Enterprise Architectures for Addressing Sustainability Silos

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Abstract A need exists for behaviour change and transparency in modern organisations where the focus needs to shift towards sustainability thinking rather than just sustainability reporting for compliance reasons. The number of organisations which are undertaking Green Initiatives and reporting on sustainability are increasing. However, many of these organisations are not viewing these initiatives strategically. The effect on information requirements and business processes is often not considered and the available tools and technologies are not used to their full potential. As a result, whilst sustainability reports are produced, the underlying infrastructure consists of "sustainability silos" comprising of a lack of integrated systems, inconsistent data and information where the integrity is not reliable. In order to address these issues this study investigates the extent to which organisations consider environmental information requirements and processes when planning their information systems and Enterprise Architecture (EA). The inclusion of Green Initiative strategies into the design of an organisation's enterprise systems and EA is proposed. This will ensure alignment between environmental management and IT planning and result in integrated systems, an improved sustainability reporting process and more effective decision making regarding the environmental impact of organisations.

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1 Introduction

Environmental information is becoming more relevant in organisations today due to legislative requirements such as the Triple Bottom Line (TBL) [1]. Organisations have to report on their impact on the environment in a format known as the environmental (EN) report, which forms one component of the sustainability report. The other two components consist of social effort responsibility and the traditional economic report [2]. The concept of sustainability and sustainability reporting has become an emerging research field as well as a major focus area for organisations [3]. Sustainability reporting is

> the practice of measuring, disclosing, and being accountable to internal and external stakeholders for organizational performance towards the goal of sustainable development. A sustainability report provides a balanced and reasonable representation of the sustainability performance of a reporting organisation – including both positive and negative contributions [2].

In a recent Ernst and Young [4] survey, 66 % of respondent organisations reported that they had an increase in enquiries from investors about sustainability-related issues in the past 12 months. The results also showed that the growth of corporate sustainability of the companies surveyed had moved beyond compliance into viewing sustainability more strategically. The inclusion of sustainability into the strategy and initial plans of an organisation is also proposed by Magoulas et al. [5]. The strategy should include the needs, goals and requirements of Green Initiatives, which will prevent "sustainability silos" and un-integrated systems.
In South Africa, organisations listed on the Johannesburg Stock Exchange (JSE) are legally obliged to submit annual sustainability reports. In addition a number of non-JSE listed organisations are producing sustainability reports voluntarily and reporting in particular, on environmental impact. Research has shown that the challenge to integrate, retrieve, store and present environmental information has existed since the 1960s [6]. This has been confirmed by more recent studies of sustainability reporting in South Africa [4, 7], which reported that the main challenges are finding the right data, assessing its credibility and determining which data is material for reporting purposes.

Other challenges relate to the tools used for producing sustainability reports. The Ernst and Young [4] survey revealed that the tools used are rudimentary, even primitive, compared with those used for financial reporting. Companies cited that spreadsheets, emails and phone calls are the principle tools used to compile sustainability reports. Only one in four respondents used software packages. Despite a number of tools being available for sustainability reporting, these tools are not being used to their full potential.

These challenges can be overcome by viewing sustainability reporting strategically and not as just a legal compliance issue done as an afterthought. The use of Enterprise Architectures (EAs) has been increasingly utilised in organisations to plan the business strategies, information strategies and technologies of an organisation. However designers of these EAs seldom take into account Green

Initiatives which will impact information and reporting requirements. The EA provides the entire view of an organisation and is the repository of the data and complexities in organisations. Klein and Gagliardi [8] define Enterprise Architecture as

> The fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution [9].

The aim of this study is to propose a framework for the incorporation of Green Initiative strategies into an organisation's Enterprise Architecture. The framework includes technology for addressing sustainability reporting challenges; as well as techniques for process re-alignment and green reengineering. The study also makes the following contributions:

An analysis of the relative usage of sustainability reporting in several organisations in South Africa and their perceptions of the process; and

An analysis of the incorporation of sustainability or Green Initiative strategies in the EA of an organisation.

A number of studies have investigated the status of sustainability reporting globally and in South Africa. Selected studies have proposed technical and reference architectures for sustainability reporting systems, however, studies providing a comprehensive framework for the whole process from a strategically and organisational perspective are limited. The layout of the paper is as follows: Sect. 2 states the research objectives and methodology of this study. Section 3 highlights techniques for sustainability reporting and approaches for business and Information Technology (IT) alignment. The results of an investigation into the sustainability reporting process and use of EAs of several organisations are presented in Sect. 4. Section 5 provides recommendations from the results of the literature and survey and discusses the conclusions and future research.

2 Research Objectives and Methodology

This research study will investigate the process of sustainability reporting and of EAs in organisations and will propose a framework for incorporating Green Initiative strategies into an EA. The research also investigates what sustainability reporting issues are most relevant to organisations. The scope of the study will focus on medium to large organisations that operate in South Africa (SA) that do sustainability reporting. The research questions addressed in this study are:

RQ1. What reporting guidelines and tools are used by organisations to support environmental reporting?
RQ2. What are the challenges of environmental reporting?
RQ3. Can an EA be used to address the challenges of environmental reporting and to prevent sustainability silos?

An inductive approach was used in order to derive an EA framework for incorporating strategies for Green Initiatives into each of the four domains of an EA. The framework was designed based on a literature review of research studies in this field. A deductive approach was then followed and a survey of organisations in South Africa was undertaken to determine their usage of environmental reporting guidelines and tools, their use of EAs as well as the challenges they are faced with. The research instrument used in the survey was on-line questionnaires consisting of questions regarding the use of sustainability reporting and Enterprise Architectures in organisations. The questions in the survey address the first two research questions (RQ1 and RQ2). The last research question (RQ3) is answered by a combination of deductive reasoning from the results of the literature review as well as from the results of the survey. More in depth evaluations of the proposed framework are currently being undertaken to further verify and validate the framework.

3 Techniques for Sustainability and Environmental Reporting

Sustainability reporting is becoming a global trend and an obligation in current times and this provides a challenge to managers [10]. One objective of sustainability reporting is to benchmark and compare sustainability performance internally as well as externally in terms of standards and other regulatory factors [11, 12]. Other objectives for sustainability reporting are to [11, 12]:

- Improve communication with stakeholders about sustainability using the sustainability report as a dialogue tool;
- Improve sustainability marketing;
- Initiate programs to eliminate hazardous substances in materials and parts purchased; and
- Increase sustainable use of natural resources (for example, land, forests and animal population).

The Global Reporting Initiative (GRI) is a global network work-based organisation that is renowned as a global standard for sustainability reporting [2]. The principal intentions of the GRI, now known as G3, involve the widespread importance of disclosure on the environmental, social and governance aspects of their performance by entities. A global consultative process which is based upon a multi-stakeholder approach is responsible for creating the G3 guidelines. The GRI produces a wide-ranging framework that is extensively applied by entities on a worldwide basis. Three out of four of the participants in the Ernst and Young [4] survey cited that they followed the GRI reporting framework.

The Guidelines for Sustainability Reporting (the Guidelines) outlines the content to be included in a sustainability report (the Report), Standard Disclosures consisting of Performance Indicators as well as guidelines for reporting on technical topics in the Report. An environmental (EN) report should include all the

information regarding the processes of an organisation's impact on the environment whether positive or negative [2]. The G3 guidelines assists companies to identify what information is needed in an EN report which forms part of the sustainability report. The guidelines classify the information for an EN report into categories, known as EN indicators. These indicators are grouped into sections of the EN data applicable for an EN report. The sections are: materials, energy, water, biodiversity (the inputs) as well as emissions, effluents and waste (the outputs).

Rea's [13] report shows that the primary challenges faced by South African companies are those connected to environmental impact namely: water scarcity, increase in electricity demand and increasing fuel prices. The five environmental indicators in Rea's [13] report which were reported as having the most challenges for South African organisations are, in order of ranking from highest to lowest:

- EN16: Total direct and indirect greenhouse gas emissions by weight;
- EN4: Indirect energy consumption by primary source;
- EN3: Direct energy consumption by primary energy source;
- EN8: Total water withdrawal by source and
- EN18: Initiatives to reduce greenhouse gas emissions and reductions achieved.

Organisations wanting to improve on their environmental impact have adopted many Green Initiatives [12]. This leads to the challenge of storing, obtaining and retrieving sustainability information effectively and efficiently in order to be able to report on it [13, 14]. Sustainability reporting in many organisations satisfies legal compliance, but is often accompanied by sustainability "silos", un-integrated systems and inconsistent information. In order to report on environmental information several systems, tools and technologies have been developed. However, the Rea [13] report shows that whilst organisations doing sustainability reporting are increasing, the approaches, techniques and tools they use to do this are still lacking. Speshock [12] recommends the alignment of an organisation's strategy or mission with work processes, decisions, information and technology (Fig. 1). Work processes and decisions can be classified as part of the operational area, whilst information and technology form part of the technological area of an organisation. In order to make the most effective use of technologically available tools, business strategy and IT must be aligned [12, 15, 16]. Velitchkov [15] further proposes the use of EAs for closing the gap between strategy definition and execution and between business and IT at strategic and operational level.

Techniques for sustainability reporting can be therefore classified into the three process levels of an organisation: strategic, operational and technological. At the strategic level, an EA plays a critical role in supporting and informing the strategic decisions made within the organisation [17]. EA is defined by the Open Group Architecture Framework (TOGAF) EA as comprising of four domains [8], namely:

The **business architecture** defines the business strategy, governance, organisation, and key business processes.

The **data architecture** describes the structure of an organisation's logical and physical data assets and data management resources.

Fig. 1 Alignment of IT with
an organisation's strategy
(Adapted from Speshock
[12])
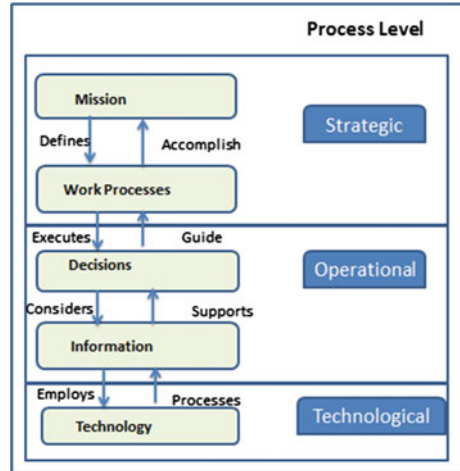
The **application architecture** provides a blueprint for the individual application systems to be deployed, their interactions, and their relationships to the core business processes of the organisation.

The **technology architecture** describes the logical software and hardware capabilities that are required to support the deployment of business, data, and application services. This includes IT infrastructure, middleware, networks, communications, processing and standards.

An EA includes the plans for how an organisation will build, deploy, use, and share its data, processes and IT assets [18]. Green Initiatives should be included in an organisation's strategy, therefore one way of ensuring alignment of a Green Initiative and business strategy with IT is to make use of an EA. Additional strategic techniques for Green Initiatives include balanced scorecards and strategy maps [7, 12]. The use of a balanced scorecard can result in a clear picture of the relationship among sustainable practices, corporate strategies and profitability [19].

At an operational level business process integration and improvement is critical for Green Initiatives and sustainability reporting, which in turn will improve information quality [12]. The foundation for execution of the EA includes core business processes and IT infrastructure [17]. Business Process Reengineering (BPR) are techniques which can help organisations fundamentally rethink how they do their work in order to dramatically improve customer service, cut operational costs and become world-class competitors [12]. Green reengineering is defined as

> The application of BPR concepts that consider environmental impact, by, for example, proactively redesigning and radically improving manufacturing, packaging and distribution processes to become more sensitive to the natural environment.

At a technological or application level, the Internet and Web 2.0 technologies can vastly improve the difficult task of providing sustainability information to stakeholders. These tools can assist organisations with improving the effectiveness and quality of their environmental information and reporting processes.

4 Proposed EA Framework for Environmental Reporting

The proposed framework is based on the incorporation of Green Initiatives into an organisation's IT strategy as recommended by Magoulas et al. [5] and [12] and is classified into three levels, namely strategic, operational and technological. Secondly the framework incorporates business strategy and IT alignment through an organisation's EA as proposed by several studies [15, 16]. This alignment is then mapped to the four domains of an EA proposed by the TOGAF framework, namely: business, data, application and technology architecture (Fig. 2). Organisation's must view sustainability strategically, and include their Green Initiatives in their EA. The strategy must be incorporated into the business architecture domain of the EA, and includes the setting of strategy and objectives for all three elements of sustainability, namely: environmental, economic and social. Managerial processes are considered here.
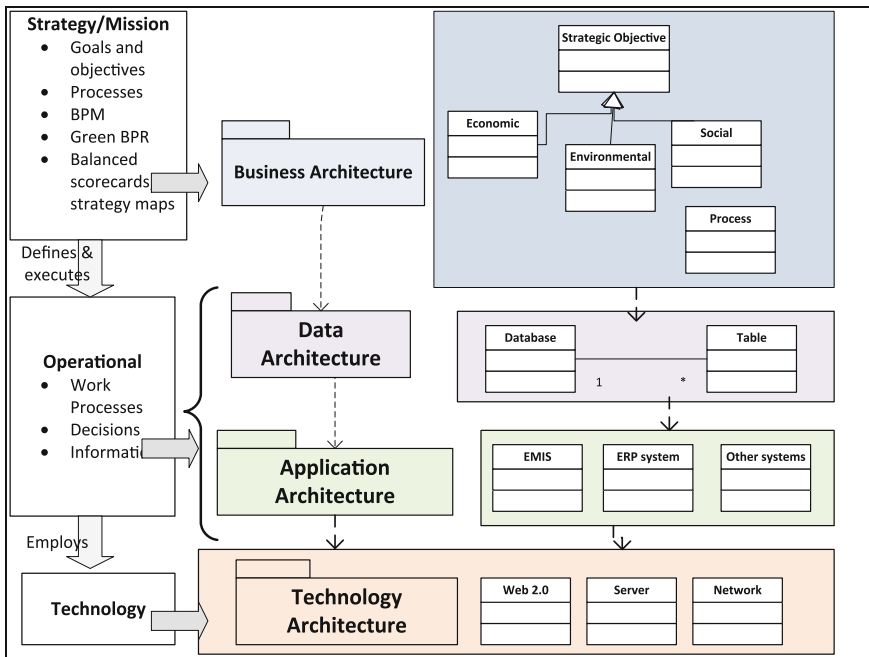

Fig. 2 Framework for integrating green initiative strategies into enterprise architectures

At the operational level, the application and data architectures must be considered. At this level, the business processes which are impacted by these strategies will therefore be taken into account using green reengineering which will result in improved process design and management. The data and application architectures must be designed based on the strategies identified in the business architecture. Examples of applications include internal information systems, Enterprise Resource Planning (ERP) systems as well as those designed specifically for environmental information management, such as Environmental Management Information Systems (EMIS). The technological architecture must also be aligned with the business architecture. Whilst several architectures for EMIS such as STORM [20] and AISLE have been proposed [21], these studies focus on technical architectures and not on the alignment of existing EAs with an organisation's environmental strategy.

5 Research Findings

Several organisations were contacted and requested to participate in survey with on-line questionnaires. A number of participants from several different types and sizes of organisations were willing to participate (Sect. 5.1). The results were analysed and several findings were made (Sect. 5.2).

5.1 Participant Profile

A survey approach was used whereby management reported on the status of sustainability reporting and the use of EAs in their organisations. Twenty one organisations were included in this study and were from a range of industries from mining and resources, to insurance to transport (Table 1). Three major role players in the automotive manufacturing industry participated, as well as three large insurance companies. Nine of the organisations are not listed on any stock exchange and therefore not required by legislation to do sustainability reporting. The respondents ranged from IT managers and Enterprise Architects to sustainability reporting managers.

In order to establish content validity, a pilot test of the questionnaire took place. Based on the results of the pilot study several changes were made to improve the questionnaire. The closed-ended questions were all statements which had to be rated using a 5-point Likert scale where 1 represents *Strongly Disagree* and 5 represents *Strongly Agree*.

Table 1 Participants profile (n = 21)

Company	Industry	Listing status	Number of employees
A	Agriculture	Not listed	101–500
B	Accounting and audit	Not listed	51–100
C	Assurance	Not listed	500+
D and E	Automotive manufacturing	Listed	500+
F	Automotive manufacturing	Not listed	101–500
G	Aviation	Listed	500+
H	Banking and financial services	Listed	500+
I	Broadcasting	Not listed	101–500
J	Consumer goods	Not listed	101–500
K	Energy and utilities	Not listed	500+
L	ICT	Not listed	1–10
M, N and O	Insurance	Listed	500+
P, Q and R	Logistics and transportation	Listed	500+
S	Paper and paper packaging	Listed	500+
T	Pharmaceuticals	Listed	500+
U	Telecommunications	Not listed	500+

5.2 Survey Results

Of the organisations surveyed, 52 % (n = 11) practice sustainability reporting both externally and internally (Table 2). Only one of the participating organisations was found to not report on sustainability. This organisation is a non-JSE listed organisation in the broadcasting industry, who only report on economic and social issues, and not on environmental impact (Table 3).

One of the questions related to whether or not an organisation considers the information and reporting requirements of sustainability or Green Initiatives when designing their EA. Only 43 % (n = 9) of the organisations surveyed do take into account environmental information when designing their EA program (Fig. 3).

Participants rated several objectives for adopting an EA program (Table 4). The objective that was ranked highest was *"To improve risk management"* ($\mu = 4.29$), while *"Include/Improve environmental concerns"* ($\mu = 3.29$) was rated second lowest. This confirms the earlier result where more than half of the participants stated that they did not include environmental information concerns in their EA.

Participants rated their inclusion of sustainability reporting in their organisation's processes (Fig. 4). Economic reporting had the highest frequency for Strongly Agree (n = 18), with social reporting the second highest frequency

Table 2 Organisations status of sustainability reporting (n = 21)

Status of sustainability reporting	n	%	Listed (n)	Unlisted (n)
Does not report on sustainability	1	5		1
Practises sustainability reporting internally only	9	43	4	5
Practises sustainability reporting internally and externally	11	52	7	4
Total	21	100	11	10

Table 3 Status of enterprise architectures (n = 21)

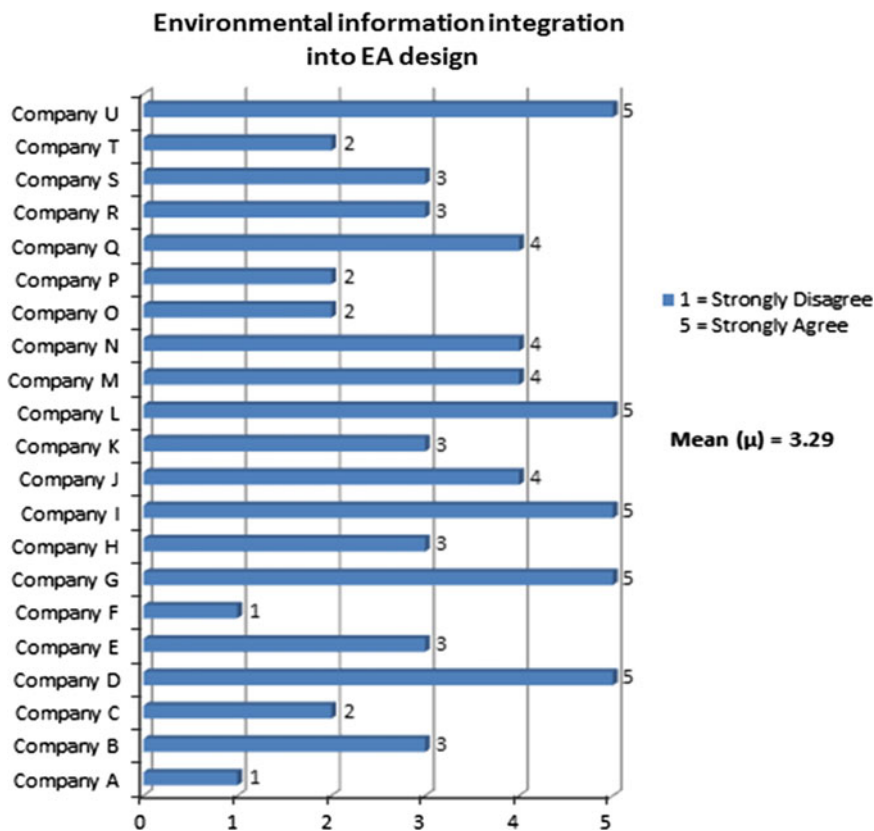| Status of EA program	n	Percentage (%)
Has an EA program	12	57
Expanding our EA program	5	24
Thinking about adopting an EA program	1	5
No specific EA program	3	14
Total	21	100

Fig. 3 Integration of environmental information into EA

(n = 16) and environmental reporting rated lowest (n = 12). This confirms that economic reporting still takes priority in most organisations and that environmental reporting is not always included in an organisation's processes.

Participants were asked to list any challenges that they are experiencing with environmental reporting which relate to the information required. One respondent stated that one challenge was "*Capturing the data and information for reporting and auditing purposes*". Another respondent stated that "*In our organisation—like*

Table 4 EA program objectives (n = 21)

| Objective	Mean (μ)	SD
Improve risk management	4.29	0.85
Improve enterprise decision making	4.19	1.17
Business efficiency/transformation	4.14	0.79
Increase effectiveness of audit compliance	4.14	1.12
Support system integration	4.10	1.00
Improve IT governance	4.10	1.00
Improve data integrity	4.10	1.26
Reduce operating costs	4.05	1.12
Improve technical integrity	4.05	1.02
Ensure continuity of organisational knowledge	4.00	0.89
Promote technical infrastructure	3.90	1.34
Reduce technical complexity	3.81	1.25
Include/improve environmental concerns	3.29	1.35
Support outsourcing initiatives	3.19	1.25
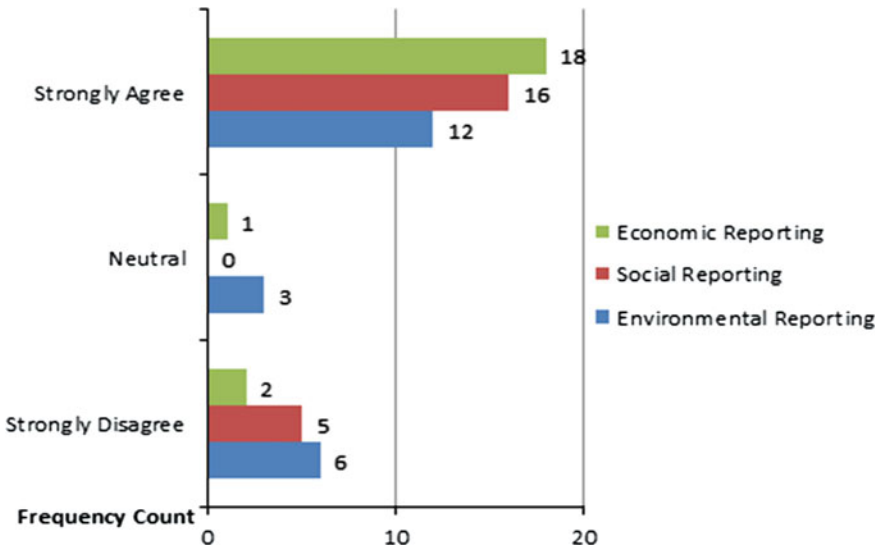
Fig. 4 Inclusion of sustainability reporting in an organisation's processes

many other ones in SA—there is no overlap between EA and Environmental issues, and in any case the interest in the latter is minimal unfortunately." Access to information and getting data on time were two other challenges cited. The cost of collecting all the necessary information for environmental reporting was an issue reported by one respondent. The respondent from the aviation industry stated that environmental reporting is not being given the priority that it should be.
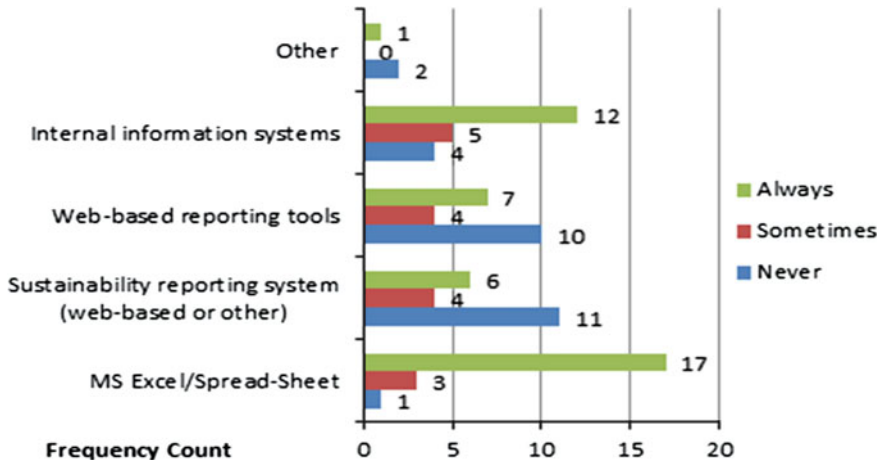
Fig. 5 Sustainability reporting tools used

An analysis of the results showed that MS-Excel is the most commonly used tool for sustainability reporting (Fig. 5). In the *"Always"* category, MS-Excel had the highest frequency count (n = 17) and internal Information Systems (IS) had the second highest the *"Always"* category (n = 12). Sustainability reporting systems and Web-based reporting tools are not widely used within these organisations. This confirms the Ernst and Young [4] and Rea [13] studies showing that the tools available are not used to their potential.

The top five EN indicators as ranked by participants were the same as the top five indicators identified by Rea [13], confirming the primary challenges as being energy, greenhouse gas emissions and water problems. However, the two studies had slight differences in the order of the five indicators. The top five ranked indicators in this study were, in order of ranking:

- EN3: Direct energy consumption by primary energy source ($\mu = 3.71$);
- EN18: Initiatives to reduce greenhouse gas emissions and reductions achieved ($\mu = 3.52$);
- EN8: Total water withdrawal by source ($\mu = 3.29$);
- EN16: Total direct and indirect greenhouse gas emissions by weight ($\mu = 3.29$); and
- EN4: Indirect energy consumption by primary source ($\mu = 3.14$).

6 Recommendations, Conclusions and Future Research

In this paper the researchers presented and discussed results from a review of the relevant literature as well as from an investigation of organisations doing sustainability reporting. From an in depth literature study it was revealed that there is

a need for management to address Green Initiatives and the related environmental information requirements and process issues at a strategic level. The survey of South African organisations confirmed other studies that whilst JSE listed companies are doing sustainability reporting they are not addressing it at a strategic level. The investigation of this study provided several contributions not provided in other studies. Firstly, the results of the survey revealed that most of the participant organisations are almost always using MS Excel spreadsheets to assist them in the process of monitoring and managing their sustainability reporting endeavours and are not using the more sophisticated tools available. Secondly, the study investigated the type of EAs used in these South African organisations, as well whether or not organisations incorporating their Green Initiative strategy and business processes in their EA. The results showed that organisations are still not viewing sustainability strategically and environmental issues are not regarding as having the same priority as financial issues. As a result systems and information are not integrated and several sustainability silos exist.

Sustainability reporting will gain more importance in South Africa, as resources are depleted and government regulations are implemented. It is important for more South African organisations to adopt Green Initiatives and start reporting on sustainability matters especially if the organisations' processes have an impact on the environment. This study has highlighted the need for management to address sustainability reporting at a strategic level. The proposed framework incorporates Green Initiatives into an organisations' EA in order to align IT with these strategies and result in integrated systems and avoid sustainability silos. This framework can assist managers with the process of producing sustainability reports more effectively and efficiently, thereby improving their competitiveness and corporate governance.

This study was limited by the number of organisations willing and available to participate. Future research into evaluations of EA frameworks for Green Initiatives and sustainability reporting is needed, particularly with more organisations. Studies which investigate the implementation of such architectures would be beneficial to the research community. More in depth investigations of organisations in South Africa and in other countries could be undertaken in order to be able to investigate approaches to environmental reporting from both a local and global perspective.

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