

## AN EXPLORATORY STUDY INTO THE USE AND VALUE OF ENVIRONMENTAL ENTERPRISE SYSTEMS

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### **Abstract**

Environmental enterprise systems (EES) are an emerging type of integrated enterprise-grade software developed for environmental sustainability. This paper reports an exploratory investigation into the use and value of EES based on case studies of an EES vendor, four organisations that have adopted EES and an organisation that has yet to adopt EES in Australia. The findings indicate that EES offers unique functionalities that the case organisations are using to automate environmental data collection and the business process of sensing and responding abnormal building energy consumptions; easily inform staff, senior managers and other stakeholders about their environmental sustainability targets and performance and transform risk, incident and building energy management processes. This is enabling the cases to improve their environmental data quality, generate different reports with ease and low costs and reduce their risks. In addition, some of the cases are using EES to create EES-enabled distinctive capabilities such as energy optimisation, risk management and analytics innovations which are contributing to achieving environmental strategic value. Based on the findings, this paper highlights three potential pathways for harvesting environmental value from EES.

**Key words:** environmental enterprise systems, Green IS, competence, capability, environmental value

## 1 Introduction

In the last decade, business organisations have faced three main environmental sustainability challenges: (a) environmental risk management, (b) environmental efficiency, and (c) the pressure for green innovation and growth (Nidumolu et al. 2015). Green Information systems (IS) are advocated as one of the mechanisms to respond to these challenges by alleviating the environmental impact of individuals, organisations and society (Elliot 2011; Melville 2010; Seidel et al. 2013; Watson et al. 2010). In the Green IS literature, there has been a growing call for IS research on providing practical solutions to mitigate environmental damage by organisations (Elliot and Webster 2017; Gholami et al. 2016; Seidel et al. 2017). Environmental enterprise systems are one types of Green IS solutions to address some of the environmental challenges organisations face (Melville and Whisnant 2014).

This research on *environmental enterprise systems (EES)* (defined as a class of enterprise systems which offers integrated enterprise-grade software for streamlining environmental management processes, data, risk and reporting) is motivated by the following two observations:

First, several established enterprise software vendors (e.g., SAP with its Sustainability Performance Management Software and Oracle with its Environmental, Health & Safety Management System) and new market entrants (e.g., Envizi and Enablon) are providing EES solutions, and the EES market is expected to increase by 12.4% per year (from US\$31.29 billion in 2015 to US\$63.16 billion by 2021) (Zion-Market-Research 2017). This fast-growing market implies that more and more organisations have implemented their EES solutions (Melville and Whisnant 2014). Although EES vendors reported that many organisations have effectively used EES to address their environmental sustainability issues without compromising economic return, EES vendors have not provided sufficient information on how organisations derive benefits from EES (that is, their EES value-creating practices). This missing information is of vast importance to other organisations start to consider implementing EES to alleviate the fairly complex, global environmental problems.

Second, EES represent a specific Green IS artefact with a unique combination of technological, information and social artefacts to address the environmental sustainability issue (Lee et al. 2015). As a technological artefact, EES share some common characteristics with other enterprise systems (e.g., enterprise resource planning systems, supply chain management systems and customer relationship management systems). These common characteristics include, for example, a centralised platform, integrated transaction data, process automation and integration with other systems. However, due to the purpose and environmental functionalities (e.g. energy and carbon management, water and waste management, incident and risk management, and sustainability reporting) of EES, their information/social artefacts and their use context are different from that of other enterprise systems. Thus, it is conjectured that there are some *distinctive* organisational capabilities associated with EES for value generation. However, little research has been conducted to investigate this important issue.

In view of the above observations, this study aims to explore the use and value of EES through several case studies. The study addresses three questions: (RQ1) *What does EES offer to organisations?* (RQ2) *How do organisations use EES and create value-enhancing mechanisms?* (RQ3) *What value do organisations achieve by using EES?*

The rest of the paper is organised as follows. Section 2 provides a literature review which is followed by a description of research method in section 3. Section 4 reports the case study results. In the final section, we discuss the findings and conclude by drawing implications for EES research and lessons to practitioners.

## 2 Background Literature

In view of the research questions, because of the lack of EES specific studies, this section reviews the literature on the use and value of Green IS as a background to this exploratory study. Based on the review studies by El Idrissi and Corbett (2016) and Wang et al. (2015a), we found three main streams of Green IS value research.

The first stream of Green IS value illustrated that organisations can utilise IT resources to develop environmental sustainability capabilities (Dao et al. 2011), to align with Green practices (Ryoo and Koo 2013), to integrate with environmental management processes (Wang et al. 2015b) to address environmental sustainability challenges and achieve value. Dao et al. (2011)'s integrative framework categorised sustainability value into short-term and long-term benefits. For short-term sustainability values, they included internal benefits (reducing environmental costs and risks, improving profitability) and external benefits (enhancing legitimacy and reputation, reinforcing and

differentiating market position, and lowering environmental impact). In long-term, these values are comprised of radical innovation in materials, products and processes; firm's strategic position as well as sharing environmental sustainability vision and exploring unmet markets to develop new green products (growth trajectory). Additionally, other researchers have incorporated IS capabilities such as environmental management processes (Wang et al. 2015b) and green practices such as companies' sustainability missions, quantified goals, objectives and detailed action plans/strategies (Ryoo and Koo 2013) to explain how organisations can derive business value from focusing on environmental sustainability. Their findings indicate that the alignment or integration between IS resources (IS infrastructure and human technical and managerial skills) and environmental practices (environmentally-friendly corporate activities to mitigate environmental burden) can improve environmental sustainability value (e.g. mitigating environmental costs and risks, enhancing reputation and legitimacy, and developing green innovation).

In the secondary stream, Gholami et al. (2013) advocated that Green IS adoption for pollution prevention, product stewardship and sustainable development can foster organisations in recycling waste, reducing travel and operational costs as well as energy consumption (environmental performance). However, empirical findings demonstrated that only long-term (strategic orientation) Green IS adoption could enhance environmental performance under the coercive pressure from policy-makers because of business incentives. Recently, Loeser et al. (2017) postulated that Green IS initiatives (action) under the mediating of Green IS strategies, generate organisational benefits such as cost reduction, corporate reputation improvement and Green innovation capabilities.

The third main stream of Green IS value research focuses on organisational capability to address how organisations respond to environmental challenges (Hedman and Henningsson 2016), how they assimilate environmental sustainability knowledge (Cooper and Molla 2017) or how they exploit Green IS functional affordances to achieve environmental sustainability transformations (Seidel et al. 2013). This suggests two dimensions of value creation: development of generic environmental sustainability capabilities/processes (e.g. pollution prevention, product stewardship, clean technologies and sustainability shared vision) and exploiting one specific environmental capability such as IS-environmental absorptive capacity or sense-making and sustainable practices in a particular context.

Green IS studies in the above three streams provide useful insights. While the second stream implies that the adoption of EES can lead to some improvement in environmental performance, the first and third stream imply that the capabilities that organisations create by leveraging the functions of EES are important sources of value. However, the previous studies have not explicitly addressed the role of EES which is the focus of this study.

### 3 Research method

The research was conducted using a case study method because of two main reasons. First, EES is an emerging area in Green IS (Wang et al. 2015a) and, hence, case studies are useful to explore this contemporary phenomenon (Benbasat et al. 1987). Secondly, the "how" (RQ2) and "what" (RQ1,3) aspects of our research questions naturally lend themselves to a case study method (Yin 2014).

Data were collected from three types of organisations: an EES Vendor, four organisations that have adopted EES and an organisation that has yet to adopt EES. The vendor was included to compare the potential and actual value of EES. The four EES user organisations and the vendor were identified by attending the 2017 Melbourne Sustainable Performance Forum, in which newly developed functionalities of EES products and successful business cases for implementing EES were reported. The sixth case was an organisation which is not currently using EES. This case was included to get useful insights into the impacts of EES by comparing and contrasting the information obtained from users and non-users of EES. In each of the six cases, data were collected through 60-90 minutes interviews (six) and documents. The targeted informants for the interviews were the key decision makers that played (or could play, *c.f.* case six) a substantial role in developing or implementing EES. Table 1 below gives background information about the case organisations, the interviewees and the documents collected.

The interview transcriptions and the archival documents were analysed by using two rounds of coding with NVivo software. The first-round coding was generated using the open coding technique (Corbin and Strauss 2015) inductively by reading line-by-line the interview transcripts and interpreting. The second-round coding was guided by the three research questions and focused on identifying common themes and patterns by grouping the initial unique open codes into a smaller number of categories, themes or constructs (Miles et al. 2014). For example, the open codes of "client attractions" and "reputation in the community" were grouped into the category of "sustainability reputation".

Case ID	Case information	Interviewee	Archival document
<b>EES Vendor</b>	Large Software Services, EES- software Vendor	11 years as Chief Executive Officer & Co-founder – Develop EES for 11 years	Organisation Website – “Solution - Platform Overview” – 4 documents
<b>Real Estate</b>	Multi-national Property& Facility Services, EES-user, publishing sustainability information since 2005	9 years as Sustainability Manager – Use EES for 9 years	A Case Study of Partnership between RES and EES software vendor to boost performance.
<b>Utility company</b>	Large Public Services, EES-user, publishing sustainability information since 2011	3 years as Risk, Insurance & Compliance Manager - Use EES for 3 years	Presentation Slides at Sustainable Performance Forum – Melbourne – 2017
<b>Financial company</b>	Multi-national Financial Services, EES-user, publishing sustainability information since 2000	2 years as Director Sustainable Business - Use EES for 2 years	Organisation Website – “Sustainability” – 3 documents
<b>Education provider</b>	Multi-national Educational Services, EES-user, publishing sustainability information since 2015	3 years as Utility Manager - Use EES for 3 years	Organisation Website – “Sustainability Program”
<b>Consulting</b>	Large Consultant Services, non-EES user, publishing sustainability information since 2016	2 years as Corporate Citizenship Manager – Use MsExcel Spreadsheets.	Organisation Report – “Environmental Policy”

Table 1: Background information about case organisations and sources of information

## 4 Findings

The main findings of the exploratory study are summarised in Table 2 and discussed in the following subsections.

Question	Findings
<i>EES functional affordances</i>	<ul style="list-style-type: none"> <li>Sustainability Reporting, Utility Expense Management, Energy Optimisation, Asset Performance Management, Environmental Risk Management, Environmental Health and Safety Management, Sustainable Supply-Chain, and Corporate Governance and Responsibility</li> </ul>
<i>EES use</i>	<ul style="list-style-type: none"> <li>Automate environmental data collection</li> <li>Automate sensing and responding to building abnormal operations</li> <li>Generate compliance and sustainability reporting</li> <li>Informing staff and senior managers</li> <li>Transform risk and incident processes</li> <li>Transform building energy management processes</li> </ul>
<i>EES-enabled capability</i>	<ul style="list-style-type: none"> <li>EES absorptive capacity</li> <li>Sustainability data analytic capability</li> <li>Stakeholders’ engagement</li> <li>Environmental innovativeness</li> <li>EES-dependent sustainability strategies</li> </ul>
<i>EES value</i>	<ul style="list-style-type: none"> <li>Energy, water, risk, air quality, waste, emission data quality</li> <li>Better quality sustainability reports with less effort</li> <li>Cost reduction</li> <li>Environmental risk reduction</li> <li>Sustainability reputation</li> <li>Supplier collaboration</li> </ul>

Table 2: Summary of findings

### 4.1 EES functional affordances (RQ1)

Historically organisations rely on spreadsheets to collect energy, water, (electronic) waste, paper, car/fleet and air-travel emission data and create a macro to integrate and consolidate these measures for high-level monitoring and reporting. EES not only overcome the limitations of a spreadsheet approach to environmental data capture, management and reporting, but also enhance these aspects (such as with higher data quality, automated processes, and effort reduction) and provide new and best of breed competency in data analytics, assets optimisation and risk profiling. As the vendor interviewee indicated:

*“We develop the platform back in 2007/2008 because we wanted to provide a carbon accounting systems for organisations to capture all the information relating to the carbon emissions profiles... around 2012 ...we started to focus on areas: waste, water, social metrics (things like diversity, community investment, employee giving a donation), set a broader sustainability metrics and built a lot more functionality at the end of 2013. We thought that energy management was probably an area that we could go into with far more significant innovation and disruptive technologies at a time that energy markets both in Australia and globally appear to start going through some significant transformations. So really that was the final major transformation of the platform that was required. We spent a lot of time, and a lot of money over the last 10 years building out what I would consider to be both of broad and deep platforms in terms of its functionalities.”*

The four organisations adopted EES from two different vendors. The costs (which the cases were not willing to disclose) of implementing and operating EES depended on the number of EES functionalities that they have selected and whether there is a strategic partnership between organisation and the software vendor. These organisations came to the EES market after developing their requirements by using either external consultants or internal teams and used that in selecting the vendor and solution. These software platforms differ in their complexity. One of the platforms offers a range of specific environmental performance systems such as energy management (e.g., building energy optimisation, utility expense management, and asset performance management) and sustainability reporting. The second solution provides an integrated EES which include not only specific environmental functions (such as air quality management, carbon emission forecasting, and greenhouse gas management) but also a comprehensive range of business/modules (e.g. profitability and costs of sustainability initiatives, enterprise risk management, and supply chain management). Table 3 describes the functions of the two EESs.

<b>Functions</b>	<b>Software 1</b>	<b>Software 2</b>
Energy, water, waste, air quality, emissions data management & reporting	x	x
Tracking consumption, energy, emissions and intensity targets	x	x
Building Ratings and Benchmarks	x	
Profitability & Costs of sustainability initiatives		x
Utility Financial Management, Reporting and Analytics (Billing Data)	x	x
Utility Bill Checking and Validation	x	
Monitoring interval data from utility meters and sub-meters	x	
Building Energy Performance Analytics	x	
Building Equipment Fault Detection	x	
Program Reporting, Measurement + Verification (Energy, water, waste, environmental, emissions, financial and project data)	x	x
Solar Monitoring (Solar meter data (generation and consumption), utility meter data, irradiation data)	x	
Corporate Governance (Document Control)		x
Corporate Responsibility (e.g. Stakeholder Relationship, Initiatives and Donations Management, Corporate Social Responsibility Reporting)		x
Enterprise Risk Management (e.g. Business Continuity Management, Change Management, Incident/Event Management, Risk Management , Insurance & Claims, Internal Audit and Control, and Mobile App)		x
EHS Management (e.g. Environmental Analysis, Audit & Compliance, and Product Compliance & Stewardship)		x
Sustainable Supply Chain (e.g. Responsible Supply-Chain)		x

*Table 3: EES functions*

The key differentiation in the EES market and what is attracting other organisations to adopt EES is the vendors’ ability to offer a platform with a breadth of coverage. To avoid duplication of IT systems, training people in those systems and the cost associated with it, vendors try to convince customers to go with one platform approach from the facility, operations, engineering, finance, and procurement sustainability. This approach is helping one of the vendor to become a market leader in Australia having the big four banks, major retailers and farmer groups, Australia Post and more than probably 10 of the top 20 property companies in Australia as its clients. As the Vendor indicated *“I think our differentiation position from that perspective is actually works very well in the market”*.

## 4.2 EES use (RQ2)

The four EES user cases differ not only in the type of EES but also in the specific modules they implemented. Three of them (Real estate company, Educational institution, and Financial institution) have adopted the solution from the first vendor of which the educational institution uses sustainability reporting, utility expense management, solar monitoring, and interval meter monitoring. The financial case implemented sustainability reporting and utility financial management, reporting, and analytics while the real estate company used three out of four modules (except utility expense management). The fourth case (Utility Company) has implemented the environmental risk and incident management modules of the second vendor. None of the cases adopted all of the modules that the vendors offer. The direct users of the systems in the four cases range from about 03 (Education) to 18 (Real Estate).

EES offer capability to connect to a broad range of utility suppliers' software platforms and hardware systems, electronic bill systems of travel and waste disposal companies as well as get data from acquirers and other enterprise systems. Virtually all four case organisations use EES to automate environmental data collection, but there are differences in what environmental data they collect as well as the level of automation. Typically energy data collection is easy to automate as the EES has APIs with smart meter providers to directly feed the data into the software. Other data such as waste and water invoices can be e-mailed to the platform and the system is smart enough extract to that data to know which customer it belongs to, which utility account it belongs to and get that done to the database. However, incidents and risk still require manual data entry.

*Well, it's automatic. They built connectors; and its connections ... [get] the information ... , [flows] into the system. You don't really need to know, just following the patterns. ... All of that is straight up data. (Financial Interviewee)*

The Utility Company and Education cases have also automated sensing of anomalies in building energy consumption and instigating actions to investigate and resolve the anomaly

*"And we will use the system to analysing the significant anomalies around energy consumption. ... we collect it [sub-metering data] as a source that goes into the system daily. So at midnight, I will get [the information of] the full day before, now that data will be used to identify any significant anomaly increased overnight usage or increase usage over a weekend. ... I can log a work order on a separate system to send a contract out to look at an issue within a building whether that will be an electricity usage, water usage, gas usage. And I can provide and attach that information file to a work-order to a contractor." (Education Interviewee)*

Another frequent use of EES is for generating compliance and sustainability reporting.

*"We use [EES software] to manage environmental data for our compliance supporting and sustainability reporting. ... We do customer report, we do project target management, all of straight up data management ..." (Financial Interviewee)*

Informing staffs and business units about consumption patterns; sustainability and environmental management professionals about environmental footprints; senior managers about environmental performance (e.g. whether organisational obligations, commitments, and compliances are achieved) is another use of EES common to all four cases

*"We can look at high level and we can also drill down the individual buildings where we can show the overall, how the energy and emissions profile and water profile on those buildings are charging. And we feed those exact reports up to our Chief Operating Officer." (Education)*

The Utility case, because of its business needs for monitoring water quality breaches, waterway contamination, sewage spill, fire and flood hazards, is using EES to transform its ability to identify and manage risk and incident processes. The case did not have a centralized environmental risk and incident management system, used to have more than 350 separate risk registers and legacy incident database that pose significant challenges with data integrity, version control, analytics and customisation to serve changing business needs.

*"... from the risk management perspective,...we used to have a whole sheet; I'm talking thousands of risks across the organisation. They were all being undertaken through Excel spreadsheets, so we have a lot of issues with data integrity. And people are basically not being held to account, not having any meaningful management actions that seat behind that, and just no ability to do sort of data analytics at all. There is no way you try to migrate 300-400 risk registers across the organisation. So one of the biggest drivers was to better understand what our risks were across our whole Enterprise and to remove duplication to focus people's attention on*

*understanding the risks in the controls that we had and implementing effective mitigation strategies in line with our risk appetite. The system provides both top down, bottom up views of risk and “incident, flexible dash-boarding and reporting which can be driven by the user – information by team, location, theme ....” (Utility Interviewee)*

The Real Estate case, because of its need for managing a large number of buildings, focused on transforming building energy management processes by adding the automatic analytic algorithms and engines into energy management process to enable automated sensing and responding with appropriate evidence, collaborating with maintenance contractors to synchronise decision-making process within 24 hours.

*“We know that if a maintenance person makes some wrong selections in a building. ... the outside air temperature sensor has been calibrated wrongly. And in that case, the energy consumption of that building triples overnight. So the item historically that has been a manual process for somebody to identify that unusual consumption bringing it to the attention of the site people at work out what went wrong and have it rectified and historically it can take months, many months. Our objective is ... to identify and rectify any fault like that within one day. That will rely on automatic analytic, not on analyst with specialist skills. The skill will be in setting up the alarm and ensuring that alarm gets to the person who can do something about it. Once the smart analyst sets up that little communication within that alarm system and that should be relatively automatic.” (Real Estate Interviewee)*

### 4.3 EES-enabled capability (RQ2)

Unlike the Consulting case which continues to run multiple Excel spreadsheets, the other four cases are developing important capabilities through the use of EES. These capabilities include EES absorptive capacity, sustainability data analytics, stakeholders’ engagement, environmental innovativeness, and EES-dependent strategic initiatives.

All four cases are developing a new capability to understand, assimilate and apply EES knowledge which is very critical to improving their environmental performance and footprint. Three areas of knowledge are being developed as a result of implementing EES. The first is around the administration of the system and looking after the data health and the quality of the system, making an update for the company, move premises and utility account. The second is the ability to gather regular and infrequent reporting needs, quickly identify the parameters and generate the report needed. The third area is the development of the ability of engineers, facility managers, and operation managers to intelligently manage risks, incidents and facilities, seek performance improvement opportunities and develop appropriate projects.

Further, the EES analytical algorithms have enabled the Utility and Real Estate cases to develop descriptive as well as predictive analytics abilities for identifying faults, anomalies, outliers and optimisation opportunities. EES adopting organisations have now the capability to take data from thousands of different data points, put it through series of complex algorithms, identify improvement opportunities and get that insight to decision makers in a user-friendly manner. This ability is possible after these organisations had gained sufficient knowledge and possessed a certain level of expertise on environmental data analytics. In the words of the interviewees:

*“a BACnet gateway [name of a device] was used to access equipment-level data to calculate facility energy profiles and to perform equipment fault detection. This enables facility managers to analyse building performance at a more granular level and to diagnose and quickly make incremental changes to operating parameters when performance anomalies occur. [We have now developed a capability to] create a workflow that allows information to get to the right people, the analytics that identified when is unusual consumption, and giving our operation managers visibility, so what kind of issues have been raised, who's done something about it, how long does it take them close that issue out, statistics more about why do we get so many of particular kinds of issues on particular buildings. (Real Estate interviewee)*

*“We can create graphs and charts based on different classifications of incidents or on frequency and so how many times we had incident on frequency or we can run complaint (so how many times have you had a complaint) what was that information break-down into? It's the first we can create a dashboard for a team or a group or the entire organisation. We are able to get the power back to the people as long as they know how to make requirements... It helps us to predict where we need to focus our resources and attention on. And that goes back to the risk assessment where it helps us to understand our risks.” (Utility Interviewee)*

Another area of capability that organisations are building through the use of EES is enhancing their ability to engage with both internal and external stakeholders about environmental performance and strategies.

*“So basically, I think it as a change. We got EES on the left-hand side, all of our reporting [...] in the middle, and every external and internal stakeholders on the right-hand side. EES provides the link of all the relevant and correct data into our reporting, and we use those reports to satisfy internal and external stakeholders’ information requests. Well, we’re using [EES software] with full potential, ... to look at more immediately and tracking an impact of project and saying how the energy changes or the water and waste changes based on what we’re doing. And using that to communicate and engage with our staffs. ... And we can also show business unit performance in different areas or team performance ... So, you can always inspire people to move by showing them where they are in the leaderboard with different metrics.”* (Financial case interviewee)

We also observed that the Real Estate case has developed an environmental innovation capability as it had collaborated with the vendor to co-develop the energy optimisation module in order to set the trend for the future direction of the solution.

*“The collaboration is the shared vision for where the product should go. We had [that was most important I guess] that alignment with ... to how they wanted to develop the product and where how we saw that being a value to our business. So we have alignment in that way, we’re willing to pay for the development of features with the expectation that they would charge in a way whereby we won’t carry 100% of the costs. Because we enhance their products and that would enable them to generate grand market share in greater features from others. So we found that kind of agreement has been beneficial to both parties.”* (Real Estate Interviewee)

Unlike the Education case, where we could not identify any unique strategy enabled by the EES, the other three cases have leveraged their EES use to pursue proactive and EES-dependent sustainability strategies. These were Facility Management Optimization Strategy (Real Estate case), Sustainability Risk Assessment (Utility Case) and Adoption of New Carbon Emissions Reduction Strategy (Financial Company).

*“This strategy [a facility management optimization strategy] integrates the optimisation of building-level asset management, energy management, operational efficiency, and waste and water management to enhance the performance of the buildings across [RES]’s portfolio. Since 2005, the firm has achieved a 44% reduction in water use intensity, 57% reduction in carbon emissions intensity and improved its recycling of waste from 29% to 43%.”* (Real Estate)

*“... that [assessment criteria consequences] allowed us to do, what our risk assessments are telling us and what we doing in terms of proactively trying to reduce risks from occurring and then when they are occurring what is the likelihood or how often are these incidents occurred which helps to inform the likelihood of that risk recurring and then what is being the consequences.”* (Utility)

*“So we have within our current strategies a number of targets, quantitative targets that we set around energy and waste specifically. And then we just released ahead of our new strategies, a science-based target around carbon emissions reduction. So [The EES] enables our commitments around carbon neutral new strategies, provides the underlying data to those strategic pillars.”* (Financial Company)

#### 4.4 EES value (RQ3)

The case organisations have reported a number of benefits associated with using EES and developing EES-enabled capabilities. First, all four cases have reported significant improvement in data quality such as completeness, reliability and integrity and the ability to build one source of truth.

*“It [EES software] has enhanced the reliability of the data and again we have our data assurance by external auditors each year. And we find the audit process is becoming shorter and shorter and easier and easier. Not very often you can say that. But it is a good thing.”* (Real Estate)

*“The second [benefit] one will probably be in the integrity of the information. Now we can be assured that it is correct and as a result we were actually able to come down [cancel] our contract with data insurance providers.”* (Education)

Second, the time and effort required to generate sustainability reports have been reduced significantly while the quality (such as traceability and auditability) of the reports have improved. In this respect, the Consulting case also reported that for their current need, Excel is sufficient.

*“We had a staff member that was dedicated to data entry 3 or 4 days a week. That is no longer required. That is back when we used to run the spreadsheets, they required daily almost in some cases all morning or all day maintenance to keep those working and keep them clean especially when you come over to a new calendar or new financial year, you have to read the entire spreadsheets.”* (Education)

*“... when we were running spread sheets that come annual report, time for a report on a calendar year January to December, it would take until about April or May to consolidate ... to fill in all the missing data before we could confidently roll information up into a format that we can use for an annual report. And there was probably 3 or 4 people not full-time, spending a period of time consolidating the spread sheets across the portfolios. This year in the first week of January, we push the button to generate a report.”* (Real Estate)

The third benefit is related to risk reduction. For the Education and Financial cases, the risk is related to the likelihood of receiving penalties for not complying timely with mandatory reporting requirements such as the National Greenhouse Gas and Energy Reporting Scheme (NGERS). Whereas for the Utility case, the risk is the potential environmental impact of odour issues, noise, land contamination, flooding, fire, pollution events and spills

*“...for every risk assessment that we do...you generally applied the consequences. One of our consequences is what would be the potential environmental impact and you applied that on a scale of 1 to 5. So 5 being current contamination of the significant area; down to kind of you know what is the clean-up costs might be? What is the longest term of the environmental damage could be? What the software has allowed us to do is, on the risk side so when you do a risk assessment, you got that said a probability-based, you have one of your consequent criteria is about environmental damage.”* (Utility)

Fourth, there are improvements in consumption, intensity and cost of energy and water. Although these savings are not directly attributed to the software, interviewees' were of the view that if it has not been for the EES software, they might not be able to achieve what they achieved.

*“And I can't directly attribute a percentage of the savings was generated but [EES software]\* high-performance [has] been an important [part] contributed to our achievement of 40% energy reduction against the 2005 baseline which saves many millions of dollars each year.”* (Real Estate)

Fifth, the EES-enabled capabilities have contributed to organisation's sustainability reputation in the industry sectors and communities. For example, the real estate case through its EES-enabled energy optimisation strategy was able to improve its environmental score whereas the Financial Company's ability to supply correct information is linked with maintaining its reputation in the community.

*“Improving the energy efficiency of property portfolio to support a net zero carbon footprint is a primary goal of [Real Estate], which has improved its National Australian Built Environment Rating System (NABERS) score from an average of 3 stars to an average of 4.8 stars since 2005.”* (Real Estate)

*“So yes, it [EES software] would be a high contributor towards the correct information. And that correct information then does go to making sure our reputation in the community ...”* (Financial)

Sixth, in the Real Estate case, we observed that EES use and capability have enhanced collaboration with suppliers.

*“I suggest that there is a great deal of efficiency to be gained and we can make our buildings much less key person dependent. ... Improve accountability and operational effectiveness of contractors and field-based teams.”* (Real Estate)

## 5 Discussions and Conclusion

Environmental sustainability is an important imperatives for IS researchers. This paper was set out to explore (a) what functions EES innovations offer to organisations (b) how organisations use EES and the capabilities being developed as a result of use and (c) what value organisations achieve by using EES.

The overall finding from this exploratory study indicates that EES represents an IS innovation and provide an integrated platform to modernise organisations' ability to alleviate some, if not, all of the insurmountable environmental challenges. This adds much needed detailed evidence and IS innovation specific elaboration to the works of Dao et al. (2011) and Ryoo and Koo (2013) that have proposed the importance of building IT-enabled capability to improve environmental sustainability. We have also provided EES use cases and EES-enabled capabilities that have not been reported in any previous research that we are aware of. Similar to the works of Dao et al. (2011), Cooper and Molla (2017), Loeser et al. (2017), and Sarkis et al. (2013), our findings indicate that organisations are harvesting both operational and strategic value by using EES. The operational values are those related to energy, water, risk, air quality, waste, emission data quality, reduction of effort and time to produce quality sustainability reports, cost reduction. The strategic values are those associated with sustainability reputation. Further to these known benefits, our findings clearly show how IS can directly contribute to environmental sustainability by offering some organisations a powerful insight about eminent environmental risks.

As a theoretical contribution to spur future EES research, we propose three potential pathways to EES value: EES systemic competence, EES use, and EES-enabled capability. First EES as discussed in section 4.1, offer specific functions that are very different from other enterprise systems. Thus, as indicated in Gholami et al. (2013) and Loeser et al. (2017), the adoption of an EES platform or specific modules of a platform enhances organisations' ability in environmental data management leading to operational benefits. Thus,

*Proposition 1: EES-systemic competence positively influences environmental operational value*

Second, the use of EES varies depending on business needs (e.g. sustainability strategy, the number of office buildings owned or leased, and the sustainability priority of organisations) and the type of EES software. For example, the use of EES in the Financial and Educational and Real Estate companies is different. The financial institution leases most of their office buildings and did not need the level of sophistication of EES needed by the Real Estate and Educational institution which own and manage a large number of buildings. Based on Seidel et al. (2013) and Loeser et al. (2017), and the discussions in 4.2 and 4.4 how organisations exploit EES functional affordances is an important differentiator to achieve environmental sustainability transformations. This can lead to the following proposition

*Proposition 2: EES use and systemic competence are positively associated with the development of EES-enabled capability and this is moderated by industry and organisation specific factors.*

Third, another indirect pathway to generate value is through the development of EES-enabled capabilities from the use of EES. From the Green IS capability literature (Cooper and Molla 2017; Dao et al. 2011; Hedman and Henningsson 2016; Ryoo and Koo 2013), we understand that developing a range of IS-enabled sustainability capability help organisations to go beyond attaining operational value to strategic benefits. The findings in 4.3 and 4.4 demonstrated that the potential strategic value such as strengthening brand image within community can only be achieved by those organisations that nurtured EES-enabled capabilities (e.g. environmental innovativeness and environmental strategies) by exploiting EES. Thus we propose the following:

*Proposition 3: The development EES-enabled capability helps organisations to achieve strategic environmental value and this is moderated by industry and organisation specific factors.*

To practitioners, this study implies that if organisations are interested to enhance their environmental operational performance, they can only focus on how to use EES effectively. On the other hand, if their environmental orientation is strategic, they need to invest in further developments of EES-enabled environmental capabilities such as environmental innovativeness capability, sustainability data analytic capability, and EES-dependent sustainability strategies. Additionally, the study highlights that organisations can simultaneously achieve sustainable competitive advantage and satisfy the social obligation of minimising their environmental footprint.

Despite these contributions, the paper has a number of limitations. First, the number of case studies is limited and in each case, we have interviewed only one key stakeholder. Although the data were triangulated through documents future studies involving multiple stakeholders would enhance and enrich these findings. Second, our participants mostly came from the service sector. Future studies involving other sectors such as manufacturing and transport and logistics can help to identify industry-specific EES-enabled capabilities that can be shared with others similar organisations.

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