HOW DO ENVIRONMENTAL ENTERPRISE SYSTEMS CONTRIBUTE TO SUSTAINABILITY VALUE? A PRACTITIONER-ORIENTED FRAMEWORK

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Abstract

Environmental enterprise systems (EES) are integrated software services that offer a platform to automate and manage environmental sustainability processes, data, risk and reporting. EES are widely used in organisations, but their benefits depend on nurturing value creating mechanisms and pathways. Since the organisational value of EES has not been well researched and documented in the information systems literature, we have undertaken an exploratory practitioner literature analysis. The findings indicate that EES investment spurs the development of EES competence and EES-enabled capability which lead to environmental efficiency and competitive values. Based on these findings and drawing from the dynamic capability theory, we contribute an EES value framework. This paper also illustrates to business organisations how to leverage EES's potential to improve environmental sustainability without trading off economic outcome.

Keywords: Green IS, Environmental enterprise systems, capability, competence, sustainability value.

1 Introduction

Environmental impact from human activity is one of the main global challenges. For example, the costs of environmental impact by humans were estimated to increase from US$6.6 trillion (about 11% of the global GDP) in 2008 to US$28.0 trillion (approximately 18% of the global GDP) in 2050 (Ghosh 2010). As a result, many countries have incorporated environmental sustainability as part of their economic and social policies (Vazquez-Brust and Sarkis 2012). Further, in the United Nations Framework Convention on Climate Change Conference in Paris (COP21) in 2015, 187 nations have signed an agreement to keep global temperature rise below 2°C within the next 15 years. Subsequently, KPMG (2015) has pointed out that tighter regulations will be imposed on (a) carbon emission and energy efficiency, (b) carbon tax and emission trading systems, and (c) sustainability reporting (for example, for greenhouse gas (GHG) emissions). Such stringent regulations will motivate business organisations to transform their operations and to mitigate their environmental footprint.

Information systems (IS) (in particular, Green IS) have been touted to facilitate sustainability business transformation (Chen et al. 2008). Nonetheless, a significant number of organisations historically manage their environmental data on paper, multiple spreadsheets, custom-built databases and stand-alone systems (El-Gayar and Fritz 2006; Verdantix 2016). These systems are vulnerable to errors and time-consuming. They also exhibit delayed reporting, offer low-quality of data and heavily rely on human experts for their operations. To address these problems, organisations are increasingly turning to and investing in a new class of enterprise systems, called environmental enterprise systems (EES) (Melville and Whisnant 2014). *EES refer to integrated software services that offer a platform to automate and manage environmental sustainability processes, data, risk and reporting*. EES can be considered as a type of green IS, commonly defined as the "design and implementation of information systems that contribute to sustainable business processes" (Boudreau et al. 2008). However, EES differ from other enterprise systems because of their environmental functionalities which include energy and carbon management, water and waste management, incident and risk management system, and sustainability reporting.

According to a global EH&S Leaders Survey (Verdantix 2016), 85% of 312 senior managers categorised improving EES as a high or moderate priority in their fiscal planning to manage operational environmental risks, incorporate sustainable data and avoid non-compliance fines/penalties. Private equity firms and venture capitalist have also reportedly invested about US$ 220 million for EES software development since 2014 (Verdantix 2016). Furthermore, the EES market is predicted to reach almost fourth-fold from US$ 11.3 billion in 2013 to around US$ 44.4 billion in 2020 (Hardesty 2015). The MMG Limited company in Melbourne, Australia had implemented SAP's EES and was able to standardise incident management; reduce safety, health, environment and community (SHEC) risks based on valid data and report; and improve the SHEC processes and outcomes by analyzing hazards, incidents, near misses and safety observations (SAP 2014). These anecdotal evidences show the increasing importance of EES.

A number of studies in the business value of IS have demonstrated that IS investments do not directly yield value (Melville et al. 2004; Schryen 2013). To gain value from IS investment, organisations need to leverage IS to nurture capabilities, and such capabilities are often unique to the IS artefact under consideration (Trinh et al. 2012). Thus, there is a strong need for identifying the viable pathways of EES value generation. There are also some Green IS value studies. For example, Sarkis et al. (2013) reported that green IS reduces resource consumption and cost, adds to revenue and mitigates risk. El Idrissi and Corbett (2016) address the issue of whether Green IS value leads to a trade-off between environmental performance and financial benefits. Others (Cooper and Molla 2016; Gholami et al. 2013; Hedman and Henningsson 2016; Seidel et al. 2013) identify the benefits of adopting "generic" Green IS practices but do not focus on a specific Green IS artefact (such as EES) value mechanisms and pathways. In fact, although many organisations have invested in EES, the benefits of EES have not been well researched and documented in the IS literature. The above discussion leads to the formulation of the following two research questions:

Q1: What potential benefits organisations can harvest out of their EES?

Q2: What are the viable mechanisms and pathways for improving the EES value in organisations?

The rest of the paper is organised as follows. First, we describe EES evolution and modules. This is followed by section 3 which highlights the research method; section 4 the result of a practitioner literature analysis. In section 5, we present and discuss the EES value framework. The paper concludes with implications for practitioners and IS literature as well as the suggestions for future studies.

2 Background literature

EES as a class of Green IS have a potential for fostering sustainable organisational capabilities (Cooper and Molla 2016; Seidel et al. 2013) which in turn can enhance sustainability value. However, as each IS artefact has its distinctive capabilities (Trinh et al. 2012), in the case of IS-enabled organisational sustainability, in this section, the EES evolution and their modules are discussed to differentiate this type of Green IS artefacts with other systems.

2.1 EES evolution

Businesses have implemented software systems since the 1980s to assist with hazardous materials management and disaster response/recovery management (Mondschein 1994). Examples include Chemical Inventory Software and Emergency Information System Chemical (EIS/C). Most of these systems were used in the chemical industry which has been a well-known polluting sector (Mondschein 1994). After the introduction of ISO 14001– Environmental Management Systems (EMS) in 1996 from the International Organization for Standardization (ISO), there has been a requirement to expand the functionalities of various types of information systems to cope with EMS modules. Such expansion resulted in the occurrence of Environmental Management Information Systems (EMIS) and Environmental, Health and Safety (EH&S) Management Information Systems (Gilbert 1999). Later, regulators and employees required information about organisations' energy and GHG emissions to be transparent and efficiently monitored, thereby leading to the emergence of Energy and Carbon Management Systems (ECMS) (Melville and Whisnant 2014). More recently, EES (a new generation of environmental information systems) have been introduced as an integrated software platform to support environmental sustainability activities in organisations. An overview of the evolution of EES is depicted in Figure 1.

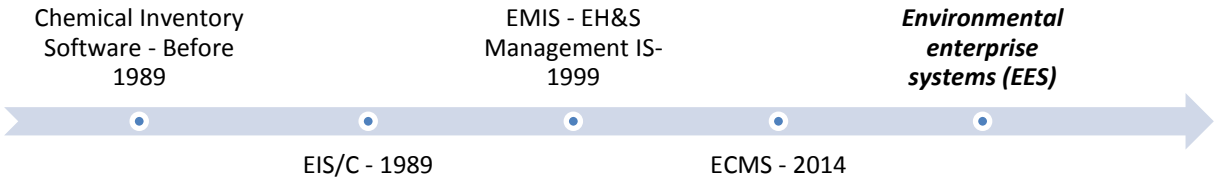

Figure 1: EES evolution

2.2 EES modules

EES are designed to overcome the limitation of legacy EMIS such as lacking of data standardisation and the omission of important environmental functionalities such as energy, waste, incident, and resource management and integrated sustainability reporting. EES also aims to streamline all environmental data with ecological processes and resources management. EES also differ in form and function from other types of enterprise systems (such as Enterprise Resource Planning, Customer Relationship Management and Supply Chain Management) because of their underlying business process and modules. Our analysis of selected EES vendor products (see Table 2) indicate EES modules such as carbon management; waste management; EH&S management; resources (energy, water and assets) management; and sustainability reporting (Verdantix 2016). Table 2 presents a snapshot of EES modules from selected vendors.

Modules*[1] / *Vendors + Software	**CM**	**EM**	**WWM**	**EH&SM**	**SR**
SAP (German) - EHS Management	✓		✓	✓	✓
ENVIZI - Carbon Systems (Australia) - ENVIZI	✓	✓			✓
ORACLE (US) - JD Edwards Enterprise-One EH&S	✓	✓		✓	✓
Credit360 (UK) - Energy & Carbon + EH&S	✓	✓		✓	✓
ENABLON (French & US) - Energy & Carbon + EH&S	✓	✓		✓	✓
Intelex (US) - Environmental Management			✓	✓	✓
IHS (US) - Energy & Natural Resource, EH&S	✓	✓	✓	✓	✓

Table 2: EES modules

[1] CM=Carbon Management, EM=Energy Management, WWM=Waste/Water Management, EH&SM=Environmental, Health and Safety Management, and SR=Sustainability Management.

3 Research Method

To answer the two questions Q1 and Q2 in the Introduction, we have undertaken an exploratory practitioner literature analysis. We chose this method because: (a) with a few exceptions (El-Gayar and Fritz 2006; Melville and Whisnant 2014), we observed limited academic research on EES but an increasing number of practitioner reports and (b) it is worthwhile to investigate the two questions from the practitioner's point of view, due to an incremental investment and use of EES in organisations. We proceeded in five stages by adopting Corbett's (2010) procedure for using and analysing practitioner literature.

(Stage 1) We chose the GreenBiz online forum (www.greenbiz.com) to source an initial set of related articles because (a) GreenBiz has been a thought leader in advancing environmental sustainability with profitable business practices, (b) the articles published on the forum focus on interdisciplinary issues on IT (note that EES is best studied using an interdisciplinary approach) and (c) all the articles published in the database were from the executives of the world leading companies who have succeeded in their sustainability efforts. Thus, the database contains a good collection of useful and relevant EES articles for our study.

(Stage 2) With the GreenBiz online database, we used the keywords "Environmental, Health and Safety management software value", "waste and water management software value", "energy and carbon management software value", and "sustainability software value" to obtain an initial set of articles. "EHS software value", "EHS management software value" and "EES value" are also added to the searching terms to enrich the results. These keywords were used because they correspond to the four typical EES modules according to our analysis of EES vendors (see Table 2). Further, business organisations often perceived EES as some special types of software to mitigate environmental impact. As indicated in Table 1, the initial search identified a total 564 articles.

(Stage 3) The initial sample contained a large number of articles. In order to manage the volume and relevance of articles to be reviewed, among the initial set of 564 articles, we selected 107 that were published from 2014 for further consideration. 2014 was chosen as a cut-off year because of the exploratory nature of our investigation, the recent phenomenon of using enterprise grade environmental software and our focus on the value which is affected by time elapsed post-adoption.

(Stage 4) Thereafter, we performed a manual screening and excluded those articles not related to EES software. This filtering process resulted in a total of 41 articles.

Search term (without quotation mark)	Number of selected articles in each stage		
	Stage 2	**Stage 3**	**Stage 4**
Environmental, health and safety management software value	32	10	7
EHS management software value (or EHS software value)	16	4	3
Waste and water management software value	76	18	5
Energy and carbon management software value	125	21	9
Sustainability software value	308	54	17
EES value	7[2]	0	0
Total	564	107	41

Table 1: Summary of search keywords and screening results

(Stage 5) Each of the 41 selected articles after Stage 4 was read in detail and analysed using the coding technique developed by Corbin and Strauss (1990). From the sentences, one researcher generated open codes of EES values as well as value creating mechanisms which were then reviewed and modified iteratively by two other researchers. This process resulted in 72 open codes of which 30 were unique. Table 3 offers a sample of the open codes, and the full list is provided in Appendix 1. Based on the *common properties* of each unique code, we first grouped them into sub-category and then later into the category. For example, an open code which has a property of "innovation" or relates to "innovativeness" was put into a sub-category of "innovativeness". Afterwards, categories were identified based on concepts that can cover a number of sub-categories such as "green innovativeness".

[2] These articles are not related to EES software.

Unique Code	Citation log	Source
• Sustainability data analytics	*"Gathering information (vs. data) allows us to transition from lagging metrics to leading indicators and predictive analytics so that we can continue to drive improvement in our performance".*	Anna Clark - President – EarthPeople – 2014 Allen Stegman - General Director of Environmental and Hazardous Materials - BNSF Railway - 2014 Working together, EHS systems and CSR rocket a company to success *(CSR – Corporate Sustainability Report)*
• Sustainability resilience	*"Leveraging EHS systems for efficiency, resilience and compliance"*	
• Fuel efficiency	*"Through performance improvements such as fuel efficiency, …"*	
• Adaptability to crisis	*"… compliance managers need a platform that allows them to respond in a crisis situation".*	
• Systems integration	*"Together, EHS, CSR and IT form a triumvirate of competencies capable of … sustainable solutions".*	

Table 3: Sample of open codes

4 Results

4.1 What potential benefits organisations can harvest out of EES?

Our analysis (Appendix 1) identified seven main benefits of EES which can be grouped into two main EES value categories based on *the common properties* such as resource consumption efficiency, cost saving and brand image (see Table 4). The two values of EES are *environmental efficiency value* and *environmental competitive value*. These two dimensions are consistent with the IS business value which is comprised of internal value and competitive value (Melville et al. 2004; Schryen 2013). Environmental efficiency value is defined as reduction of natural resource consumption and costs at the process level, such as energy and water (Ambec and Lanoie 2008; Sarkis et al. 2013). Environmental competitive value refers to sustainability brand image and reputation at enterprise-wide level (Orsato 2006; Porter and van der Linde 1995).

Category	Sub-category	Unique codes
Environmental efficiency value	Environmental cost efficiency	• Energy cost saving
	Environmental resource efficiency	• Water consumption efficiency • Resources efficiency • Energy efficiency • Fuel efficiency
Environmental competitive value	Sustainable brand reputation	• Brand reputation • Employee retention

Table 4: EES value conception

4.2 What are the mechanisms and pathways for increasing EES value?

The result of the open coding shows that EES value can be obtained through 23 mechanisms, such as system and data integration, environmental data analytics and process, product and material innovativeness (Table 5 and Appendix 1). Some of these mechanisms are inbuilt in the EES software. Other mechanisms, however, require concerted efforts by organisations: (a) to build skills in using EES, (b) integrate EES with other enterprise systems and (c) exploit the new capacity and data insight created through EES implementation for improving environmental innovation, adaptation and compliance. Our analysis has further classified these 23 value-creating mechanisms into two main categories: *EES competence* and *EES-enabled capability*.

EES competence can be defined as (a) a bundle of distinctive environmental process integration and data analytics resources embedded in EES software; and (b) the knowledge, skills and experiences internally developed in using EES for producing sustainability outcomes. Thus, defined EES competence includes three dimensions - EES integration, EES absorptive capacity and EES data analytics. EES offer an ability to incorporate several environmental modules together. They standardise environmental data with business data and process and allow integration with other enterprise systems such as supply chain management (SCM), customer relationship management (CRM) and enterprise resource planning (ERP) systems (Wang et al. 2015). Additionally, employees and managers are developing new skills in using environmental information and assimilating environmental sustainability knowledge, thereby contributing to the development of EES-absorptive

capacity (Cooper and Molla 2016). Furthermore, EES incorporate useful tools for sustainability data analysis (Seddon et al. 2016).

EES-enabled capability is referred as a triumvirate of leveraging the EES competence to develop innovation practices while being adaptive to market needs and environmental regulation changes for achieving sustainability benefits. Therefore, EES-enabled capability includes environmental innovativeness, environmental adaptability and regulatory compliance. EES infrastructure allows organisations to open to new ideas in planning, designing, production and distribution; and to develop and adopt new materials, products and processes for enhancing environmental process efficiency and organisational effectiveness in sustainability (Wong 2013). Moreover, EES's integrated platform enables information to be shared within and beyond organisational boundaries, thereby enabling organisations to sense and respond to changing market needs and stakeholders' sustainability expectations. This environmental adaptability leads to the reconfiguration of environmental management practices to cope with these changes for maintaining sustainability value (Wong 2013). The ability to generate dynamic sustainability reports of EES results in the comprehensive understanding of government regulations and international agreement about organisations' environmental obligations. This can activate environmentally sustainable strategy and support better sustainability decision-making to comply with environmental regulations (Butler 2011).

Category	Sub-category	Unique codes
EES competence	EES-Integration (internal and external)	• Platform automation • Integration of environmental data with business data • Centralised data platform • Environmental process automation • Real-time [water consumption] data • Building management systems integration • Infrastructure capability • Integration of ecological and business processes • Systems integration
	EES-data analytics	• Sustainability data analytics • Energy Big Data analytics
	EES-Absorptive capacity	• Knowledge capability • Learning and assimilation of sustainability systems • Employee engagement • Knowledge exchange and collaboration
EES-enabled capability	Environmental innovativeness	• Green product innovativeness • Materials innovation • Green process innovativeness
	Environmental adaptability	• Adaptability to crisis • Sustainability resilience
	Regulatory compliance	• Sustainability risk management • Corporate sustainability targets • Regulatory compliance effectiveness

Table 5: EES value-creating mechanisms' conception

5 The EES value framework

Based on our findings and discussions in the previous section, we posit that organisations obtain environmental efficiency and competitive benefits from EES in two ways (a) developing EES competence and (b) mobilising, deploying and exploiting the EES competence to create a higher order and dynamic EES-enabled capability. Our conjecture leads to the EES value framework depicted in Figure 2.

The theoretical foundation for the framework can be drawn from the dynamic capability theory (DCT) (Teece et al. 1997) which is an extension of the resource-based view (RBV) model. DCT postulates that organisations with strong or higher-order capabilities (Winter 2003) do not only adapt to ecosystem business challenges and environmental regulation changes but also shape themselves by innovation and collaboration. While the RBV focuses on the four properties (value, rare, imperfectly imitable and non-substitutable - VRIN) of resources, DCT stresses on the development of resources for building, renewing and reconfiguring organisational capabilities to adapt to the dynamic business environment (Teece et al. 1997).

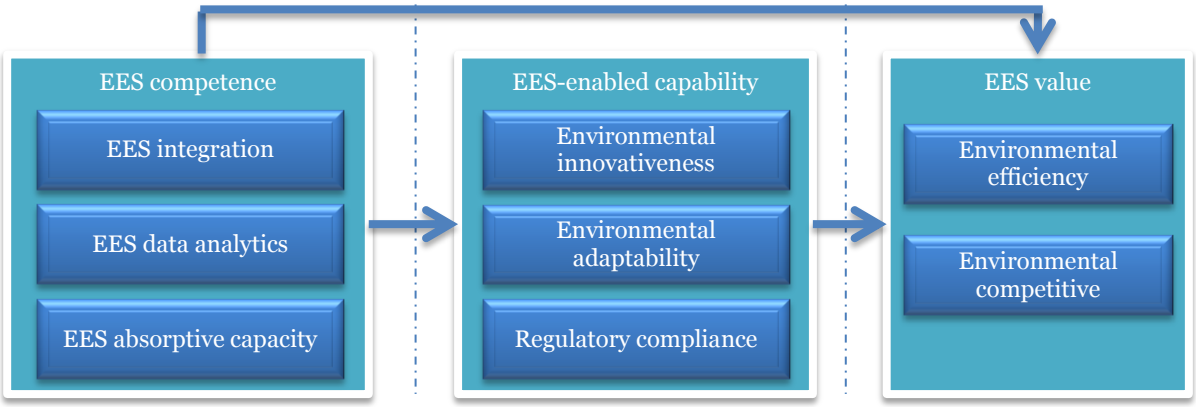

Figure 2: EES value framework

As a class of ES, EES competence shared some common properties with ES competence which is comprised of technological aspect and human skills and knowledge aspect (Trinh et al. 2012). EES investment is a valuable and non-substitutable resource for organisations in the global sustainability megatrend. Although the environmental technology of EES competence can be imitated by the availability of package software, third-party consultants and even modest investments in training (Teece 2014), this kind of "best practices" can create short-lived competitive advantages such as technical eco-efficiency or environmental productivity. The other aspect of EES competence consisting of the skills and knowledge of employee in incorporating, learning, assimilating and analysing environmental information varies from one enterprise to the other as they are related to human resources. This feature might also be imperfectly imitable and make the combination of these abilities into a rare resource of the organisation. Thus, EES competence can be a valuable, rare, difficult-to-imitate and non-substitutable resource that can generate sustainable value (Teece 2014). In the context of environmental sustainability, these attributes of EES might not be socially desirable, but in reality and particularly in the short term, they are not avoidable.

Additionally, this VRIN resource, under the lens of DCT, can be leveraged by organisations to develop EES-enabled capabilities to achieve a higher-order status which in turn creates sustainability benefits. In comparison to EES competence which stresses on efficiency, EES-enabled capabilities are more about innovating, adapting and orchestrating (Teece 2014) to re-configure organisational resources and business processes to gain sustainable competitive value.

EES competence and EES value

The environmental sustainability context, in which EES are relatively scarce, implies that the availability of the integrated environmental enterprise systems can account for variation in environmental efficiency and competitive value. The changes introduced to energy and carbon management business processes; to timely identifying environmental risk and to regulatory compliance themselves become assets of greater worth. Thus, EES implementation builds and renews sustainability which can affect not only how effectively and efficiently an organisation fulfils its environmental obligation but also adds to its competitiveness. For example, EES implementation offers organisations a centralised platform with automating data which reduces data duplication, data entry error and missing compliance targets leading to cost efficiency (Jill Gilbert – President, CEO - Lexicon Systems). Also, EES absorptive capacity is considered as the ability to acquire, assimilate and transfer EES knowledge by employees and managers. Thus, the more they learn about sustainability and EES, the more they engage and being innovative to improve business process, product design and to reduce environmental risk (such as non-compliance fines and prosecutions for environmental crime). The organisation which has these environmental advantages can overcome competitors in sustainability reputation. The analysis above leads to:

Proposition 1: Through developing EES competence which includes EES integration, EES data analytics and EES absorptive capacity, organisations can achieve environmental efficiency and environmental competitive value.

EES competence and EES-enabled capability

EES competence is a desired organisational resource that potentially adds to organisational readiness to undertake successful environmental material, process and product innovation; to overcome

sustainability challenges from market and stakeholders; and to satisfy environmental compliance requirements. EES infrastructure integration allows environmental information being shared within and beyond organisational boundaries which make organisations open to new ideas. This ability in combination with the capacity of acquiring, assimilating and transferring environmental knowledge as well as business data analytics tools can enhance environmental innovativeness in several business areas such as reusing waste as materials, digitalizing business process and improving product design for environment. For instance, according to Shelley Zimmer, the Environmental Marketing Manager of Printing Supplies, HP has creatively recycled plastics instead of buying the new ones with as a result of data analysis in managing, reusing and recycling waste.

Another capability that can be fostered by environmental information sharing is environmental adaptability. Environmental adaptability represents the ability to sense and respond to tighter regulations and stakeholders' incremental expectations about environmental sustainability. When organisations have sufficient information about their environmental impacts, they are able to anticipate potential changes in global mega-trends that have significant magnitude in regulation and public expectation. They can develop sustainability preemption ability and become one of the leaders in their industry. These can lead to building sustainability brand reputation. For example, in 2014, Anna Clark, President – EarthPeople, argued that "compliance managers need a centralised platform" with free flow information to respond quickly to the environmental crises. Allen Stegman, the General Director of Environmental and Hazardous materials for BNSF Railway, supported that EH&S data analytics allow BNSF to "transition from lagging metrics to leading indicators and predictive analytics" so that they can continue to drive improvement in their performance.

Further, not only do environmental data analytic tools demonstrate the potential areas of cost saving, but those competencies also support better sustainability decision-making, more precise predictions regarding market and regulation changes, and boost environmental innovativeness. For example, according to Lauren Hepler, Senior Editor – GreenBiz Group, in the environmental sustainability context, cost savings and environmental commitment goals are the two inextricably targets which Big Data software tools can help organisations assess and manage to increase efficiency. This means that EES competence with built-in environmental data analytic software supports environmental regulatory compliances, which in turn increase environmental efficiency.

Therefore, EES-enabled capability which consists of environmental innovativeness, adaptability and regulatory compliance can be developed and renewed out of EES integration, EES-absorptive capacity and EES data analytics. This leads to the second proposition.

Proposition 2: EES competence can be leveraged by organisations to develop a higher-order capability in environmental innovativeness, environmental adaptability and regulatory compliance.

EES-enabled capability and EES value

EES value is generated from environmental innovativeness as innovation always leads to efficiency and competitive advantage. For example, sustainability brand reputation is usually accompanied by sustainability products and services. Henk Campher, Edelman's Senior Vice President, Business and Social Purpose, reported that "combining the sustainability of the product and the brand to [can] create a unique sustainable brand value proposition and identity". Green products embed on customers a perspective about the sustainability image of enterprise, leading to a competitive advantage for that enterprise in comparison with others. Moreover, in the case of HP, using waste to replace materials is an environmental innovativeness that brings about cost savings and mitigates waste to the environment. It generates environmental efficiency in cost and resource consumption. Other EES capabilities like adaptability and regulatory compliance also contribute to the resilience of enterprises when faced with stringent environmental obligations. As a result of sensing capability, companies can go beyond the regulatory commitments to pre-emption of available resources that create the competitive value for them. Additionally, compliance means that businesses have standardised environmental process and data to develop their environmental management initiatives into best practices. Thus:

Proposition 3: Organisations that nurture EES-enabled capability harvest more value out of their EES implementation.

6 Conclusion, limitation and future research

The global consensus of tackle climate change reflects the need to take actions at community, organisational and national level. This requires understanding the continued use of IS to transform

and build sustainable organisations. In this paper, because of the increasing diffusion of EES on the one hand and the lack of EES specific studies on the other hand, we set out to explore two questions: (a) what EES values are harvested by organisations and (b) how they do that. Based on a practitioner literature analysis, this paper breaks new ground for both practitioners and researchers.

Theoretically, this research introduces to the IS literature a relatively new class of Green IS - environmental enterprise systems (EES). The study also clarifies two EES value dimensions: environmental efficiency and environmental competitive value. Further, EES value-creating mechanisms and pathways are discovered. Organisations, through EES implementation, are developing EES competence to gain environmental benefits. Some of them are exploiting EES competence to build EES-enabled capability to achieve EES value. Noticeably, this study contributes three propositions that can be developed further and tested in the future studies.

To practitioners, the study highlights how their peers are overcoming the trade-off between economic benefits and environmental sustainability targets by developing EES competence and EES-enabled capability. This also indicates that for sustainability software investment to yield value, organisations have to cultivate appropriate environmental resources and capabilities.

Despite these contributions, this research has some limitations. First, we have used the practitioner literature which might be biassed towards discussing successful stories and neglecting the greenwashing phenomena. Empirical studies such as in-depth case studies can be followed from our current work to develop the EES value framework. Second, the analysed data which comes from one online database within the last two and a half years (2014-2016) may not fully cover all the dimensions of EES value and value mechanisms. A wider range of database and longer study period could be more beneficial. Third, empirical evidence is crucial for determining the validity and utility of the framework developed in this study. A survey will be appropriate to provide an empirical test of the framework. This study focused only on an organisational level. The macro-level value such as the value to the natural environment and social welfare are not sufficiently discussed both theoretically and from the findings and will be addressed in the forthcoming works.

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Appendix 1: Unique codes from practitioner literature analysis

Unique Code	Citation log	Source
• Knowledge capability • Infrastructure capabilities • Regulatory compliance effectiveness	*"Companies that invest in knowledge and infrastructure capabilities also benefit through better [firm] performance, beginning with increased efficiency in regulatory compliance".*	Enablon - Sustainable Performance Forum - Houston 2015 "Turning organizational stress into resilience"
• Platform automation • Sustainability risk management	*"First is to measure and manage metrics of sustainability risk and performance to the company, and second to track their impact on the communities in which they operate. Automated EHS platforms can perform these functions for suppliers, also".*	Voss - Stakeholder-relations Executive – Sedex - 2015 "Turning organizational stress into resilience"
• Knowledge exchange and collaboration • Learning and assimilation of sustainability systems	*"For companies aiming for resilience and beyond, EHS or GRC systems facilitate knowledge exchange and collaboration".* *"... the value of harnessing an opportunity hiding in plain sight - in this case, leveraging the innovation potential within compliance". "As managers learn more, they are overcoming the obstacles with every module they adopt, each process they cultivate and each user they train".*	Anna Clark - President – EarthPeople - 2015 "Turning organizational stress into resilience" *GRC – Governance, Risk and Compliance*

• Environmental process automation • Centralised data platform • Resources efficiency	*"Automating EHS business processes reduces the risks of data duplication, data entry errors, e-discovery, and missing compliance targets".* *"Having a centralized system enables Apache to manage resources more effectively where we are forced to maintain status quo, and in many cases do more, with less".*	Jill Gilbert – President, CEO - Lexicon Systems Lisa Cruz - Advisor in EHS - Apache Corporation - 2015 "How to turn environmental compliance into a competitive edge"
• Sustainability data analytics	*"Gathering information (vs. data) allows us to transition from lagging metrics to leading indicators and predictive analytics so that we can continue to drive improvement in our performance".*	Anna Clark - President – EarthPeople – 2014 Allen Stegman - General Director of Environmental and Hazardous Materials - BNSF Railway - 2014
• Sustainability resilience	*"Leveraging EHS systems for efficiency, resilience and compliance"*	
• Fuel efficiency	*"Through performance improvements such as fuel efficiency, …"*	Working together, EHS systems and CSR rocket a company to success *(CSR – Corporate Sustainability Report)*
• Adaptability to crisis	*"… compliance managers need a platform that allows them to respond in a crisis situation".*	
• Systems integration	*"Together, EHS, CSR and IT form a triumvirate of competencies capable of … sustainable solutions".*	
• Building management systems integration • Energy cost saving	*"It's great we've integrated 125 buildings … 6 building management systems".* *"Through energy management, … and fault detection and diagnosis, … saved more than $1 million a year in energy costs, …"*	Rob Bernard - Chief Environmental Strategist, Microsoft Corp - 2016 "Why Microsoft gave sustainability a promotion"
• Environmental data integration with business data	*"…how integration and analysis of energy data and production data is simplified …".* *"… materials, consumables, energy, waste and carbon emissions, makes it easier to identify potential savings".*	Nick Blandford – Global Blogging Program Manager – Schneider Electric - 2015 How to focus CFOs on energy management investments
• Brand reputation • Green product innovativeness	*"This is at the heart of a sustainable brand — combining the sustainability of the product and the brand to create a unique sustainable brand value proposition and identity".*	Henk Campher – Senior Vice President, Business and Social Purpose – Edelman - 2014 The anatomy of a sustainable brand
• Materials innovation	*"Because of the increasing scarcity of resources and the increasing cost of natural resource extraction, it's increasingly important for companies to source materials from waste".*	Shelley Zimmer - Environmental Marketing Manager of Printing Supplies – HP - 2014 How HP is closing the loop on cartridge recycling
• Integration of ecological and business processes • Green process innovativeness	*"Including natural and social capital accounting and optimization in our mainstream business processes could help business go beyond just monitoring negative impacts …"*	Thomas Odenwald - Senior Vice-President of Sustainability – SAP - 2015 5 ways to apply natural capital valuation in your business
• Employee retention • Employee engagement	*"… software platform to help companies engage employees in social impact and sustainability".* *"Productivity, efficiency and employee retention are undisputedly tied to profitability".*	Barbara Grady-Senior Writer-GreenBiz Group - 2015 How Aveda and Alcoa use purpose and impact to hook employees
• Corporate sustainability targets • Energy Big Data analytics	*"… Big Data software tools being built to help assess and manage energy use".* *"Operating cost reductions are still king …, but … cost-cutting inextricably is tied to corporate sustainability goals and increased efficiency".*	Lauren Hepler – Senior Editor – GreenBiz Group - 2015 5 ways Big Data can help rein in energy use
• Real-time data • Water efficiency • Energy efficiency	*"The real-time data empowers the team to respond quickly, … while allowing it to use data analytics to enhance decision-making … reduced water consumption … increased the energy efficiency and useful life of Walmart's assets".*	Kellen Utecht - Director of Sustainability – Phigenics - 2015 Quenching Walmart's thirst for water efficiency

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