank you, Gwyn Jones, for your support and ability to read English better than myself, your Welsh is better too.

Also, thanks to my supervisory team, Prof. Colin Booth for your unwavering belief in me and my abilities, without your encouragement this would not have been produced. To Dr Abdul-Majeed Mahamadu thank you for being there for the technical aspects and alternative perspective on parts of the papers.

Thanks to my mum who has not really understood why I would want to do this but has supported me anyway.

I dedicate this to my dad who did not have the opportunities that I have had, and I hope would have been proud of what I have achieved.

About the Author

After working for 13 years in the engineering sector, I started university later than most other students. This experience gave me inside knowledge of the constraints and opportunities that exist within the engineering sector in relation to their environmental challenges. Further, these insights motivated me to study for my first degree in BSc (Hons) in Geography. This taught me about a range of subjects but, most importantly, enabled me to discover a passion for environmental management. Therefore, next I studied for a higher degree (MSc Environmental Management), where I could immerse myself with much greater knowledge about environmental management systems (EMS). Next to better appreciate the organisational aspects of adopting EMS, I studied for an MBA. Reading for a second higher degree enabled me to better understand business environments and the issues (particularly economic constraints), which must be managed to build and maintain an organisation.

It was my qualifications and insights of environmental management that led me to the world of academia, as a Senior Lecturer at the University of Derby (UoD). The focus of my teaching has been, and continues to mostly be, on environmental management, with particular attention on ISO14001. Next, and to further strengthen my skillset, I trained to be an internal auditor and then a lead auditor for ISO14001. These courses enabled me to do work with the Forestry Commission, auditing sites for their management review process. This auditing experience permitted me to gain hands-on experience and understanding of the ways in which organisations set-up their management systems and also some consideration for the reasons why they choose certain objectives over others.

When the environmental manager at UoD departed their post, I was offered a secondment away from my academic post to perform a review and gap analysis of the university's own management systems. Part of my recommendations was to change from using Ecocampus and to adopt ISO14001. This proposal was agreed by the Governing Council of the UoD and I was tasked with implementing and delivering this update. Again, this provided valuable hands-on experience of the benefits and barriers to operating a management system to the expectations of the ISO14001 standard. The system has now been in place for 7 years, albeit now run by the UoD estates team and I have returned full-time to my substantive teaching post.

The Institute of Environmental Management and Assessment (IEMA) is the largest professional body for environmental practitioners worldwide, with nearly 20,000 members. I have been involved in this organisation for 21 years. Furthermore, I have been the Chairperson of the IEMA Midlands Regional Steering Group for over 10 years. Concomitantly, during this timeframe I have also developed a research profile, supported by my mentor, collaborator, and doctorate supervisor Professor Colin Booth, which has used my background knowledge and skills to explore many environmental issues (e.g. decarbonisation, sustainable buildings, amongst others). Most research investigations, however, have focussed on understanding the implementation of EMS in organisations. This collective evidence contributed to the raising of my membership status to Fellow (FIEMA), the highest membership position, with only ~300 persons reaching this grade worldwide.

Credited Learning

In accordance with the expectations of all doctorate candidates registered at UWE Bristol, the candidate has completed the mandatory learning requirements of 60-credits of research training modules. The specific modules taken and passed are detailed beneath (Table A).

Table A: Required taught component of the DPhil.

Module Title	Grade (pass/fail)	Number of credits
Research in a Contemporary Context (USSJLK-30-M)	Pass	30
Advanced Specialist Text Study (UFMFJG-15-M)	Pass	15
Qualitative and Quantitative Methods (USPJVK-15-M)	Pass	15

Supervisory Team

Director of Studies: Prof. Colin A. Booth (UWE, Bristol)
Second Supervisor: Dr Abdul-Majeed Mahamadu (The Bartlett, UCL).

Preface to the DPhil Thesis

This thesis is presented for the award of a DPhil degree by portfolio. The DPhil is an award that recognises the intellectual merit of papers, which are published and then drawn together as a thesis. This differs from the traditional PhD as it is more accessible to someone who is working fulltime and wishes to complete a Doctorate degree.

The supporting evidence comprises of journal and book chapter articles, all of which are either published or have been accepted for publication. While this is not a traditional doctorate (i.e., PhD), as it is not focused on one task, its structure is set out in the same manner.

Portfolio of Publications used to Support the Thesis

The DPhil thesis uses a collection of published articles (n=12) as the evidence to support the content of the chapters. The full citation information for each article is detailed beneath, plus an indication of the candidate's contribution to each work.

Article 1 (Book Chapter): **Horry, R.E.** & Booth, C.A. (2018) Use of environmental management systems to mitigate urban pollution. In: Charlesworth, S.M. and Booth, C.A. (Editors) *Urban Pollution: Science and Management*. Wiley–Blackwells: Oxford. pp. 293–302.

Candidate's contribution: Lead author; producing about 90% of the work; particularly conceptualization, methodology, formal analysis, investigation, resources, writing - original draft preparation, and project administration.

Article 2 (Conference Paper and Book Chapter): Shutler, R., **Horry, R.E.** and Booth, C.A. (2024) Saving nemo and friends from the potential impacts of permitted building developments on the beaches of Jersey. In: Gorse, C., Booth, C.A., Scott, L., Dastbaz, M. and Drotleff, B.O. (Editors) *Sustainable Ecological Engineering Design*. Springer Nature, Chan, Switzerland. (in press).

Candidate's contribution: Co-author; producing about 30% of the work; particularly writing review and editing, supervision, and project administration.

Article 3 (Conference Paper and Book Chapter): Mundy, P., Henderson, E., **Horry, R.E.** and Booth, C.A. (2024) Building certification schemes: Are they driving or derailing sustainable development in the construction sector? In: Gorse, C., Booth, C.A., Scott, L., Dastbaz, M. and Drotleff, B.O. (Editors) *Sustainable Ecological Engineering Design*. Springer Nature, Chan, Switzerland. (in press).

Candidate's contribution: Co-author; producing about 30% of the work; particularly writing review, editing and supervision.

Article 4 (Conference Paper and Book Chapter): Baranova, P., **Horry, R.E.** and Booth, C.A. (2024) To infinity and beyond the environmental impact minimisation paradigm. In: Gorse, C., Booth, C.A., Scott, L., Dastbaz, M. and Drotleff, B.O. (Editors) *Sustainable Ecological Engineering Design*. Springer Nature, Chan, Switzerland. (in press).

Candidate's contribution: Co-author; producing about 40% of the work; particularly investigation, resources, and writing - review and editing.

Article 5 (Journal Paper): **Horry, R.E.**, Booth, C.A., Mahamadu, M.J. and Ball, S. (2023) Benefits and barriers to the implementation of ISO14001 in the Architecture, Engineering and Construction sectors: A systematic literature review - *Proceedings of the Institution of Civil Engineers – Engineering Sustainability*. DOI: 10.1680/jensu.23.00038.

Candidate's contribution: Lead author; producing about 60% of the work; particularly conceptualization, methodology, formal analysis, investigation, resources, writing - original draft preparation, and project administration.

Article 6 (Journal Paper): Rasheed, A.S., Booth, C.A. and **Horry, R.E.** (2023) Stakeholder perceptions of the benefits and barriers of implementing environmental management systems in the Maldivian construction industry. *Journal of Housing and the Built Environment*. 38, pp. 2821-2850.

Candidate's contribution: Co-author; producing about 20% of the work; particularly, investigation, and writing - review and editing.

Article 7 (Journal Paper): Beck-Schildt, J.C., Booth, C.A., **Horry, R.E.** and Wiejak-Roy, G. (2023) Stakeholder opinions of implementing environmental management systems in the construction sector of the USA. *Buildings.* 13, pp. 1241.

Candidate's contribution: Co-author; producing about 20% of the work; particularly writing - review and editing.

Article 8 (Journal Paper) Bailey, M., Booth, C.A., **Horry, R.E.**, Vidalakis, C., Mahamadu, A.M. and Baffour Awuah, K.G. (2021) Opinions of small and medium UK construction companies on environmental management systems. *Proceedings of the Institution of Civil Engineers – Management Procurement and Law.* 174, pp. 23-34.

Candidate's contribution: Co-author; producing about 25% of the work; particularly writing review and editing, and project administration.

Article 9 (Conference Paper and Book Chapter): **Horry, R.E.**, Booth, C.A. & Mahamadu, M.J. (2023) Towards a consensus of expert opinions on implementing ISO14001 in the architecture, engineering, and constructor sectors of the UK. *Sustainable Development & Planning* XII. WIT Press, Southampton. pp. 329-341.

Candidate's contribution: Lead author; producing about 70% of the work; particularly conceptualization, methodology, formal analysis, investigation, resources, writing - original draft preparation, and project administration.

Article 10 (Journal Paper): **Horry, R.E.**, Booth, C.A. and Mahamadu, A.M. (2023) Environmental management systems in the architecture, engineering, and construction sector: A phenomenological study. *Proceedings of the Institution of Civil Engineers – Engineering Sustainability*. http://doi.org/10.1680/jensu.23.00031.

Candidate's contribution: Lead author; producing about 70% of the work; particularly conceptualization, methodology, formal analysis, investigation, resources, writing - original draft preparation, and project administration.

Article 11 (Journal Paper): **Horry, R.E.**, Booth, C.A., Mahamadu, A.M., Manu, P. and Georgakis, P. (2021) Environmental management systems in the architectural, engineering and construction sectors: A roadmap to aid the delivery of the sustainable development goals. *Environment, Development and Sustainability.* https://doi.org/10.1007/s10668-021-01874-3.

Candidate's contribution: Lead author; producing about 60% of the work; particularly conceptualization, methodology, formal analysis, investigation, resources, writing - original draft preparation, and project administration.

Article 12 (Book Chapter): **Horry, R.E.**, Booth, C.A. and Mahamadu, A.M. (2023) Contributions of environmental management systems (ISO14001) towards the delivery of sustainable development goal 12. In: Opoku, A. (Editor) *Elgar Research Companion to the Built Environment and the Sustainable Development Goals (SDGs)*. Edward Elgar Publishing, Cheltenham.

Candidate's contribution: Lead author; producing about 80% of the work; particularly conceptualization, methodology, investigation, resources, writing - original draft preparation, and project administration.

About this Thesis and its Structure

The thesis is divided into eight chapters and uses the information and findings revealed in each of the published articles listed earlier to deliver the objectives of the thesis. An overview and insights of the chapters are described beneath (Figure A).

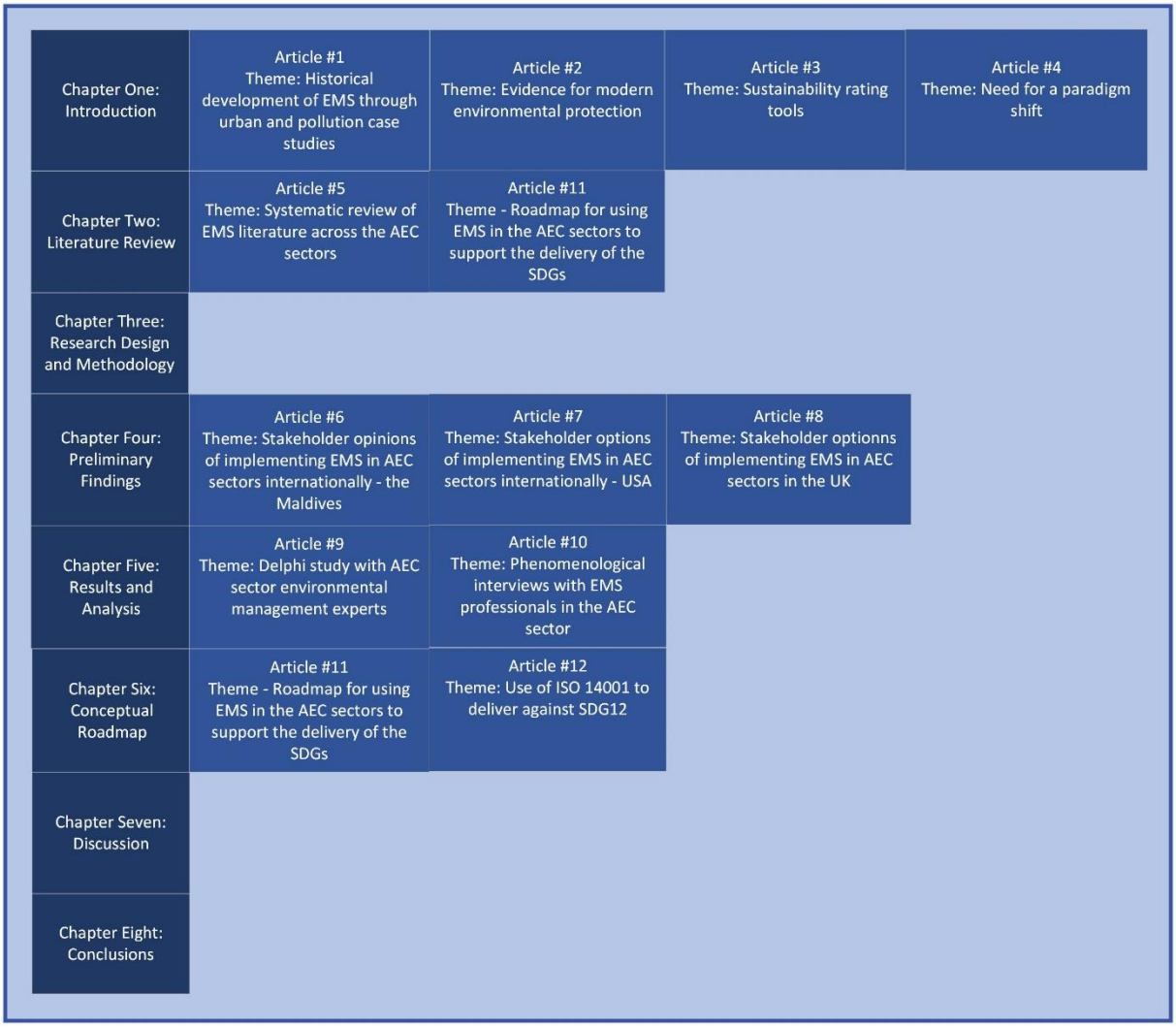

Figure A: The structure the DPhil thesis.

Chapter One: This uses information published and an overview of Articles #1-#4. These articles set the scene in terms of environmental pressures and society's awareness of these. It looks at the history of Environmental Management Systems (EMS) noting that these have only come to the fore in the last 30 years. The processes involved with EMS in terms of policy, goals, plans and legal requirements are highlighted, as are the variety of standards; however, the focus is on ISO14001. Environmental management is considered in the sense of how organisations response to this challenge can impact their profitability. The study examines the Architectural, Engineering and Construction (AEC) sectors, as these have traditionally had significant environmental impacts associated with their operations. The growing interest of the public through media exposure will potentially have knock on effects in terms of the viability of the various organisations. This along with the predictions for population increase and increasing

urbanisation will see these sectors having the opportunity to produce the sustainable future that we will need to ensure the viability of future generations. The question is will this be what happens in practice. This leads neatly to the aim of this study, which is to identify and examine the benefits and barriers to the uptake and implementation of EMS (particularly ISO14001) in the AEC sectors and to use these to create a roadmap that indicate pathways for AEC organisations to support the delivery of the SDGs.

Chapter Two: This uses information from Articles #5 and #11. It presents a brief literature review of EMS journal articles. This review highlights that organisations are still focused on the economic benefits of any actions and that there is a tendency to justify any action with a suitable return on investment to ensure that projects are completed.

Chapter Three: This uses information published in Articles #2-#11. The chapter describes the research design and methodology in general and then how it was used in the thesis. Overall, a pragmatist philosophical stance was taken as this allows for the benefit of the doubt. The environment and environmental management are relatively new in terms of understanding and awareness, being around 40 years old and as a discipline it tends to be reactive rather than proactive. A range of methods were used over the course of the production of the publications including questionnaire surveys, archival review, case study, Delphi studies, interviews, and systematic literature reviews.

Chapter Four: This uses information published in Articles #6-#8. This chapter builds on the work produced in the earlier chapters. It presents the preliminary findings based on several pieces of research. As there is a great deal of variation in what are deemed to be the benefits and barriers to the implementation of ISO14001 it was necessary to first establish a baseline from which to work. The baseline is presented in the form of three Articles: one on the use of ISO14001 in the Maldives, one in the USA and one in the UK.

Chapter Five: This uses information published in Articles #9 and #10. This chapter discusses the main results. Following on from the preliminary findings, it was decided that more in-depth investigations were required to ascertain the benefits and barriers to the use of ISO14001. This firstly involved a Delphi study to gain a consensus of thought and then a phenomenological study to gain an understanding of the lived-experiences of those working with ISO14001.

Chapter Six: This uses information published in Articles #11 and #12. This illustrates the creation of a roadmap to enable those who wish to use ISO14001 to help work towards delivering sustainability in relation to the SDGs. It also examines how the use of an EMS can be expanded and still provide the same benefits as using an EMS in the purest environmental approach.

Chapter Seven: This uses information published in all the Articles. This is where the discussion on the overarching themes and results from this body of work can be found.

Chapter Eight: This summarises the evidence of the study to demonstrate the accomplishment of the thesis aim and objectives; plus, it also proffers conclusions and recommendations based on the findings.

The Thesis

This thesis as previously mentioned is made up of 12 research outputs. Figure B provides the reader with an overview of the thesis; linkages between the chapters, objectives, and the outputs in a single diagram to facilitate a clear understanding of how this thesis comes together.

Figure B: An overview of the DPhil thesis.

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CHAPTER 1: INTRODUCTION

This chapter uses information published in Articles #1-#4. These articles form part of the background for the thesis. The purpose of each article is detailed in boxes throughout the work beginning with Box 1. Article boxes are used to provide a summary of individual articles at relevant points throughout the thesis.

BOX 1

ARTICLE 1: The aim of this publication was to provide an overview of the importance for organisations to have an established EMS in place. It then employed a series of infamous case studies to examine if an EMS could have been a useful means of mitigating polluting events.

ARTICLE 2: Ths aim of this publication was to evaluate the significance of waiving the requriements for an EIA on small scale developments and to consider the cumulative impact those small-scale developments may have on the natural environment in Jersey.

ARTICLE 3: The aim of this publication was to pose the question as to whether building certificate schemes are the answer to addressing the sustainability dilemma within the construction industry or whether they are simply designed to meet the needs of the market?

ARTICLE 4: The aim of this publication was to explore current EMS procedures and processes to propose a conceptual framework of how the existing system could be improved/expanded to become more nature-based, with the inclusion of an ecologically holistic approach.

*boxes are used throughout to help guide the reader.

This chapter demonstrates the background to environmental management by first considering what management systems are, then examining environmental management systems. Following on from this it will consider some of the issues in relation to human interaction with the environment and the challenges that have been encountered (Article #1). This work will then focus on the Architecture, Engineering and Construction (AEC) sectors and how their activities impact the environment. Business and sustainability will also be discussed followed by reviewing the research gap and the need for this thesis. So firstly, what are management systems?

ARTICLE 1

In this book chapter looking at urban pollution there was a review of the historic situation using case studies which drew the conclusions that it is always easy to be wise after the event, and all those involved with the incidents highlighted were doing what they thought to be the best at the time. There was no deliberate intent to damage or injure. However, when you consider these incidents it becomes clear that they all have the issues be they human error, lack of management control, lack of planning or increase in demand. We cannot control earthquakes but we can build facilities, which can withstand them. We cannot avoid using relief or new staff but we can make sure they have all the skills and information they need to do the job. We have to expand processes to fill demand but we can think of the risks involved and mitigate the potential for failures.

1.1 MANAGEMENT SYSTEMS

Management systems are tools used for strategic control of an organisation, so it can monitor, evaluate, and improve its performance (Hill and Jones, 2007). They can be formal or informal, and they can be used to examine performance and/or knowledge. They are primarily used within businesses but can fit into any organisation where performance and activities need to be monitored. Performance management can involve evaluation using a balanced scorecard (Oliveira *et al.,* 2021), management by objectives (Islami *et al.,* 2018) or budget-driven plans (Millar *et al.,* 2001). Knowledge management tends to focus on people, process, content/IT,

and strategy (Manesh *et al.,* 2020). Such systems allow analysis of situations to give a perspective on progress and opportunities for improvement. They tend to use iterative processes, which form a continuous cycle of plan, analysis, implementation, and evaluation (commonly known as plan, do, check, act) (Abualwafa *et al.,* 2023) examples include ISO14001, ISO9001, ISO45001, and ISO27001 (Figure 1.1).

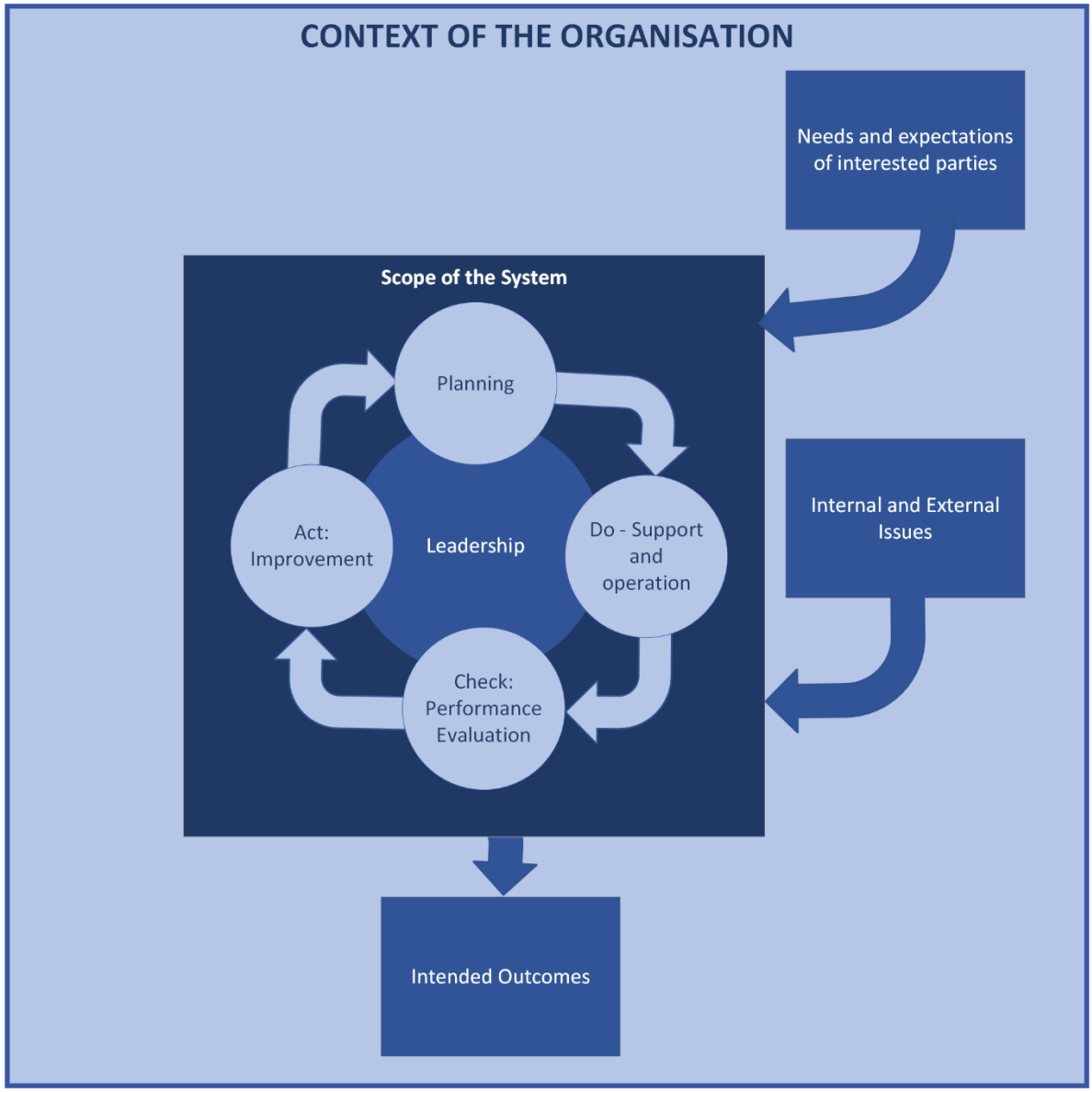


Figure 1.1: Plan-do-check-act (Adapted from ISO, 2023a).

The International Standards Organisation (ISO) are a major contributor to the production of standards against which businesses can be certified (OECD, 2016). This is where organisations can implement a standard, which is then checked for effectiveness by a third party before the company can be awarded the standard; stating that their operations comply to the requirements as set out by ISO (British Standards Institute, 2023). This is common in respect of all ISO standards for example: Quality Management (ISO 9001/2), Occupational Health and Safety (ISO 45001) and Information Security Management (ISO 27001). The ideology behind

systems management though has a long history and can be traced back to Aristotle's statement *"The whole is more than the sum of its parts".* This has resulted in businesses putting in place management systems to help them organise their operations, to create order, to have procedures and processes, which are documented and can be followed by all staff.

In respect of Environmental Management Systems (EMS) there are several types available for businesses to choose from; ISO14001 is the most popular globally, but there is a European version called the Eco-Management and Audit Scheme (EMAS) and then there are options for businesses to develop an EMS via a staged process, such as the Acorn scheme, or in the case of Universities, the Eco-campus scheme. The articles used to support this thesis will focus on the use of ISO14001 as this tends to be the more popular choice of system within the AEC sectors. Therefore, environmental management systems will now be explored in more detail.

1.2 ENVIRONMENTAL MANAGEMENT SYSTEMS (EMS)

An Environmental Management System (EMS) is an organisational tool (Figure 1.1) that can help businesses manage and positively reduce their negative impact on the environment (Christini *et al.,* 2004; Oke, 2004). Further, the use of the tool helps a company measure its environmental performance and provides the framework for such work as the integration of sustainable development goals (SDGs) within the organisation's corporate plan (Ilinitch *et al.,* 1998; Jolevski, 2013; Owolana and Booth, 2016); thus, it is both a performance and knowledge-based management system.

Within organisations, environmental management should be treated as an integral part of any operation, alongside the option for corporate social responsibility (CSR), to ensure the organisations not only acknowledge the impacts of their operations but also that they have plans and strategies in place to minimise their negative impacts on the environment and society. This is relevant to both their daily operations and any resulting risk from an emergency (e.g. pollution events, etc.).

Typically, an EMS encompasses policies, goals, plans and regulatory requirements and is usually reflected in the company's annual reports. Christini *et al.* (2004) list the following basic characteristics for an organisation's EMS:

1. Goals, methods, and a timeline for achieving environmental criteria.
2. Procedures for maintaining a paper trail in relation to those goals.
3. A defined structure and a matrix of responsibilities, as well as allocated resources.
4. Corrective actions and emergency procedures.
5. An employee training plan.
6. A plan for monitoring and auditing the organisation's performance in achieving the EMS goals.

There are many different EMS. As noted earlier, however, this research will focus on ISO14001, which originated from BS7750 (in 1996) and has been updated twice in the intervening years (ISO14001:2004 and ISO14001:2015). The standard has progressed over these iterations resulting in a process, which now puts greater emphasis on senior management commitment and the risks and opportunities in relation to the organisations' operations.

There has been an increased use and popularity of EMS over the last 20 years, and they can be found in a variety of sectors. Adoption of the ISO14001 EMS has increased from ~15,000 certifications in 1999 to more than 346,000 in 2016 (ISO, 2023b) (Figure 1.2). Neumayer and Perkins (2004) examined the uptake of ISO14001 and noted certifications were 49.6% in Europe, 34.8% in Asia, 7.3% in North America, 3.9% in Australia and New Zealand, 2.5% in Africa and 1.9% in Central and South America. In 2021, the number of valid certificates had reached 420,433 (ISO, 2023b). These figures have not only increased but it is also noted that there is a change in the location, in terms of the highest number of certificates; China - 217,592; the UK - 17,378; Spain - 14,122; Japan - 21,976 and Italy - 18,135; America - 4,171; and Thailand - 4,381 (ISO, 2023b). Other researchers (Orcos and Palomas, 2019) have investigated the uneven application of ISO14001. They suggest that national culture impacts the perceived importance of the concerns of those considering adopting the standard (Orcos and Palomas, 2019). It is also noteworthy that of the declared sectors (in 2021), construction had the highest representation of all sectors with 68,551 certificates (ISO, 2023b) (Figure 1.3).

Environmental management systems (EMS) (particularly ISO14001) set out with the aim to enable organisations to prevent pollution, enable continual improvement and comply with legislation (BSi, 2015). While environmental management practices can be defined as "*the techniques, policies and procedures a firm uses that are specifically aimed at monitoring and controlling the impact of its operations on the natural environment*" (Yu and Ramanathan, 2016). It must, however, be acknowledged that despite environmental standards having focused on continual improvement, they do not actually specify a level of improvement or harm reduction (i.e., pollution prevention). Therefore, they have been accused of not enabling a transformation in terms of sustainability (Brown, 2016), but purely a means to attain legal compliance. Others had suggested that standards are being used increasingly to create economic value – cost savings or increased market share and opportunities for business rather than environmental improvements (Jones and Laquidara–Carr, 2018). The next section will review the situation that currently exists in relation to ISO14001 and why this standard is needed.

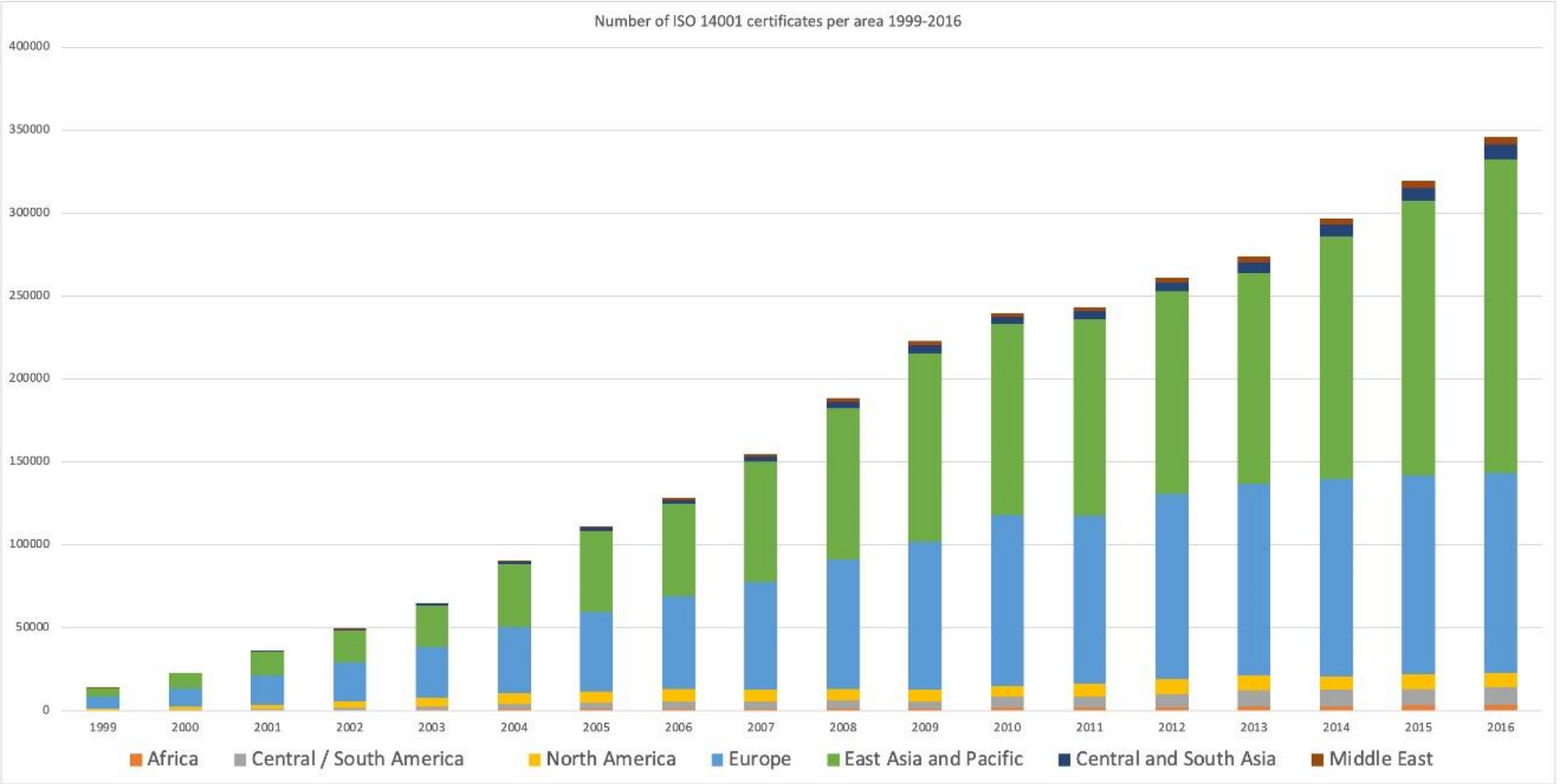


Figure 1.2: Annual totals of certificates issued per region 1999-2016 (Source: ISO, 2023b).

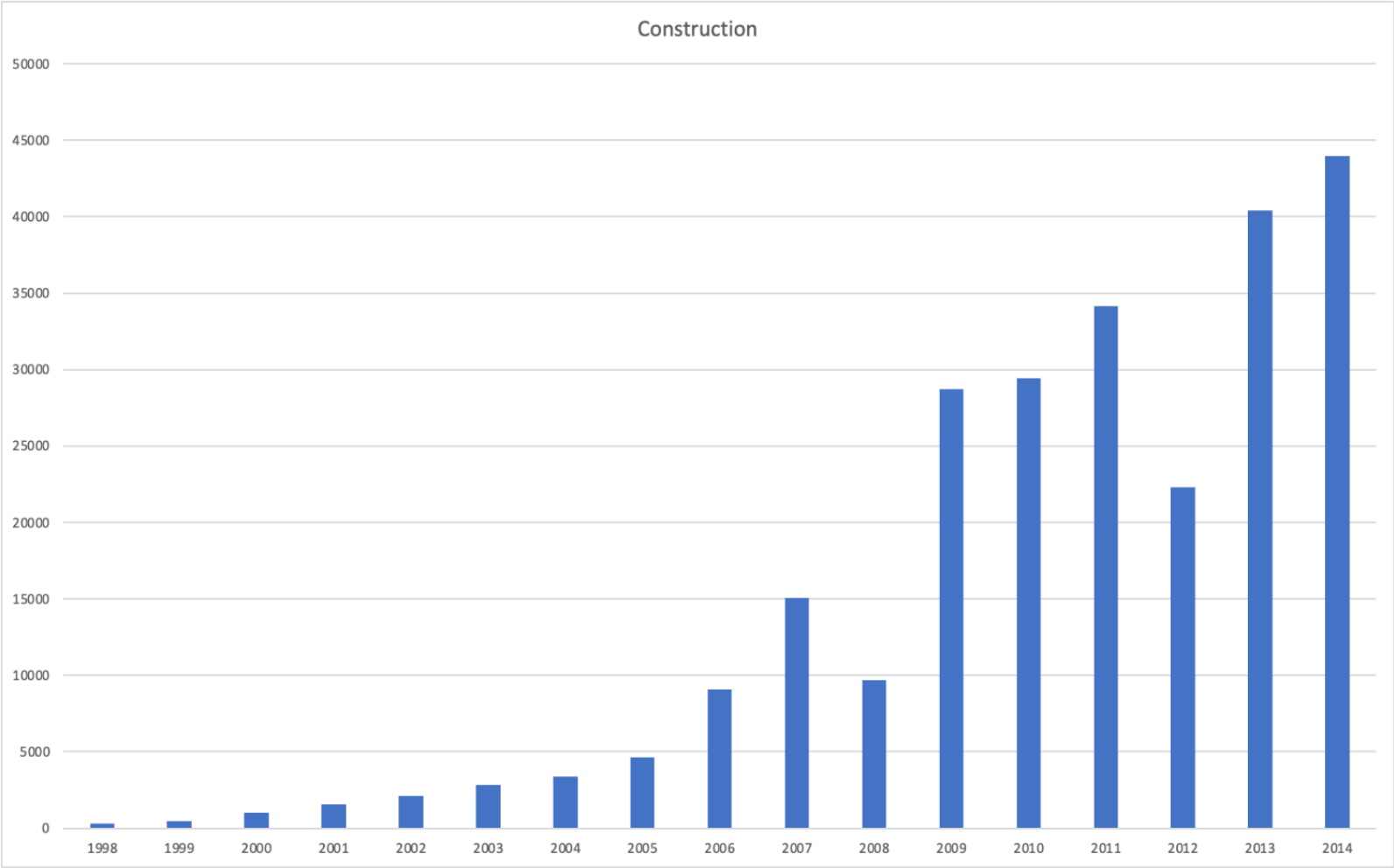


Figure 1.3: Annual totals of ISO14001 certificates in the construction sector 1998- 2014 (ISO, 2023b)

1.3 WHY DO WE NEED ENVIRONMENTAL MANAGEMENT SYSTEMS?

Society from the time of the industrial revolution has had an increasingly negative impact on the environment (World Economic Forum, 2023), especially in situations where organisations did not comprehend or envisage the impacts of their operations (e.g., Chernobyl and Bunsfield). As a society, however, we have become increasingly aware of the impact that our actions are having on the environment and the need for organisations to manage that impact, not only in terms of resource use but also in terms of potential pollution (Watson and Emery, 2004) and the negative publicity that follows (Hillary, 2004). Both these citations are from almost 20 years ago and remain unrectified. As a result, there needs to be active consideration on how we as humans' impact the environment and how these impacts can be mitigated to ensure the survival of the planet (Mulvihill and Ali, 2016). One means of doing this is using EMS which have been on the increase since the late 1980s with more organisations expecting their suppliers to have such a system in place (Sakr *et al.,* 2010, Mariotti *et al.,* 2014). The question remains though as to how effective these are for ensuring the sound environmental performance of an organisation and what exactly are the benefits and barriers to introducing such a system to an organisation? Researchers have looked at how and where ISO14001 has been introduced, focusing on different sectors in a variety of countries and they have reflected on the barriers and benefits (Shen and Tam, 2002; Johnson, 2020). There are, however, still an extremely wide range of answers to the questions. Is this because either it is different for all organisations or that there is a commonality that just has not been discovered yet.

When thinking about environmental management, it is easy to immediately consider our own needs as being paramount and that we manage the environment for our own benefit. To some degree, that probably is the case. An increasing number of organisations, however, are not just preserving the environment in respect of the resources they need or can then use, but also to promote a green image; to foster positive public relations, to attract better employees through their ethical performance/operations or, in some instances, because morally it is the right thing to do (Gonza´lez-Benito and Gonza´lez-Benito, 2005; Arena *et al.,* 2012). Society has, after all, one planet on which to exist and, as such, has finite and limited resources. Thankfully, humans are immensely creative and, as technology improves, they seem to find ways to use resources more wisely (e.g., reduce, reuse, recycle). It is essential, however, for us to manage not just the resources we use but also the pollution we create and leave behind.

There will, of course, always be those organisations that just want to make a profit and fail to appreciate the adverse legacy they leave for others or future generations to clear up. Thankfully, this trend is declining, as both people and organisations come to realise that the environment where they live, and work does matter. Without doubt, we, or future generations, will have to deal with the environmental and pollution issues created in the past or those still to be created (Mulvihill and Ali, 2016). An example of such issues can be found in Article #2.

ARTICLE 2

This puiblication reviews Jersey's EIA legislation, highlights when and where EIAs have been waived and considers the concomitant implications of cumulative impacts that small–scale permitted building developments could have on the island's coastal environment. A sequential mixed methods strategy was utilized to address the aim, using a combination of public archive records and freedom of information requests, together with interviews of government officials. Results reveal there are concerning issues with the existing system, which could be exploited and open to abuse. The present process is subjective and relies heavily on decision makers: experience and judgement. Moreover, there is also potential for political pressure to be exerted, in that the Minister for the Environment, in particular circumstances, can overrule decisions made by planning officers in contradiction to the legislation.

Until recent times, humans chose to concentrate their attention on progress and industrial achievement with minimal thought to the environment (Mulvihill and Ali, 2016). Fortunately, there were a group of individuals who had the foresight to recognise potential problems caused by pollution, and they fought for the introduction of environmental legislation (e.g., the Alkali Act, 1863). Environmental management, however, has a short history (Figure 1.4), in terms of the length of time that humans have occupied the planet, and it is noted that many environmental issues are historic in creation (Mulvihill and Ali, 2016).

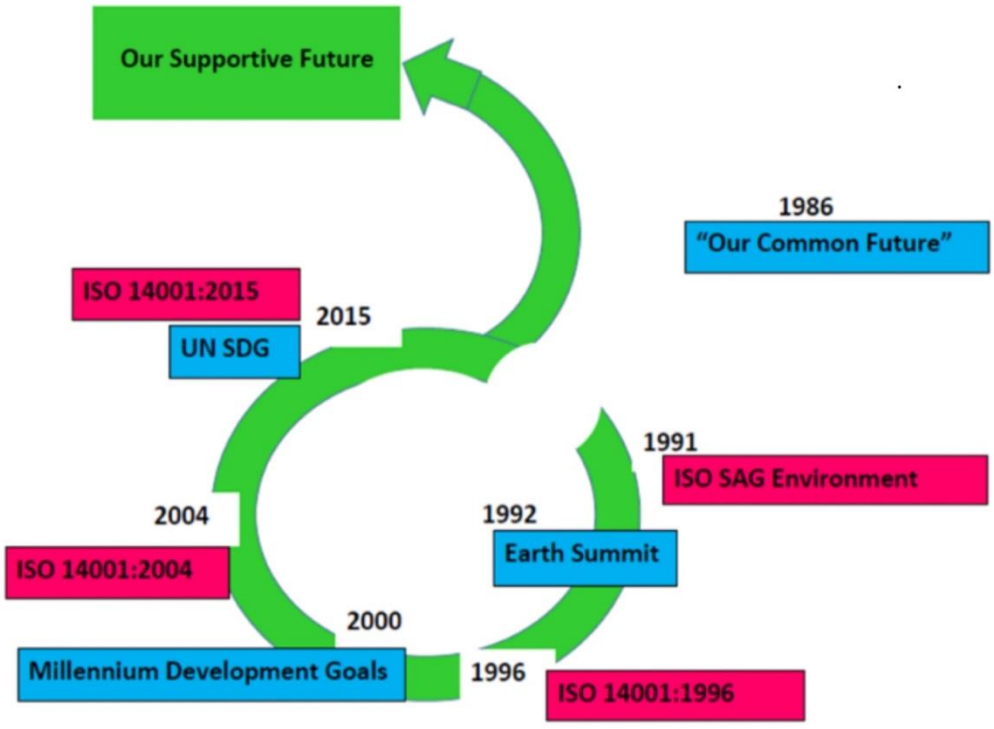


Figure 1.4: An integrated journey of ISO14001 and sustainability milestones through time (source ISO, 2023c).

Many nations have long industrial heritages but, sadly, our predecessors were not always aware or careful in respect to their environmental and pollution impacts. Nowadays, we should have a far greater awareness of our impacts. Our knowledge is always improving, but we should have acquired a better understanding of the perils associated with our modern industrial and

domestic processes (Mulvihill and Ali, 2016). An EMS could help reduce these impacts. The next section explains why an investigation and analysis of EMS in these sectors is so important.

1.4 ARCHITECTURE, ENGINEERING AND CONSTRUCTION (AEC) SECTORS

This study will focus on the Architecture, Engineering and Construction (AEC) sectors due to the magnitude of the potential environmental impacts within these sectors. Data from the United Nations (UN) suggests that extraction and processing of materials, fuels and food produces half of the total greenhouse gases and is responsible for more than 90% of biodiversity loss in conjunction with water stress (IPR, 2019). It is thought that the most vulnerable countries (MVC) and their populations will be impacted disproportionately, with figures showing that in 2020 the number of people classed as living in extreme poverty rose to 724 million and around 1 in 4 of the global population lacked safe drinking water (UN, 2020a). Water scarcity alone could displace 700 million people by 2030 (UN, 2020b). Since the 1970s the extraction of resources has increased three–fold and it is estimated that by 2060 material use could double to 190 billion tonnes and greenhouse gases could increase by 43% (IPR, 2019). Othman and Nadim (2010) noted that the AEC sectors used around 50% of the natural resources consumed, utilised 40% of the energy generated and produced 50% of the waste created globally. The Circle Economy (2020) notes that 50.8 billion tonnes of minerals are consumed each year and 38.8% of that goes into housing. All European Union (EU) member countries were challenged in the Waste Framework Directive 2008/98/EC to achieve at least 70% re–use, recycling, or other recovery of non–hazardous Construction and Demolition Waste (CDW) by 2020. The UK has now left the EU, and other countries outside the EU will not be impacted, but the question remains as whether this is enough and why a cradle–to–cradle approach is not the aim (McDonough and Braungart, 2002). Amid all these challenges it is vital that, to survive and succeed, the AEC sectors needs to be more sustainable. An EMS offers a starting point towards this accomplishment. The next section will explore the role of environmental management within the AEC sectors.

1.5 ENVIRONMENTAL MANAGEMENT IN THE AEC SECTORS

The construction industry is perceived as a key player in the national economy of both developed and developing nations, owing to its investment value, job creation potential and its contribution to GDP (Zhang *et al.,* 2000). The sector though is often criticised due to its poor performance and wasteful practices, resulting from the fragmented and diverse nature of the industry (Liu *et al.,* 2012). The construction sector is closely linked to the architecture and engineering sectors, which form constituent parts of the construction of new building. These are all also closely linked to the indices of sustainable development, as construction activities significantly impact the natural environment, as well as the social and economic conditions of a society (Myers, 2005; Du Plessis, 2007). Transitioning these sectors towards more sustainable practices has proven to be challenging under these circumstances (Myers, 2005). There is, however, as noted, an increasing uptake in the use of ISO14001 being seen generally and more specifically in the construction sectors (Figures 1.2 and 1.3).

There is increasing pressure on organisations within the AEC sectors to be more environmentally and ecologically sound, as well as sustainable. In response to this many organisations have developed various approaches including policies, procedures, economic

measures, and formal EMS to support the protection of the natural environment (Kartam *et al.,* 2004; Liyin *et al.,* 2006; Gorse and Drotleff, 2023). Studies in the construction industry have illustrated that environmental management practices are primarily driven by legislative and regulatory pressures (Liyin *et al.,* 2006; Serpell *et al.,* 2013). Further drivers occur due to client demands, and the competitive advantage gained by organisations adopting a proactive environmental attitude (Rodriguez *et al.,* 2011; Serpell *et al.,* 2013).

Attitudes towards environmental management have shifted more positively in recent years with certification schemes such as BREEAM (Article #3) coming to fruition. There is also an increasing number of organisations who continue to adopt voluntary EMS standards (Figure 1.2). Christini *et al.* (2004) suggested that organisations in the AEC sectors would benefit greatly from having a comprehensive and certified EMS. The adoption of a formal standard would help organisations to demonstrate their corporate commitment to achieving sustainable development in the construction process, providing a competitive edge in the industry (Selih, 2007). It is also noted that even though interest in environmental issues continues to grow, implementation of EMS in organisations is still relatively uncommon (Turk, 2009; Schmidt and Osebold, 2017). It is also suggested that the adoption of sustainable construction practices is still at its early stages, given what can still be achieved, both in the developed and developing world (Park and Ahn, 2012; Serpell *et al.,* 2013; Brennan and Cotgrave, 2014). Due to the linkages to sustainability the next section will explore the overlap within this theme.

ARTICLE 3

This publication applies the Building Research Establishment Environmental Assessment Method (BREEAM) Certification Scheme to a listed building refurbishment case study. It analyses the use of credit assessments to determine the distribution of the scheme criteria against a common conceptualisation of sustainability: the three pillars of environmental, social and economic. Despite BREEAM being considered one of the strongest assessment tools, findings reveal limited consideration to all but environmental aspects. The assessment criteria focus on environmental improvements, e.g. energy efficiency, as opposed to a 'sustainable' assessment method that would address broader social and economic issues.

1.6 SUSTAINABILITY

Environment is one of the three pillars of sustainability, the others being economics and society and as such it is intrinsically linked to the other two pillars: the triple bottom line (Elkington, 1998). Subsequently a new pillar, humans, has been added to this vision to ensure communities are included (Gorse *et al.,* 2023), but it is the three pillars that remain the most utilised. The words sustainability and sustainable development tend to be used interchangeably but as noted by Gorse *et al.* (2023), sustainability is the aim and sustainable development is the route to that aim. The concept of sustainable development came to the world's attention through the UNCED document *"Our Common Future"* commonly referred to as the Brundtland Report. The report defines sustainable development as *"the development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (Brundtland, 1987). The Brundtland Report and the UNCED Earth Summit in Rio which followed led to the creation of the Millennium Development Goals (eight in total, with a humancentric focus) and later to their updated version, the Sustainable Development Goals (Gorse *et al.,* 2023), which consist of 17 themes (Figure 1.5). The AEC sector's work impacts many of the SDGs and, as noted earlier, are responsible for major environmental challenges. The construction sector would for example be able to be linked to SDG 12 and 13 through the consumption of

energy, globally consuming 40% of the generated energy (Cucuzzella, 2009; Ade and Rehm, 2019) and as a result, produce a considerable amount of CO_2.

Figure 1.5 SDG themes (source: UN, 2020a)

As a society we cannot just assume resources will always be available. If everyone on the planet were to achieve the same standards of living a huge number of resources would be required. To enable equity there must be changes in the way that society manages these issues, to ensure parity for all without stripping the planet of every resource there is (Article #4).

ARTICLE 4

This publication proposes an overdue broadening of the EMS adoption spectrum from a well-established Environmental Impact Minimisation (EIM) paradigm towards an Ecological Impact Enrichment (EIE) paradigm, which encourages proactive organisational responses towards ecological positive gain such as increase in biodiversity. Contemporary EMS processes are critiqued to develop a conceptual framework of how an approach to environmental performance management can be re-imagined towards being more ecologically holistic.

Developed nations will need to re-examine their thoughts and ideas concerning what is a typical construction. There will need to be consideration of the implications of our actions, and it must be remembered that global resources are just that global and, therefore, not to be just supplied to the highest bidder but shared equitably between all. This means that, as a global society, consideration must be given to not only how to ensure equity amongst the population but also that some people will need to reassess how they live, and organisations will need to discover new and innovative means of ensuring that material resources are not just used once and then discarded. The AEC sectors use a huge amount and variety of materials, but it is also increasingly known for reusing them when buildings are demolished. In fact, some modern buildings are

now designed with the foresight to follow cradle-to-cradle principles (McDonough and Braungart, 2002: Booth *et al*., 2012); whereby, timbers are pre-marked at the construction stage to later indicate to demolition teams where to cut at the dismantling stage to salvage the most material. So, in this respect, the AEC sector is being responsible concerning the reuse aspect of the waste hierarchy. There are, however, still issues in the way that many buildings are constructed in terms of the use of resources or the increase of CO_2 resulting from the production of those materials for example concrete.

Sustainability within the AEC sectors, particularly within construction has received increasing attention over recent years (Berardi, 2012). This links to the risks these activities can impose on the natural environment and their impact in terms of the social, economic, cultural, and political dimensions of sustainability (Boyko *et al.,* 2012; Villeneuve *et al.,* 2017). Data suggest 40% of the global energy consumption and over 30% of the global CO_2 equivalent emissions are attributed to buildings, making the building sector a significant contributor to harmful emissions (Cucuzzella, 2009; Ade and Rehm, 2019). Furthermore, the building sector also consumes 12% of freshwater and 30% of raw materials and it is responsible for around 20% of wastewater and up to 40% of landfill waste globally (Ade and Rehm, 2019). It is, therefore, clear that the AEC sectors have enormous potential for making a considerable impact in terms of the sustainability of the planet both in a positive or negative manner.

Projects within the AEC sectors and their impacts will be varied, and it is acknowledged that to mitigate the projected impacts effective sustainable development action is required. The current predictions suggest that by 2050, two–thirds of the global population will be living in urban areas (Mattoni *et al.,* 2018). There is an expectation that there will be 14 new mega cities and that these along with the world's largest cities will require over 500 million m^2 of new office space and more than 250 million new houses (Ding, 2008; Ade and Rehm, 2019). It is imperative that consideration is given to how these cities are designed and built as it will have a major impact on the delivery of the SDGs and the future health of the planet. It is noted that other models are coming to the fore, such as Doughnut Economics (Raworth, 2017), which looks at social boundaries with 12 indicators and 9 planetary boundaries, the Six Pillars of Sustainable Construction and the work of the UK Green Building Council (Gorse *et al.,* 2023), these are not the focus of this thesis but are noted as being part of the ongoing work in the sectors. What must be noted is that organisations have environmental responsibilities and how they manage this has been a point of discussion over the last 20 years. The next section will examine why it is vital that organisations acknowledge and manage both their actual and potential environmental impacts.

1.7 BUSINESS AND ENVIRONMENTAL RESPONSIBILITIES

While it must be acknowledged that businesses exist to make an economic contribution to shareholders and society, this does not mean that they are not able make a positive environmental contribution at the same time. It is possible that organisations can be sustainable in terms of economics, society, and the environment (Gorse *et al.,* 2023). Some researchers have considered these opportunities and suggested that potential links exist between environmental rating tools and the SDGs (Gibberd, 2015; Alawneh *et al.,* 2018). Gibberd (2015) combined the ecological footprint criteria and the Human Development Index to suggest a BEST index. Alawneh *et al.* (2018) looked at how a combined water and energy

efficiency method could be developed to assess and improve United Nations (UN) Sustainable Development Goals (SDGs) delivery. It is noted, however, that there is a risk that the benefits which are being achieved by organisations are those that can be delivered at the lowest cost to the organisations or that the organisations can use the system as purely a public relations (PR) tool, rather than to improve their environmental performance. This has promoted the view of the standards being less effective in promoting sustainability than market mechanisms, such as carbon trading (Bon and Hutchinson, 2010). Something is, therefore, needed to make the process of delivering environmental sustainability easy and more transparent.

The next section will examine the research gap that this study sets out to fill and it then continues by stating the purpose of this study.

1.8 RESEARCH GAP

A great deal of research has been conducted on the benefits and barriers of ISO14001 across many sectors, including education (Price, 2005; Joy, 2019), tourism (Chan and Wong, 2006; Hamzah *et al.,* 2015), manufacturing (Nishitani, 2009; Zobel, 2013) and health provision (Mehralian *et al.,* 2017; Seifert and Guenther, 2019), amongst others. By comparison there has been less attention focussed on the AEC sectors, despite their significant resource implications and potential environmental impacts. Of the published studies there seems to be an absence of comprehensive investigations that have identified and clarified the benefits and barriers to the implementation of ISO14001 within the AEC sectors. It is also noted that no previous studies have considered the potential influences that could be achieved in these sectors if they were to use their EMS to engage with the SDGs to increase their sustainability. This guides us towards the purpose of this study.

1.9 THE PURPOSE OF THIS STUDY

Given the research gap that exists, this study intends to resolve the following research question (Figures 1.6 and 1.7):

> *"What evidence is available to support the decision-making of AEC organisations who want to implement an EMS that can improve both their environmental and sustainability performance?"*

To establish the necessary evidence needed to answer this research question, the ensuing purpose of this study is proposed. This study aims to:

> *"Identify and examine benefits and barriers to uptake and implementation of EMS (particularly ISO14001) in the AEC sectors and to use these to create a roadmap that can indicate pathways for AEC organisations to support the delivery of SDGs."*

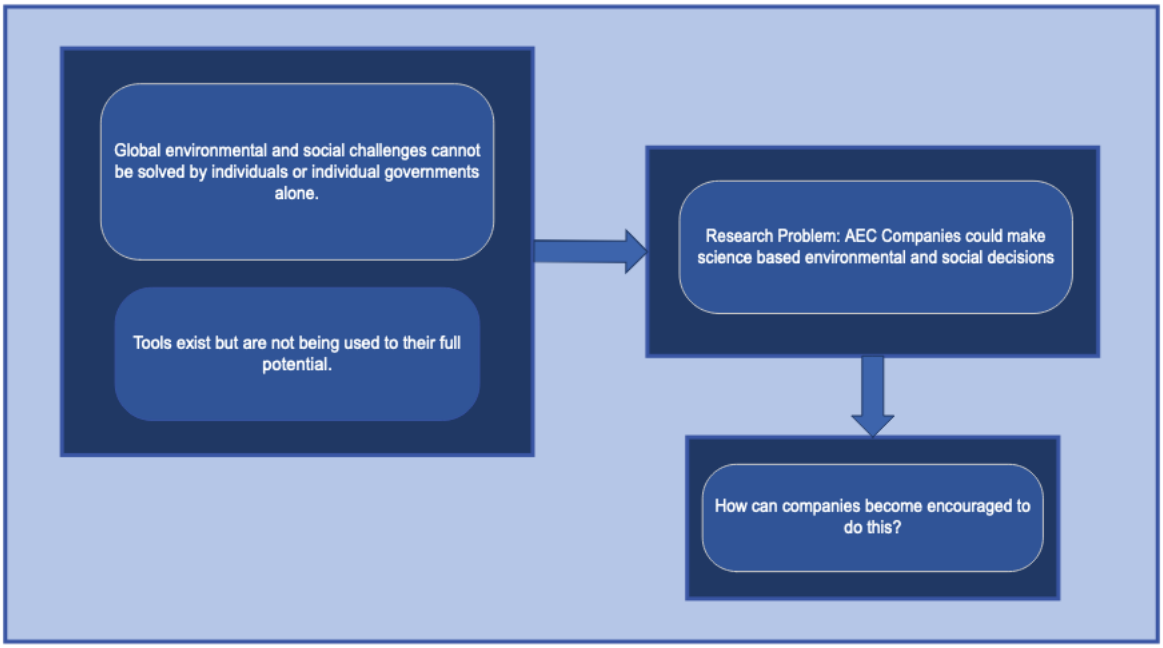


Figure 1.6: Identifying the research problem.

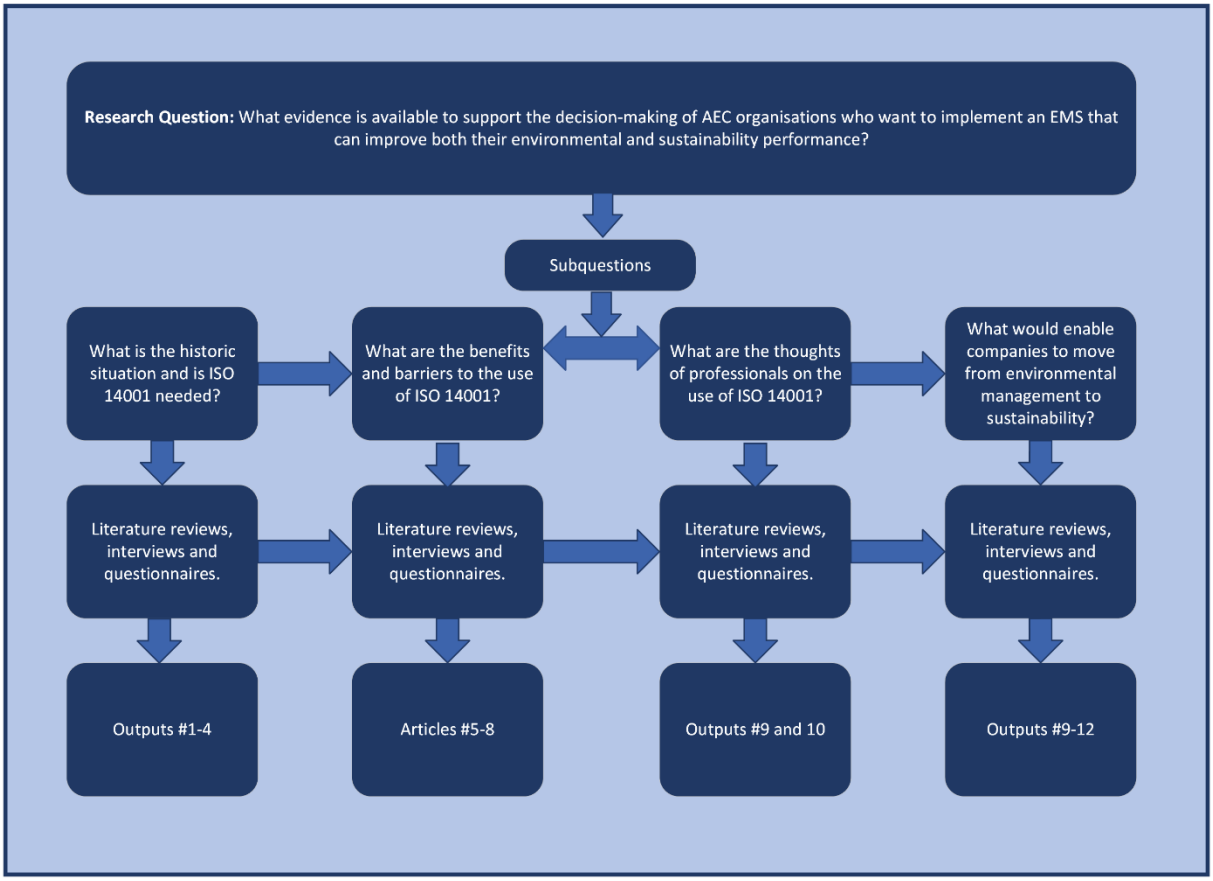


Figure 1.7: How this thesis links together.

The aim of this thesis will be achieved through the delivery of the following objectives and, as the study is a DPhil by publication, accords with the evidence published in the articles available in the appendix:

Objective One: Ascertain environmental issues and provide insights into how and why EMS can be implemented to address and mitigate concerns.
Objective Two: Produce a desktop study to reveal the most widely reported benefits and barriers of implementing EMS in the AEC sectors.
Objective Three: Use case study examples to gauge stakeholder perceptions of the benefits and barriers of adopting EMS in the AEC sectors.
Objective Four: Disclose how the AEC sectors of the UK are implementing EMS to improve their environmental and sustainability performance targets.
Objective Five: Design and validate a roadmap for the AEC sectors to highlight how their EMS could support the delivery of the SDGs.
Objective Six: Contextualise and deliberate the findings of the earlier objectives with existing knowledge on the uptake and adoption of environmental management practices in the AEC sectors.
Objective Seven: Conclude and provide recommendations for the implementation of EMS in the AEC sectors.

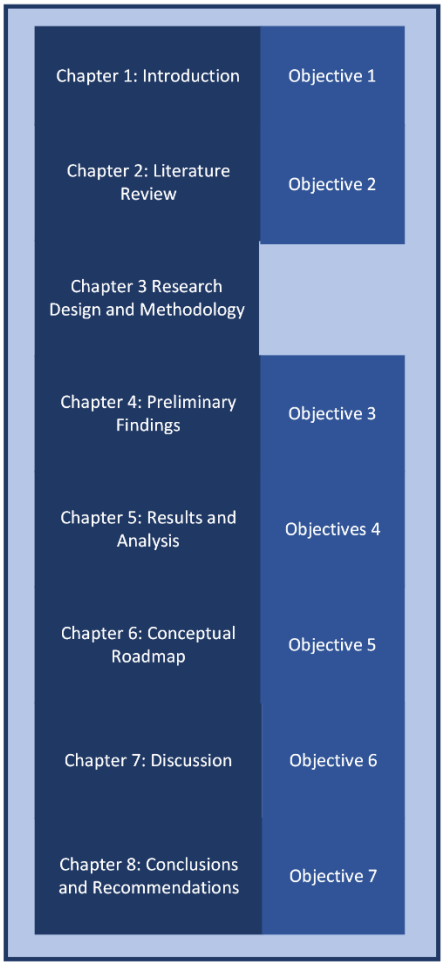


Figure 1.8: The map of the DPhil chapters and delivery of the objectives.

1.10 CHAPTER SUMMARY

This first chapter has set the scene in respect of defining management systems, and in particular environmental management systems. The nature of environmental issues and examples of degradation have been discussed, and this has revealed the urgency and necessity to establish a need for a mechanism to minimise environmental impacts. There have been insights into the uptake and implementation globally of EMS and within the various sectors, this was the first of the objectives to be delivered within this study. The chapter has also highlighted the research gap that the study intends to satisfy and fulfil, plus it has established the study aim and objectives.

The chapters following will present a literature review and then the prevalence of benefits and barriers towards the use of ISO14001 in the AEC sectors will be examined through case studies. This will then be followed by a Delphi study, which further explores the benefits and barriers and then a phenomenological study, which investigates the lived experiences of those involved in the implementation of ISO14001. From this point, the work will focus on the creation of a tool to take AEC sector organisations from the standard environmental management system to one where they can implement work on the SDGs but gain the same benefits. Next, the usefulness of this tool will be demonstrated by a review of the use of EMS to deliver SDG12 – Resource Consumption and Production. Then, a discussion will follow, which brings together the Articles presented in this DPhil thesis to clarify and contextualise the situation. Finally, conclusions and recommendations will be presented.

In the next chapter, a literature review of the known benefits and barriers of implementing ISO14001 in the AEC sectors will be reported and also the evidence of a research gap that this thesis contributes towards satisfying.

CHAPTER 2: LITERATURE REVIEW

This chapter uses information published in Articles #5 and #11. The purpose these articles is described in Box 2.

BOX 2

ARTICLE 5: The aim of this publication is to produce a systematic PRISMA based literature review followed by a vosviewer analysis of the keywords from the literature.

ARTICLE 11: The aim of this publication is to produce a roadmap that utilises the known benefits of implementing Environmental Management Systems in the AEC sectors to support the delivery of the SDGs.

2.1 INTRODUCTION

EMS uptake has increased over recent years, particularly in the construction sector (Figures 1.2 and 1.3). This chapter will examine the academic literature that exists on this topic. Various researchers have examined the uptake of EMS and research has been conducted on ISO14001 over the years to gauge organisational opinions of the benefits and barriers of implementing ISO14001 in general (Carrillo-Labella *et al.,* 2020; Chen *et al.,* 2020), and within the AEC sector more specifically, e.g., Hong Kong (Shen and Tam 2002), Nigeria (Owolana and Booth, 2016), UK (Bailey *et al.,* 2020), but the debate continues as to the benefits and barriers. One particularly influential piece of research was conducted by Shen and Tam (2002), who were amongst the first to explore the plethora of benefits and barriers recognised to be associated with adopting ISO14001. Their study investigated the Hong Kong construction industry, revealing that environmental protection and reduced environmental risk were considered the most significant benefits of implementing an EMS, whilst increased management costs and lack of trained staff and expertise were considered the most important barriers (Shen and Tam, 2002). This chapter will examine the benefits and barriers within the AEC sector cited in peer reviewed literature, to test the validity of the research data and this will form the knowledge base for this thesis. In doing so, Objective Two will be achieved.

2.2 BENEFITS OF ISO14001

The benefits noted in research have included the protection of the natural environment this was cited by Zhang *et al.* (2020) and in Owolana and Booth's (2016) study of the Nigerian construction industry it was found to be the most significant benefit along with reduced environmental related sickness and injury. Also, a similar finding was noted by Bailey *et al.* (2020) who investigated the UK construction industry revealing a reduction of environmental risks and contribution to environmental protection were considered the most significant benefits.

Many researchers have also reiterated the view that environmental management positively influences the economic performance of an organisation (Gotschol *et al.,* 2014; Yu and Ramanathan, 2016) due to the competitive advantage gained through the improved corporate image (Toffel, 2000; Poksinska *et al.,* 2003; Castka and Balzarova, 2008; Psomas *et al.,* 2011, Vatalis *et al.,* 2011, Chen *et al.,* 2016, Onkangi *et al.,* 2018; Bailey *et al.,* 2020). The long-term

competitive advantage (Chavin, 2005) may well link to the ability to compete for tenders (Turk, 2009). EMS has been noted as promoting financial benefits (Berrone and Gomez–Mejia, 2009; Mariotti *et al.,* 2014), which could be through increased trading opportunities, by cost savings or as a result of reduced liability. Studies across several countries have revealed organisations are primarily driven by economic benefits, plus other factors such as improved corporate image and opportunity to enter international markets (Zhang *et al.,* 2000; Tam, 2008; Tambovceva and Geipele, 2011). This improved corporate image and enhanced public perception (Arulrajah *et al.,* 2015; Santos *et al.,* 2016; Horry *et al.,* 2022a) can improve relations with stakeholders, due to the responsible environmental measures adopted in business practices (Poksinska *et al.,* 2003; Castka and Balzarova, 2008; Psomas *et al.,* 2011) as well as sustainable outcomes (Castka and Balzarova, 2008; Liu *et al.,* 2012). Hence, organisations in the AEC sectors are becoming more receptive to the notion of environmental management in their organisations (Yusof *et al.,* 2016).

Other researchers have purported, that compliance is ensured by the implementation of an EMS (Cole *et al.,* 2006; Lopez-Gamero *et al.,* 2010; Singh *et al.,* 2015; Heras-Saizarbitoria *et al.,* 2016). This can also be linked back to economic benefits due to the reduced risk of liability and hefty fines for non-compliance (Arimura *et al.,* 2008; Chan, 2008). It is recognised that a formal EMS improves environmental standards and reduces the environmental impacts of an organisation (Franchetti, 2011; Nguyen and Hens, 2015; Puig *et al.,* 2015), for example through improved energy efficiency (Pesce *et al.,* 2018) and efficient waste management (Arimura *et al.,* 2008; Turk, 2009, Bailey *et al*., 2020; Johnstone, 2020; Wang and Mao, 2020) and waste minimization (Comoglio and Botta, 2012). These types of activity reduce the environmental impacts of an organisation (Franchetti, 2011; Nguyen and Hens, 2015; Puig *et al.,* 2015) and reduces costs. Cost savings again, are an economic advantage and as such may well be judged against the costs of implementation to ascertain if this is an economically viable or even a beneficial action for an organisation to take. This idea is supported by Yang *et al.* (2009) who suggest that environmental management does not directly influence financial performance, but rather it is the resulting improved environmental performance that reduces negative environmental impacts on the economic performance of an organisation.

Hibiki and Arimura (2011) stated that an EMS also provides a platform to communicate the environmental performance of an organisation to a wider audience through certification. This is supported by the work of Castka and Prajogo (2013) who noted that an increasing number of organisations have implemented EMS primarily driven by the opportunity it presents to showcase their environmental commitment. The showcasing of the work also demonstrates to stakeholders in the supply chain who are increasingly pressuring for ISO14001, plus highlights the legal compliance (Hillary, 2004; Tinsley, 2014; Zhang *et al.*, 2014) of the organisations. There are also benefits which are cited that link to human resources and operational efficiency of the organisations. It is suggested that by promoting sustainable practices there is an increasing environmental awareness within the employees (Zhang *et al.,* 2014; Boiral *et al.,* 2018) and that the use of standardizing management procedures can minimise negative environmental impacts (Gallagher *et al.,* 2004; Barrow, 2005).

The most commonly cited benefits in literature (Table 2.1), include improving corporate image, reducing environmental risks, improving environmental standards, reducing environmental complaints, reducing environmental related sickness, increasing competitiveness, improving workforce morale and cost savings due to reduced risk of fines (Shen and Tam, 2002; Turk,

2009; Sakr *et al.,* 2010; Teriö and Kähkönen, 2011; Nguyen and Hens, 2015; Owolana and Booth, 2016; Johnson, 2020).

Table 2.1: Top ten frequently reported benefits of ISO14001 in the AEC sector (based on Horry et al., 2022b).

#	BENEFITS
1	Improved environmental performance
2	Cost reductions
3	Enrich corporate and public image
4	Compliance with regulations
5	Competitive advantage
6	Reduce waste generation at source
7	Customer satisfaction/demand
8	Protect the environment
9	Employee environmental awareness
10	Reduce environmental impacts

The use of ISO14001 can also be beneficial to organisations looking to expand their environmental work to have a more sustainability focussed strategy and to enable engagement with the SDGs (Horry *et al.,* 2022b). It has been noted that it is possible to use the system as a means of mapping how the work that organisations are doing contributes to the delivery of the SDGs (Horry *et al.*, 2022b).

2.3 BARRIERS TO IMPLEMENTATION OF ISO14001

In respect of the barriers, Shen and Tam (2002) cited increased management costs, lack of trained staff and expertise were considered the most significant barriers to the implementation of ISO14001, as well as low awareness. These are identified as the most common obstacles, especially in developing nations (Turk, 2009; Owolana and Booth, 2016).

Cost of implementation is still cited as a barrier (Ayarkwa *et al.,* 2010; Famiyeh *et al.,* 2014,) but this is now also having to be considered in relation to cost benefit (Bailey *et al.,* 2020) as cost savings are a known benefit. While significant, however, the issue of lack of knowledge and awareness, limited human resources and expertise along with financial constraints (Shen and Tam, 2002; Sakr *et al.,* 2010; Brennan and Cotgrave, 2014) are not the only barriers noted in research although increasingly issues for developing nations (Turk, 2009; Owolana and Booth, 2016). Liyin *et al.* (2006) further suggests a more influential issue is that of the passive environmental culture in the sectors that impedes organisations from adopting a proactive approach towards protecting the natural environment.

Other barriers are the more operational issues, such as the difficulties of creating documentation, which has also been noted as a challenge by previous researchers (Bansal and Hunter, 2003; Ayarkwa *et al.,* 2010; Famiyeh *et al.,* 2014; Owolana and Booth, 2016; Schmidt and Osebold, 2017) in relation to EMS. This is particularly relevant for SMEs who may not have the staff time available to manage the requirements. Finally, time is identified as a barrier (Bailey *et al.,* 2020; Horry *et al.,* 2022a) as this is an extra task to be added an organisation's daily routine.

In developing countries, barriers such as lack of government legal enforcement, which could include legislation and lack of technological support in the organisation were found to be important barriers (Owolana and Booth 2016). It has been suggested that legal enforcement and financial incentives could promote the implementation of EMS in such areas (Ofori *et al.,* 2002; Tam, 2008; Sakr *et al.,* 2010) (Table 2.2). The major barriers, highlighted include cost, lack of appropriately trained staff, lack of client and subcontractor support, time required, lack of supplier cooperation, difficulty in coordinating environmental work over a multitude of tiers in the supply chain, lack of workforce support, increase documentation, lack of technical support, lack of training, lack of legal enforcement and the required change process (Shen and Tam, 2002; Babakri *et al.,* 2003; Turk, 2009; Turk, 2012; Yusoff *et al.,* 2015; Owolana and Booth, 2016; Schmidt and Osebold, 2017; Bailey *et al.,* 2020; Johnson, 2020).

Over the years that ISO14001 has been in existence, Horry *et al.* (2022a) suggests barriers have changed slightly reflecting changes in expectations within business and those of wider society. Today, there is more focus on the improvements that can be made through stakeholders, tender requirements, community participation, industry standards, more efficient operations, increased employee awareness, and energy efficiency savings. Environmental improvement, however, are still viewed as the main benefit of implementing and using an EMS (Horry *et al.,* 2022a). In terms of barriers, cost is still the main influencing factor but, it must be noted that the 2015 updated ISO14001 framework, with the additional requirement for senior management commitment (Lewandowska and Matuszak-Flejszman, 2014), can also be viewed as a challenge.

ISO14001 when used well is a proactive approach to help minimise environmental impacts. It is, however, criticised as a management standard because it does not guarantee any real improvements in environmental performance, as the standard does not explicitly state the criteria for defining and measuring a particular environmental aspect (Valdez and Chini, 2002; Mariotti *et al.,* 2014). This is reflective of a concept termed 'symbolic adoption', which refers to the organisations using standards to legitimise their environmental activities but not necessarily producing an effective improvement (Aravind and Christmann, 2011*)*. This concept is detrimental to the credibility and reliability of the standard, as it does not result in a tangible reduction of any negative environmental impacts (Ferron–Vilchez, 2016). Furthermore, the effectiveness of ISO14001 as a proactive management model is challenged by Ball (2002), as it is suggested the standard is only useful in reducing the impact, in reaction to environmental issues. Even though, however, interest in environmental issues continues to grow, implementation of EMS in organisations is still relatively uncommon (Turk, 2009; Schmidt and Osebold, 2017). Liyin *et al.* (2006) and Serpell *et al.* (2013) support this idea noting that the construction industry environmental management practices are primarily driven by legislative and regulatory pressures. It is to a lesser degree influenced by client demands and the competitive advantage (Selih, 2007; Rodriguez *et al.,* 2011; Serpell *et al.,* 2013), which have a

financial impact (Vatalis *et al.,* 2011; Chen *et al.,* 2016). Studies across several countries, however, have supported the idea that organisations are primarily driven by economic benefits, plus other factors such as improved corporate image and opportunity to access international markets (Zhang *et al.,* 2000; Tam, 2008; Tambovceva and Geipele, 2011; Owolana and Booth, 2016). These factors have started to result in construction organisations becoming more receptive to the notion of environmental management within their organisations (Yusof *et al.,* 2016).

In terms of a contribution to sustainable development, Barrow (2005) suggests environmental management can contribute to sustainable development as it can identify key; issues, threats, opportunities, and limits, as well as determine realistic strategies by coordinating the physical, biological and socio–economic interests of the stakeholders. These stakeholders can include members of the public, noting that public pressure has intensified, and the increased awareness of the natural environment has contributed to an improved corporate accountability and responsibility (Ormazabal *et al.,* 2017). Along with the public desire for better protection of the environment there has been an increase in regulatory standards, as well as market pressures to protect investors' interests and maintain competitiveness, which have also contributed to promote positive actions (Ervin *et al.,* 2013; Khanna and Speir, 2013; Ormazabal *et al.,* 2015). These factors along with the internal drivers within organisations, which Ormazabal *et al.,* (2015) noted are often managerially driven by attitude, organisational frameworks, and training mechanisms.

Table 2.2: Top ten frequently reported barriers of ISO14001 in the AEC sector (based on Horry et al., 2022a).

#	BARRIERS
1	Cost
2	Lack of stakeholder support
3	Lack of expertise
4	Lack of training
5	Lack of stakeholder demand
6	Lack of employee involvement
7	**Time**
8	Documentation
9	Lack of knowledge about ISO 14001
10	Existing subcontractor system

2.4 LINKAGES TO SUSTAINABILITY

As society moves towards a recognised need to be sustainable and not just to purely be working towards sustainable development (Gorse *et al.,* 2023), action needs to be taken to ensure organisations within the AEC sector deliver on the necessary objectives. It is widely reported

that for design and business to be sustainable it needs to go beyond the traditional economic approach and overcome short–term issues (Naess, 1994; Goubran *et al.,* 2019). Sectors such as architecture have been highlighted for having unsustainable practices (Vefago and Avellaneda, 2010). Suggestions have been made such as the multistep framework proposed by Cucuzzella (2016) that requires system–wide innovations to change unsustainable practices. While Dyllick and Muff (2015) offered the idea of four levels for sustainability in business, the first being business as usual, however, this first level is now discounted as it is generally accepted that business as usual is no longer acceptable; then there are three other options remaining, namely: sustainability with economic considerations; sustainability with the creation of value across the pillars of sustainability; or focussing on the sustainability challenges to bring about a better society. This, however, leaves the creation of the objectives to the organisation which may result in the problem appearing to be too big to tackle. One option which would make the creation of objectives easier would be the use of the SDGs whereby organisations could focus on what they could deliver from the 17 topics. A potential route to deliver this would be to use an existing process, such as ISO14001 to deliver these goals.

Environmental management systems (EMS) (particularly ISO14001) aim to enable organisations to prevent pollution, enable continual improvement and comply with legislation (BSi, 2015). Although it is acknowledged that environmental standards have focused on continual improvement, they do not actually specify a level of improvement or harm reduction (i.e. pollution prevention). Therefore, they have been accused of not enabling a transformation in terms of sustainability (Brown, 2016). Others had suggested that standards are being used increasingly to create economic value; cost savings or increased market share and opportunities for business rather than environmental improvements (Jones and Laquidara–Car, 2018). It must, however, be acknowledged that organisations exist to make an economic contribution to society, this does not however preclude them from at the same time making a positive contribution to society. It is possible as previously stated that organisations can be sustainable in terms of economics, society, and the environment (Gorse *et al.,* 2023).

Researchers have attempted to ascertain how the construction sector could contribute to the SDG work, with Lynch and Mosbah (2017) highlighting SDG 1 (no poverty), SDG 9 (industry, innovation, and infrastructure) and SDG 11 (sustainable cities and communities) as opportunities to engage. Others such as Goubran *et al.* (2019) note that buildings play a part in the use of renewable energy (SDG 7), in sustainable consumption and production (SDG 12), and in climate adaptation (SDG 13). While Di Foggia (2018) also supports the idea that SDGs 11 and 13 are the most significant ones. If research, however, continues to focus on standard tools and regional case studies, it is possible the findings will remain of limited use when what is really needed is a truly transformational change. It is in this work that the AEC sectors could lead the way in facilitating the vital change if sustainability is to be achieved.

2.5 RATIONALE FOR THIS STUDY

The SDGs were created as an expansion and updating of the previous MDGs back in 2015. The aim being to reflect the need for them to be economically, socially, and environmentally sustainable through the 17 goals. Many of these goals link to the AEC sector for example SDG 12: Responsible Production and Consumption, which is a huge challenge for the AEC sectors due to the nature of their work and the resources required to deliver on their projects and SDG

11: Sustainable Cities and Communities which is where the AEC sectors can make huge positive impacts within their operations, through design, material choice and construction. There is worldwide interest in the adoption of sustainable practices within the AEC sectors. Therefore, it is proposed that a need exists for an amalgamated approach that is relevant for the AEC sectors and all organisations working within them. Further, there is a general desire amongst the populace for all sectors to be more responsible in terms of sustainability. The market mechanisms, however, limit the options in terms of what can be delivered, and it is suggested here that standards could be used more effectively.

The work presented in this thesis is both unique and timely. While others have examined the benefits and barriers of implementing ISO14001 in a variety of sectors, there is limited work within the AEC sectors and almost nothing in relation to the case studies used. Furthermore, there has been no studies to assist AEC organisations in how gaining an understanding of the opportunities for using their EMS to support their activities towards any sustainability targets. Given the timeframe for the SDGs to be achieved by 2030, there is an urgency for the AEC sectors to act now and the findings of this thesis represent a giant step forward in supporting the necessary actions that the AEC organisations could and should take. This thesis delivers a roadmap which not only can improve the performance of the AEC sector in delivering positive impacts for society, but also demonstrate to their stakeholders the work that they are engaging in.

2.6 CHAPTER SUMMARY

This chapter set out to review the key literature surrounding the benefits (Table 2.1) and barriers (Table 2.2) of ISO14001 and whether the initial benefits cited in Shen and Tam (2002) were still accurate. This work has suggested that while cost remains a major barrier to implementation; cost savings are also seen as a benefit so there is a cost benefit analysis required to ascertain in individual cases to establish the benefits/barriers of such a system. Categories of benefits and barriers have been shown to include PR, environmental, legal, operational, HR, economic and community. Here again, however, it has been shown that there are differences in terms of the benefits and barriers noted. There remains the need to clarify the benefits and barriers which exist in relation to the use of ISO14001 within the AEC sectors, therefore further investigation is necessary, particularly in how ISO14001 can be utilised to deliver on sustainability. Based on the literature reviews conducted, the benefits and barriers (Tables 2.1 and 2.2) have been utilised in the articles which are going to be reported in the following chapters. Delivery of this chapter has enabled Objective Two to be achieved but has also highlighted the need for more engagement within the AEC sectors in respect of the need to deliver sustainability.

The next chapter will focus on describing various research design options in general and then reveal those that were selected for use within the published articles, which support and underpin this thesis.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

This chapter uses information published in Articles #2-#11. The description of the research design, data collection and analysis activities of each article are illustrated in Box 3.

BOX 3

- ARTICLE 2: This study collected interview data and archive documents
- ARTICLE 3: This study collected case study data that was interrogated by comparison to an existing standard.
- ARTICLE 4: This study involved the collection of qualitative data via questionnaires using non-probability sampling.
- ARTICLE 5: This study involved a Prisma literature review.
- ARTICLE 6: This study collected questionnaire data that was interrogated by using weighted average analysis.
- ARTICLE 7: This study collected questionnaire data that was interrogated by using weighted average analysis.
- ARTICLE 8: This study collected questionnaire data that was interrogated by using weighted average analysis along with interviews for further information.
- ARTICLE 9: This study took a Delphi methodology that collected questionnaire data.
- ARTICLE 10: This study utilised a phenomenological methodology, using semi structured interview data and used Interpretive Phenomenological Analysis.
- ARTICLE 11: This study involved two validation exercises and used questionniares to seek agreement and approval from experts.

3.1 INTRODUCTION

In research there are many options in terms of research approach and design. This chapter will review research philosophies, paradigms, approaches, and strategies. These will be examined, and the research approaches selected in this thesis will be addressed. This will be followed by a review of sampling techniques, analytical tools and the methods utilised in the articles. This section will also address the topics of validation of data and research ethics followed by consideration of the limitations of research design and methodology.

3.2 RESEARCH DESIGN

Research design is a framework or structure to guide the process of conducting research (Denscombe, 2021). One of the most commonly adopted tools for this process is the research onion (Figure 3.1), proposed by Saunders *et al., (*2016). The tool can be used to logically shape and organise decisions about the steps involved is creating an investigative research journey. To highlight how these steps have been completed in this thesis an adapted version of the research onion has been included (Figure 3.2).

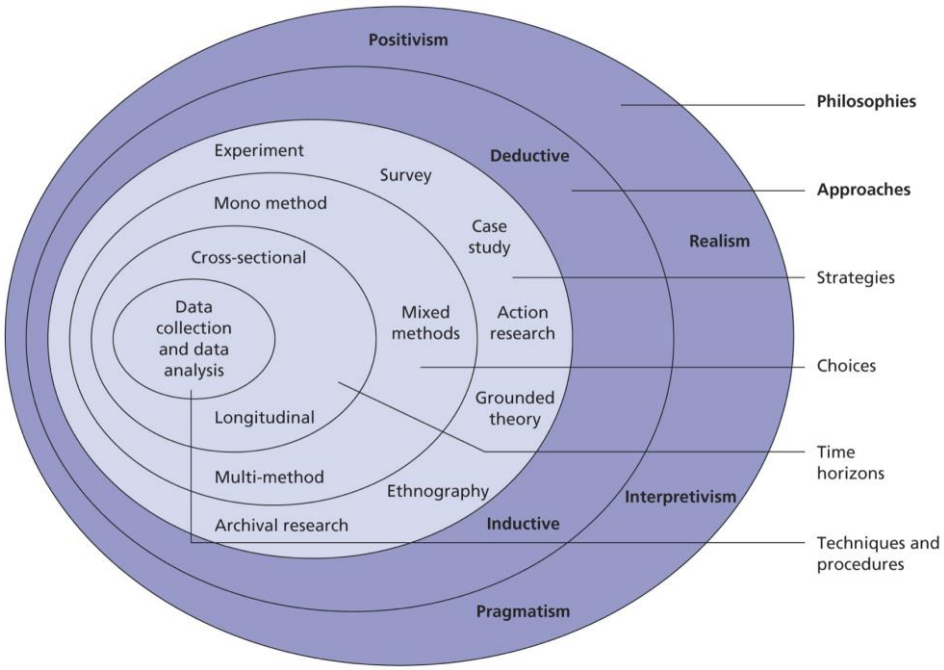


Figure 3.1: Research Onion detailing the research decisions made at each stage of the planning (adapted from Saunders et al., 2016).

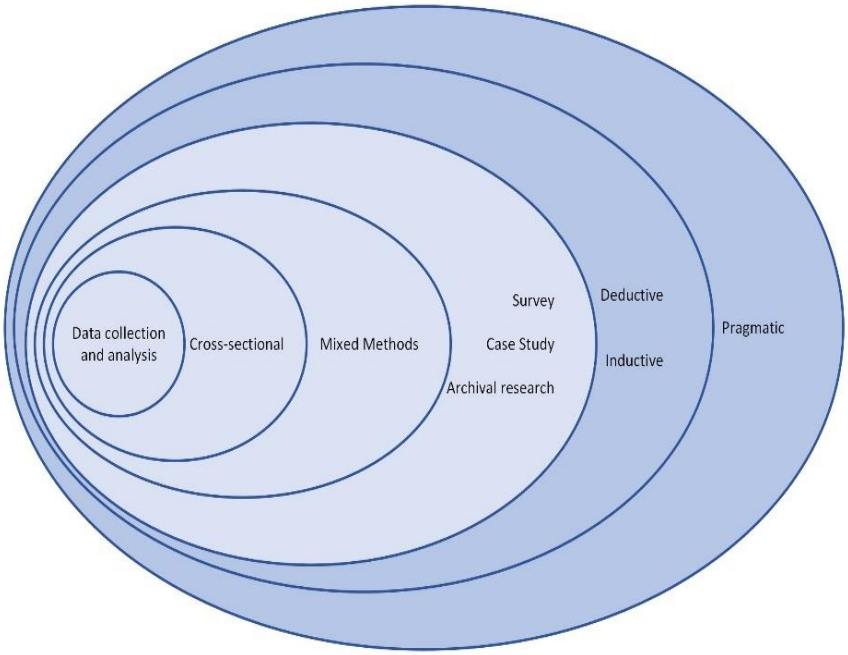


Figure 3.2 Research Onion in this work (adapted from Saunders et al., 2016)

De Villiers and Fouche (2015) noted that *"different paradigms naturally hold opposing ontological and epistemological outlooks"* and that there are different assumptions. The understanding of knowledge (ontology) and knowledge (epistemology) (Table 3.1) are the foundations of the research methods used within disciplines (Mouton, 2012). Grix (2002) stated that these thoughts in relation to the ontology and epistemology enable the formation of the questions constructed within the research and the methodology selected to conduct the investigations.

Table 3.1: Philosophical paradigms with definitions.

	DEFINITION
Epistemology	The study of *"how phenomena [can] come to be known"* (Giacomini, 2010, p. 131). Epistemology is the theory of knowledge; how knowledge is validated, and the methods used to bring this about. Walliman (2011) notes that this is focused on how we know things within each discipline and how this knowledge is constructed. It is the epistemology which leads to the decision on the research paradigm to be followed and from this the method of data collection which is relevant within this research paradigm (de Villiers and Fouche, 2015). Pascale (2011) takes this further in stating that epistemology examines **"***the nature, sources, and limits of knowledge," and that it provides "a justificatory account of the scientific production of knowledge".*
Ontology	The ontology is the researcher's view of the knowledge and how they draw understanding from this. The perspective could be that of a realist, the researcher is separate or relativist, where there are other factors involved. Ontology then translates into epistemology where the questions regarding how the researcher views knowledge are determined (de Villiers and Fouche, 2015). The outcome of the epistemology decisions determines the research paradigm in which the researcher will conduct research (de Villiers and Fouche, 2015). This is followed by the decision on how we can go about obtaining the required knowledge (methodology) and determining the method of data collection pertaining to a research paradigm.
Axiological	Axiology is concerned with value and the value placed on different aspects of the research by the researcher (Saunders *et al.*, 2012). It examines how your values impact on how you proceed with your research, whether you are trying to explain, predict or understand the world (Lee and Lings, 2008).

The words 'philosophy' and 'paradigm' are often banded about within academic arenas as part of many theoretical conversations (Denscombe, 2021; Hammond and Wellington, 2021). In simple terms, however, philosophy is chiefly about the researcher and their approach, while the paradigm is the practices and beliefs about the approach taken in the research. In terms of research philosophies then a decision must be made as to the paradigm to be used within the research (Table 3.2).

The paradigm, which was deemed most appropriate and, therefore, the philosophy selected for this thesis is Pragmatism. The reason for the pragmatic approach being used is because this does not consider truth and reality but accepts that multiple realities can exist and can be subject to empirical inquiry (Creswell and Clark, 2011). As this study examines human perspectives on the need for environmental management and the effectiveness of current approaches this has necessitated the research question being approached through the lived human experience (Goles and Hirschheim, 2000; Tashakkori and Teddlie, 2008; Morgan, 2014). The pragmatist philosophy considers that knowledge and reality are formed from beliefs and habits that are socially constructed over time (Yefimov, 2004). Pragmatists tend to believe that all knowledge is the result of socially constructed views, and these may or may not link to personal individual perceptions (Morgan, 2014). Reality is something that cannot be determined according to Pragmatists (Pansiri, 2005). In this approach reality is a normative concept where knowledge can never be totally abstracted from beliefs, habits, and experiences (Howe, 1988). The pragmatist approach sees reality is true in relation to the understanding of our experiences (James, 2000). Truth is viewed over time resulting from research (James, 2000; Ray, 2004; Baker and Schaltegger, 2015). Here conclusions are drawn after careful consideration of data and philosophical arguments are unsolvable due to the reliance on human experience and needs having dependence on the context (Dillon *et al.,* 2000). The next consideration was the approach to be used.

Table 3.2: Various research paradigms with their meanings, along with some advantages and disadvantages.

Philosophies	Definition	Positives in respect of use	Negatives in respect of use
Positivism	Positivism is a philosophy that only observable facts can be studied, that this and only this provides genuine knowledge. That these studies should be objective and value neutral (Braun and Clarke, 2013). The methods used should be precise, and capable of being verified, this will produce empirical evidence. Formulated by Auguste Compte, who stated that much of the world around us operations to laws, which also applies to society (Calhoun, 2002).	Quantitative in approach. Well-designed structure giving validity and reliability (Cohen *et al.,* 2007). Findings can be generalised for the population (Johnson and Onwuegbuzie, 2004).	Inflexible – difficult to apply to a particular context (Johnson and Onwuegbuzie, 2004). Need to disregard emotions – an inability to measure thoughts and attitudes (Hammersley, 2013).
Realism	Tends to be on a scale of how realistic or not the researcher may be on a topic and that this can vary. But some things can be described as the floor being solid. Realists aim to conform to reality, within their research. Maxwell and Mittapalli (2010) note that there is a world which is discrete from our interpretation, but it is the researcher's interpretation which results in the form of realism used. Philips (1987) defines realism as: the view that entities exist independently of being perceived or independent of our theories about them.	Mainly used in qualitative research (Braun and Clarke, 2013). External reality provides a basis for knowledge (Braun and Clarke, 2013). Underpins other qualitative processes.	Only one truth – (Braun and Clarke, 2013). You can only ascertain the truth, if you remove yourself as the researcher and use the appropriate means – i.e., clear glass window (Braun and Clarke, 2013).
Interpretivism	Here researchers have a view of reality which is constructed by members of society giving access to multiple realities (Greener, 2008). They examine the meanings within this reality. This philosophy is based in realism but does not enable predictions to be made (Walliman, 2011). Inductive reasoning is used beginning with specific observations and aiming to draw a general conclusion from these (Walliman, 2011). This is opposite to positivism. This philosophy can take advantage of case studies, ethnographical, grounded theory analysis (Gunbayi and Sorm, 2018).	Qualitative in approach. The nature of reality is constructed and therefore multiple (Myers, 2005). Focus on specific interests or events (Klein and Myers, 1999).	Weak in terms of prediction to larger population. Influence of the researcher (Saunders *et al.,* 2012).
Objectivism	Here the belief is that reality exists, whether we acknowledge it or not. To gain knowledge of reality it must be observed, and that the truth can be found through repetition of observation in controlled situations (Hiller, 2016) Created by Ayn Rand. Right of humans to a peaceful existence and our potential as creative beings. The main point within this philosophy is that reality exists separate from our interpretation of it. That we as observers have limited knowledge and that therefore we may be wrong in our assumptions, but that confidence exists with the increasing evidence found.	A positivist and realist approach. Here it can be used to examine emotions, reasoning, perception of or connected to events (Given, 2012).	Some claim, for example Nihilists that there is no objective reality which means that all epistemologies and methods are equal, it is about preference (Given, 2012).
Pragmatism	Here the researcher identifies an issue or problem and assesses it, taking a broad view. This means of enquiry enables a better understanding of the situation. The researchers believe that all philosophical topics are best seen in relation to their uses and how they work. "*Thinking begins in what may fairly enough be called a forked-road situation, a situation which is ambiguous, which presents a dilemma, which proposes alternatives. ..... In the suspense of uncertainty, we metaphorically climb a tree; we try to find some standpoint from which we may survey additional facts and, getting a more commanding view of the situation, may decide how the facts stand related to one another.* "(Dewey 1910).	We need to know enough to allow action (Moskowitz, 2005). Use of literal meaning is easier to understand (Eysenck and Keane, 2006).	Lacks certainty and all the information potentially (Moskowitz, 2005). Lack of individual thoughts on a subject (Eysenck and Keane, 2006).
Functionalist	This sees society as a functioning whole and examines how this works. Human behaviour is governed by relative stable structures...that social structures are based mainly on shared values or preferences and suggests that re-establishing equilibrium can best solve most social problems (Brym and Li, 2007). The individual while not significant does form part of society and their relations in respect of this will impact on society. It lost favour in the 1960s and was replaced by structuralism. Survey research can be one of the methods used by functionalists (Gunbayi and Sorm, 2018).	Useful for descriptive quantitative research due to the desire to describe (Shirish, 2013). Works well for organisational studies Gunbayi and Sorm 2018).	Looking to describe situations within individual organisations (Gunbayi and Sorm, 2018).
Radical humanist	Here humans are the priority, but that there is a connection making the world peaceful. This is brought about with a full understanding of reality. The consciousness is dominated by ideological structures (Burrel and Morgan 1979). Uses participatory action and critical discourse amongst other methods (Gunbayi and Sorm, 2018).	Research focuses on subjective nature and uses interviews, observation, and focus groups (Gunbayi and Sorm, 2018).	Subjective in nature (Gunbayi and Sorm, 2018).
Radical structuralist	Defined as "*committed to radical change, emancipation, and potentiality, in an analysis which emphasizes structural conflict, modes of domination, contradiction and deprivation*" (Burrell & Morgan, 1979). That change is brought about by conflict, but that this is not because of consciousness but of contradictions. The aim is to analyse this conflict, over time. This could use technical action research, experimental or quazi experimental (Gunbayi and Sorm, 2018).	Good for structural conflict and contradiction (Gunbayi and Sorm, 2018).	Focus is on conflict and contradiction (Gunbayi and Sorm, 2018).

Rationale for choice of philosophy
It is recognised thjat there is a mix of evidence in the articles supporting the research presented in this thesis. The thesis as a whole adopted the philosophy of pragmatism as this allowed for the negative aspects of qualitative and quantitative research to be mitigated.

3.3 RESEARCH APPROACHES

At the beginning of any research a decision must be made in relation to the approach to be used within the research (Table 3.3). In the case of this DPhil, a decision was made at the start of each individual article.

Table 3.3: Explanation of Approach terminology.

Approaches	Definition
Deductive	Tests an existing theory, in such a manner that no uncertainty remains. It moves from a general theory to specifics with the assumption of truth (Eysenck and Keane 2006).
Inductive	This approach aims to develop a theory or hypothesis (Loseke 2013). Observations or experiences are used to come up with a general truth (Walliman 2011), this cannot be confirmed as the actual truth, moving from a general statement that can be tested and resulting in the creation of a theory (Brynard and Hanekom 2010). The issue is that a conclusion using an inductive approach can be invalidated but not proven. This is an approach which draws generalisations from samples (Eysenck and Keane 2006).
Abductive	Formulated by Charles Sanders Peirce, here the researcher begins with an observation and then looks for the simplest most likely reason for the observation. While it results in a possible conclusion this conclusion cannot be verified (Burch, 2001).
Rationale for choice of approach	
Due to the area of research and that all those taking part will have different experiences of using ISO14001, a inductive approach was selected for the thesis.	

3.4 RESEARCH METHODOLOGIES

In relation to the selection of suitable methodologies researchers must select these dependent on the aim of their project. A variety of analytical methods are available for use depending on whether it is probability or non-probability sampling, and these must be reviewed prior to conducting any data gathering to determine the most appropriate method for the task (Table 3.4).

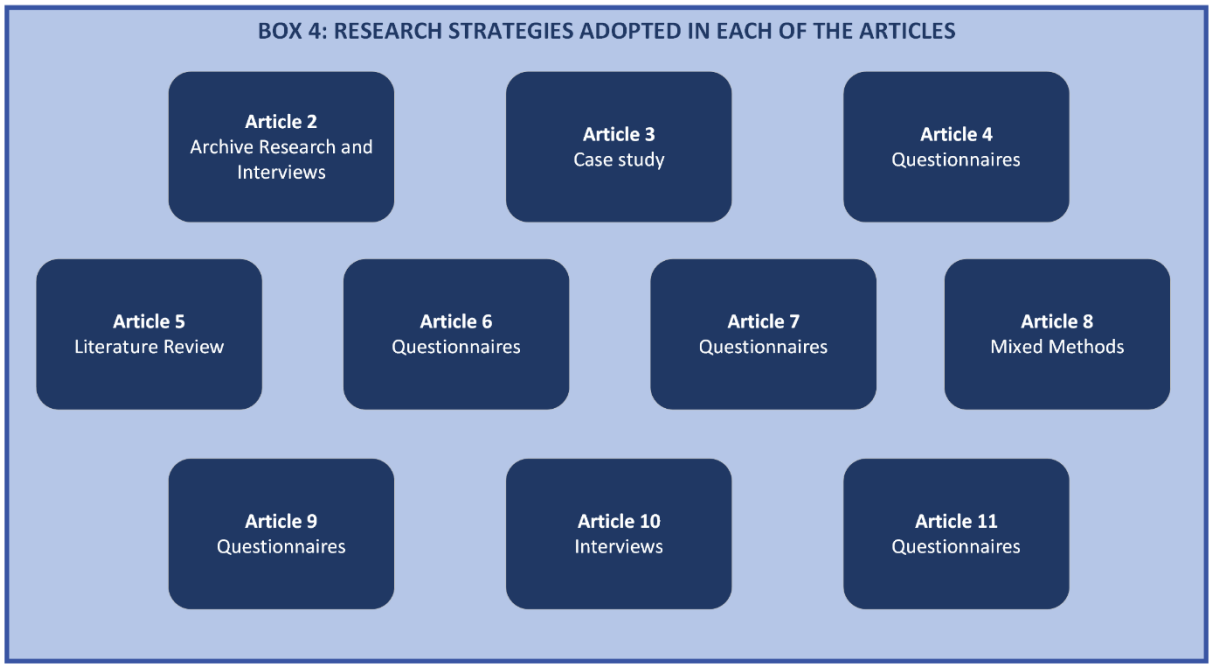
Table 3.4: Types of research strategies available to researchers.

Strategies	Definition
Experiment	A means to validate, support, refute a certain hypothesis. The experiment must be repeatable with analysis of the data. Experiments can be field based, laboratory, randomised controlled trials, natural or retrospective (Denscombe, 2021). Issues to manage include the observer effect (Denscombe, 2021).
Survey	Gathering information on a set of questions from a group, usually to generalise the results to the population. Surveys again can be postal, face to face, group administered, phone, email web-based or via social media (Denscombe, 2021). Issues can include response rates, so it is important to think about the likely response rate (Denscombe, 2021). Another consideration needs to be non-response bias, which could be non-contact or non-response through refusal bias (Denscombe, 2021).
Case study	Systematic investigation of an individual, group or community. This strategy enables an in-depth analysis which can then be used to say how this would have an impact on a more generalised situation (Denscombe, 2021). The disadvantages include the production of generalised findings which can be open to criticism (Denscombe, 2021).
Action Research	This approach can be traced back to Kurt Lewin (1946). Lingard *et al.* (2008) describes this as a community-based means of making improvements, for example in the healthcare sector by working in a cooperative way with the community. In Lingard *et al's* (2008) work practitioners within healthcare improved their delivery of services. Action research sets out with the aim of bringing about change to specific areas. The researchers are looking to produce change via a feedback loop and participation (Denscombe, 2021). Having the participants be active in the research is a benefit however impartiality and workload are seen as challenges in this type of work (Denscombe, 2021).
Content Analysis	In this method researchers are looking for the hidden message, this could be in speeches or other written materials. It begins with a selection of texts, this is then broken into smaller sections, then the issues to be reviewed are detected, coding of the relevant words/sentences, counting the number of times these appear and then analysing the data (Denscombe 2021).
Grounded Theory	Tends to be used in qualitative research. This originated in the work of Glaser and Strauss (1967). It is a theory which is adapted by researchers (Denscombe 2021). However, despite this adapting of the theory there are two points which tend to remain consistent: 1) It generates theories and 2) It emphasises the value of empirical field work and the collecting of data from the real world (Denscombe 2021). So here we again see the research happening and then the theory emerges from the data (Denscombe 2021). Pidgeon and Henwood (1997) state that the idea is to conduct a close review of qualitative data, collected by interviews based in a local setting.
Thematic Analysis	This is a method used to gain an understanding of qualitative data. It can be used in a variety of research paradigms. Braun and Clark (2006) have an approach which is most often cited. It provides a systematic and accessible means of analysing qualitative data, where the aim is not just to summarize the information but to gain understanding and meaning from the data. This method is used to gain an understanding of qualitative data in a variety of research paradigms. Braun and Clark (2006) have an approach which is most often cited. It provides a systematic and accessible means of analysing qualitative data, where the aim is not just to summarize the information but to gain understanding and meaning from the data. TA has a two-stage review process (Braun and Clarke, 2006, 2012, 2013).
Ethnography	Explores culture from the insider perspective, therefore one of the challenges is the time that the researcher needs to be living within the culture they are researching. The types include naturalism, covert and overt (however with overt there is a danger that the researcher will have more influence on the behaviours being observed (Denscombe, 2021).
Discourse Analysis	Again, this analysis is focused on the qualitative data where the relationship between the social world and the language in use are examined. Here researchers examine language as a means of social engagement which impacts on the social world (Johnson and McLean, 2020). Much of this work is influenced by Michel Foucault's theories who examined language in relation to specific knowledge and the impact this had on the power on inequality.
Archival research	Here researchers extract evidence from archives which may be held within museums or churches for example. These records could be images, film, manuscripts, or other documents (Denscombe, 2021).

Beneath is a summary of the various strategies utilised in each of the articles which underpin this thesis.

In this work due to the requirement for the participants to have a thorough knowledge of the AEC sectors and an in-depth knowledge of ISO14001 (Articles #6, #7, #8, #9, #10, #11) it was necessary to use purposeful sampling. This was also required in Articles #2 and #4 due to the nature of the subjects being researched.

Sections 3.4.1 to 3.4.5 will describe the methodologies used in this DPhil thesis.



3.4.1 Research Strategy - Archive (Article #2)

Archive research uses a range of activities to examine records (such as documents) to gain an understanding of an organisation or period of time (Ventresca and Mohr, 2002); whereby, material was originally created as an information source and not purposely for the intention of research (Heng *et al*., 2018). This could be beneficial when using pre-existing data sets as it could be claimed that it can prevent any influence of the researcher in the creation of the data. This does not, however, remove the potential for bias from the original collector of the data (Heng *et al*., (2018). One useful point of this approach is that there is the opportunity to source longitudinal data (Barnes et al., 2018); thereby, removing the need for the researcher to wait several years to collect primary data.

Article #2 utilises archive research, which enabled the researchers to examine passed planning applications to establish the actions of the planning committees over several different requests. The research design for this article followed an inductive reasoning approach and applied a sequential mixed method of archival and qualitative research strategies.

3.4.2 Research Strategy - Case Study (Article #3)

Case studies are a useful means of gaining an in-depth understanding of a situation, or phenomenon. Denscombe (2021) notes that one of the benefits of using a case study is that it allows for a variety of methods to be applied. It also permits an in-depth analysis of the situation under review (Denscombe, 2021). There are, however, some disadvantages such as the likelihood of focus being on the process rather than the outcomes, another issue is the ability to generalise accurately from the findings and of course actually gaining access to the information can be challenging (Denscombe, 2021).

Articles #2 and #3 featured case studies. In Article #2 a review was conducted of the situation in Jersey in respect of the use of EIA. Article #3 applied the Building Research Establishment

Environmental Assessment Method (BREEAM) Certification Scheme to a listed building refurbishment case study.

3.4.3 Research Strategy – Questionnaires, interviews, or mixed methods (Articles #2, #4, #6-#11)

Articles #2, #4 and #6-#11 use a mix of questionnaires, interviews and mixed methods approaches. Questionnaires are also sometimes referred to as surveys and as noted by Check and Schutt, (2012) a survey is a *"collection of information from a sample of individuals through their responses to questions."* The benefit of a questionnaire or survey is that it can use quantitative or qualitative research strategies with numerically rated answers or open-ended questions or both in a mixed method approach and it is quick to deliver. This makes it a popular approach in research (Singleton and Straits, 2009). Questionnaires are not, without disadvantages: pre-coded questions can frustrate participants, and result in researcher bias, it is also not possible to question the responses or check for truthfulness (Denscombe, 2021). Another form of qualitative data gathering is by interview, where more detailed information can be obtained through the interviewer using a semi structured approach. Interviews are an excellent method to gain insight into a situation (Denscombe, 2021). The disadvantages of interviews are widely reported: validity, interviewer effect, reliability, time, resources, inhibitions, invasion of privacy (Denscombe, 2021) and costly therefore not suitable for large numbers of participants (Ponto, 2015). Mixed methods are a combination of questionnaires and interviews to gain a more in-depth understanding of the situation.

3.4.4 Research Strategy – Delphi (Article #9)

Article #9 uses a Delphi approach. The Delphi technique uses purposeful sampling, where experts are selected based on their interest or expertise on the subject (Denscombe, 2010), although criteria are often used to define an expert (e.g., participant qualifications and/or professional body membership, amongst others). Cantrill *et al.* (1996) states that they are informed and knowledgeable individuals with relevant experiences and interests in the theme of the study. Choosing appropriate participants is extremely important within the planning of the Delphi process, as it is dependent on expert opinions and, therefore, is reliant on expert knowledge (Okoli and Pawlowski, 2004). The optimal number of experts for a Delphi survey has been a subject of debate. Okoli and Pawlowski (2004) proposes that panels should be between 10 and 18 experts; while Linstone and Turoff (2002) suggests between 10 and 50 experts is appropriate. In terms of a minimum number Mitchell and McGoldrick (1994) recommend that panels should be no less than 8 experts. In Article #9, 41 experts were approached to take part in the survey, which was administered using Qualtrics. This was done in accordance with the expectations of the UWE research ethics regulations.

This strategy links to interviews but is more in-depth as it enables the systematic collection and analysis of expert opinions on specific issues, where the purpose is to gain an unbiased consensus through a controlled feedback mechanism (McKenna, 1994). Throughout the process the researcher is working to reduce any variability in the answers, using the mean or median scores of the previous round to inform experts of the consensus responses (Mullen, 2003). Normally, the Delphi is complete when there are diminishing returns, a convergence of

opinion or the agreement did not improve (Fink *et al.,* 1984). At this point Banayan *et al*. (2015) states that no further investigation is required.

The Delphi method was selected to enable the confirmation of views of experts to reach a group judgement (Helmer, 1977), and it has been noted as being suitable to explore areas where controversy, debate or a lack of clarity exist. A Delphi approach looks for a statistical representation of the "group response", the process is then repeated, and this enables the participants to change their minds on their responses to be more in line with the group or not, the aim is to arrive at an expert consensus (Adler and Ziglio, 1996). There is a requirement for the sample population for this type of research to be knowledgeable within the area of inquiry.

In the case of Article #9, the participants were required to have more than 5-years' experience in the AEC sector, be educated to a degree level or equivalent and ideally be a member of a professional body (e.g., Institute of Environmental Management and Assessment (IEMA)). The advantage here was the depth of information and insights gained. There are disadvantages to this method which links to those noted with interviews: validity, interviewer effect, reliability, time, resources, inhibitions, and invasion of privacy (Denscombe, 2021).

3.5 SAMPLE, SELECTION, INCLUSION CRITERIA AND RECRUITMENT

In research it is impractical to include all the population in questionnaires or interviews. It is necessary, therefore, to have a sampling approach and strategy (Denscombe, 2021), which will produce data that can be extrapolated to a larger population and to do this within both time and financial constraints (Denscombe, 2021). It may be that the researchers are considering a certain part of the population for example people with diabetes (Vilafranca Cartegena *et al.,* 2022) so this would be part of the inclusion criteria in the selection process. The first consideration is whether probability or non-probability samples are required (Table 3.5).

Table 3.5: Sampling approaches available to researchers.

Approach	Definition
Probability Sampling	Random selection of participants based on the theory of a normal distribution of events (Denscombe, 2021). Here the researcher has no influence over the participants selected (Denscombe, 2021). This works best for large numbers of a known population usually used with large scale surveys.
Non-Probability Sampling	Here there are elements of choice at the discretion of the researcher. Again, it is a representative or exploratory sample and tends to be smaller numbers involved (Denscombe, 2021).

Once this decision has been made there are certain techniques which can be utilised with these approaches (Table 3.6).

Table 3.6: Sampling techniques available to researchers.

Sample Techniques	Sampling Approach	Definition
Cluster Sampling	Probability	Here groups of participants are selected usually based on location. Two conditions must exist for this type of sampling: 1) must be existing groups, 2) must be representative of the heterogeneity of the entire population (Descombe, 2021). Benefits are that it is cheaper for the researcher (often used in market research) and it is expected that the group will be a mini version of the larger population, but this is not guaranteed (Denscombe, 2021).
Convenience Sampling	Non-probability	This is quick and inexpensive. It is based on the convenience to the researcher (Descombe, 2021).
Multi-Stage Sampling	Probability	This involves a sequence of stages where each sample is drawn from the earlier sample group (Descombe, 2021). Useful if the population does not supply a cross section of the general population or it is too costly to include all (Descombe, 2021).
Purposive Sampling	Non-probability	Here a small number of participants are used, and their selection is based on known criteria, i.e., relevance and knowledge (Descombe, 2021). The aim is to get a representative sample of participants who can provide insight and sound information on a topic which may not be known to all of the general population (Descombe, 2021).
Quota Sampling	Non-probability	This is similar to stratisfied sampling and establishes criteria which are vital for inclusion and to ensure that this is representative of the general population under consideration (Denscombe, 2021). The researcher decides on who to use to fill the quota (Denscombe, 2021).
Snowball Sampling	Non-probability	This is where participants nominate other people who could participate (Denscombe, 2021). The advantage is that the number of participants increases quickly. It also encourages participation as paricipants nominate people who they know meet the inclusion criteria (Denscombe, 2021).
Stratisfied Sampling	Probability	This is not totally random sampling as it separates the research population into subgroups which are then randomly sampled. This ensures that vital parts of the group are represented, i.e., equal numbers of men and women (Denscombe, 2021). Requirements are that the subgroups must be homogeneous in the common factors and that this factor must be relevant (Denscombe, 2021).
Systematic Sampling	Probability	While very close to random sampling the researchers here select in a systematic manner picking every *n*th item or name from a list. The number is dependent on the sample required (Denscombe, 2021). The aim is that the list has not impacted on the randomness of the sample.
Random Sampling	Probability	No opportunity for the researcher to influence this so is often touted as the ideal method of sampling (Denscombe, 2021). It is not however totally random as there are constraints such as a *"known population"*, a sampling frame and a set process for selection which could be as simple as a random number generator (Denscombe, 2021).
Theoretical Sampling	Non-probability	This technique involves the selection of participants through discovery as the research progresses (Denscombe, 2021). It is based on theory development, which is supported by evidence and this evidence dictates who may be included as a participant (Denscombe, 2021).

Due to the nature of the enquiry, the basis of this thesis, probability sampling approaches (i.e., random, or systematic sampling, etc.) were not included as the participants needed to be experienced in respect of ISO14001. In contrast, purposive sampling (a non–probability sampling technique) (Etikan and Bala, 2017) was adopted, using explicit inclusion criteria, namely: participants must have a minimum of five years' experience of working in the AEC sector, be employed by an AEC organisation that has adopted ISO14001 and they must have been personally involved in the implementation and operation of ISO14001 before and/or after accreditation. This allowed a specific targeted group of participants to be invited for interview (Klar and Leeper, 2019). To allow for an open and frank discussion, which is encouraged in this type of study, there was the need to assure participants that nothing would be included in any publication that may identify them personally or their employers.

Other factors that need to be considered in any research project is the size of the population sample. According to Denscombe (2021), the size can be calculated via statistical, pragmatic, or cumulative approaches. Denscombe (2021) suggests that a statistical approach is best, however, he notes that for smaller scale surveys a pragmatic approach is often taken. The cumulative approach can be taken usually with small scale questionnaires where the researcher adds more participants until there is no benefit in adding more, in effect a consensus has been

reached (Denscombe, 2021). In some works, the precedent of earlier studies can also be used as a justification for what is deemed an acceptable sample size. Throughout this work a pragmatic approach was adopted due to the requirement for the participants to understand and have used ISO14001.

3.6 QUALITATIVE OR QUANTITATIVE DATA

Data as previously mentioned, can be gathered for research that is either qualitative or quantitative in nature. Qualitative data supplies more in-depth responses in the form of verbal or written responses rather than just a tick in a box. Quantitative data is numerical and can be analysed using statistical methods, it tends to be used to supply large data sets. The software used with the quantitative data in these articles was SPSS (version 20) and Excel (versions 16.76 and 19).

3.6.1 A reflectivity positionality statement

As an academic with twenty years-experience of teaching environmental management and as someone who has personally been involved in implementing ISO14001, I have witnessed 'first-hand' how the ISO14001 system has developed and been modified through its various iterations. Further, I have also witnessed the organisational benefits and barriers as ISO14001 has been transformed.

As the IEMA Chair for the Midlands Steering Group, a Fellow of IEMA and a lead auditor of ISO14001 my experiences have provided me with not only in-depth knowledge of the subject area but also an understanding of the different experiences of using ISO14001. It is duly acknowledged that these insights and experiences had to be managed carefully to ensure that personal prejudice was minimised or restricted in the way questions were constructed to ensure that my views did not have any detrimental effect or bias on the outcomes of my research. Similarly, it is important to acknowledge that as a widely recognised professional in the environmental sector, some participants may have opted to position their responses to conform with their perceived believes of my own thoughts. It was necessary, therefore, to select experienced professionals whenever possible who have equivalent standing in the sector and who are sure of their own abilities to deliver valid responses. Throughout each of the published articles this has been a consideration I have rationalised and contend with.

3.6.2 Qualitative data used in this work

Qualitative data at its most basic is words or images, it also tends to involve small number of items or participants (Denscombe, 2021). It is noted by Denscombe (2021) that there is a tendency with qualitative research to focus on *"seeing things in context"* where the assumption is that *"(social) realities are wholes that cannot be understood in isolation from their contexts, nor can they be fragmented for separate study of their parts"* (Lincoln and Guba,1985:39). Methodologies which are used in qualitative research are noted in Table 3.7.

Table 3.7: Qualitative data sources (adapted from Denscombe, 2021).

Research Methods	Data Sources
Questionnaires (open ended questions)	Transcripts of the answers to the questions.
Interviews	Transcripts of interviews, focus groups or other forums.
Observation	Video recordings of events or human interaction, images, artifacts, and other cultural objects.
Documents	Reports, minutes of meetings, diaries.

The articles that used qualitative data were #2, #8, and #10. Most qualitative data is analysed for themes using software such as Nvivo. This, however, was not suitable as the work conducted require a more in-depth analysis of the themes particularly in the case of the phenomenological study and therefore, an interpretive phenomenological analysis using a manual process was used (Table 3.8). This involved the researchers repeatedly reading each of the transcripts to extract interrelated themes and meanings (Amos, 2016). This was to ensure that the themes and subthemes highlighted were an accurate representation of the phenomenon under review (Smith, 1995; Smith and Osbourn, 2003).

Table 3.8: Description of the stepwise process used to analyse the participant interview narratives (based on Smith (1995), Osborn and Smith (1998)).

Step	Description
1	Reading and re-reading of the interview transcripts to gain firstly a general sense of the whole interview responses.
2	The transcripts were then re-read noting any emerging themes and these were then noted.
3	Taking the noted themes, these were then grouped and defined, allowing for a focus on any interrelationships between the themes.
4	Where shared themes existed, these were then used to produce meaningful and accurate statements. These lead to the production of the meaning and experience of the participants using their own words.
5	The superordinate themes and statements were then compared against the original transcripts to verify the findings.

The strategy for this work was to collect secondary data, then to confirm the validity of this data to the AEC sectors. From this data it was possible to ascertain how an EMS can be used to provide more sustainable wins to an organisation and society. The data was collected from secondary sources at the beginning of this research journey, but this was followed up with primary data to confirm whether the secondary data was sound and accurate.

The benefits and barriers from the literature review were gathered and confirmed as being a true representation by professional environmental managers. From this it was possible to highlight the potential to utilise EMS to deliver on other agendas such as the SDGs by way of a roadmap. This was also confirmed as being of use with professionals within the AEC sectors.

3.6.3 Quantitative data analysis used in this work

There are many ways to interrogate and explore quantitative data (Dancey and Reidy, 2002; Denscombe, 2021). Normality tests (e.g. Anderson Darlin, Shapiro-Wilk and Kolmogorov-

Smirnov) are employed to determine the distribution of the data and to inform the researcher whether to use parametric or non-parametric tests (Dancey and Reidy, 2002; Denscombe, 2021). Parametric tests assume the data has a normal distribution of values and any variances in data should be approximately equal and without extremes (Dancey and Reidy, 2002); while non-parametric tests make no such assumptions (Dancey and Reidy, 2002) (Table 3.9).

Table 3.9 Parametric and non-parametric tests

Parametric tests (means)	Non-Parametric tessts (medians)
1-sample t test	1-sample Sign, 1-sample Wilcoxon
2-sample t test	Mann-Whitney test
One-way ANOVA	Kruskal-Wallis, Mood's median test
Factorial DOE with one factor and one blocking variable	Friedman test

The articles used to support this thesis collected various types of data and then used a variety of tests to analyse the data (Table 3.10 and 3.11).

Table 3.10: Quantitative tests used to analyse the data.

Test	Definition
Cronbach's Alpha	This provides a measure of internal consistency of a test or scale. The results are given as being between 0 and 1. The test measures the inter-relatedness of the items within the test (Tavakol and Dennick, 2011).
Reliability Test	This is whether the research results can produce the same results i.e., results which are consistent. Referred to as dependability in qualitative research (Denscombe, 2021).
Normality test (Anderson Darling)	This test looks at how well the data fits a particular distribution. It allows for a more sensitive test but there needs to be a calculation of critical values for the distribution (Nelson, 1998).
Normality test (Kendall's W)	This is a non-parametric test for rank correlation used to reveal the level of agreement amongst participants (Ameyaw *et al.,* 2016); to determine basic descriptive statistics; and to determine the weighted average rankings of the responses (Bailey *et al.,* 2020).

Table 3.11: Descriptive statistics.

Test	Definition
Mean	A calculation of central tendency (Dancey and Reidy (2002). An average of the numbers within the data set.
Mode	The most frequently occurring number within a data set (Dancey and Reidy, 2002).
Median	The middle number if all numbers are written out in numerical order (Dancey and Reidy, 2002).
Skewness	A measure of asymmetry, so whether the data is distorted. If the data is severely skewed, then the test would need to be non-parametric (Dancey and Reidy, 2002).
Kurtosis	The measure of peak or flatness of the distribution of data, a high peak is leptokurtic and flat distribution is platykurtic (Dancey and Reidy, 2002).
Standard Deviation	A measure of how dispersed the data is against the mean (Dancey and Reidy, 2002), a small standard deviation would mean that the data is clustered around the mean. An issue with this is that it does not provide information on the data between the extremes (Dancey and Reidy, 2002).
Standard Error	Usually the term for standard deviation. It is a measure of the amount that the sample means deviate from the mean (Dancey and Reidy, 2002).
Pearson Correlation Coefficient	Most common approach for measuring a linear correlation, measuring the strength and direction between two variables (Dancey and Reidy, 2002).
Spearmans Rank	This is the nonparametric alternative to Pearson which examines the degree that two sets of data are correlated (Faizi and Alvi, 2023). Pair sets of data is needed for this test; these must be in some way related (Faizi and Alvi, 2023). It is recommended that there are at least 10 pairs of data to ensure that results do not occur by chance.
Weighted Average	Here an average is calculated but some of the data points are weighed higher than others to show their level of importance, in terms of rank (Hesterberg, 2012). If all data points had the same weighting it would result in a mean.

3.6.4 Research approach adopted in this study

This study as noted used a variety of approaches which were dependent on the requirements for each individual article: the approach, method, and reasons for selection are given below (Table 3.12). It is the intent that this final thesis will demonstrate the use of a variety of approaches, strategies, sampling techniques and data analysis methods.

Table 3.12: Research Approaches used in this DPhil.

Article	Research Approach	Methodology	Reasons for the approach
2	Inductive	Archival Research and Interviews	This article was in relation to the environmental practices within Jersey and it was necessary to look at historic planning applications to gain a perspective. The interviews to clarify the process.
3	Abductive	Case Study	To examine the effectiveness of BREEAM in listed buildings taking a case study approach enabled a more focused discussion on the benefits and challenges.
4	Deductive	Questionnaires	This was used to gain validation of the researchers' thoughts on the suggested paradigm shift.
5	Inductive	Literature Review	A literature review provides an understanding of the issues being faced within environmental management from a broad perspective.
6	Deductive	Questionnaires	This was used to gain an understanding of the experience of industry professionals in their experience of using ISO 14001. (Maldives)
7	Deductive	Questionnaires	This was used to gain an understanding of the experience of industry professionals in their experience of using ISO 14001. (USA)
8	Deductive	Mixed Methods	This was used to gain an understanding of the experience of industry professionals in their experience of using ISO 14001. (UK)
9	Deductive	Questionnaires	To gain the thoughts of industry professionals but this time incorporating interviews to gain more in-depth knowledge.
10	Inductive	Interviews	To gain an understanding of the professionals' view of ISO 14001 using a phenomenological approach.
11	Deductive	Questionnaires	To gain the thoughts of industry professionals but this time incorporating interviews to gain more in-depth knowledge.

3.7 VALIDATION

Validation is often linked to credibility and whether the researcher can show that their data is accurate (Denscombe, 2021). It was, however, noted by Lincoln and Guba (1985) that it is not possible in qualitative research to prove that what they have found is correct. There are, however, means to support that the findings reflect the situation at that moment in time. This includes respondent validation where the researcher goes back to the participants to check for accuracy (Denscombe, 2021).

This was the approach taken within the Article #11; whereby, expert opinions were sought. Firstly, to validate the literature review (Phase One) and then to validate the roadmap that was created (Phase Two). The validation process itself was conducted through questionnaire surveys shared with AEC sector relevant persons.

Phase One – the list of benefits and barriers were shared via a Qualtrics questionnaire survey (recording participant details and opinions) with a panel of environmental experts who were members of the Institute of Environmental Management and Assessment (IEMA) LinkedIn group. Eligibility criteria used to include participants as experts was that they needed to be: (i) an IEMA member of five years or more, who work in environmental management; and (ii) hold the minimum of a Bachelor degree qualification.

Phase Two – the roadmap (explained in Chapter Six) was shared via a Qualtrics questionnaire survey (recording participant details and opinions) with a panel of AEC industry–facing professionals from each of the sectors and who are based in organisations that hold ISO14001 certification. Eligibility criteria used to include participants as experts was that they needed to be: (i) employed in one of the AEC sectors for a minimum of five years and work on

sustainability–related projects; (ii) membership of an AEC professional body; and (iii) hold the minimum of a Bachelor degree qualification.

These methods have enabled an understanding to be garnered in respect of how ISO14001 is viewed within the AEC sectors and by then going on to conduct the interviews other questions raised through the literature reviews and questionnaires have been able to be clarified. Of course, it is noted that any research involving people must apply ethical considerations.

3.8 RESEARCH GOVERNANCE AND ETHICS

The UWE, Bristol is required by the Concordat to Support Research Integrity, which is a national framework to ensure a good standard of research and reassure government, business, and international parties of the integrity of the research and researchers involved. UWE works to ensure the integrity of any research conducted by staff or students complies to these standards and have processes in place to ensure that this is the case. To ensure this happens the University has a Code of Good Research Conduct (2022), which is accessible via the UWE webpages.

Ethics and moral standards are integral to research studies (Oliver, 2010). Therefore, consent to take part was sought from all participants, who were also informed that their involvement was voluntary, and their responses would be anonymous. In most of the articles used in the thesis, participants were also offered a window of opportunity (two weeks from their involvement) to withdraw if they desired. The study was conducted in accordance with the ethics regulations at the University of the West of England (UWE), Bristol. Ethical approval was either through the University of Derby (the author's employer) or UWE, Bristol (Table 3.13). This work complies with the UWE Bristol Code of Good Research Conduct and Policy.

Table 3.13 Details of the ethical approval process for each of the articles used in the study.

Article number	Ethics approval required	Documents available
Article #1	No	N/A
Article #2	Yes	Student work, ethics approval in module at University of Derby
Article #3	No	N/A
Article #4	Yes	Approval was given by the University Research and Ethics Committee
Article #5	No	N/A
Article #6	Yes	Student work, ethics approval in module at University of UWE, Bristol
Article #7	Yes	Student work, ethics approval in module at University of UWE, Bristol
Article #8	Yes	Student work, ethics approval in module at University of UWe, Bristol
Article #9	Yes	Approval was given by the University Research and Ethics Committee
Article #10	Yes	Approval was given by the University Research and Ethics Committee
Article #11	Yes	Approval was given by the University Research and Ethics Committee
Article #12	No	N/A

3.9 LIMITATIONS OF THE RESEARCH DESIGN AND METHODOLOGY

All research has limitations, which can be in the design, method, or the analysis. Some of these limitations have been mentioned at earlier points of this document. In terms of this research a Pragmatic approach was used which allows for the investigation of what works in the real world (Denscombe, 2021) but does have limitations as noted in that it lacks certainty and potentially does not have all the information (Moskowitz, 2005). As Eysenck and Keane (2005) note there can be a lack of individual thoughts on a subject. This, however, is balanced by the usefulness of the approach in respect of mixed method approaches (Denscombe, 2021).

In this thesis the limitations have been the identification of participants, access to suitable participants, engagement with participants, the resultant sample sizes and understanding and interpretation of the responses. All the limitations, however, are managed and within the articles submitted have been conducted to standards followed in earlier research.

3.10 CHAPTER SUMMARY

This chapter described and discussed research design philosophies and methodologies available to researchers, before stating that pragmatism underpinned the design of this study. A review was provided of methods, sampling techniques and analytical tools utilised in the supporting articles. Data validation and ethics were also addressed along with the limitations of the study design. It has been demonstrated that a wide range of methods have been used within this work and that these were carefully selected to ensure that the most appropriate and accurate data was gathered to inform not only the articles but also the DPhil thesis.

Chapters Four to Six will now demonstrate how these methods have been used in the articles. Firstly, by examining the background situation in relation to the management of the environment and subsequently to move the readers' focus to the benefits and barriers of the use of ISO14001 in the AEC sectors internationally and within the UK. In this work the international review focused on the Maldives and the USA. The situation in respect of the benefits and barriers to the implementation of ISO14001 within the Maldives, the USA and the UK will be the focus of the next chapter.

CHAPTER 4: PRELIMINARY FINDINGS

This chapter uses information published in Articles #6-#8. The purpose of each article is illustrated in Box 4. The purpose of this chapter is to set the scene in relation to the current benefits and barriers influencing the adoption of ISO14001 in the AEC sectors.

BOX 4

ARTICLE 6: The aim of this publication is to explore the potential of EMS by examining the perceptions of the benefits and barriers of implementing EMSs within the construction sector of a developing nation, the Maldives.

ARTICLE 7: The aim of this publication is gain an understanding as to why there is a genergal lack of EMS uptake within the USA construction sector.

ARTICLE 8: The aim of this publication is to gain an understanding of how stakeholders perceive the benefits and barriers of EMS within the UK SME construction sector.

4.1 INTRODUCTION

Building on the information and evidence disclosed in the earlier chapters, this chapter examines the use of ISO14001 through three geographical studies. The intention is to provide insights of the benefits and barriers of ISO14001 from a developing nation (Republic of the Maldives) and a developed nation (USA), which are vastly different in respect of legislation, environment, and expectations of society and to then compare these to the UK. In terms of the findings, the articles will now be discussed in numerical article order (#6-#8).

4.2 PRELIMINARY FINDINGS

This section presents the findings from the three case studies (one developing nation country and two developed nation countries), namely: (i) the Republic of the Maldives (Article #6); (ii) the USA (Article #7) and (iii) the UK (Article #8).

4.2.1 – An international review utilising a developing nation of the implementation of ISO14001

ARTICLE 6

This research was conducting via a literature review followed by a questionnaire. The results of the respondents' opinions suggested that the primary benefits of having an EMS in the Maldives are perceived as the enhancement of corporate image and environmental protection; while the major barriers are lack of legal enforcement and the requirement for company structures and policies to change to accommodate an EMS. The findings also suggest that those companies who establish a waste management plan and where authorities enforce legal environmental requirements are believed to be the most effective means to encourage more widespread adoption. Based on these findings, it is recommended that managers, need to increasingly promote the principles of environmental management and sustainable practices/behaviours amongst construction industry stakeholders. Furthermore, policy makers within the Maldives should be exploring the viability of establishing financial incentive schemes (particularly for SMEs), in addition to encouraging wider adoption of EMSs across the Maldivian industry sectors.

The results in this article noted that improving corporate image in environmental performance was perceived to be the most significant benefit in the adoption of EMS in construction practice within the Maldives. It was suggested that ISO certified organisations were likely to be regarded as more competent due to the international recognition of the standard; hence, improving the corporate image and credibility of the organisation (Tam, 2008). Likewise, even in developed

countries, such as the Sweden and Hong Kong, the enhancement of corporate image was cited as a significant motive and benefit of adopting an EMS (Shen and Tam, 2002; Poksinska *et al.,* 2003; Horry *et al.,* 2022a).

The contribution to environmental protection was perceived to be the second most significant benefit. This perception links to the increased focus on environmental issues in the Maldives in recent years. The result resonates with the findings in both Hong Kong (Shen and Tam, 2002) and Nigeria (Owolana and Booth, 2016), where contribution to environmental protection were identified as one of the most significant benefits of implementing an EMS in construction (Bailey *et al.,* 2020).

In terms of the least significant benefits the research findings interesting cite cost savings due to the reduction of fines associated with convictions. This is probably due to the absence until recently of any construction law in the Maldives, and hence, there have not been any legislative frameworks to regulate the industry. The reduction of environmental complaints was found to be the next least significant benefit. This finding can also be seen to relate to the lack of government legislation and legal frameworks to govern the industry, limiting the avenues that could be used in raising environmental complaints by third parties. The case study in Nigeria, also a developing country, shows similarities to the Maldives relating to the political sphere and corruptive practices, and a lack of concern for the implementation of standards and policies in environmental management (Owolana and Booth, 2016). If consideration, however, is given to Hong Kong, a more developed country, the reduction of environmental complaints was ranked as a more significant beneficial factor, indicating the presence of appropriate channels for lodging complaints and raising concerns (Shen and Tam, 2002).

In respect of the barriers to engagement, the research findings reveal the most significant barrier to implementing an EMS in the Maldives is the lack legal enforcement. This result reflects the lack of a well-structured and effective legislative framework to regulate the construction industry, a case common to most developing countries (Hortensius and Barthel, 1997; Tam, 2008; Owolana and Booth, 2016).

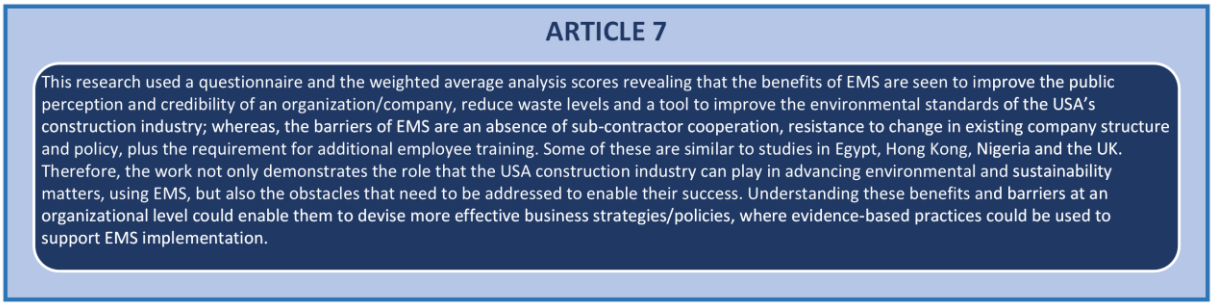
The government in the Maldives could lead efforts to promote and encourage environmental management practices in the country, by improving the legal framework and developing the required infrastructure for formal environmental management practices within the industry. Additionally, financial incentive schemes administered by the government may trigger widespread adoption of EMS in the country (Davy, 1997; Ofori *et al.,* 2002). Liyin *et al.,* (2006), however, remarked that government efforts alone would be insufficient to drive the environmental management agenda, unless organisations are internally motivated and committed to such practices.

Changes of existing company structure, policy and the lack of trained staff and expertise were also found to be significant obstacles to the implementation of EMS in the Maldives. This finding signifies the reluctance of the industry to change their organisational structure, which stems from top management commitment to the subject. Shaheen and Charoenngnam (2004) suggests that industry in the Maldives is still in its infancy in applying the concept of sustainable construction, demonstrating similarities to a case study from Egypt (Sakr *et al.,* 2010) and so their hesitancy to restructure the organisational policies to include environmental management components is justifiable.

In respect of the least important barriers to uptake of environmental management within the industry the research findings indicate lack of supplier and sub-contractor cooperation. This result is rooted in the fragmented nature of the relationship that exists between the supply chain and the construction organisations in the Maldives, the former is often perceived to be less influential than the latter. A similar outcome was observed in the study undertaken in Nigeria (Owolana and Booth, 2016) indicating that issues with the supply chain are typically considered to be minor barriers in developing countries.

Lack of support of working staff was also observed to be a less significant barrier to the adoption of EMS in the Maldives. This is due to the top–down management approach that is still prevalent within construction organisations in the country, where working staff are designated their roles and responsibilities. This managerial style mirrors the traditional top-down approach used in environmental management, in which environmental policies are implemented and enforced through laws and fines (Barrow, 2005).

4.2.2 – An international review utilising a developed nation of the implementation of ISO14001



The top-rated benefit to the use of ISO14001 in this article was the *'contribution to the environmental standards of the construction industry'*. This suggests participants have concern for environmental protection; that contractors see a rising of standards as making of a positive contribution to the environment (Bailey *et al.,* 2020). This was followed by *'improves corporate image and credibility'*, which conforms to the findings of a study on Malaysian manufacturing firms (Haslinda and Chan, 2010). It has been reported that highly visible environmental practices, such as EMS, significantly contribute to a better corporate environmental image and reputation of businesses in the USA (Morales-Raya *et al.,* 2018). This improved image and reputation could be a result of the demonstration of a commitment to environmental management, through increasing stakeholder confidence, and reducing environmental impact by incorporating EMS into company policy and strategy (Arena *et al.,* 2012; Morales-Raya *et el.,* 2018).

While at the other end of the scale the least significant factors were *'reduces costs'.* The belief that an EMS does not reduce costs but is more likely to increase them, may also contribute to participants ranking this benefit factor as they did. Increased overhead costs may lead to higher prices and, consequently, a loss of competitiveness (Šiškina *et al.,* 2009) and *'relieves environmental regulation and policy burden'* suggesting that a more passive approach may be taken towards compliance with environmental building regulations, codes and EMS to avoid attention.

In respect of the barriers to engagement the most important factor was that of '*lack of subcontractor cooperation'*, To establish effective EMS implementation, previous studies have recognized that subcontractors must improve their commitment to the contractors' EMS (Valdez and Chini, 2002; Swaffield and Johnson, 2005). It is, however, the responsibility of the contractor to communicate and provide training to raise awareness of this (Valdez and Chini, 2002; Swaffield and Johnson, 2005).

4.2.3 – A review of the use of ISO14001 within the UK construction sector

When considering the results of this study '*Reduction of environmental risks*' was considered highly significant when compared to the other responses with is supported by the findings of Shen and Tam (2002). The next two highest responses were – '*Contribution to levels of environmental protection generally within society*' and '*Contribution to environmental standards of the construction industry as a whole*' are viewed by contractors as extremely significant in terms of being beneficial factors of EMS implementation. While the least important benefits were noted as being, '*Reduced transport costs through travel management strategy'* not mentioned by Shen and Tam (2002), '*reduction of environmental complaints*' which was noted as neutral by Shen and Tam (2002), '*reduction of environmental-related sickness and injuries*' and '*reduction of fines associated with convictions*' which generally align with the findings of Shen and Tam (2002).

In respect of the most significant barrier to the implementation of environmental management systems in the construction industry was a '*lack of subcontractor co-operation'*. Unlike the responses to EMS benefits, the most significant three statements on the BARIV scale are extremely closely ranked especially when the α and mean values are considered. The cumulative response values for the 2nd most highly ranked statement on the BARIV scale '*Cost Savings do not balance against expense of thoroughly implementing management strategies*' actually obtained a greater α value by two points. Similarly, the statement ranked 3rd on the BARIV scale *'Increase in management and operational costs'* obtained a higher α value by 1 point. '*Lack of sub-contractor co-operation'* was highlighted as a significant barrier in the study of Shen and Tam (2002) and was also considered a key barrier with both the questionnaire they undertook showing this but also interviews revealing that controlling their environment performance is extremely difficult and time-consuming.

From the findings in Shen and Tam (2002), *"increases in management and operational costs"* was the most highly ranked statement, which is comparable with this study. The factor ranked 2nd '*Cost savings do not balance against expense'* indicates that the contractors felt that despite initial investments they were or would not get any significant returns. It would, therefore, appear that the purported benefits of cost reductions from implementation of an EMS would not be realised, and that any investment was a fruitless exercise in terms of reducing real costs and adding monetary value to the organisation.

The factor ranked 3rd was '*Increase in management and operational costs'*. This is directly correlated with the 2nd that the increase in costs is not directly reflected in the level of savings to be made elsewhere in the organisation. Virtually all the papers reviewed showed increases in management costs are a key barrier to implementation. This includes Shen and Tam (2002) whose study ranked this item as the most important by a large margin. Whilst it is evident that

this is an important issue it is not clear whether this is largely a true or perceived situation, which is manifesting itself in the views of the respondents. Further research is required in this area to attempt to quantify whether the costs or value are accurately measured when it comes to EMS.

The four lowest ranked statements in Shen and Tam's (2002) study are matched with those found here, albeit in a different order. This indicates that despite the time and cultural differences these marginal barriers are the same. There is also parity between the two studies on highest ranked and lowest ranked barriers for both studies and this seems to suggest that despite changes in policy, greater awareness and indeed levels of implementation the same issues have yet to be resolved. Overall, this study corroborates several findings that have previously been highlighted in construction management and EMS studies.

The UK along with many other countries in the world are currently challenged with how to reduce their carbon footprint and minimise impact on the environment. One way that can be achieved is by using an environmental management system as this allows organisations to understand where and how they impact the environment.

ARTICLE 8

Using a questionnaire with SME construction companies detailed statistical analysis showed that systems can sometimes produce quantifiable benefits to organisations in terms of costs reduction, but also illustrate, from a contractors' view the greatest benefit is a reduction in the impact on the environment outweighing those benefits of a financial nature. Findings also demonstrate numberous barriers, both internal and external to the organisation, exist with regard to the adoption and use of EMS. The most crticial barrier was that cost savings do not always balance with the expense of implementation. Furthermore, waste minimisation at design stage is viewed as most important. In general, the opinions gauged in this study indicate short-term profits are normally considered more imperative than long-term gains. Therefore despite a need to focus on developing strategies for removing or reducing challenges of using an EMS, the reality is that EMS may not be the panacea to sustainable development, as is often touted.

If these organisations are to be encouraged to use a science-based approach to reduce their impacts they will need a mechanism by which this can be achieved, ISO14001 is one such tool. To encourage organisations to use such a system there needs to be an understanding of what the benefits and barriers to the use of such an approach are to enable the barriers to be mitigated and the benefits to be heightened.

4.2.4 Comparison of results.

The results of these three studies were all ranked in terms of the benefits and barriers and while these are not in the same in all the countries some similarities can be drawn. It should also be considered that a developed country will potentially have different challenges and be at a different point in the environmental management progression than a developing nation such as the Maldives. Another consideration should be whether the organisations concerned have any benefits in relation to trade and the promotion of trade. There are similarities noted across the three articles (Table 4.1 and Table 4.2).

Table 4.1: Benefits from Articles #6, #7 and #8.

Rank	Article #6	Article #7	Article #8
1	Improving corporate image	Contributes to the environmental standards of the sector	Reduction in environmental risks
2	Contribution to environmental protection	Improves corporate image and credibility	Contribution to levels of environmental protection
3	Contribution to improvement of public environmental standards	Reduces waste	Contribution to the environmental standards of the sector
4	Reduction in environmental risks	Improves environmental performance	Compliance with employers prequalification requirements
5	Reduction in environmental related sickness and injury	Increases energy savings	Segregation of waste resulting in cost neutral or cost positive disposal
6	Increasing overall business competitiveness	Reduces environmental impacts	Minimising production costs through more efficient ordering and waste minimisation
7	Improving staff working environment thus increasing their morale	Improves finished product quality and value	Improved corporate image increasing overall business competitiveness
8	Reduction in environmental complaints	Improves workers health, safety and welfare	Reduced transport costs through managed travel strategy
9	Cost savings due to the reduction of fines associated with convictions	Reduces environmental complaints from clients	Reduced environmental complaints
10		Improves relationships with stakeholders, clients and regulators	Improved staff work environment, thus increasing morale

Table 4.2: Barriers from Articles #6, #7 and #8.

Rank	Article #6	Article #7	Article #8
1	Lack of government legal enforcement	Cost savings do not balance the cost of implementing EMS strategies	Lack of subcontractor cooperation
2	Change of existing practice of company structure and policy	The implementation costs are high	Cost savings do not balance against the expense of thoroughly implementing management strategies
3	Lack of trained staff and expertise	Difficulty identifying environmental issues	Increase in management and operational costs
4	Lack of tailor made training on environmental management	Uncertainty regarding the benefits of EMS	Lack of client support
5	Lack of technical support within the organisation	Additional documentation	Increase in documentation workload
6	Increased management and operation cost	Low employee support	TIme consuming for improving environmental performance
7	Difficult coordination of environmental performance amongst multi-tier subcontractors	Lack of client support	Difficult coordination of environmental performance amongst multi-tier subcontractors
8	Lack of client support	Lack of subcontractor cooperation	Lack of trained staff and expertise
9	Time consuming for improving	Lack of internal technical support	Ambitious or absent government
10	Increase in documentation workload	The requirement for additional employee training on new policies	Lack of working staff support

*Demographics of engagement can be found in the articles within the appendices.

4.3 CHAPTER SUMMARY

This chapter has used a range of examples to gauge stakeholder perceptions of the benefits and barriers of adopting EMS in the AEC sectors, which has contributed to the delivery of Objective Three. Here again, however, the results while showing some similarities are not always ranked in the same order when considering the importance to the participants. There are also some which may be due to the developing nature of the area in relation to consideration of environmental impacts. This may be because of the legislative requirements within the areas and/or the requirements of stakeholder groups. Therefore, there is still a need to clarify these issues and further investigation is necessary to ascertain the benefits and barriers through a more thorough means. Therefore, the next chapter will investigate the situation in more depth and attempt to clarify the standpoint by using a Delphi study aimed at reaching a consensus of opinions between experts. It will then delve deeper through a phenomenological investigation to gain greater insight into the lived-experience of those working with ISO14001 in the AEC sectors.

CHAPTER 5: MAIN FINDINGS

This chapter uses information published in Articles #9 and #10. The purpose of each article is illustrated in Box 5.

BOX 5

ARTICLE 9: The aim of this publication is to reveal the consensus opinions of an expert panel of sustainability and environmental professionals working within the AEC sectors on their perceptions of the benefits and barriers of implementing ISO 14001 in the UK.

ARTICLE 10: The aim of this publication is to explore the '*lived-experience*' of those environmental professionals involved in the implementation and operation of ISO 14001 in AEC organisations in an attempt to understand underlying issues associated with implementing ISO 14001 and to gather generalised insights into gaining and maintaining ISO 14001 accreditation.

5.1 INTRODUCTION

This chapter builds on the preliminary evidence presented in the previous chapters by expanding the scope to include a much greater quantity of benefits and barriers and to use stakeholders to gauge consensus on their priorities in the AEC sector. Then, the chapter employs a phenomenological methodology to explore real-life experiences of adopting an EMS to reveal deeper insights around implementation. In doing so, the chapter further supports the delivery of Objective Three but also the delivery of Objective Four.

5.2 DELPHI STUDY (ARTICLE #9)

Delphi studies, as noted, by Denscombe (2021), are useful for sourcing 'state of the art' information, as they use the views and opinions of experts. Although experts do not always agree (Denscombe, 2021). The process involves a structured approach (Hammond and Wellington, 2021). The experts are asked to give their individual insights, and their responses are anonymised (Denscombe, 2021). The collective views of all the experts are then fed back in an iterative process in an attempt to reach a consensus between the experts on the topic under review (Hammond and Wellington, 2021).

In this instance fifteen industry experts accepted the invitation to take part in the Delphi study. These participants were all employed in senior posts relevant to the theme of the study, they were all very experienced in the AEC sectors, highly qualified, members of relevant professional bodies, and very experienced in sustainability and/or EMS.

Each participant completed and returned a survey (Delphi Round One) that asked them to independently rate 145 statements, across 17 subject categories, using a Likert–scale (strongly agree, agree, slightly agree, neutral/neither agree nor disagree, slightly disagree, disagree, strongly disagree). These responses were analysed and used to inform the next stage of the Delphi process. A follow–up survey (Delphi Round Two) was returned to all the participants, which showed the statistical mean response for each statement from round one and asked them to confirm or adjust their original responses in comparison to the group responses. Nine of the original experts (a 60% response rate) opted to accept the invitation to take part in the second round. Of these experts, only one participant wished to make any amendments to their original selections. Consequently, the Delphi survey was closed after only two rounds.

This raises some issues, which are discussed in greater detail in Article #9. In respect of the term consensus, however, there is debate about what is required, with Duffield (1993) defining consensus as being the stability of the responses between the rounds. Others have stated that it would be when most participants agree (Butterworth and Bishop, 1995). In this instance, a Kendall's W value greater than or equal to 3.5 was used, where the top three categories of benefits, where agreement was found were: employee engagement, public relations, and legal compliance. This is interesting, particularly in terms of employee engagement, as while it is flagged as a benefit in research it is not usually cited as the major benefit. Also interesting in terms of the barriers was the fact that the participants did not reach an acceptable level of agreement on any categories of the barriers, which would suggest that barriers maybe very specific to the individual organisations involved and dependent on the reasons for the implementation of the system and/or what is deemed a barrier.

5.2.1 EMS BENEFITS (ARTICLE #9)

Experts' responses (after two rounds) to the benefit statements are surmised in Table 5.1 including the weighted average rankings (BIV) for each of the eight categories, which reveals the highest ranked benefits of implementing ISO14001 are:

(i) improved relationships with stakeholders,
(ii) tender requirement,
(iii) community participation,
(iv) industry standards,
(v) efficient operations,
(vi) employee environmental awareness,
(vii) cost savings through energy efficiency, and
(viii) improved environmental performance.

This is surmised in Horry *et al*. (2022a), which identifies an exhaustive list of the benefits (n=86) and barriers (n=59) of implementing ISO14001 in the AEC sectors. These factors were used in the next phase of the study.

Table 5.1: A consensus of the expert responses to the reported benefits of implementing ISO14001 in the AEC sectors.

Category code	Reported benefits of implementing ISO14001	Mean	SD	BIV	Kendall's W
PR1	Enriches corporate and public image	5.94	0.827	14.17	0.375
PR2	Enhances image with regulators	6.06	0.966	12.26	
PR3	Improves relationships with stakeholders	5.82	0.728	16.90	
PR4	Credibility of the organisation	6.24	0.752	14.40	
PR5	Green image	5.82	0.951	10.81	
PR6	Reduced complaints	4.35	1.455	8.46	
PR7	Market differentiation	4.76	1.251	7.86	
PR8	Investor confidence	5.41	1.278	10.25	
ENV1	Competitive advantage	5.06	1.197	9.48	0.338
ENV2	Long term competitiveness	5.18	0.883	10.95	
ENV3	Higher profits	4	1.118	7.31	
ENV4	Market based pressures	4.76	1.147	9.76	
ENV5	Stakeholder pressure	5.41	1.121	11.37	
ENV6	New market opportunities	5.18	1.38	8.47	
ENV7	Tender requirement	6.53	0.514	19.75	
ENV8	Equal access to green market	4.94	1.519	8.02	

ENV9	Facilitate trade	4.59	1.176	8.99	
ENV10	Pressure from competitors	4.47	1.231	8.09	
ENV11	Remove trade barriers	4.18	0.951	10.00	
ENV12	To increased market share	4.59	1.278	8.26	
ENV13	Customer satisfaction	4.71	1.404	8.20	
ENV14	Improved customer perception	5.47	1.179	14.97	
ENV15	Customer trust	5.35	1.272	13.13	
SOC1	Improved community relations	4.65	1.539	7.97	0.163
SOC2	Social pressure (community/activists)	4.47	1.419	8.46	
SOC3	Increase stakeholder confidence	5.06	1.519	8.96	
SOC4	Social legitimacy and responsibility	4.88	1.495	8.76	
SOC5	Less complaints	4.29	1.105	8.81	
SOC6	Community participation	4.35	1.169	9.41	
SOC7	To improve industry/ government relations	4.71	1.49	9.08	
SOC8	Government support/ incentives	4.35	1.412	7.80	
LC1	Industry standards	6.06	0.556	15.00	0.359
LC2	Compliance with regulations	6.18	0.809	13.10	
LC3	Liability threats	5.59	1.064	11.37	
LC4	Ensuring legal compliance	5.76	1.2	9.10	
LC5	Reduction in fines	4.65	1.412	7.95	
LC6	Lower risk of liabilities/due diligence	5.41	1.121	13.67	
LC7	Cost of non–compliance	5.06	1.144	8.75	
LC8	Improved relations with regulators	5.76	1.393	9.47	
OP1	Efficient operations	5.53	0.8	13.10	0.317
OP2	Improved quality in product/service	5.24	1.091	9.99	
OP3	Cost savings through process improvements	5.06	1.209	9.62	
OP4	Improve organisational systems	6.06	0.827	11.37	
OP5	Increase in efficiency and productivity	5.24	1.091	11.04	
OP6	Management open to research/criticism	4.76	0.752	9.79	
OP7	Higher productivity	4.59	1.228	9.09	
OP8	Standardised processes	6	0.866	11.14	
OP9	Improved risk management (H&S)	5	1.225	10.29	
OP10	Corporate management	5.47	1.231	9.48	
OP11	Conformity	5.53	0.943	11.14	
OP12	Flexible	4.29	0.849	9.09	
SE1	Better employee morale	4.59	1.228	11.87	0.453
SE2	Employee environmental awareness	5.94	0.748	13.13	
SE3	Employee involvement and collaboration	5.24	0.903	9.74	
SE4	Motivated employees	4.53	0.874	9.32	
SE5	Employee satisfaction	4.35	0.996	8.61	
SE6	Subcontractor relations	4.59	1.604	8.71	
SE7	Involvement of senior management	5.82	0.951	10.39	
SE8	Top management commitment	6.06	0.966	10.88	
SE9	Increasing staff skills	5.41	1.064	9.81	
SE10	Better working conditions	5.06	0.899	10.95	
CS1	Cost reduction	4.65	1.32	7.81	0.099
CS2	Lower insurance costs	4.47	0.8	9.62	
CS3	Cost savings through energy efficiency	5.06	1.029	10.86	
EI1	Reduce resources used	5.47	0.874	11.52	0.249
EI2	Reduced carbon footprint	5.59	0.712	11.87	
EI3	Reduce waste generation at source	5.71	0.772	11.87	
EI4	Save costs related to water use	5.47	0.8	12.05	
EI5	Better environmental information flow	5.59	1.004	10.25	
EI6	Continuous improvement	6.18	0.636	12.61	
EI7	Reduction in pollutants	5.82	0.636	13.33	
EI8	Monitor and measure supplier performance	5.29	0.849	11.87	
EI9	Environmental impact reversal awareness	5.12	0.993	11.52	
EI10	Improved environmental performance	5.94	0.748	14.17	
EI11	Pollution prevention	5.94	0.748	12.24	
EI12	Increase public awareness of environmental issues	4.71	0.985	12.24	
EI13	Reduced environmental impact	5.94	0.748	14.17	
EI14	Reduced environmental risks	6.12	0.697	13.88	

EI15	Protect the environment	6.06	0.899	12.08	
EI16	Reduce waste generation at source	5.76	0.664	13.67	
EI17	Increased recycling	5.53	0.8	11.14	
EI18	Environmental awareness	6.06	0.827	12.08	
EI19	Desire for certification	5.59	1.176	10.77	
EI20	Reduce emissions	5.65	0.702	13.33	
EI21	Commitment to environmental responsibility	6.24	0.831	10.88	
EI22	Reduce environmental incidents	5.94	0.827	11.68	

**Descriptors for the benefit category codes: PR= Public relations; ENV= Business improvements; SOC= Societal impacts; LC= Legal compliance; OP= Improved operations; SE= Staff engagement; CS= Cost savings; and EI= Environmental improvements.*

These benefits suggest that as systems develop there is more of a focus on the benefits in relation to the external environment in relation to (i) improved relationships with stakeholders (Turk, 2009) which could be a result of the impact of public pressure, (ii) tender requirement (Turk, 2009; Bailey *et al.,* 2020), where more organisations are looking at the impact of the supply chain (iii) community participation (Shen and Tam, 2002) and (iv) industry standards (Bailey *et al.,* 2020), where there is increasing interest within sectors. Also noted are those areas where there are financial implications, such as: (v) efficient operations (Butterworth and Bishop, 1995) which has the potential to increase cost savings, (vii) cost savings through energy efficiency (Shen and Tam, 2002) which highlights the increasing pressure resulting from the pandemic and rises in energy prices. While those factors which focus on the environmental performance with (vi) employee environmental awareness (Owolana and Booth, 2016) which assists in the running of an EMS, and (viii) improved environmental performance (Owolana and Booth, 2016; Bailey *et al.,* 2020] have become more significant again possibly due to the potential for negative public attention through the media.

5.2.2 EMS BARRIERS (ARTICLE #9)

The experts' responses (after two rounds) to the barrier statements are summarised in Table 5.2. Again, this includes the weighted average rankings (BIV) for each of the seven categories, which reveals the highest ranked barriers to implementing ISO14001 are: (i) open to public scrutiny, (ii) costs involved, (iii) top management commitment towards implementation (iv) lack of link to EIA, (v) public not interested; (vi) lack of support to assist staff; and (vii) legal compliance.

Table 5.2: A consensus of the expert responses to the reported barriers of implementing ISO14001 in the AEC sectors.

Category code	Reported barriers of implementing ISO14001	Mean	SD	BIV	Kendall's W
PR1	Negative publicity	2.59	1.06	4.75	0.28
PR2	Purely image building	2.76	0.97	5.47	
PR3	Open to public scrutiny	3.06	1.03	5.85	
C1	Cost involved	3.82	1.38	6.68	0.13
C2	Cost may be higher than benefits	3.41	1.70	6.44	
C3	Does not add value	2.82	1.38	6.01	
M1	Top management commitment towards	3.18	1.63	6.01	0.13
M2	Industry not ready	2.47	1.38	4.55	
M3	Setting up management structures required	3.65	1.50	5.47	
E1	Identification of environmental aspect/impact	3.07	1.62	5.00	0.14
E2	Little improvement in environmental performance	2.87	1.60	5.64	
E3	Lack of link to EIA	3.87	1.25	6.29	
E4	Lack of environmentally sound technology	3.53	1.19	6.01	
E5	No environmental improvements	2.53	1.13	5.50	
OP1	Decreased competitiveness	2.82	1.13	5.23	0.20
OP2	Existing subcontractor system	3.59	1.33	6.34	

OP3	Unsuitable standard	2.88	1.36	4.88	
OP4	Change to existing practises	3.41	1.18	5.38	
OP5	Not required for export	3.47	1.23	7.28	
OP6	Public not interested	3.94	1.09	7.79	
OP7	Lack of resources	4.00	1.17	7.31	
OP8	Disruption to workflow	3.41	1.37	5.69	
OP9	Bureaucratic	3.41	1.54	5.83	
OP10	To increase sales not to improve environment	3.53	1.46	6.74	
OP11	Time	3.94	1.52	6.14	
OP12	Lack of awareness of the standard	4.12	1.41	6.44	
OP13	Need for audits	3.53	1.59	5.75	
OP14	Documentation required	3.82	1.51	5.56	
OP15	Can use ISO 9000 to deliver the objectives	3.76	1.52	6.56	
OP16	Uncertainty of the benefits	3.76	1.64	6.48	
OP17	Lack of incentives	4.00	1.62	6.06	
OP18	Relies on peer pressure/manufacturing initiatives	3.35	1.41	5.38	
OP19	No major impact in the sector	3.12	1.50	5.67	
OP20	Lack of guidelines	2.88	1.11	4.80	
OP21	Incompatible sub–contracting system	3.59	1.28	6.01	
OP22	Suppliers and contractors must also improve	4.59	1.33	6.49	
OP23	Competitive pressures	3.59	1.42	6.34	
OP24	Lack of stakeholder support	3.59	1.42	5.87	
OP25	Lack of stakeholder demand or pressure	3.41	1.54	5.38	
OP26	Lack of rigour in the process	3.00	1.17	6.22	
OP27	Focus is on the process not the results	3.53	1.63	5.38	
OP28	Sector is weak in terms of environment	3.53	1.46	5.91	
OP29	Risk low	3.00	1.28	6.50	
OP30	Lack of materials/technology to assist	3.29	1.45	5.93	
EE1	Employee resistance	3.59	1.58	6.02	0.10
EE2	Complexity of the standards	3.53	1.63	5.22	
EE3	Lack of knowledge about ISO14001	4.24	1.52	6.45	
EE4	Lack of support to assist staff	4.00	1.32	7.21	
EE5	Change is stressful	4.24	1.35	6.83	
EE6	Need for tailor made training	4.00	1.50	5.75	
EE7	Lack of experience consultants	3.59	1.77	5.55	
EE8	Lack of experience	3.71	1.61	6.14	
EE9	Lack of expertise	3.76	1.89	5.76	
EE10	Lack of training (general)	3.82	1.67	6.14	
EE11	Lack of knowledge	3.88	1.90	5.85	
LR1	Legal ramifications	2.76	1.35	5.53	0.19
LR2	Legal issues resulting from engagement	2.82	1.47	5.69	
LR3	Legal compliance	2.82	1.43	5.85	
LR4	No mechanical control	2.88	1.22	5.60	

**Descriptors for the barrier category codes: PR= Public relations; C= Costs; M= Management; E= Environmental issues; OP= Organisational operations; EE= Employee engagement; and LR= Legal requirements.*

An important barrier elicited is that of being open to public scrutiny (Zuchi and Sohal, 2004), which could be explained in relation to the ease with which information is obtained and negative publicity shared. The new version of ISO14001 did put a requirement on senior management engagement, so it is understandable that this has now become a more significant barrier to engagement (Owolana and Booth, 2016). It is interesting, however, how the other barriers have changed from being ones which are more to do with enabling the organisation to implement systems to how these system work with other projects, such as the linkages to the EIA process (Chen *et al.,* 2004). The inclusion of the lack of public interest (Chen *et al.,* 2004) is noteworthy as it is generally thought that there is currently more interest in the environment; however, this is actually viewed as a barrier by the participants. While training and experience have always been listed as barriers, in this study a lack of support to assist staff (Owolana and Booth, 2016) was highlighted, which may include training. A requirement of the standard (vii)

legal compliance (Kien *et al.,* 1999) is listed as a barrier to engagement, which, given that it is part of the standard, needs further investigation to ascertain why it is considered a barrier.

5.3 SUMMARY OF DELPHI FINDINGS

This work has re-examined the benefits and barriers noted in literature and has expanded the number of each to ensure a broader and more inclusive view of the benefits and barriers that are experienced is also considered. By conducting a Delphi study, a consensus of professional opinions was sort, and this has provided a ranked view of considerably more benefits and barriers to ensure that those which may not have been experienced in all organisations are still recognised as being part of the decision-making process when considering the adoption of an EMS.

5.4 PHENOMENOLOGICAL STUDY (ARTICLE #10)

A phenomenological-based methodology (i.e., understanding experiences) uses a lifeworld perspective to gain a deeper understanding of personal experiences (Willig, 2013). It takes a qualitative research approach with semi-structured interviews as the means of inquiry. Due to the nature of the enquiry, participants need to be experienced in the topic under investigation and, therefore, purposive sampling (a non-probability sampling technique) is adopted (Etikan and Bala, 2017). Following on from the interviews, the next task is to find themes/sub-themes and meaning in the responses. The researchers repeatedly read each of the transcripts (Amos, 2016), to extract accurate representations of the phenomenon under review (Smith, 1995; Smith and Osborne, 2003).

In the phenomenological study herein the themes and subthemes generated through analysis of the transcripts, along with selected verbatim quotes, are presented under five main section headings: (i) participant demographics and backgrounds; (ii) Opening doors; (iii) It is more than it ever was; (iv) A standard for achieving objectives; and (v) A modern-day necessity. To protect the anonymity of the participants, no personal information about the participants is used in any of the descriptions and the direct comments included do not divulge any identifying factors.

5.4.1 Results from the interviews

All the participants stated that their organisations were engaged in contributing to the sustainability agenda, and many were keen to note that their organisations were early adopters in respect of setting sustainability-related objectives. Several participants from large organisations mentioned that there is a "*groupwide approach to sustainability".* Here, though the participants are talking about survival rather than true sustainability. It suggested that while organisations may engage voluntarily on the easy, quick wins in relation to sustainability, external pressures seem to be driving them to do more in relation to the sustainability agenda. This becomes more obvious with comments related to the tendering process, where all participants noted that the requirement for such framework engagement includes criteria such as the organisation must have ISO14001 *"in any contract in business, if you're not meeting the current standards, you won't be entertained or considered for a framework or contract. Obviously, putting the business ahead in its field by gaining 14001 early and to a higher, demonstrable standard than others was a benefit* [looking up, seemingly in thought] *…and*

demonstrating the commitments that we'd got to our sustainability standards". It is generally accepted by many in society that it is the right thing to do, the reasons why many organisations are involved however is not just to protect the environment, but it appears to be to increase their opportunities to engage with tendering processes and ensuring the financial health of their organisations.

The majority of those interviewed worked on combined management systems, where more than just ISO14001 was involved. The use of group procedures made the work easier for those new sections of the organisation coming on board. An issue highlighted by most participants appears to be the aligning of central teams in relation to their responsibilities, this particularly relates to areas who perceive themselves to having minimal negative impacts (such as accounts or finance).

Lack of knowledge is a constant theme and those who were early adopters had to deal with this, it appears the Health and Safety staff tended to be handed the task, and it was treated as a risk-focused exercise. Several of those interviewed noted that they were doing much of the work themselves and that this had required them to pull it together rather than having information stored, readily available, in files on shelves. There did appear, however, to be a collective view that ISO14001 is a minimum standard, rather than a benefit *"to say that there's any benefit to having the minimum, there isn't, because I think the world expects a lot more on top of that…14001 is just like a benchmark*".

The comments above infer that ISO14001 is great at managing the environmental impacts, but it maybe needs to be a little more prescriptive in relation to what is possible when a company has gone past that initial phase in the development of their environmental management system. Cost savings again were highlighted *"management of waste can actually be a massive cost, not saving necessarily, but actually generate profit".*

A criticism was, and there was a consensus between participants on this, that the focus of ISO14001 was on the organisations facilities rather than their operations and that is potentially an issue in this sector. It could, in this instance, be questioned as to whether this produces the best outcome for the environment, particularly if all those involved are only working towards objectives that they know they are guaranteed to be able to deliver rather than being aspirational and maybe not quite achieve them.

Some of the participants declared they were purely using the system for the environmental management of their work; however, most were using the system to manage their sustainability work too, which was highlighted by the participant who said *"you only put in what you are happy to achieve…we don't have a separate 14001 management system. You make the 14001 fit the system you've got…14001 isn't being used as a marketing tool,* [shakes head] *but the net zero strategy in approach is…maybe there needs to be another 14001, which looks at sustainability rather than environmental stuff".* This is something which organisations should look at going forward.

All the participants declared they would recommend the uptake of ISO14001 to organisations but with the proviso that it *"has to work for the business".*

An interesting point made was that not all those asking for ISO14001 have it themselves. This is evidenced by the statement *"what I find fascinating is that many client organisations require 14001 as part of any contractual work that they undertake. But very few of those organisations have ISO14001* [shaking their head]*"*. This would bring into question how these organisations are managing their own impacts and what happens to building projects after handover? Are they managed in a sustainable manner or are the owners relying on the AEC sector to deliver an environmentally sound building and saying the work is complete?

5.5 SUMMARY OF PHENOMENOLOGICAL FINDINGS

From this section it must be noted that many of the participants were early adopters, which provides an informed perspective of the benefits and barriers to the use of ISO14001. The use of a phenomenological approach also allows for the answers to questions to be interrogated more than a questionnaire would. Many of those involved are using combined systems due to the systems being mature. The fact that the construction organisations did not have the system include their building sites but purely their offices and transport included in scope is a point which requires more consideration in the future, as this will not provide an accurate perspective of the impact of those organisations. The comment about only including objectives within the management system which are certain of being achieved is another point which will require further investigation in the future as this would appear to go against the spirit of ISO14001. It is clear from the work conducted here that the phenomenological approach has provided a deeper understanding of the use of EMS in the UK and therefore delivered on Objective Four.

5.6 CHAPTER SUMMARY

This chapter used findings from two articles: a Delphi study to gain a group consensus of a hierarchical list of the benefits and barriers and then used a phenomenological methodology to delve deeper into the lived experience of implementing and operating an EMS. In doing so, this fulfils Objective Three and delivers Objective Four.

The Delphi study revealed a consensus of AEC expert opinions on the benefits and barriers of implementing ISO14001 in the AEC sectors. The responses of the experts to the various types/categories, originally identified by Horry *et al*. (2021), have been ranked to ascertain the main benefits and barriers of implementation. The highest ranked benefits were: (i) improved relationships with stakeholders, (ii) tender requirement, (iii) community participation, (iv) industry standards, (v) efficient operations, (vi) employee environmental awareness, (vii) cost savings through energy efficiency and (viii) improved environmental performance. The highest ranked barriers were: (i) open to public scrutiny, (ii) costs involved, (iii) top management commitment towards implementation (iv) lack of link to EIA, (v) public not interested; (vi) lack of support to assist staff; and (vii) legal compliance.

These findings suggest a shift in priorities in respect of the benefits and barriers of engaging with ISO14001. There is an increasing focus on external issues, in terms of the improved relationships with stakeholders and the need to have ISO14001 for certain tenders. This requirement to engage with tenders, particularly those from the UK Government, was confirmed in the phenomenological study, where it was noted as being a tick box on the form.

This research also found that in organisations that had established systems in place some were separating out environmental and sustainability objectives. The participants did, however, note that ISO14001 is a starting point for organisations. The separating of environmental management and the more ethereal sustainability agenda is an issue as there is the risk that organisations will be compliant but not aim for sustainability.

The next chapter will build on this topic through the design and validation of a roadmap for the AEC sectors to highlight how their EMS could support the delivery of the SDGs; thereby, combining environment and sustainability.

CHAPTER 6: A ROADMAP CREATED FOR THE ARCHITECURE, ENGINEERING AND CONSTRUCTION SECTORS TO SUPPORT THE DELIVERY OF THE SUSTAINABLE DEVELOPMENT GOALS

This chapter uses information published in Articles #11 and #12. The purpose of each article is illustrated in Box 6.

BOX 6

ARTICLE 11: The aim of this publication is to produce a roadmap that utilises the known benefits of implementing environmental management systems in the AEC sectors to support the delivery of the SDGs.

ARTICLE 12: The aim of this publication is to explore the benefits and barriers of implementing environmental management systems in the construction sector and demonstrating how ISO 14001 and its associated training towards sustainability are key in facilitating the delivery of SDG-12.

6.1 INTRODUCTION

Having highlighted the benefits and barriers of how AEC organisations are implementing EMS in the previous chapters. This chapter continues to address the aim of this thesis by highlighting the opportunities for organisations to do more with their EMS. It was decided that to do this a roadmap would be required. This chapter, therefore, aims to deliver a roadmap (Blackwell *et al.,* 2008) to highlight to organisations within the AEC sector to how they can support the sustainable development goals. Further, SDG 12 will be used as the focus for additional evidence (Article #12). In doing so, Objective Five will be achieved.

6.2 CREATION OF THE ROADMAP

The first part of the Delphi study (Phase 1) identified a wealth of benefits (n=86) and barriers (n=59). These factors have been used to underpin a roadmap to support the potential delivery of the SDGs.

ARTICLE 11

This study presents a systematic review of published literature across the AEC sectors to identify the reported benefits and barriers of implementing ISO 14001 systems and, in doing so, enabled the conception of a roadmap towards the delivery of the SDGs. The stepwise PRISMA reveiw process facilitated the compiling of both academic articles and professional reports (n=44), which permitted the creation of an inventory of the perceived benefits (n=86) and recognised barriers (n=63) to implemenitng ISO 14001 across the AEC sectors.

The roadmap was created by mapping the benefits of ISO14001 against the SDGs to ascertain which benefits would be delivered by working on the SDGs. This was done by cross-linking each of the validated benefits of implementing ISO14001 in the AEC sectors against each of the SDGs. Recognising that some of these objectives could be achieved more easily than others, an indication of the relative expected timescales was included. The experiences of the research team exceed exceeding 100-years for the AEC disciplines and 50-years for sustainability issues. Since this approach, however, could be considered as being subjective, a decision was made to seek the opinions of independent AEC industry experts with sustainability experience to validate its creation and, hence Phase Two was implemented. The roadmap (Figure 6.1) shows

1,462 total potential cells where benefits could be achieved, of which 503 were considered to produce a tangible opportunity to the organisation. Blank cells have been excluded due to their minimal cost benefit profile and hence the following percentages are calculated from the more realisable benefits. Most of these are green (74%, n=372), suggesting there are more achievable opportunities for AEC organisations operating an EMS to contribute to the delivery of the SDGs and these could be achieved quite swiftly. There are blue coloured cells (equating to 21%) and grey coloured cells (equating to 5%) for the medium- and longer-term benefits. The green blocks are mapped to areas which area closely linked to the sector and would be easiest to achieve in the short term. The blue blocks tend to be areas outside the standard operations of this sector and will therefore require collaboration with other parties to deliver on the goal. The grey blocks are areas where it is more likely to be longer term before benefits are seen in these goal areas, as in the case of partnerships where the stakeholders may not be at the same point of the journey towards sustainability and therefore may not wish to be involved now but in the long–term things will probably change.

As can be seen all the EMS benefits have linkages across to the SDGs (Figure 6.1). SDGs 8, 12 and 13, link with at least one of the sub-benefits for each of the group benefits. SDG 8 links with the greatest number of sub-benefits (n=59), while SDG 2 links with the least number of sub-benefits (n=12). All the SDGs link with at least ten of the sub-benefits, with four (SDG 4, 8, 12 and 13) link with at least half of the benefits. The public relations, market, and social group benefits link to the most SDGs (mostly 5, 8, 10, 12). In terms of the sub-benefits: customer satisfaction, commitment to environmental responsibility, green image, improved community relations and improved industry/government relations link to the most SDGs (mostly 3, 5, 10, 12, 13).

6.3 VALIDATION OF THE ROADMAP

After the roadmap was designed, it was presented to a group of 12 AEC industry experts to validate. These experts were from each of the AEC sectors, and all met and/or exceeded each of the participant criteria detailed earlier. As with a similar study (Ezekannagha *et al*., 2020), where validation was sought, a purposive but criteria-based cohort of participants were invited because the experience and insights of experts was deemed to be a necessary and overriding factor in the validation process.

Participants were invited to review the document and to make comment about its potential usefulness in assisting organisations to engage with the SDG agenda. While most of the participants (n=10) thought that the roadmap was useful there were requests for instructions about the use of the roadmap to make the process simpler. This roadmap tool was thought by the participants to be of use in one of two ways, depending on whether the focus is on achieving the SDGs where it will show the potential benefits of this or, if the objective is to gain the benefits and, therefore, identify which SDGs would help in the achievement of these. This work will continue to assess the ability of the use of ISO14001 to assist in the delivery of sustainability and will focus on one SDG in particular; SDG12 this SDG was deemed significant as it concerns resource use, and this has been highlighted as issue that is of particular relevance to the AEC sectors.

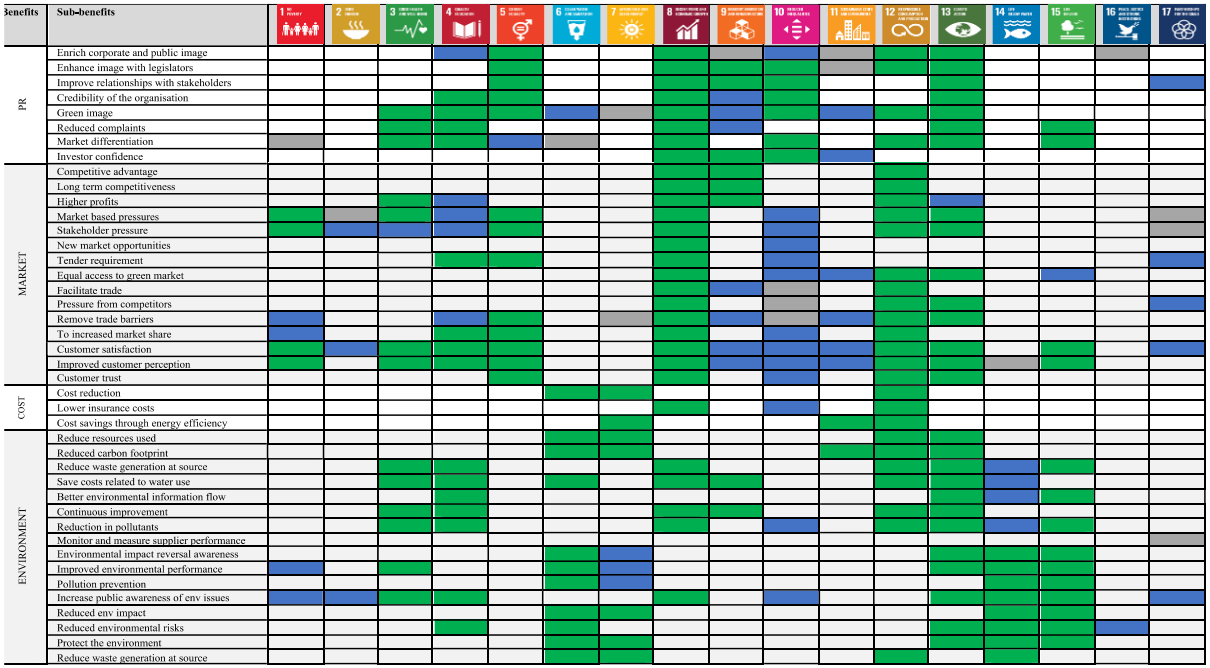


Figure 6.1: Roadmap of how EMS benefits link to the SDGs.

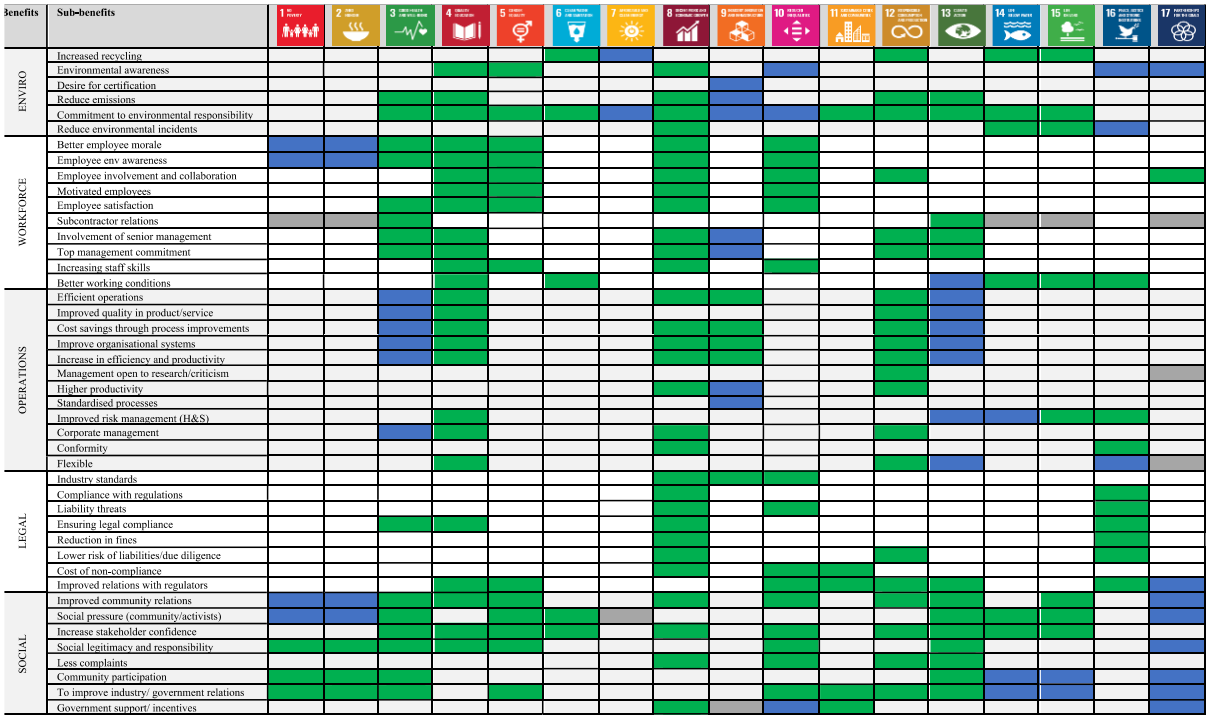


Figure 6.1 (cont.): Roadmap of how EMS benefits link to the SDGs.

6.4 EVIDENCE TO SUPPORT ISO14001 BEING USED TO DELIVER SDG12

In an economically focused society, the concept of responsible consumption is an interesting goal, as economic development requires there to be a demand and, therefore, consumption. If it is assumed, however, that as a concept SDG-12 is the way the world should be moving then we accept that there is a need to limit our consumption and production to ensure a sustainable future then we have another challenge.

ARTICLE 12

This chapter has explored the benefits and barriers of implementing environmental management systems in the construction sector and demonstrating how skills and training, gathered through the uptake of ISO 14001, are key in facilitating the delivery of SDG-12.

We need to find people in society that are qualified or sufficiently knowledgeable to enable the organisations to take this alternative path to the future. Green jobs are becoming a hot topic in sustainability and government circles with the need being seen to train people in sustainability skills to enable the net zero agenda to be managed. It is often the lack of these skills that are cited as one of the barriers to the implementation of ISO14001. This is evidenced by a participant in a recent study who said *"14001 is still the main bedrock for the environment, part of sustainability"* (unpublished data). So, we have a situation where we need to be responsible in terms of consumption and production but those who produce the goods may not understand the concept or wish to abide by its philosophy.

In relation to the current state of play there are a variety of positions with some organisations leading the way and others being laggards. Looking at what would be considered good practice today in respect of SDG-12, the following would be a good starting point:

- *Sustainability reporting* – many organisations report on their sustainability, but these are often viewed as being superficial and a marketing device (Squier and Booth, 2023).

- *Closed loop operations (circular economy)* – again a push for organisations to operate closed loop exists but there is a challenge in terms of understanding and the opportunities to discover how you can produce a closed loop system either within your production processes or by linking with other organisations who may be able to use the resources, which are no longer of use within your organisation. Further reading - Liu and Ramakrishna (2021).

- *Efficient waste management* this is about reducing as much of the waste as possible so following the waste hierarchy, to ensure that the first option is prevention. The most effective way to prevent waste is to ensure that waste is considered in the design process. Reducing the waste is all about thinking of the options for closed loop systems. Further reading - Letcher and Vallero (2019).

- *Renewable energy production* – here the idea is not so much about the materials used in construction but how you could make the building more sustainable in relation to energy use. Further reading – Nelson and Starcher (2017).

- *Reduced material footprints* – thinking about the carbon footprint of the materials both through the extraction, transport, use and their ability to be reused is important in ensuring that they are responsibly consumed. Ideally the materials should be produced and/or sourced as close to the site of their use as possible. Further reading – Klemeš (2015).

- *Net zero carbon opportunities* – all organisations now should be thinking about the options for zero carbon. This is not just in terms of their resource use in the production processes but also in relation to energy used in their offices, transport options, waste production and disposal. So not limiting themselves to scope 1 and 2 being *"fairly easy to manage"* (unpublished data) but also considering scope 3 where confusion exists in relation to how to measure and who should measure it as noted *"some of that scope three stuff has been measured three or four times by four different people."* (unpublished data).

6.5 CHAPTER SUMMARY

This chapter used the extended list of benefits (n=86) and barriers (n=59) to create and validate a roadmap to support the delivery of the SDGs. In doing so, it fulfils Objective Five. The roadmap is a means for AEC organisations to use their EMS to identify where they could contribute to the delivery of the SDGs. SDG12 was then used to highlight how this could be achieved.

The next chapter will now compile and combine evidence and findings presented in all the earlier chapters to formulate a stepwise discussion about implementing EMS in the AEC sectors.

CHAPTER 7: DISCUSSION

7.1 INTRODUCTION

This chapter brings together the evidence and findings presented in the earlier chapters to produce a single discussion and to contextualise the new information with existing knowledge. In doing so, the chapter will deliver Objective Six.

7.2 DISCUSSION

The thesis objectives (1-5) will each be used to provide a stepwise structure to order the discussion.

Objective One: Ascertain environmental issues and provide insights into how and why EMS can be implemented to address and mitigate concerns.

Society has many challenges in relation to the management of the environment and delivering environmental sustainability (Chapter One). Article #1 discussed urban pollution incidents and how these can be prevented. One significant way to reduce incidents is through the use of legislation which can and has been put in place to protect the environment with laws such as EIA Regulations, which aim to consider any significant impact on the environment and take into consideration those impacts in a formal way (Glasson & Therivel, 2019) and has in many countries been designed to mitigate harmful impacts on the environment. In planning EIA was implemented with the purpose of establishing and acknowledging where a development may impact the environment, both negatively and positively, and to propose mitigation methods for any negative impacts. Information in an EIA report can then be used by Planning Officers to support decision making (Carroll *et al*., 2019). EIA it must be remembered is not a decision but a tool. In the case of Article #2, concerning EIA in Jersey it was noted in the findings that there was a lack of documentation and that while planning applications for large developments may have an EIA attached to the public register, there was no database or register for these documents, or the information contained in them, that could be used by other applicants to assess any potential cumulative impacts. This was not the same as seen in Guernsey's legislation, which specifies that the Planning Department will provide relevant information to an applicant with a scoping opinion, including baseline information, along with where the information has come from. Information that comes into the Planning Department regarding environmental impact is then given to later applicants meaning cumulative impact can be assessed more comprehensively. This will have definite impacts on how development is managed within an area. This is a clear example of a tool only being as effective as the people using it.

The AEC sectors are making giant strides towards improving environmental management and supporting sustainability. This can be done in a variety of ways, and it is not always necessary to have legislation to bring about positive change, there are voluntary standards such as BREEAM which was reviewed in Article #3. In this Article it was noted that there are limitations in respect of the assessment scheme, and it raised questions as to the effectiveness of criteria to evaluate all aspects of sustainability, to encourage improvement and innovation in construction. In Article #3 the criteria were found not relevant for the refurbishment of listed

buildings as most of the criteria were related to environmental impacts, while social and economic aspects shared the remaining 27% of credits available. This research (Article #3) noted that historic buildings may be penalised unfairly through a BREEAM credit scoring that favours environmental aspects; as listed building restrictions limit changes to the building envelope, effecting potential material upgrading and energy efficiency criteria. These two categories are amongst the highest scoring in BREEAM assessments, if unachievable then the overall score will be negatively impacted disproportionately as a result. This also fails to consider the embodied energy savings that may be made as a result of retaining the listed building envelope, further compounding the detrimental impact to the potential achievable score. Another issue in relation to how the tool can be used is whether it is flexible enough to deal with all the potential building types. BREEAM assessments as with ISO14001 are voluntary so there is no incentive for clients to undertake a second assessment to validate in-use building performance. This undermines the assessment as the data cannot be validated in operation. By including a requirement for follow-up assessment after building occupation, it would be possible to not only validate the original assessment score, but also to determine whether the BREEAM rating performance level is achieved. This would also be the case if contractors could hand over the ISO14001 relating to their site to those who had commissioned or purchased the completed building. Resulting in a more joined up approach to sustainability.

In terms of that ongoing assessment both ISO14001 and BREEAM do not incentivise users to ensure systems continue to function in line with the proposed design parameters. Optimum building performance is reliant on systems being properly maintained and serviced throughout their lifetime. The lack of a requirement for on-going servicing and maintenance undermines the potential benefits of new energy efficient systems. This would be, however, a challenge in terms of how it could operate particularly for speculative developers where there may be a lack of engagement within such a requirement. In respect of ISO14001, while contractors are required to have ISO14001 as part of the tender process, this does not necessarily mean that the system includes the construction site or that if it does that the work continues when the building is handed over for occupancy. The lack of post occupancy assessment of the building performance and impact of development noted in the Article #3 was an issue noted by Andrade and Braganca (2016) who argue that "*even if a building is designed and built to be sustainable, do users use it wisely and according to the principles underlying it?*" Post occupancy evaluation is essential to validate actual performance which is heavily reliant on operational factors (Curwell *et al.,* 1999). Andrade and Braganca's point is equally applicable to ISO14001. There needs to be a joined-up approach to enable sustainability to run through the lifecycle of buildings, where either penalties or tax breaks exist to encourage engagement.

Environmental management should not always be purely about environmental impact minimisation. An investigation into EMS adoption (Article #4) suggested that for many the focus is to be legal compliant, specifically *"waste minimisation through discharge emissions and pollution control"*. The researchers, however, suggest that a more effective approach would be one of Ecological Improvement Enrichment. Several of the participants in Article #4 indicated that the EMS they were familiar with can support progression along the EIM-EIE spectrum: *"EMS provides the framework for environmental management. There are minimum criteria to adhere to and standard approaches, but as a framework it can support more ambitious objectives, if the organisation and/or individual has such aims".* Again, this could be used to support the delivery of sustainability.

Objective Two: Produce a desktop study to reveal the most widely reported benefits and barriers of implementing EMS in the AEC sectors.

Chapter 2 has detailed the literature reviews conducted as part of this thesis. It shows that since the benefits and barriers reported by Shen and Tam (2002) there are differences appearing in relation to AEC sectors. The situation in respect of sustainability and environmental management detailed in the last section highlights an increased requirement for means to manage environmental impacts, and a move away from a compliance focused approach witnessed in earlier research.

Articles #6-#8 also suggest that there may be signs of change as it is noted that the benefits cited for using ISO14001 are moving away from the legal compliance (Shen and Tam, 2002). It is apparent that ISO14001 has become a requirement on a large proportion of tenders particularly those relating to government departments. Therefore, to enable businesses to compete they must have an environmental management system in place. This is a definite change in stakeholder perspective from previous research, but it must be questioned as to whether those producing the tenders should also consider the environmental impacts of their operations rather than requiring the subcontractors to deliver on these points. When considering these preliminary findings which focus on a small number of benefits and barriers the perceived importance of these is very country dependent in respect of both legislative requirements but also societal expectations. There needs to be a global focus on what we as society consider to be acceptable in relation to the health of the planet. For too long humans have existed in an economically focused society but to ensure a sustainable future action needs to be taken now. There is an increasing demand for staff to fill the green job vacancies in sustainability to enable the net zero agenda to be managed, but a lack of skills due to a multitude of factors including pay and prospects within the sector highlight the value placed on such roles. The lack of these skills has been noted as one of the barriers to the implementation of ISO14001.

Objective Three: Use case study examples to gauge stakeholder perceptions of the benefits and barriers of adopting EMS in the AEC sectors.

Case study examples (Articles #6, #7, #8) investigated the benefits and barriers to the implementation of ISO14001 in the Maldives, the USA, and the UK. This work highlighted the need for more in-depth investigations through the work in Chapter 5, to ascertain the situation behind some of the issues raised.

This resulted in a Delphi study and a phenomenological study being conducted. The Delphi study while aiming to reach a consensus, highlighted the variety of experiences in respect of the use of ISO14001 that exist which could be related to several factors such as size and maturity of the organisation, interest of senior management, and willingness of the workforce to engage with the process. Nevertheless, this study did demonstrate that it was the barriers where lack of consensus was most prevalent and that in relation to the benefits there was more agreement. Further research on the impact of company size and maturity is suggested in Chapter 8.

The phenomenological study participants proposed that ISO14001 is purely a starting point. This insight suggests that the organisations whose employees took part in this research are aiming to be more sustainable than purely ticking a box on a tender form. It must be noted though that all those taking part worked within organisations who were not new to the ISO14001 system and had been working to these standards for many years, which may not have been the situation for the participants in Articles #6, #7 and #8. It does suggest though that something more is needed than just ISO14001, to enable organisations to navigate the issues of delivering on environmental and sustainability objectives moving forward. This something would need to enable them to demonstrate more clearly their unique position on the road to sustainability. It could be suggested that there should be a system which differentiates between those who have just gained the system and those who are really making a difference in respect of reducing their negative environmental impacts.

The difference of opinion witnessed in the phenomenological interviews in relation to the suitability of ISO14001 to manage both sustainability and environmental management, is interesting, in that ISO14001 is a system, which was designed to be flexible and as such can be used for whatever the requirements of the organisation are. Yet the concerns expressed are very much centred around the ability or willingness of the organisations to state their sustainability objectives in a system that will be audited and could result in nonconformities being registered against their objectives.

Objective Four: Disclose how the AEC sectors of the UK are implementing EMS to improve their environmental and sustainability performance targets.

Article #8 examined the benefits and barriers to the use of ISO14001 in the UK and this was then augmented with data from the Delphi study followed by the phenomenological study, which delivered a perspective on what was behind these seemingly fixed perceptions of the ISO14001 benefits and barriers (Article #9) and through the phenomenological work (Article #10) more clarity was gained, and existing knowledge expanded to show that it is not just about environmental management but perhaps more importantly the opportunities to include sustainability. This, however, comes with risks in respect of the organisations objectives not being so clear that they are easy to achieve, and this may cause issues in relation to non-conformities within the audits as mentioned earlier.

Article #4 also noted conflicting views on the role of "*individual organisations"* in EMS adoption as our earlier analysis delivered an 'undecided' verdict against this group. Some of the survey comments, however, put the emphases firmly back onto this group: *"a lot of this is down to the individual organisation, the scope of their EMS, and whether this has been identified in their aspects register".*

Legislation in conjunction with peer pressures and changes in industry were all suggested as means to make this shift towards an "Ecological Improvement Enrichment" approach. This also links to the idea of being able to include sustainable development within an EMS. This, of course, would require certification bodies and auditors to play their part in encouraging this mindset shift that promotes the delivery of sustainable holistic outcomes.

A consideration is therefore required of organisations as to how they should use ISO14001. In the phenomenological study (Article #10) it was interesting that not all the organisations

involved are utilising ISO14001 to manage both environment and sustainability objectives within their operations, some are still separating-out issues such as waste management and energy use into an environmental management system and operating sustainability within another part of the business. This will, of course, result in a doubling-up on costs in terms of staff time and expertise and it is suggested that benefits could be achieved while acknowledging the conversations which would be required with the accrediting bodies from rationalising these areas into one overarching concept within the organisations.

The concern expressed in relation to not achieving their own objectives is an issue which does need to be acknowledged but there is a need to push the boundaries of what is possible in relation to such systems. It also brings into question whether auditors are seeing the need for all objectives to be ticked off the "to do list" in one or two years, as opposed to the objectives being aspirational; something to aim for.

Objective Five: Design and validate a roadmap for the AEC sectors to highlight how their EMS

From the findings of the previous objectives (1-4) as a sector, AEC organisations need to address the issue of sustainability as it has potentially huge impacts in relation to their operations, to the nature of the work they do, but there are major opportunities in terms of sustainability and the potential contribution to the achievement of the SDGs. Horry *et al.* (2022b) noted that while Goubran *et al.* (2019) found the AEC sector were related to all the goals the greatest contribution potentially could be made in SDGs 6, 7 and 11, it could also be suggested that SDGs 4, 8, 12, and 13 were also significant. Horry *et al.* (2022b) went on to support this proposition through a PRISMA based literature review and the creation of a roadmap (Article #11). This roadmap details how work toward the SDGs could be delivered, thereby creating a truly sustainable management system.

The use of the SDGs is a means for organisations to focus on the economic, environmental, and societal needs of the planet. It is acknowledged that the goals are a huge challenge for society and not possible for any one organisation to deliver, and that a combined effort is required (Gorse *et al.,* 2023) to enable progress. The roadmap (Article #11) is proposed as a method to enable organisations to consider what they are achieving through their EMS and to establish how they can achieve similar benefits while having an increased impact on the global issues. In many cases this could bring greater rewards in terms of positive public relations and reputational issues, while demonstrating to customers a genuine impact on societal issues and the positive well-being of their staff and neighbouring communities.

To engage organisations with this idea there needs to be a clear understanding of which SDGs will be the easiest to target. While other researchers have highlighted SDGs 1, 9 and 11 (Lynch and Mosbah, 2017) and SDGs 7, 12 and 13 (Goubran *et al.,* 2019), it is suggested here that first and foremost the AEC sectors should be focusing on SDG 4 – quality education to ensure that the workforce understands about the environment and sustainability, SDG 8 – decent work and economic growth, SDG 12 – responsible consumption and SDG 13 – climate action. If these are combined with SDG 17, which is partnership for goals, this would enable construction organisations, architects, planners, government, and certification bodies to work together to make sustainability a definite possibility. As previously noted, the construction sector has a huge potential to impact on the sustainability of society both in positive and negative terms. The roadmap (Article #11) is a method to improve the performance of the AEC sectors in

delivering positive impacts for society. It may be that organisations start by focusing on small positive steps to move to a more sustainable agenda within their strategy or work on a local project. But whatever they do, there is clear interest in terms of sustainability from the public (Erdil *et al*., 2018) and this will only increase over time. Currently society faces huge threats in terms of biodiversity, food, and health throughout the world (Daszak *et al*., 2000) and the SDGs will help us as a global society to focus on improving our interactions (Georgeson *et al*. 2017) and help establish how we can work together to improve the issues.

Suchman (1995) acknowledged that while the SDGs are a global challenge there are opportunities for organisations to focus on economic, environmental, and societal needs while increasing their societal legitimacy, bringing with it positive PR. The whole premise must be that organisations must behave in a different manner from what has been custom and practice, it is no longer sufficient to just do the minimum, we are past that point. A caveat, however, is that as Hahn and Kuhnen (2013) noted many organisations may not have the financial ability or staff availability to do this work. But even the smallest actions could make a difference and the SDGs provide a focus for action (Georgeson *et al.,* 2017), a means to improve all operations for example in terms of consumption of raw materials. In relation to the AEC sector there is already a need to improve the reduce–reuse–recycle strategy of construction and demolition waste particularly in developing nations due to the limited technological resources and infrastructure (Owolana and Booth, 2016).

If the SDG targets and indicators are considered, most of the targets can be delivered through a well thought out EMS, where organisations other than the government can bring about change. As noted by a participant in a recent study *"by demonstrating that an obligation is as strong as a legal commitment and entwining the objectives of the system to the strategic measures, then it becomes one of the same things. It doesn't need to be an additional burden to any business. You know, the sustainability metrics have got to be core business indicators. So, if they're well integrated and the corporate systems are integrated and, you know, people are doing things to the best of our ability, they're doing it once and then that information has been used multiple times"* (Unpublished data).

7.3 CHAPTER SUMMARY

This chapter used the thesis objectives (1-5) to provide a framework for a discussion that contextualises and deliberates findings from the earlier chapters combined with existing knowledge on the uptake and adoption of environmental management practices in the AEC sectors. It has explained how this study has not only expanded current knowledge on the uptake and implementation of EMS within the AEC sector, but also considered how this can be utilised to enable organisations within these sectors to improve their sustainability performance and concomitantly help deliver on the SDGs. It has noted the immediate need for organisations to take action to enable society to delivery sustainability. Given that we are midway through the timeframe of the SDGs to be delivered it is imperative that organisations act and realise the opportunities available to them to ensure sustainability in respect of the five pillars of the SDGS: people, planet, prosperity peace, and partnerships. Society is at a pivotal point in history where brave actions need to be taken, we can't ignore the required actions or not act through fear of failure or of not achieving our objectives. This work has highlighted the situation, the opportunities, and the prospects for positive changes within the AEC sector.

There are only six years remaining in the timeline of the SDGs, we have gone from the human centred MDGs to the more holistic SDGs, time is of the essence, or we will need to move on to what the Sustainable Development Priorities? Now is the time for action, it is essential for the survival of our planet as we know it so that future generations can also experience our quality of life. If this is not done voluntarily there will have to be government intervention and it will have to be mandatory but that would necessitate agreement across all governments for trade not to be impacted negatively. This chapter has now delivered Objective Six.

The next and final chapter will surmise the overall study by providing conclusions and recommendations, plus consideration of the potential implications generated from the contribution to new knowledge and suggestions for where the AEC should be going in the next 5-10 years.

CHAPTER 8: CONCLUSION AND RECOMMENDATIONS

8.1 INTRODUCTION

This chapter will bring together the conclusions for this body of work by considering the research gap in relation to the lack of the attention focused on the AEC sectors. It will consider the lack of research on the potential positive impacts, which could be achieved in these sectors if they were to examine the opportunities to engage with the SDGs to increase their sustainability, to deliver Objective Seven.

It will then examine how the Articles have delivered on the objectives of the research, the implications of the findings from those articles and how this work has added to existing knowledge. The delivery of the objectives has resulted in the answering of the research question by firstly focusing on the AEC sectors and then by producing a roadmap to encourage the use of ISO14001 to deliver on the SDGs. It is, of course, necessary to acknowledge that while there are limitations with any research the articles have been peer reviewed and are deemed to be sufficiently robust to provide a contribution to the discussions surrounding ISO14001 and sustainability. This thesis set out to address seven research objectives (Table 8.1).

Table 8.1: Objectives that this thesis set out to address

Objective 1	Ascertain environmental issues and provide insights into how and why EMS can be implemented to address and mitigate concerns.
Objective 2	Produce a desktop study to reveal the most widely reported benefits and barriers of implementing EMS in the AEC sectors.
Objective 3	Use case study examples to gauge stakeholder perceptions of the benefits and barriers of adopting EMS in the AEC sectors.
Objective 4	Disclose how the AEC sectors of the UK are implementing EMS to improve their environmental and sustainability performance targets.
Objective 5	Design and validate a roadmap for the AEC sectors to highlight how their EMS could support the delivery of the SDGs.
Objective 6	Contextualise and deliberate the findings of the earlier objectives with existing knowledge on the uptake and adoption of environmental management practices in the AEC sectors.
Objective 7	Conclude and provide recommendations for the implementation of EMS in the AEC sectors.

This chapter will now review the key findings which address the objectives of this thesis before detailing the implications of these findings. Then the limitations will be examined, and suggestions made for future research.

8.2 REVISITING THE PURPOSE OF THIS STUDY

This research study began by proposing that global issues cannot be solved by individuals or single Governments alone. As a society we will always be looking for new knowledge. Our current understanding of the environment suggests a precautionary approach is required to help ensure the sustainability of the planet. An EMS was purported as one way to ensure that

environmental impacts of an organisation's operations are identified and can then be mitigated. The study has demonstrated a plethora of benefits and barriers towards implementing an EMS in the AEC sectors. Further, it has used a suite of data collection tools to explore organisations priorities and to delve deeper into the use of ISO14001. This enabled the creation of a roadmap to indicate to these sectors where they can support the delivery of the SDGs. Whilst this study alone will not resolve global issues it does make a sizeable contribution to new knowledge that can support environmental and sustainable improvements. Further, it contributes to filling the research gap and it answers the main research question.

8.3 REVIEW OF THE RESEARCH AIM AND OBJECTIVES

Chapter One of this thesis set out the research question and objectives. The research question focused on how AEC organisations can be encouraged to make more science based environmental and social decisions which will help contribute to the activities and impact of others (Figure 1.6) and other sub questions (Figure 1.7) to deliver on the aim of this study.

That aim was to identify and examine the benefits and barriers to the uptake and implementation of EMS (particularly ISO14001) in the AEC sectors. Then to use this information to create a roadmap that can indicate pathways for AEC organisations to support the delivery of the SDGs. This was achieved through several objectives and the findings of these facilitated a general discussion (Chapter Seven). The following provides a brief overview of all the thesis objectives (1-7):

Objective One: Ascertain environmental issues and provide insights into how and why EMS can be implemented to address and mitigate concerns.

This primary objective was to ascertain the current situation concerning the need for environmental management by considering current and background issues. Several challenges and incidents were considered. These included the viability of EIA to consider cumulative impacts, and whether standards such as BREEAM effectively acknowledge and mitigate for the issues of remediating listed buildings. Also reviewed where some environmental disasters and whether the presence of an EMS would have prevented the accident. It then continued by looking at the history of EMS and why the situations the world is facing require management. This formed the basis for Chapter One of the thesis.

Objective Two: Produce a desktop study to reveal the most widely reported benefits and barriers of implementing EMS in the AEC sectors.

The extensive literature review is the subject of Chapter Two where information published in Articles #5 and #11 is presented. The review highlighted that organisations are still focused on the economic benefits of any actions and that there is a tendency to justify any action with a suitable return on investment to ensure that projects are completed.

Objective Three: Use case study examples to gauge stakeholder perceptions of the benefits and barriers of adopting EMS in the AEC sectors.

Three case study examples (Maldives, USA, UK) were presented using evidence from Articles #6, #7 and #8. Each of these demonstrated stakeholder opinions of the benefits and barriers in each of the countries. This was then reviewed in Chapter Four to compare the findings.

Objective Four: Disclose how the AEC sectors of the UK are implementing EMS to improve their environmental and sustainability performance targets.

The Delphi study (Article #9) and the phenomenological work (Article #10) enabled a deeper appreciation of the challenges and opportunities available using ISO14001. Questionnaires while effective at gaining large amounts of data quickly do not produce the detailed information which can be gained from interviews. The work detailed in Chapter Five gives a new perspective on the benefits and barriers to the use of ISO14001.

Objective Five: Design and validate a roadmap for the AEC sectors to highlight how their EMS could support the delivery of the SDGs.

All the information obtained within this study enabled the work within Article #11 to be delivered. The knowledge obtained from the literature reviews, the deeper understanding through the Delphi study and Phenomenological work resulted in a thorough investigation with a validation by experts. This resulted in the design and validation of a roadmap taking the known benefits of ISO14001, using and cross referencing them against the SDG goals allowed a map to be produced that can indicate pathways for AEC organisations to support the delivery of the SDGs as discussed in Chapter Six.

Objective Six: Contextualise and deliberate the findings of the earlier objectives with existing knowledge on the uptake and adoption of environmental management practices in the AEC sectors.

The collected works (Articles #1-#12) have provided a new understanding of the benefits and barriers to the use of ISO14001. This has then been used to examine how this knowledge can help organisations within the AEC sector to engage more effectively with the concept of sustainability and with the SDGs. This formed the discussion within Chapter Seven. It must also be noted that the situation remains that many organisations are still using their EMS for purely legal compliance and having a separate team dedicated to sustainability. If a more holistic sustainable route existed, then more ambitious objectives could be delivered as noted in Article #4 but currently this is dependent on the efforts of individual organisations. Drawing on participants' own experience, EMS are capable of targeting activities to support net positive gain, *"most businesses will aim for minimal compliance, as their core business and mission is not ecological enhancement. It cannot be assumed that they will voluntarily adopt these measures without legal drivers".* This gain does not just have to be ecological of course, it could be linked to economic and societal improvements as well.

It was noted by one of the participants that *"reducing environmental impacts and enhancing ecological impacts aren't mutually exclusive*" and that it is necessary to recognise that *"not all impacts are ecologically driven - some are specifically related to human health (e.g., noise, air*

pollution)". As ecologically holistic impacts are not targeted by EMS at large, *"they [EMS] could be altered to focus more on the importance of ecological enrichment where applicable".* A concerning response in Article #4 was that "*most EMS are there to tick boxes and get certificates, the certification organisations play a key role here".* While this is disheartening, certification does require progression and how that is envisaged needs to be explored by the relevant regulators and certification bodies. There needs to be a move away from pure compliance to a more ecologically sound improvements within society. The roadmap can assist in this journey.

Objective Seven: Conclude and provide recommendations for the implementation of EMS in the AEC sectors.

This chapter sets out to bring this thesis together to demonstrate not only the delivery of the original aim of this research, but also the objectives. It highlights the limitations of the research but also the new knowledge that has been delivered to the subject area because of the publications of the Articles #1-#12 which form the basis of this thesis.

This study overall suggests that in terms of environmental management ISO14001 has become an expected norm within business in respect of its requirement on the frameworks for tendering for UK government projects. This could, however, be reduced to being a tick on the tender application paperwork, rather than anything more thorough. The professionals who engaged with this researcher all vouch for the value in having a system to take their organisations further than just the basic criteria, or that idea of we *"have the badge".* The challenge of bringing sustainability into the equation is another matter, with some suggesting that there may be a reluctance to state sustainability factors as objectives as this may require organisations to deliver on something which may prove challenging. From the accounts analysed in this study, ISO14001 is still a firm favourite for delivery of environmental objectives, but it seems it has a way to go to become widely accepted as a delivery mechanism for sustainability.

Literature shows there is worldwide interest in the adoption of sustainable practices within the AEC sectors. Therefore, it is proposed that a need exists for an amalgamated approach that is relevant for the sectors and all organisations working within them. In terms of the benefits and barriers these are similar to research that has been conducted in other industry sectors. This study has highlighted an extensive list of benefits to support the implementation of ISO14001 within the AEC sectors, and while it is acknowledged that there are also barriers, to move forward in a sustainable manner the framework of ISO14001 would enable organisations to focus on delivery of SDG objectives. This linking of the benefits to the SDGs in a roadmap has shown how organisations could help in the delivery of the SDGs. As more people are pushing for a green return following the Coronavirus pandemic and the extreme weather events, there seems to be an increasing interest in the environment. Along with this there is a general desire amongst the population for sectors to be seen as being more responsible in terms of sustainability. The market mechanisms, however, limit the options in terms of what can be delivered, and it is suggested here that the standards could be used more effectively. One potential way forward is for the professional bodies to push for a level to be created for their individual sectors, that organisations could then sign up to. A gold standard: they could gain a sector specific badge, meaning, that while organisations can use an EMS for the benefit of the

impacts of the organisation and monitoring of their progress; they could also utilise it to demonstrate their commitment to the SDGs, by going above and beyond the standard.

If the AEC sectors are to play a leading role in the journey to sustainability, there is a need to work towards a clear delivery plan for achieving the SDGs. This would help to ensure not just environmental survival but social and economic success against issues such as climate change and the resultant migration of populations. The sectors, need to work on the SDGs and to align with the 5 Ps: people, planet, prosperity, peace, and partnership, which require actions to be taken by a range of stakeholders including governments and for organisations to go beyond the purely environmental objectives of sustainable development. A huge opportunity exists for the AEC sectors to be ahead of the curve in terms of using the roadmap to help demonstrate the economic viability of delivery of the SDGs.

Industries such as construction rely on the environment for their business and, therefore, it would be expected that they should be amenable to promoting sustainability, not just in terms of their operations but also in terms of how they interact with the communities where their operations are sited. More research is also needed into the application of the roadmap in practical terms to test the validity of the design and use. It is suggested that this should be a first step to understand the usefulness of the roadmap in helping organisations assess where they can make positive changes and how these can be highlighted to stakeholders.

The roadmap that was presented in Chapter Six was designed to promote involvement with the local community, which will allow stakeholders to have an increasingly transparent view of the organisation's sustainability performance. It would enable the process to highlight any conflicts that had occurred and how the response to these conflicts was appropriate and had been justified. This would result in a system which not only enables the SDGs to be worked towards on a global scale, but also the actions and impacts of those organisations who are engaging can be measured, recorded and actions justified, benefiting society, the environment and the economic performance of the organisation involved. Data provided to the sector bodies from the organisations would deliver more information on how their sectors are progressing in terms of the SDGs and demonstrate to all stakeholders which sectors, and more particularly which organisations are truly committed to sustainability.

8.4 THE MAIN IMPLICATIONS OF THE STUDY

The work presented in this thesis has revealed many new and thought-provoking findings that need consideration at various levels, namely:

- An EMS can provide many more opportunities to improve the sustainability of an organisation than purely the basic deliverables of legal compliance, waste management and evidence of engagement. Organisations who expand the scope of their EMS could benefit in both cost reduction and reputational areas.
- Green finance is any structured financial activity that has been created to promote better environmental outcomes. Therefore, it is possible that green finance applications could be supported through evidence gathered from an EMS.
- There is more financial investment appearing in the markets from ethical investment companies. The inclusion of an EMS in the companies' strategic approach to managing

their environmental, economic, and social impacts could make them of more interest to ethical investors.

- The exclusion of construction sites from the scope of the EMS in construction organisations will result in major impacts of their operations not being acknowledge as the construction site is a fundamental aspect of the organisations operations.
- Organisational concern over how the lack of achievement of objectives may be classed as non-conformities by external auditors is preventing organisations from including sustainability in their EMS. It is not clear, however at this time whether that would be the case or not.
- The worldwide drive for carbon neutrality is a factor that could be included in an EMS. This drive is in many countries focusing on Net Zero by 2050 (UK Government, 2021). Including carbon reduction in an EMS would not only save staff time but would promote the importance of this item on the company's sustainability agenda.
- The need for AEC sectors to include biodiversity net gain in relation to planning permissions could be supported through the effective use of an EMS to demonstrate their commitment and provide reassurance to the planners of their environmental priorities.

Since these insights are far-reaching, there are implications not only for AEC organisations but for policymakers too.

8.4.1 Implications for organisations in the AEC sectors

The AEC sectors have challenges, as noted in Chapter One. Organisations in the AEC sectors are seen as being more resource intensive and often working in areas where there is local opposition to the planned developments. As societal awareness of the issues of environmental degradation increases, sectors such as the AEC will need to justify their actions and demonstrate how they are managing their impact on the planet. This calls for them to be particularly mindful of the opportunities which sustainability work can bring to their organisations in terms of being seen as responsible and trustworthy organisations. By utilising an EMS and expanding the objectives to include more sustainability targets they will be able to demonstrate to their stakeholders not only their commitment but also the positive impacts which they are delivering.

8.4.2 Implications for government policymakers

Governments are the leaders within society and as such should be setting the standards for businesses to achieve. Reticence on their part will not enable the sustainability work required to manage the impacts that as race we humans are having on the environment. There is a desperate need for governments to have a coherent plan which is not deviated from without a clear and valid reason for doing so. Organisations will generally work towards government guidance but if this approach lacks focus and is constantly changing it will only lead to frustration and confusion within all sectors.

8.4.3 Implications for research

Studies into the benefits and barriers of adopting and using ISO14001 have been ongoing for ~25 years. Whilst there has been an increase in the number of certifications released, a catalogue of challenges still exists as to how organisations within the AEC sector can be encouraged to do much more. Some areas of potential research include:

- The impact of the roadmap when used by an organisation to focus on the delivery of the most relevant SDGs.
- An investigation into the opportunities and challenges of using the roadmap within the sectors.
- Whether the roadmap changes an organisations perspective on the deliverability of the SDGs.
- Whether the roadmap could be focused on national and/or local issues to gain a true perspective of where society is in terms of sustainability.
- How the roadmap could be used in other sectors that have an impact on a global scale.
- How the barriers to implementation of ISO14001 may delay the delivery of SDGs through organisations.

Looking forward, it is imperative to understand how organisations are approaching these challenges and where the blockages exist in relation to them becoming more sustainable. This could also be investigated in many of the other sectors such as hospitality, tourism, healthcare, manufacturing and many more. Further this could be extended to other countries to expand the focus of the investigations too. Similarly, research could be conducted on the impact of the size of the organisations and how this affects the opportunities to be involved in the delivery of sustainability. Investigations could also look at other environmental management systems such as BS8555 and Acorn to ascertain if the barriers and benefits are the same as those found in this work. By focusing on BS8555 and Acorn, which allow SMEs to implement a step-by-step approach to implementation of an EMS, it would be possible to establish how SMEs can also engages and contribute to the attainment of the SDGs and the impact of organisations size on the benefits and barriers that are experienced. Research could also consider whether other systems are required or whether ISO14001 can be used to deliver on business continuity and risk management, particularly in relation to the environmental/sustainability agenda within organisations. Other areas for consideration could be whether the costs, value and maturity of the EMS are accurately measured currently and why legal compliance has now appeared as a barrier to implementation? Despite environmental management being on the agenda since the late 1980s there are still many questions to be answered and a great deal of work to be done before we can begin to conceive that as a society we are operating in a sustainable manner.

8.5 CONTRIBUTIONS TO THE BODY OF KNOWLEDGE

This work has provided new insights into the way in which ISO14001 is utilised within the AEC sectors and has highlighted issues which need to be addressed to ensure that the sector is effectively managing its impact on the environment. This work has also highlighted how the SDGs can be worked on within the AEC sectors and how the benefits and barriers to the use of an EMS underpin this work. EMS can be used for more than just ensuring legal compliance, some organisations understand this, but many are not taking advantage of this benefit and

seeing the opportunities which can be gained through using ISO14001 to deliver on sustainability.

This section summarises the contribution to knowledge this research has made through the research objectives.

Objective One: Ascertain environmental issues and provide insights into how and why EMS can be implemented to address and mitigate concerns.

This work has delivered new knowledge through highlighting the challenges which still exist in how we manage the environmental impacts of our activities from Article #1 where environmental pollution incidents highlighted the need for more control over processes to minimise the opportunities for human error. Then in Article #2 where the lack of continuity in relation to the EIA process and, therefore, the opportunities for cumulative impacts to be missed, suggesting that processes need to be reviewed to ensure their effectiveness. In Article #3 there is the issue of how environmental sustainability is measured and whether this discourages re-purposing of old buildings. In Article #4 consideration was given to whether a new way of envisioning how organisations operate and whether a new paradigm was needed to move society away from the focus on economic enhancement to more ecological enhancement.

Objective Two: Produce a desktop study to reveal the most widely reported benefits and barriers of implementing EMS in the AEC sectors.

Through the literature reviews knowledge has been synthesised to highlight the current challenges within the sector and to enable consideration to be given on how to mitigate against the challenges.

Objective Three: Use case study examples to gauge stakeholder perceptions of the benefits and barriers of adopting EMS in the AEC sectors.

Articles #6, #7 and #8 have enabled there to be clarity on the varying benefits and barriers that are experienced in the implementation of ISO14001 in both developed and developing nations, with similarities and differences being seen in the results. This new information has enabled a greater understanding of what is required to encourage the use of the system with a greater understanding of the challenges faced in these areas.

Objective Four: Disclose how the AEC sectors of the UK are implementing EMS to improve their environmental and sustainability performance targets.

Questionnaires will only ever provide limited data based on the questions asked. The interviews conducted as part of the Delphi study (Article #9) and the Phenomenological work (Article #10) have delivered more detailed understanding of the challenges and opportunities being faced when using ISO14001. This understanding and new knowledge will enable future research to follow on and work to ascertain how the benefits to the use of ISO14001 can be used as driver for the delivering of sustainability and to examine why some organisations use their supply chain to deliver on their environmental management rather than engaging with the system themselves.

Objective Five: Design and validate a roadmap for the AEC sectors to highlight how their EMS could support the delivery of the SDGs.

The research and resulting new knowledge (Articles #1-#10) enabled ISO14001 to be considered as a mechanism to enable organisations to look at how they could engage with the SDG delivery. This was delivered as a completed roadmap in Article #11.

Objective Six: Contextualise and deliberate the findings of the earlier objectives with existing knowledge on the uptake and adoption of environmental management practices in the AEC sectors.

The collected works (Articles #1-#12) have delivered new knowledge to the sector which has provided a new understanding not only of the current benefits and barriers to the use of ISO14001, but also this has been utilised to produce the road map (Article #11) to help organisations within the AEC sector to engage more effectively with the concept of sustainability.

Objective Seven: Conclude and provide recommendations for the implementation of EMS in the AEC sectors.

This final chapter has brought together this series of articles (#1-#12), which form a coherent whole in terms of new knowledge. It has delivered on the original aim and the seven objectives. It will now proceed to examine the limitations of the research.

8.6 RESEARCH LIMITATIONS

Within any research there will always be limitations to the study. The limitations of each article are revealed in detail within each publication. An overview of some of these are presented beneath.

8.6.1 Reflection on the research

The main limitations within this work were the challenges in respect of obtaining responses to the questionnaires particularly in the earlier papers. While this is a limitation it is not uncommon in research and the numbers obtained were similar to other studies produced. The other main limitation was that the Delphi process itself was a challenge as the participants elected to stay with their original answers rather than to comply with the majority. This can, however, be explained due to the number of years' experience the participants had and that their experience was as they had originally described it. In relation to the phenomenological study the challenge was to gain a representative sample from all parts of the AEC sectors due to the use of ISO14001 being more prevalent in construction than the other areas, such as architectural practices.

8.7 WHERE SHOULD THE AEC SECTORS BE GOING IN THE NEXT 5–10 YEARS?

When looking at the future for ISO14001 we cannot avoid the looming date of 2030 for the delivery of the SDGs and the ambitions to be net zero by across the globe in the following years.

This is a critical time for humanity and the planet. It is not feasible to ignore the situation any longer and the benefits of using an EMS should now be focused on having a planet which continues to be capable of sustaining life. There will be issues in relation to increased migration and food security, along with the sustainability of resources for the expanding population. If the prediction from the Institute of Economics and Peace (2023) of the 14 mega cities (usually a city with more than 10 million residents) becomes a reality as a species, we will have to re-examine our needs in relation to material possessions. The AEC sector will be faced with huge challenges in relation to materials but also suitable locations which are less vulnerable to natural disasters and where due to availability of materials it is feasible to build. More emphasis will have to be placed on the sustainability of the developments if we are to move sufficiently in the direction of sustainability.

Academics have developed theories and produced research papers, but now the focus must be on knowledge transfer and how society enables businesses and the academic community to work together for the benefit of all. One potential way forward is for the professional bodies (e.g. IEMA, RIBA, ICE, CIOB, CIBSE, RICS) to push for a level to be created for their individual sectors, that organisations could then sign-up to. For instance, there could be a gold standard – where they could gain a sector specific badge, meaning, that while organisations can use an EMS for the benefit of the impacts of the organisation and monitoring of their progress, they could also utilise it to demonstrate their commitment to the SDGs, by going above and beyond the standard.

8.8 FINAL CONCLUDING NOTES

The work has noted opportunities for improvement in the way that ISO14001 is used within the AEC sector, by encouraging organisations to work not just on their environmental management in the purest sense but also to work towards being sustainable not just for the benefit of the organisation but also for the society within which the organisation exists. It is noted that there are currently issues in relation to the excluding of the construction sites from the EMS of some construction organisations, and recommendations to address this and other points are proposed in the next section.

8.9 RECOMMENDATIONS

Based on the findings revealed in this thesis, there are many recommendations for others to consider.

8.9.1 Recommendations for AEC organisations

AEC organisations should consider the options for utilising ISO14001 on their construction sites and then providing their customers with a system which can be handed over with the building to enable the continued support of the sustainability criteria of the site. This system could begin with any EIA created for the planning application. This should be discussed with auditors to ascertain the most effective means of delivering this.

8.9.2 Recommendations for policymakers

Policymakers need to encourage the adoption of EMS to improve national and international targets (e.g. Net Zero, Biodiversity Net Gain, Green Growth). As highlighted in this study many of those who are required to have ISO14001 to engage with tenders through frameworks noted that those organisations who are asking for their suppliers to have ISO14001 did not necessarily have the system themselves. This demonstrates a lack of joined up sustainable thinking, as while the building is under construction environmental management is deemed important but not so after the handover. Therefore, it is recommended that all those requiring their suppliers have ISO14001 should also engage with the system.

8.9.3 Recommendations for future research

It is advised that future research examines the barriers to using ISO14001 for more sustainability focused objectives rather than purely the standard environmental ones such as waste production or energy use. Also, this approach could be used to compare the different data sets for national against international studies. More work needs to be done in how to engage business with the findings, which are being discussed within the academic community. Producing the research is important but it must have an impact on organisations in the real world if it is to be of true value to society.

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