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A Model for Green IT Strategy: A Content Analysis Approach

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ABSTRACT

Lately there has been a greater awareness of the need for Green IT. However, companies often embark on fragmented efforts, not showing a clear vision. This paper sets out to answer the question of what organizations should consider when formulating and implementing a Green IT strategy. To answer the question a content analysis approach is followed. From the content analysis the underlying concepts were identified and analysed. The result is a holistic model for Green IT Strategy that provides guidance to companies embarking on formulating and implementing a Green IT Strategy.

1. Introduction

Society's reliance on Information Technology (IT) has increased tremendously in the last few decades. Unfortunately, the growth of the IT sector has occurred at the expense of the environment. The adverse environmental impact of IT operations is partly due to the production and disposal of IT equipment, which can result in harmful pollution and toxic materials being released into the environment (Murugesan, 2008). Furthermore, IT equipment consumes large amounts of electricity, and this results in significant amounts of carbon dioxide (CO_2) being released into the atmosphere (Gartner, 2007). Since CO_2 is classified as a greenhouse gas, it contributes to the phenomenon of climate change (Packard & Reinhardt, 2007).

Organisations are socially and ethically required to minimise the environmental impact of their IT operations (Murugesan, 2008). However, in addition to fulfilling their responsibility towards environmental sustainability, organisations can gain a competitive advantage through adopting green IT practices.

Traditionally, adopting green practices has been synonymous with increased costs in complying with environmental laws – leading, in turn, to a decrease in competitiveness (Porter & van der Linde, 1995). However, Porter and van der Linde (1995) found that going green can lead to a competitive advantage by increasing efficiency throughout an operation. Porter and van der Linde state that pollution and waste are the by-products of inefficiency; and, furthermore, they represent wasted resources. As a result, green IT initiatives can yield significant cost saving by improving efficiency and reducing waste.

In addition to cost saving, green IT practices can mitigate some of the environmental risks associated with the emergence of a green economy. Organisations that mitigate these risks more effectively than their competitors would be able to gain a competitive advantage (Lash & Wellington, 2007).

Green IT practices can also add green value to the organisation's products and services. Such green value is critical for capturing the growing number of customers with environmentally friendly buying criteria. By aligning customer value with green value, organisations can differentiate their products and services from those of their competitors, thereby leading to an opportunity for competitive advantage (Lurie, 2009).

In order to reap the benefits of green IT and to fulfil their social and ethical responsibilities, organisations need to formulate and implement a comprehensive green IT strategy. When formulating strategic decisions, the use of a clear decision process enhances the effectiveness of such decisions (Dean & Sharfma, 1996). As a result, top IT management require a model or framework which could guide their thinking and allow for a clear decision process when formulating green IT strategy.

As a result, this paper sets out to answer the question of what organisations should consider when formulating and implementing green IT strategy. To answer the research question, the paper defines a model for green IT strategy. The model was defined by conducting a content analysis of the literature on green IT. The content-analysis research technique was utilised to identify the underlying concepts within the literature related to green IT strategy formulation and execution. The research methodology followed for this study is presented in the following section.

2. Research Methodology

This section will define the research methodology used to formulate a model for green IT strategy. At the core of methodology utilised is the content analysis research technique which is discussed next.

2.1. Content Analysis Overview

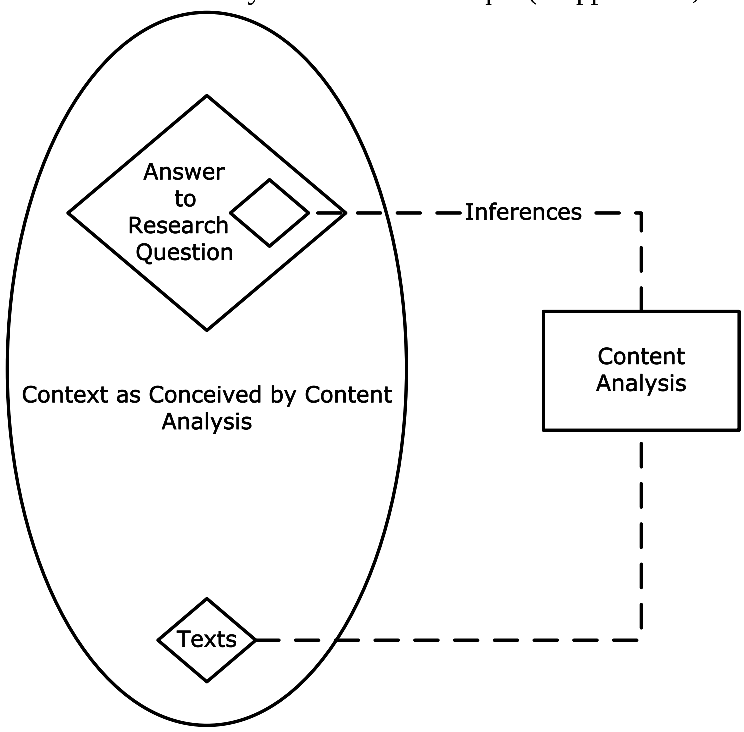
Krippendorff (Content Analysis: An Introduction to its Methodology, 2004, p. 18) defines content analysis as:

…a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use".

Content analysis is defined as a "research technique", since it involves specialised and specific procedures (Krippendorff, 2004, p. 18). Such procedures involve compressing volumes of text into fewer content categories – by means of explicit coding rules (Wati & Koo, 2010). Furthermore, this research technique makes inferences from a body of texts to the context of their use, by either analysing an entire population of texts or a carefully selected sample from that population. The selection of a sample calls for a detailed sampling design, as discussed in section 2.3.

Krippendorff's definition emphasises the need for reliable and valid results. Consequently, a content analysis design typically ensures the reliability and validity of the study though a variety of measures, as will be discussed in section 2.4. In addition, the inferences drawn from a body of texts during a content analysis serve to answer a research question concerning a context of texts (Krippendorff, 2004, p. 82). The content analysis research technique described in this section is visually illustrated below in Figure 3.1.

Figure-2.1. The content analysis research technique (Krippendorff, 2004, p. 82)



A content analysis follows a specific structured process – to help ensure the reliability and validity of the study. Krippendorff (Content Analysis: An Introduction to its Methodology, 2004, p. 83) defines six steps within a content analysis, as listed below:

- Unitizing
- Sampling
- Coding
- Reducing
- Inferring
- Narrating

These six steps occur within the *Content Analysis* block represented in Figure 2.1. The first step, *unitizing*, is a systematic approach for distinguishing texts which are applicable to the content analysis (Krippendorff, 2004, p. 83). Following the unitizing step, the process of *sampling* can then take place.

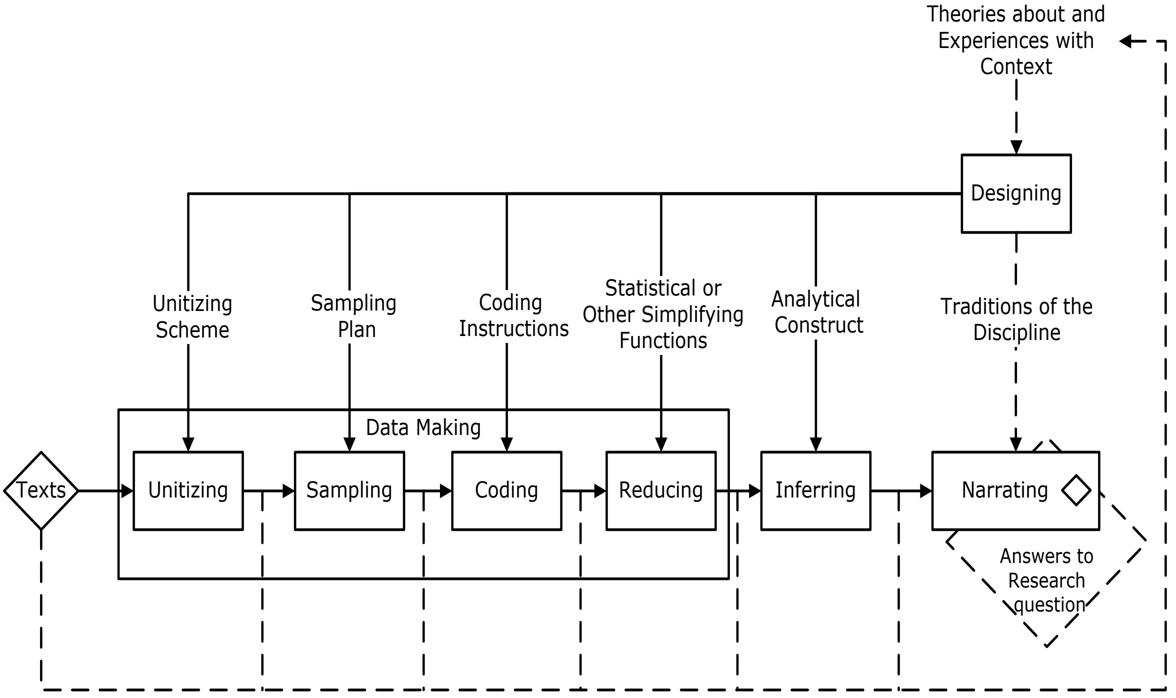
Sampling refers to drawing a manageable set of texts from the population when it is unrealistic to perform a content analysis on the entire population of texts (Krippendorff, 2004, p. 84). The sampling design should ensure that the sample is representative of the population, and that a content analysis on the sample would ideally achieve the same results, as with the entire population (Krippendorff, 2004, p. 84).

Once a sample has been drawn from the population, the *coding* process can begin. Coding refers to the process of transforming texts from the sample into analysable units (Krippendorff, 2004, p. 84). This is achieved by tagging concepts within each of the texts in the sample.

Coding can be performed in one of two ways: *emerging coding* or *a priori coding* (Stemler, 2001). *Emerging coding* follows a grounded-theory approach, where the codes emerge during a preliminary examination of the data (Odena, 2007; Stemler, 2001). As a result, the codes are defined without being influenced by any preconceived ideas; and this is done through a process of inductive reasoning (Odena, 2007). On the contrary, *a priori coding* utilises predefined codes and categories which are based on theory (Stemler, 2001). For the purposes of this study, emerging coding will be utilised in order to follow a grounded-theory approach.

Once the coding process has been completed, the resulting data must be reduced in order for it to be presented efficiently. This process can include measures such as presenting the frequency of codes within a table, or presenting the data by utilising a statistical technique (Krippendorff, 2004, p. 84). Once the *reducing* process is complete, the overall stage of *data making* is likewise complete. *Data making* encompasses the first four steps of the content analysis process, and may be illustrated, as in Figure 2.2 below within a diagram of the entire content analysis process.

Figure-3.2. Components of a content analysis (Krippendorff, 2004, p. 86)



Once the four data-making steps have been completed, the researcher must make sense of the content by means of *inferring.* Krippendorff (Content Analysis: An Introduction to its Methodology, 2004, p. 85) states that the inferring stage *"…bridges the gap between descriptive amounts of text and what they mean, refer to, entail, provoke or cause"*. However, these inferences must be presented in a meaningful way.

The *narrating* step involves the process of writing up the results of the content analysis in a meaningful way – which others can then understand (Krippendorff, 2004, p. 85). The narrating step will address how the inferences drawn from data can provide answers to the research question.

Even though the steps are described as if they are in a linear flow, it is possible to revisit previous steps and for some iteration to be involved, as illustrated in Figure 3.2. As the process moves forward step by step, the theories and experiences with the context can be altered. This, in turn, influences the research design, as indicated by the *Designing* block in Figure 3.2. Furthermore, the execution of the steps in Figure 3.2 will vary – depending on the research paradigm chosen for the study.

2.3. Sampling Design

The content analysis on green IT was conducted from secondary sources in the literature. The population of texts on green IT is significant. A Google search on the phrase "Green IT" yields close to 3 million search results[1], while an identical Google Scholar search yields over 28 000 results[1]. Because of the large population of texts available, a manageable sample needs to be drawn from the entire population of texts on green IT, in order to conduct the detailed content analysis.

Even though much information exists on green IT, the number of reputable sources is limited (Molla, 2008). Academic journals have been slow to accept papers on green IT. Databases, such as EBSCOhost, Emerald and ScienceDirect, yield few results when searching for "Green Information Technology" and other synonymous phrases. A comprehensive search was conducted early in 2010, and has been continually updated during the course of the study. The latest search update occurred on 15 November 2010. The searches yielded few results, as shown in Table 3.1 on the following page. All searches were performed on article abstracts and were limited to peer-reviewed journals only.

Table-3.1. Search results for academic databases

Search phrase	**Database**		
	EBSCOhost	Emerald	ScienceDirect
"Green Information Technology" *	7	0	1
"Green ICT"	3	0	0
"Green computing"	10	0	0
"Sustainable Information Technology" **	3	0	1
"Sustainable ICT"	3	1	1
"Sustainable Computing"	1	0	0

* Search engine was unable to search for "Green IT" as an exact phrase since "IT" is treated as a stop word
** Search engine was unable to search for "Sustainable IT" as an exact phrase since "IT" is treated as a stop word

However, green IT is a suitable and critical topic for information systems research, as a study conducted by Elliot (2007) revealed. Fortunately, green IT publications are becoming more frequent

Contrary to the relatively low number of published academic texts on green IT, industry texts on the subject are plentiful, as environmental issues are currently at the top of the agenda for many businesses. However, as with most industry sources it is imperative to separate marketing hype from objective material. Based on the make-up of the population of texts, it is evident that selecting a sample from the literature is a challenging undertaking. According to Krippendorff (Content Analysis: An Introduction to its Methodology, 2004, p. 113), the sample should be carefully selected, in order to eliminate any bias which could skew the findings of the research. In order to eliminate potential bias in sample selection, an appropriate sampling plan needs to be used.

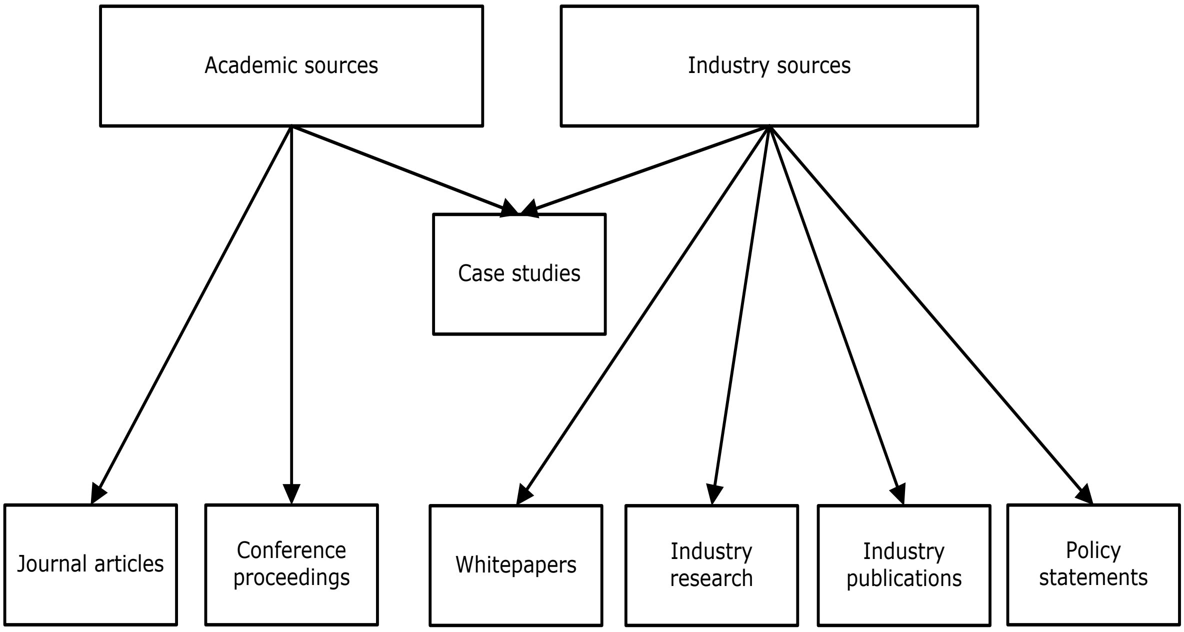
To select the sample a multistage sampling process was followed. Since the application of this research is to be of a practical nature, it is essential that a healthy balance of industry and academic

[1]Search results last updated 15 November 2010

sources be selected for the content analysis. Furthermore, industry sources should not be over-represented within the sample simply because of their large representation within the population of texts.

In order to ensure representation across all areas of the population of texts, the population was divided into several categories: *Journal articles*, *Conference proceedings*, *Case studies*, *Whitepapers*, *Industry research*, *Industry publications* and *Policy statements*. Each of these categories is classified under either *Academic sources* or *Industry sources,* as represented in Figure 3.3 below.

Figure-3.3. Structure of the literature on Green IT



Within each of these categories, representative texts were selected by means of relevance sampling. Relevance sampling selects texts based on their sources, situations, time periods, genres and inter-textualities (Krippendorff, 2004, p. 118). Because the texts in the population are unequally informative, it is consequently important to choose texts within each category which would be the most informative and contribute best towards the research objectives. To select relevant texts, the reputation of the author, the reputation of the source or publication and the topic relevance to the research objectives all need to be considered.

With regard to academic publications, another technique known as snowball sampling was utilised (Krippendorff, 2004, pp. 117−118). When applied to texts, snowball sampling can be used to discover texts by means of a citation network. Because of the limited number of quality academic sources available, snowball sampling was used to find academic texts which were relevant and most often cited.

For the purpose of this study, a sample was selected based on the sampling design described in this section. The selected sample is listed below in Table 3.2. It shows the category of each selected text – in addition to the justification of each selection.

Table-2.2. The sample

1	**Source**	Murugesan, S. (2008, January/February). Harnessing Green IT: Principles and Practices. *IEEE IT Professional Magazine*, 24−33
	Category	Academic: Journal articles
	Justification	Murugesan has published several articles on green IT and can be considered as one of the leading academics in the field of green IT. Furthermore, this article was published in the well-respected IT Professional magazine from the IEEE Computer Society. Finally, the focus of the article is on adopting a holistic approach for green IT implementation, which makes it especially relevant to the research objectives.

2	**Source**	Gabriel, C. (2008). Why it's Not Naive to be Green. *Business Information Review*, *25* (4), 230–237.
	Category	Academic: Journal articles
	Justification	Gabriel offered a unique perspective on green IT, by stating that green IT does not exist, since IT operations will always have an undesirable environmental impact. This article was chosen because of its unique perspective and because of its focus on information management, which is an issue largely ignored by other sources.
3	**Source**	Molla, A. (2008). GITAM: A Model for the Adoption of Green IT. *19th Australasian Conference on Information Systems*, (pp. 658–668). Christchurch.
	Category	Academic: Conference proceedings
	Justification	Molla has presented several papers on the topic of green IT. This selected paper presents a model for green IT adoption and addresses many of the forces which influence green IT strategy. Because of its relevance to the research objectives, this selection was an obvious choice.
4	**Source**	Bose, I., & Chandrasekhar, R. (2009, November 24). *Green IT Matters at Wipro Ltd.* Retrieved August 3, 2010, from The Harvard Business Review: http://hbr.org/
	Category	Academic: Case study
	Justification	This case study was selected since it was published by the Harvard Business Review. In addition, it proved to be a very comprehensive case study which could contribute significantly to answering the research question.
5	**Source**	Stuenkel, M. (2009). Green IT Best Practices at the University of Michigan. *EDUCAUSE Quarterly (EQ), 32* (3).
	Category	Academic: Case study
	Justification	The case study centred on user-awareness and involving all stakeholders when adopting green IT practices. Furthermore, the University of Michigan has been very successful with re-use and recycling initiatives, which often yield limited success when implemented in practice. However, the main reason this case study was selected was because of its focus on the human aspect of green IT adoption.
6	**Source**	Dimension Data. (2009). *IT for Green: Green IT Overview Brochure.* Retrieved from Dimension Data: http://www.dimensiondata.com/
	Category	Industry: Whitepaper
	Justification	Dimension Data is one of South Africa's largest IT service providers and a leader in green IT implementations in South Africa. This whitepaper provided insight into green IT services which are available on the IT services market.

7	**Source**	Mingay, S. (2007, December 7). *Green IT: The New Industry Shock Wave*. Retrieved March 5, 2010, from Gartner: http://www.gartner.com
	Category	Industry: Industry research
	Justification	Gartner is a leader in ICT industry research. This document addressed wide range of issues which were all relevant to the research objectives.
8	**Source**	Furber, P. (2008, February). Guidelines Now, Law in the Future: Green IT - CIO Roundtable. *Brainstorm Magazine*, *7* (6).
	Category	Industry: Industry publication
	Justification	Brainstorm magazine is a well-known industry publication in South Africa. The article provided insight into green IT strategy in South Africa and was specifically chosen because of its focus on government regulation.
9	**Source**	HP. (2008, June). *HP's Climate Strategy.* Retrieved August 9, 2010, from HP Global Citizenship: http://www.hp.com/hpinfo/globalcitizenship
	Category	Industry: Policy statements
	Justification	HP is a leading vendor and manufacturer of IT hardware. This text was selected since it provided insight on which measures hardware vendors are putting in place to green their own operations, as well as their products.
10	**Source**	Microsoft. (2009). *Microsoft on the Topic: Environmental Sustainability*. Retrieved August 24, 2010, from Microsoft: http://download.microsoft.com
	Category	Industry: Policy statements
	Justification	Microsoft is one of the leading IT companies in the world with a broad technology base. Microsoft's core focus is software and the text provides insight on environmental sustainability from the perspective of a leading software provider.
11	**Source**	Australian Computer Society. (2007). *Australian Computer Society Statement on Green ICT*. Retrieved July 28, 2010, from Australian Computer Society: http://www.acs.org.au
	Category	Industry: Policy statements
	Justification	This document is published by the Australian Computer Society. It presents research which was conducted on the impact of Australian IT operations on the environment. Furthermore, the policy statement outlines green IT practices which organisations can implement.

The following section will address how the study ensures reliability and validity.

2.4. Reliability and Validity

The reliability and validity of a study are both critical aspects of the research design. Within qualitative research, validity takes priority over reliability, since arguments concerning the content are considered to be more important than methodical issues (Kohlbacher, 2005). Furthermore, the phenomenological paradigm and qualitative research lend themselves to results of high validity, but tend to be less reliable (Collis & Hussey, 2003, p. 55). Since this study will follow a qualitative methodology, the emphasis will be on the validity of the results.

The research design ensures the validity of the study by means of several measures. The most important measure is the sampling design. According to Stemler (2001), validity within a content analysis can be achieved by the use of multiple sources. The sampling design ensures that the sample consists of several categories of texts, ensuring a representation of texts from multiple sources. The resulting balance between academic and industry sources enhances the validity of the study. In essence, the sampling design represents a triangulation of academic and industry sources in the literature.

For the results of a content analysis to be valid, the coding process should yield categories which are mutually exclusive and exhaustive (Stemler, 2001). For this study, the categorisation process was conducted by two researchers. Utilising a researcher during the categorisation process – who was not involved in the coding process – helped to eliminate any biased views on the meanings of the codes and categories. This process acts as a form of semantic validation, and helps to establish semantic validity.

In addition to measures which enhance validity, the research design ensures reliability in several ways. Firstly, the use of MAXQDA to assist the content analysis process increases the reliability of the analysis, since it reduces the possibility of human error when calculating frequency and occurrence of codes. In addition, the content- analysis process lends itself to the reliability of the results. It allows for a systematic and structured methodology for analysing the literature. Utilising such a structured-content analysis approach within the research design enhances the reproducibility of the results.

When utilising a content analysis as part of the research design, the reliability of the content analysis data can be measured through inter-code agreement between the two different coders. This process involves two or more researchers analysing the same sample and then measuring the how these independent analyses correlate. Calculating this inter-code agreement is typically established by means of calculating Cohen's kappa value to determine agreement between coders (Krippendorff, 2004, pp. 246‒249).

However, the circumstances under which the research is conducted did not allow for the sample to be coded by two separate coders. Testing inter-code agreement is suggested for future research, in order to statistically measure the reliability of the findings.

The following section will discuss the measuring instrument utilised for this study.

2.5. The Measuring Instrument

The content analysis was performed by coding the sample within the MAXQDA software package. MAXQDA was used to measure the occurrence and frequency of the codes which were tagged within the sample. Furthermore, the code matrix browser within MAXQDA was used to enhance the understanding of the relationship between codes and the texts making up the sample.

Ultimately, it is the researcher which acts as the measuring instrument – as is common in qualitative research (Patton, 2002, p. 14). The measurements resulting from the queries performed in MAXQDA do not answer the research question. The primary research objective is achieved by interpreting the measurements resulting from the computer-assisted analysis in a qualitative manner. Since the measuring instrument was the last aspect of the methodology to be addressed, the following section will discuss the coding and reducing stages of the content analysis conducted during this research study.

3. Coding and Reducing

Section 2 defined the methodology applied for this study. In addition, section 2 discussed the sampling design which essentially constitutes the first two steps of the content analysis process: *unitizing* and *sampling.* Section 3 continues the discussion on how the content-analysis process was followed – by describing the implementation of the third and fourth phases: *coding* and *reducing.*

3.1. Coding

Coding is the third step in the content-analysis process, and it refers to the process of transforming texts from the sample into analysable units (Krippendorff, 2004, p. 84). This is accomplished by tagging concepts within each of the documents in the sample. The coding step within the content-analysis process was conducted by utilising the MAXQDA software package.

The documents from the sample were loaded into the MAXQDA software package. The coding was conducted by manually highlighting sentences and paragraphs, while applying codes to the highlighted areas in the document. The process of highlighting texts and applying codes is referred to as *tagging*, and it produces a list of *tags*.

The documents were coded by means of *emerging coding*. When *emerging coding* is utilised, the codes are defined as they are encountered in the sample. This allows for the researcher to follow a grounded approach to the content analysis, as there is no list of predefined codes which could potentially skew the objectivity of the study (Odena, 2007; Stemler, 2001).

The first documents coded yielded many codes – because of the emerging process that was followed. However, as more documents were coded, fewer new codes emerged, as the list of codes started to become saturated. When the last few documents had been coded very few new codes emerged. The declining number of emerging codes was a sign that the sample had captured most of the core concepts.

The initial coding of the sample yielded 831 codes. These codes were tagged 2767 times within the sample of 11 documents. The codes varied in scope – from general to very specific. The specific concepts were tagged under specific codes, even though the encountered concepts would be able to fit under a general code. For example, a document within the sample might refer to *energy efficiency* as a general green IT concept. A code was created for this high-level concept, and all general references to *energy efficiency* would then be tagged with the same code, when encountered again in the sample.

However, if a reference to *data-centre energy efficiency* were encountered in the sample, it would be coded as a specific code (i.e. *data-centre energy efficiency*). As a result, the initial coding resulted in a list of codes that overlapped in many instances. The overlap required the codes to be reduced by means of categorisation. This will be addressed later in this section.

Even though 831 codes were defined within the sample, more than 50% of the total tags were applied to the top 89 most tagged codes. This may be attributed to a high number of detailed and specific codes. These were each tagged fewer times than the codes that were more general in nature. This concentrated tag distribution is clearly illustrated in Figure 3.1 on the following page.

Figure-3.1. Tag distribution

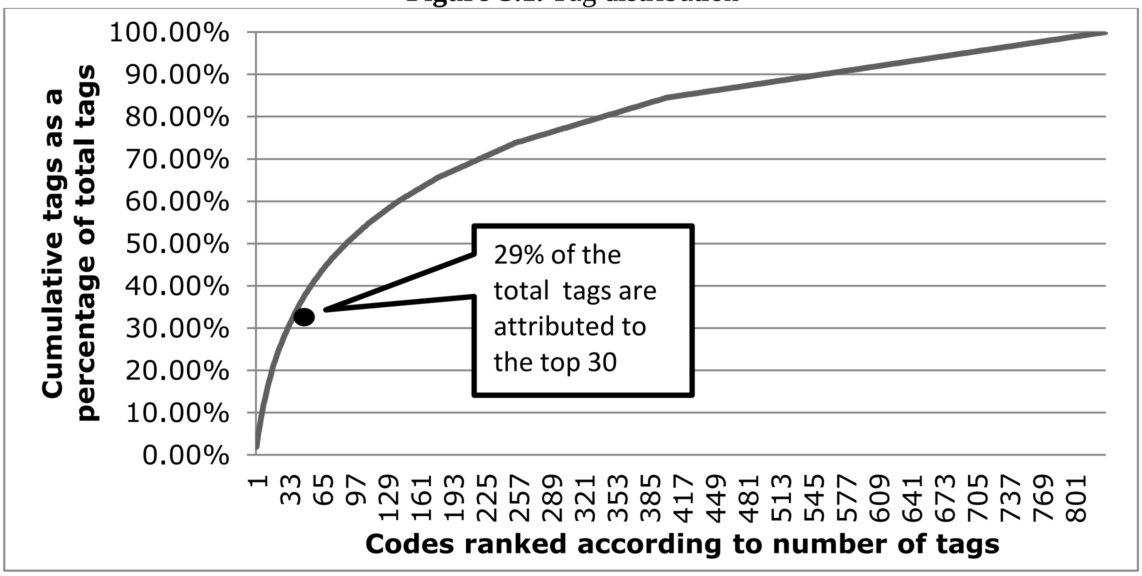


Table 3.1 on the following pages lists the 30 most-tagged codes within the sample. The two highest-tagged codes are *Energy efficiency* and *Energy saving.* These were tagged 53 and 48 times, respectively. The top 30 tagged codes were coded a cumulative 806 times, which represents 29% of the 2767 total tags. This data point is shown on the graph in Figure 3.1 to illustrate the high code density amongst the top-ranked codes.

The following section discusses the *reducing* process and how the 831 codes were reduced to 28 categories.

Table-3.1. Top 30 tagged codes

Ranking	Code label	Number of tags	Cumulative tags
1	Energy efficiency	53	53
2	Energy saving	48	101

Continue

3	Climate change	47	148
4	IT as a green enabler	42	190
5	IT best practice	41	231
6	Recycling	36	267
7	E-waste	32	299
8	CO_2 reduction	32	331
9	Virtualization	32	363
10	Environmental sustainability	29	392
11	Disposal of IT equipment	29	421
12	Greenhouse gas emissions	28	449
13	Efficiency	26	475
14	Procurement	26	501
15	Power management	26	527
16	Carbon footprint	25	552
17	Desktop computers	24	576
18	Cost saving	21	597
19	Climate savers computing initiative	20	617
20	Green design	20	637
21	Opportunities	19	656
22	Services	19	675
23	Green economy	17	692
24	Environmental impact of IT	17	709
25	Carbon dioxide	17	726
26	Material efficiency	17	743
27	PC Power management software	17	760
28	Green IT strategy	16	776
29	Regulation driving green IT	15	791
30	Data-centre power consumption	15	806

3.2. Reducing

Reducing is the fourth step in the overall content analysis process. It follows on the *coding* phase by reducing the codes into categories; which are easier to interpret. During the coding phase, 831 codes emerged. The list of codes provides an overview of the concepts addressed within the sample. However, the sheer number of codes is still overwhelming when attempting to interpret the content. As a result, the amount of information must be reduced – by means of categorisation – before it can be interpreted accurately.

The categorisation of the codes was conducted by two researchers. The use of two researchers enhanced the validity of the categories, since it reduced any bias with regard to the categorisation of the codes. The categorisation was conducted during lengthy meetings, where the categories were debated between the two researchers – until there was consensus on where each of the codes should be categorised.

The categorisation of 831 codes can be overwhelming and time consuming, but a process of elimination was used to ease the reduction of the 831 codes into 28 categories. Firstly, the codes were scanned for obvious themes. During the initial scan, several categories emerged. As each category was identified and its codes appropriately grouped, it reduced the remaining number of uncategorised codes, making it easier to identify the additional categories.

The primary objective of this study is to define a model for the formulation and execution of green IT strategy. Therefore, when the list of codes was scanned for possible categories, the primary objective of the study was used to guide the identification of categories. As a result, the defined categories were either directly or indirectly linked to green IT strategy formulation and the execution thereof.

It should be noted that the categories are not intended to be orthogonal. In many instances, codes were encountered which could have been grouped within more than one category. In such a situation, the research team made a judgement on which category would provide the best fit. In the end, the categorisation process yielded 28 categories. These categories are listed in Table 3.2 on the following page, along with the number of codes, cumulative number of tags for each category and core codes which fall under each category. It should be noted that the core codes are not necessarily the most tagged within the category. The core codes were selected to capture the essence and meaning of each category for the reader.

Table-4.2. List of categories [1]

Category label		Number of codes	Number of tags	Core codes
1	Ethical conduct	82	341	• Environmental sustainability • Safeguard our environment • Social responsibility
2	Environmental sustainability risks	34	107	• Climate change • Utility security
3	Pressure from government	34	104	• Carbon tax • Environmental legislation • Regulatory compliance
4	Pressure from society	15	32	• Green awareness • Public perception • Pressure from green movements
5	Corporate influence	13	9	• Environmental targets (corporate) • Commitment from CEO
6	Financial realities	16	32	• Energy cost rising • Green IT budget • Economic viability
7	Bottom-line benefits	36	195	• Green value • Cost saving
8	IT system performance	12	13	• Maintenance reduction • Remove complexity • Scalability • Simplify IT
9	Practicality	4	4	• Limited success with re-use • Limited success with recycling
10	IT lifecycle management	31	142	• Re-use • Recycling • Disposal of IT equipment
11	Procurement	21	86	• Green credentials of suppliers • Epeat procurement requirement
12	Suppliers	5	6	• Suppliers driving green IT • Role of technology providers

13	Transparency	7	32	• Carbon disclosure project • Reporting
14	Monitoring and measuring the environmental impact	36	103	• Carbon accounting • Measure power consumption • Benchmark power savings • Green metrics
15	Operations	59	192	• Use of renewable energy sources • Production of IT equipment
16	People	45	105	• User behavioural changes • Internal green awareness • Green IT acceptance • User education
17	Corporate culture	6	9	• Resistance to change • Corporate green community
18	Organisational structure	8	23	• Organisational efficiencies • Data centre consolidation
19	Supporting infrastructure	2	3	• Environmental management system
20	Green design		530	• Virtualization (date centre design) • Non-toxic materials (product design) • Thin client (Desktop design)
21	Standards	12	47	• Epeat • Energy star • ISO 14001
22	Knowledge	23	59	• Green IT symposium • Collaborate with partners and suppliers • Climate savers computing initiative
23	Corporate governance	2	3	• Corporate governance
24	Offset IT impact	7	20	• Carbon offset programmes • Planting trees
25	IT as a green enabler	29	106	• Travel substitution • Using IT to create green awareness • Digital document management
26	Organisational reality	29	46	• Green IT strategy driven by type of sector • Data-centre growth • Green IT strategy

				priority for organisations with large IT assets
27	Market forces	17	49	• Green economy • Green customers
28	Leadership	7	13	• Green IT support form top management • Senior executives driving green IT

The following section will use the 28 categories which emerged from the *reducing* phase in order to construct a model for green IT strategy.

4. Model Construction

The previous section discussed how the *coding* and *reducing* phases were implemented for the content analysis of the green IT sample. Section 4 continues the discussion on the content analysis process by addressing the final two phases, namely *inferring* and *narrating*. However, the section starts by defining a foundation on which the model can be constructed.

4.1. Model Foundation

The research question posed by the study asks what organisations should consider when formulating and implementing a green IT strategy. Unfortunately, the list of 28 categories on its own does not answer the research question. The primary objective of the study is to define a model for green IT strategy to answer the research question. As a result, the 28 categories that emerged during the reducing phase must be interpreted so that a model for green IT strategy may be inferred from the categories.

In order for the model to answer the research question, it is critical to base the foundation of the model construction on the research question and the objectives. By examining the research question and the objectives, we should be able to formulate building blocks for the model. As a result, the list of categories was divided into two main themes that relate to the research question.

Table-4.1. Forces on green IT strategy formulation

1	Ethical conduct
2	Bottom-line benefits
3	IT system performance
4	Pressure from government
5	Pressure from society
6	Market forces
7	Environmental sustainability risks
8	Suppliers
9	Corporate influence
10	Practicality
11	Financial realities
12	Industry/market reality
13	Corporate culture
14	Supporting infrastructure
15	Organisational structure
16	Standards
17	Corporate governance
18	Knowledge
19	Leadership

The first theme was identified as *forces* on green IT strategy. All the categories that correspond to this theme influence or determine the scope and nature of an organisation’s green IT strategy. These forces on green IT strategy formation are listed below in Table 4.1.

In addition, another theme was identified related to the implementation of green IT strategy. This theme was labelled as *practices.* All the categories that facilitate the implementation of green IT strategy are listed in Table 4.2 below.

Table-4.2. Green IT practices

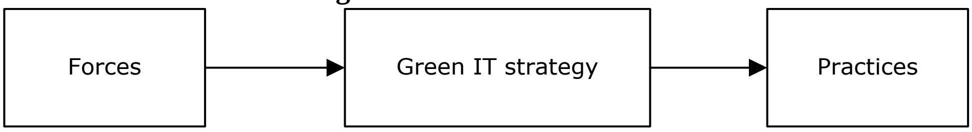
1	Offset IT impact
2	IT as a green enabler
3	Transparency
4	Monitor and measure the environmental impact
5	Green design
6	IT lifecycle management
7	Procurement
8	Operations
9	People

In addition to the two themes that were identified, *green IT strategy* is a concept which is core to the research question, and would serve as the third building block for the model. As a result, *green IT strategy* is placed at the centre of the diagram shown in Figure 4.1 on the following page, since it is the focus of the research question. Figure 4.1 illustrates the foundation used for the construction of the model for green IT strategy.

The forces listed in Table 4.1 affect the scope and nature of an organisation's green IT strategy and are represented in Figure 5.1 by the *Forces* block. The arrow connecting the *Forces* and *Green IT strategy* blocks indicates the influence the forces listed in Table 4.1 have on the nature and scope of an organisation's green IT strategy.

Once a green IT strategy has been formulated, it is then implemented via a series of practices. These are listed in Table 4.2. This relationship is represented in Figure 4.1 by the arrow connecting the *Green IT strategy* and *Practices* block.

Figure-4.1. Model foundation



The relationship between the components serves as a foundation for further developing these high-level components into a detailed model for green IT strategy formulation and implementation. In order to transform the relationships in Figure 4.1 into a fully developed model, the *Forces* and *Practices* components must be expanded further. Consequently, the followings section will expand the *Forces* component.

4.2. Forces

By examining the list of categories in Table 5.1, it became clear that the *forces* component could be expanded by identifying specific individual forces that influence green IT strategy. In order to identify these specific forces, the author looked at the list of uncategorised codes. During the categorisation process, several codes were not grouped in any categories since they were too general in nature. These general codes held clues to the definition of specific forces within the green IT model.

As a result, five distinct forces emerged from analysing the categories in Table 4.1. The first force on green IT strategy formulation is defined as *drivers*. This will now be discussed.

4.2.1. Drivers

By scanning the list of uncategorised codes, the *green IT- pull* code stood out. Within the sample, Molla (2008) refers to green IT adoption being "pulled" by ethical and economic considerations. The *green IT- pull* code refers to internal motivation to adopt green IT practices within the organisation. By examining the list of categories, we find that the ethical and economic considerations Molla refers to are synonymous with the *ethical conduct* and *bottom-line benefits* categories.

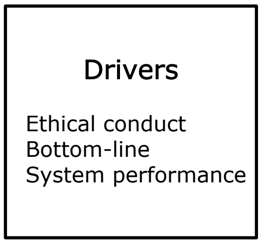
Ethical conduct could stem from internal or external pressures, instead of internal motivation. However, if an organisation is forced to be ethical one could argue that such ethical conduct is not sincere. Therefore, *ethical conduct* is listed as a *driver*, because ethics should be driven by the desire to do the right thing. In this context, this is the minimising of the organisation's impact on the environment.

However, cost reduction is the greatest motivation for green IT adoption, as a study conducted by Forrester research has revealed (Mines, 2010). Cost reduction is one of the *bottom-line benefits* Green IT systems can exhibit. However, organisations can also be motivated by the opportunities for revenue that exist by targeting green customers and taking advantage of the shift to a green economy.

Furthermore, the list of categories presented another motivation for adopting green IT, namely *IT-system performance*. The inherent efficiencies and reduction in complexity related to green IT could improve IT system performance and present a strong motivation for adopting green IT practices.

Ethical conduct, bottom-line benefits and *IT-system performance* all refer to an internal motivation for adopting green IT practices. These three categories can be described as *drivers,* since they "drive" green IT adoption. Furthermore, the word *driver* has a motivational connotation, which captures the essence of this force. The *drivers* component of the model may be seen in Figure 4.2 below.

Figure-4.2. The *Drivers* model component



There is a clear distinction between reasons organisations want to adopt green IT and why they are forced or pressurised to adopt green IT. The following section will discuss *pressures* as a force on green IT-strategy formulation.

4.2.2. Pressures

In addition to *green IT pull*, the uncategorised code labelled as *green IT push* provided the basis for another force on green IT strategy formulation. The *green IT push* code refers to forces which pressurise or force green IT adoption. As a result, *pressures* was chosen as an appropriate label for this force.

Five categories may be classified as *pressures.* Some of the categories were simple to identify, since some to the category labels contained the word "pressure". Firstly, the *pressure from government* category was listed under this force. In many countries, government forces or pressurises organisations to adopt green operating practices. This is usually done by means of environmental legislation, regulations and carbon taxes.

However, not all government measures are forced upon organisations. Some of the measures are voluntary. For example, organisations can choose to neglect decreasing their carbon emissions – and simply pay the resulting carbon tax. Some may consider the carbon tax to be a driver or a motivation to adopt green IT because of the financial implications. However, it is modelled as a *pressure* because the motivation is artificially created by an external entity – as a means of pushing environmentally friendly practices.

In addition to government pressure, *pressure from society* is also classified under this model component. As green awareness in society continues to grow, organisations will face increasing pressure from society to minimise the environmental impact of all functions of their business. This, in turn, will affect the scope of an organisation's green IT strategy.

Market forces is closely related to *pressure from society* and forms the third *pressure*. As society becomes more concerned about the environment, so will the organisation's customers. Customers with environmentally friendly purchasing criteria will – in increasing numbers – probably pressurise organisations to align their operating practices, products and services with their demands.

Furthermore, *environmental sustainability risks* is a category which will put pressure on organisations to rethink their business practices as regards their environmental footprint. Issues, such as utility security, will push organisations to minimise their electricity consumption by adopting efficient green IT practices.

However, issues such as the physical risk associated with climate change, will result in organisations mitigating the risk, without necessarily utilising green IT. For example, organisations may move their data-centres in response to perceived changes in weather patterns and the rise in sea level, as a result of climate change. Hurricane Katrina prompted companies, like Continental airlines, to establish back-up data-centres in underground bunkers for use during hurricanes (Mitchell, 2009). Therefore, whether *environmental sustainability risks* will impact green IT strategy in an organisation will depend on the nature of the risk and the means whereby it can be mitigated.

In addition to external pressures, internal pressures can also affect green IT strategy. *Corporate influence* is an example of such an internal pressure. For example, if an organisation is adopting a comprehensive green strategy, it is likely to pressurise or enforce green IT adoption within the IT department.

However, *corporate influence* only refers to those corporate forces which pressurise for green IT adoption. Certain corporate influences may actually hamper the adoption of green IT. The lack of a green IT budget would be an example of such a constraint. Those corporate issues that could hamper green IT adoption are listed under the *reality* component.

Corporate influence marks the last category to be grouped under this component of the model. Therefore, the *pressure* component of the green IT model can now be summarised in Figure 4.3 below.

Figure-4.3. The *Pressures* model component

Pressures
Government Society Market forces Environmental sustainability risks Corporate

Reality is the next force that affects green IT strategy. It will be discussed in the following section.

4.2.3. Reality

Reality is the third force that influences green IT strategy formulation. Realities need to be taken into consideration when formulating green IT strategy. These realities can either help or hinder the adoption of green IT. Furthermore, IT departments tend to have little or no control over such realities.

Practicality is the first category to be grouped under *reality. Practicality* is a reality that can often limit the scale of green IT adoption. For example, an organisation may have bold ambitions to implement state-of-the-art green technology, only to discover that such technology is not yet practical at such an early stage of the technology's lifecycle. Furthermore, certain practices, such as recycling and re-use, may be easy to implement in theory, but the practicality of implementing such measures may influence whether it will be implemented.

Financial realities forms the second category to be grouped under this component. Financial realities can either hinder or encourage green IT adoption. For example, a situation, such as the lack of a green IT budget is a financial issue which can hinder green IT adoption. However, financial realities, such as the ever-increasing cost of electricity, will in turn, encourage green IT adoption, especially in organisations with large data-centres.

Suppliers is another example of a reality that could either hinder or encourage green IT adoption. Since green design of IT infrastructure is a crucial measure in lessening the environmental impact of IT operations, the availably of green hardware and software will significantly influence the potential effectiveness of a design. On the other hand, certain vendors might push green hardware and software as their standard product offering. In consequence, some organisations that have no green IT strategy in place could still inadvertently be running green technology in their IT department.

Finally, the reality of the specific sector, industry or situation in which the organisation operates could influence the scope and nature of green IT strategy. For example, the reality within the IT services industry is that providing standard IT services in an environmentally friendly manner may not be an "order winner". On the other hand, power efficiency could be considered an order qualifier for IT hardware vendors. As a result, the *organisational realities* category is grouped as a *reality*.

The four categories which fall under the *reality* model component are shown in Figure 4.4 below. Thereafter, *status quo* will be discussed in the next section.

Figure-4.4. The *Reality* model component

4.2.4. Status Quo

Status quo is a force that refers to the current state within the organisation. Green IT strategy determines the green IT status that the organisation plans to work towards. On the other hand, *status quo* refers to the current state of the organisation – and this also includes the current green IT status. The current state within the organisation will determine the depth of the green IT strategy required to reach its goals. As a result, the status quo within an organisation will affect the nature and scope of its green IT strategy.

However, in addition to influencing green IT strategy, the status quo is also affected by green IT strategy implementation. Green IT practices would typically change or maintain the status quo of an organisation, based on its current green IT status.

The categories that are listed under *status quo* are *corporate culture*, *supporting infrastructure* and *organisational structure*. Firstly, the corporate culture of an organisation could be a deciding factor of the success of a green IT strategy implementation. As a result, corporate culture needs to be taken into consideration when formulating green IT strategy. Certain practices needed to implement the strategy might even change certain aspects of the corporate culture – in order to help ensure the success of green IT adoption within the organisation.

Furthermore, the state of the *supporting infrastructure* within the organisation will also affect the specifics of green IT strategy implementation. For example, the presence of an environmental management system would typically result in the integration of certain green IT practices within the current environmental management system.

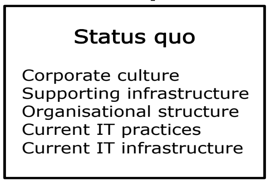
Organisational structure is the third category to be grouped under *status quo*. Certain structures within the organisation are better suited for green IT practices. Therefore, the current organisational structure may dictate the extent or possibility of certain practices. However, the green IT strategy could also include changes to the organisational structure, if executive management supports such an initiative.

The three categories grouped under *status quo* are not exhaustive. Since green IT practices set out to change or maintain the status quo, it is logical that *current IT practices* should be listed under this force. Even though *current IT practices* was not explicitly defined as a category, it was created to address this shortcoming.

Furthermore, green IT strategy may be hampered by the current IT infrastructure that is in place. For example, certain practices may not be possible within the current IT infrastructure, since the infrastructure may need to be in place until the end of its life – to ensure a return on the initial investment. Even though these issues are not explicitly coded as a category, the essence of these issues is captured by the *green IT readiness* and *green IT context* codes; these were tagged six times collectively.

The two additional categories are listed along with the rest of the *status quo* categories in Figure 5.5 below.

Figure-4.5. The *Status quo* model component



The following section will address how green IT strategy formulation may be guided in order to increase its effectiveness.

4.2.5. Guidance

Several categories emerged during the reducing phase, that are associated with positive influences, which can guide or steer green IT strategy formulation and implementation. Consequently, this force was labelled as *guidance.*

The first category that guides green IT strategy and implementation is *standards.* Standards can guide manufacturers to create energy-efficient products manufactured in an environmentally friendly way. These standards also guide organisations when procuring IT hardware, since they may be used as benchmarks for environmental performance. Even general environmental management standards, such as ISO 14001 can guide green IT strategy.

Furthermore, good *corporate governance* guidelines can lead organisations to address the issue of sustainability. For example, the King III code on corporate governance addresses organisations' responsibility towards sustainability, and the principles behind such corporate governance practices that support the formulation of green IT strategy. As a result, the *corporate governance* category is listed under *guidance.*

The third category to fall under guidance is *knowledge.* The knowledge gained from collaborating with partners, customers, suppliers and environmental associations will guide effective green IT strategy formulation and its implementation. Without comprehensive knowledge on green IT technology, design and practices, an organisation is likely to be less effective in its endeavour to implement green IT and its successful adoption.

Finally, *leadership* is the last category to be listed under *guidance*. Effective leadership is required to convince the organisation to reduce the environmental footprint of their IT operations. Furthermore, effective leadership is required to ensure the green IT strategy is successfully implemented, and is not only a strategy that remains on paper. Figure 4.6 on the following page lists the categories that constitute the *guidance* component of the green IT model.

Figure-4.6. The *Guidance* model component

Guidance

Standards
Corporate governance
Knowledge
Leadership

Guidance marks the final component that can be classified as a force within the model. The following section will address the *practices* component of the model.

4.3. Practices

The components of the model defined up to this point are all classified as *forces* on green IT strategy. These forces influence the formulation of green IT strategy. However, a strategy on paper is of little use unless it can be implemented effectively. The execution of green IT strategy is made possible by implementing certain *practices*.

When the list of practices in Table 4.2 was examined, no distinct sub-components could be identified. However, one of the distinctions that could be noted was that certain practices are IT practices, while others are merely business practices. However, even though certain practices are strictly speaking not IT practices, it may nevertheless become the responsibility of the IT department to drive these practices. Therefore, making such a distinction within the model did not really prove feasible. However, what this observation illustrates is the fact that green IT adoption extends far beyond the mere implementation of green technology.

The first practice, *offset IT-impact,* is classified as a *practice* since it is a measure to neutralise the impact of IT operations. If the goal of the organisation's green IT strategy is to become carbon neutral, such offset practices are essential means to realise such a goal.

Secondly, the practice of leveraging *IT as a green enabler* is a means whereby IT can reduce the environmental footprint of other functions in the organisation. However, whether such practices will form part of any green IT strategy is dependent on the alignment of green IT strategy and overall enterprise green strategy.

Transparency is a category that is also listed as a practice. However, transparency will not result in any direct reduction in the environmental footprint of the organisation's IT operations. If part of the green IT strategy is to strengthen the green credentials of the organisation, then being transparent about the organisation's environmental footprint is essential. As a result, *transparency* is still listed as a *practice*, since it is a means whereby certain aspects of a green IT strategy can be realised.

The *transparency* practice is facilitated by means of the *monitor and measure the environmental impact* category. *Monitor and measure the environmental impact* in also classified as a practice, since it enables the *transparency* practice. Furthermore, monitoring and measuring also influences green IT strategy, since this category provides IT management with information related to the environmental impact of certain IT functions, as well as the effectiveness of certain green IT practices that have already been implemented. Therefore, even though monitoring and measuring is a practice, its influence on green IT strategy refinement should be noted. This will be done in the final model.

Furthermore, *green design* is also listed as a practice. The green design of IT infrastructure is one of the core measures organisations can implement to reduce the environmental footprint of its IT operations. However, *green design* also refers to the design of products and services. For organisations that offer IT products and services, green design extends beyond greening their own IT operations. As a result, an organisation with IT as its core business will have a green IT strategy which targets its own IT operations, as well as designing environmentally friendly IT products and services.

The sixth category to be listed as a practice is *IT lifecycle management*. *IT lifecycle management* is a practice which can be implemented to reach strategic goals for the clean disposal of IT equipment, as well as extending the life of old equipment. As a result, *IT lifecycle management* in a practice which implements selected aspects of a green IT strategy.

Procurement is a practice that is closely related to greening the IT supply chain. If the green IT strategy involves minimising the IT department's environmental impact down the supply chain, then strict procurement practices will be essential. Organisations can green their supply chain by only buying from suppliers who themselves have comprehensive green policies in place. Furthermore, procurement practices can ensure that the organisation purchases IT equipment that complies with energy efficiency and environmental-friendly manufacturing standards. Buying equipment that offers green features should also form part of the green design of IT infrastructure to reach environmental footprint-reduction targets.

Operations practice refers to the day-to-day use of IT systems and the running of the IT department. For green IT strategy to be effective, it needs to change the way IT systems are used, operated and maintained. Therefore, it is essential to implement operating practices that support the implementation of the green IT strategy. A core contributor to the success of operational practices is the use of the organisation's IT systems.

The final practice to be listed is *people*. The installation of green IT infrastructure and the formulation of practices do not necessarily ensure the successful implementation of a green IT strategy. It is ultimately up to the people within the organisation to ensure that the strategy is successfully implemented. Appropriate people practices enable the employees within the organisation to implement green IT strategy on a user level within the organisation. As a result, effective people practice is essential to ensure the successful implementation of green IT strategy.

People is the final category to be grouped under the *practices* model component. As a result, the completed *practices* model component is summarised in Figure 5.7 below.

Figure-4.7. The *Practices* model component

Practices

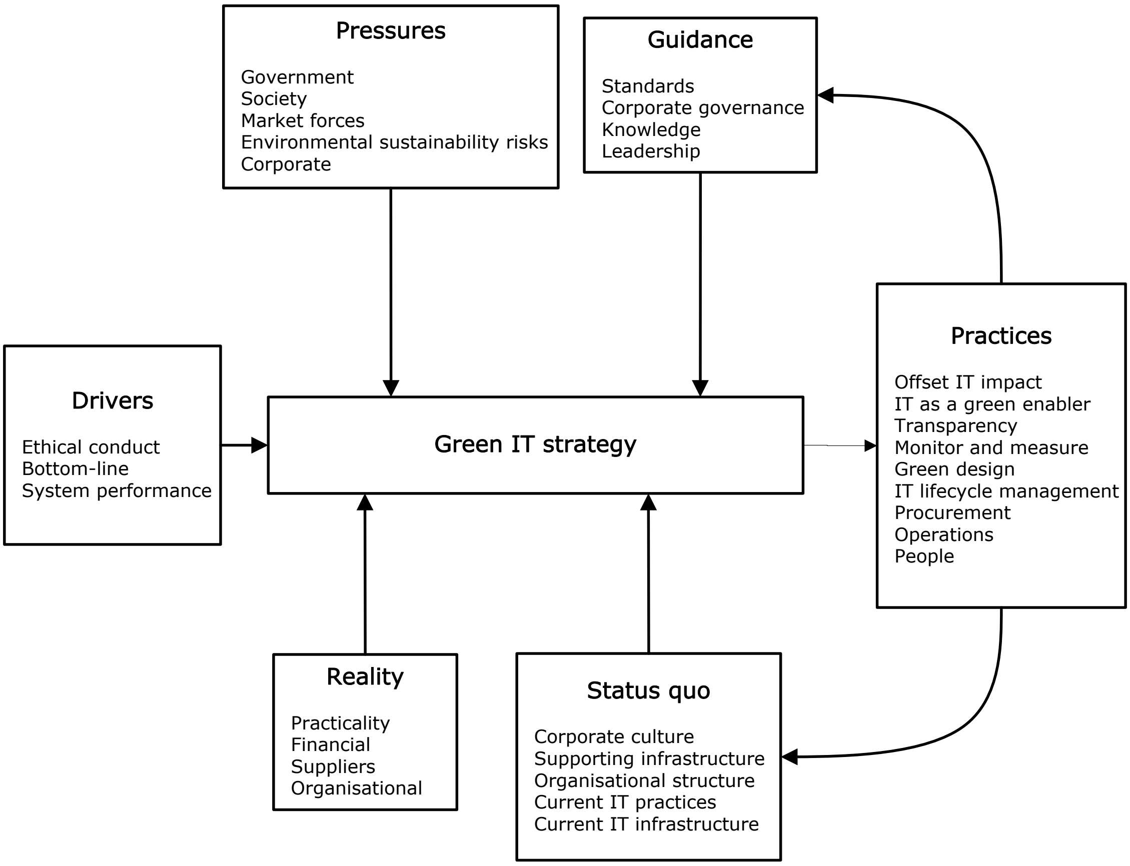
Offset IT impact
IT as a green enabler
Transparency
Monitor and measure
Green design
IT lifecycle management
Procurement
Operations
People

Since all the components of the model have been defined, the model for green IT strategy may now be constructed. This will be done in the following section.

4.4. Model Construction

The discussion of *forces* and *practices* in sections 4.2 and 4.3 yielded several model components. These are summarised in Figure 4.2 through to Figure 4.7. These model components can be integrated into the model foundation that is illustrated in Figure 4.1. The resulting model for green IT strategy is presented in Figure 4.8 below.

Figure-4.8. A model for green IT strategy



In Figure 4.8, *Green IT strategy* is placed in the centre of the diagram, since it is the focus of the model. The five components that are classified as *forces*, namely *Drivers*, *Pressures*, *Guidance*, *Reality* and *Status quo* all influence the formulation of *Green IT strategy*. This influence is indicated by the arrows from each of the five forces that point towards the *Green IT strategy* block.

Once a green IT strategy has been formulated, it can be implemented by means of practices, as indicated by the arrow connecting the *Green IT strategy* and *Practices* blocks. Furthermore, a feedback loop exists between *Practices* and *Guidance,* as represented by the arrow connecting these two components. As green IT practices are implemented, the IT department can assess the effectiveness and practicality of these measures. The experience gained from implementing specific green IT practices acts as guidance for the refinement of the organisation’s green IT strategy.

In addition, a similar feedback loop is shown between the *Practices* and *Status quo* blocks. Since *status quo* refers to the current situation within the organisation, certain green IT practices will set out to change this situation within the organisation with the aim of greening its IT operations. As the practices affect the current situation within the organisation, they will, in turn, influence the refinement of green IT strategy.

The feedback loops indicate that green IT strategy formulation and refinement constitute a continuous process and a long-term issue. For comprehensive green IT strategies to be most effective there are no quick and simple solutions. Green IT strategy formulation requires holistic thinking since several forces must be considered during its formulation.

Furthermore, the implementation of green IT strategy requires a holistic approach by implementing several practices. The kinds of the practices represented in the model indicate how green IT extends beyond the mere implementation of green technologies. Since the model for green IT strategy has been defined in this section, the primary objective of the study has been realised.

5. Conclusion

This study utilised a content analysis approach on green IT literature to formulate a model for green IT strategy. The resulting model indicates that green IT strategy formulation requires holistic thinking, since several forces affect green IT strategy. As a result, these forces should be considered when a green IT strategy is to be formulated. However, even if a strategy is formulated by considering all the forces at play, it is of little use if it is not implemented effectively. The model indicates that green IT strategy should be implemented though a series of practices. These practices are not limited to IT practices alone, but include, in addition, several business practices. This indicates that green IT adoption extends far beyond the mere implementation of green technology.

Even though current green IT practices set out to minimise IT's environmental impact, they cannot completely eliminate the impact on the environment. Therefore, green IT research needs to continue delivering innovations which will work towards the ultimate goal of zero environmental impact.

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