SME and Green-IT - A decision model

Frederik Kramer[1], Naoum Jamous[2]

Abstract

Because of the enduring warnings of experts and the continuous impact of the climate change, sustainability has become a major concern of Small and Medium-Sized Enterprises (SMEs). The information technology sector offers a variety of products that address sustainability. These range from environmental management information systems (EMIS) to hardware (e.g. energy efficient CPUs) as well as software components (e.g. hyper-visors). As "sustainability" and especially the buzz-word "Green IT" became door openers in almost every IT marketing campaign, a useful evaluation becomes even harder. Due to their special constraints in terms of size, focus, skills, capital, and applied decision methods, SMEs struggle even harder than large enterprise to purposefully evaluate complex technologies. This article provides a structured evaluation model of IT-based sustainability technologies for SMEs. The model is based on multi-criteria decision making (MCDM) and comprises different decision categories such as flexibility, risk, strategy, and cost / benefits as well as respective subcategories (e.g. implementation of a sustainability strategy) that we found to be important in the context of IT, SMEs, and sustainability.

1. Introduction

Climate change and global warming are a reality. Even if experts around the world are still debating its empirical impacts on our environment, the frequency of man-induced natural catastrophes speaks for itself. More often we see pictures of withered crops, landslides, and torrential rainfalls (Bergman, 2011). The damage caused by the rising emission of greenhouse gases is already irreversible. Lately, even the People's Republic of China[3] admitted the need to take immediate action. Worldwide information production is growing exponentially. In 2011, the International Data Cooperation (IDC) provided a study stating that the amount of data is doubling every two years (Gantz and Reinsel, 2011). To handle and process this vast amount of data, more and more information technology is needed. The power consumption of hardware is one of the most influential cost drivers in today's enterprise IT.

The buzz term "Green-IT" comprises a various set of technologies that together promise more sustainable production processes and/or the use of information technology. The term, although neither sharply defined nor unanimously agreed upon, mostly denotes ecological objectives. However, the most persuasive and most used argument for the utilization of certain technologies has always been its directly measurable economic impact. In other words, this means technology applications must either save money, create direct economic benefit (monetary returns), or pay off strategically (i.e. granting a competitive edge). Occasionally, statutory requirements force companies to use technology even if those economic benefits are not measurable.

---

[1] Fujistu IS Lab, Magdeburg Research and Competence Cluster (MRCC) at Otto-von-Guericke University Magdeburg

[2] Chair of Business Informatics I, Magdeburg Research and Competence Cluster (MRCC) at Otto-von-Guericke University Magdeburg.

[3] The country accounts for 24% of the global emission of greenhouse gases (Zand, 2013)

2. Structure and Goals of the paper

This research proposes a multi-criteria decision method that enables SMEs to evaluate single technology components in the field of "Green-IT". The main research artifact is a specially tailored criteria catalog that comprises the special focus of SME towards information technology adoption in the context of "Green-IT". The paper is structured as follows: in Section 3 we provide a brief introduction to "Green-IT" and relate it to software and hardware innovation, and in Section 4 we provide an overview of the relevant decision criteria for SMEs as compared to large enterprises. In Sections 4.1-4.4 we discuss the decision criteria with regard to strategy, flexibility, risk, and capital and align them with SME decision making. In Section 5 we introduce the Analytic Hierarchy Process (AHP) as decision tool for multi-criteria decision making. In Section 6 we take the results of Section 4 and integrate them into a criteria catalog that can be used with the method explained in Section 5. Section 6 is devoted to discussing our research findings and give an outlook on future research activities.

3. A definition of "Green IT"

"Green-IT" comprises a various set of different technologies. In 1992 the U.S. Environmental Protection Agency (EPA) introduced the "Energy Star" label. The objective of this early sustainability label was to brand energy efficient products[4]. Already during the 1980's, Eidgenoessische Technische Hochschule Zurich had started a special course on "Umweltinformatik" and the Eidgenoessische Materialpruefungs- und Forschungsanstalt (EMPA) conducted research on this matter. In brief Green-IT can be defined as all means that render information technology more sustainable (Tiefenhoff and Schiefer, 2010).

3.1 Hardware

Historically many "Green-IT" innovations stem from the research centers of hardware vendors. Large hardware vendors continuously seek to improve the energy efficiency of their product portfolio. This is not limited to energy efficient CPU's or RAM, but also to entire server racks or solutions. The Green500[5] list, for instance, is an extension of the Top500[6] supercomputer list that shows the most efficient of these in terms of float point operations per second (FLOPS) per Watt. Energy efficiency improvements are only linear as compared to the exponential improvement of the overall computing power[7]. Apart from computers and computer hardware, energy efficiency of products plays a decisive role for market success today. For example, the automotive, aviation, and energy industries have paid increasing attention to lowering the ecological footprints of their products and/or production processes.

3.2 Software

Life cycle based energy analysis and management is more complex than just analyzing or improving one product or one special process. Similar to financial accounting, the goal is to provide exact measurements of the ecological footprint of different processes and work-flows in a corporate value chain. Information systems that address these requirements on an enterprise level are often named Environmental Management Information Systems (EMISs) or Corporate Environmental Management Information Systems (CEMISs). CEMISs address a wide range of different objectives. Apart from environmental reporting (for

[4] the label is not limited to computer hardware
[5] http://www.green500.org
[6] http://www.top500.org
[7] http://en.wikipedia.org/wiki/Performance_per_watt

internal or external purposes), they allow for better supplier selection based on ecological information, risk mitigation, and cost optimized production processes (Goméz, 2009).

Together with the rise of open source software, the procurement paradigm of computational resources is also shifting. Amazon started Amazon Web Services (AWS) in order to rent temporarily underused computational resources to customers in order to improve their asset utilization. This has become known as a part of today's cloud computing paradigm. At the core of all of these innovations lie hypervisor/virtualization technologies, such as VMware, KVM, XEN, and Hyper-V. Hypervisors are essentially pieces of software that run natively on bare metal hardware (Type-1-Hypervisor) or as part of a host operating system (Type-2-Hypervisor). They abstract hardware through a software layer, essentially enabling more efficient utilization of the physical hardware.

4. Technology Decisions in SME

A single instance of a certain "Green-IT" technology might only deliver marginal ecological benefits, such as a new energy efficient CPU. If it is employed a couple of thousand times in a large computing center, however, it might account for a significant improvement in the ecological footprint of that company.

The same applies to CEMISs if they can be applied to report on and account for hundreds of complex business processes instead of just a handful of them. Be it a pure ecological improvement or a cost reduction caused by better energy efficiency, large economies of scale often help to justify investments and to outweigh inherent risk. Unfortunately, large economies of scale rarely materialize in SMEs. Instead, scarcity of financial and human resources, operational focus, entrepreneurial decision makers, tacit strategies, and non-formalized decision methods render SME decisions particularly difficult.

Apart from these qualitative characteristics, The European Commission defines SMEs by the quantitative indicators presented in Table 1:

Class	Full Time Employees	Annual Turn Over / Balance Sheet	Relative Percentage based on the number of companies in Europe (EU-27) as of 2008
Large[8]	≥ 250	More than 50 Mio. Euro or more than 43 Mio. Euro	0,2
Medium-sized	< 250	≤ 50 Mio. Euro or ≤ 43 Mio. Euro	1,1
Small	< 50	≤ 10 Mio. Euro or ≤ 10 Mio. Euro	6,7
Micro	< 10	≤ 2 Mio. Euro oder ≤ 2 Mio. Euro	92,0

Table 1
Quantitative SME characteristics according to the European Commission
Source: (European Commission, 2003)

In the following four subsections (strategy, flexibility, risk, and cost/benefit), we will discuss the special circumstances in which SMEs usually operate.

[8]Just for comparison. Large enterprises are not part of the SME.

4.1 Strategy

Strategy is usually defined as a rather long-term oriented abstract bundle of actions to reach a desired goal. Amongst scholars it is almost unquestionable that strategy is the omnipotent weapon towards business success. One of the most widely cited works on the matter is the book “Competitive Strategy” by Micheal Porter (Porter, 1980). Peter Drucker states that strategy is a “purposeful action” (Drucker, 1986). Mintzberg (Mintzberg, 1987) differentiates the term strategy into five P’s as follows:

- Planned action (plan),
- Perspective towards the market (perspective),
- Spontaneous action (ploy),
- An emergent chain of action (pattern) and
- The own position in the market (position)

Contrary to large enterprises, where all of the P's of Mintzbergs definition are more or less observable, SMEs rarely conduct conscious strategic planning (Hunsdiek und May-Strobl, 1986). There are multiple factors for missing strategic planning in SMEs. Firstly, SMEs seldom understand formal methods and do not have the required skills to plan strategically (Stonehouse and Pemberton, 2002). Secondly, they are almost exclusively focused on daily business. The battle to survive in the marketplace is simply too brutal and forces them to concentrate on operation rather than strategy. In absence of full-scale strategic planning, it is of utmost importance that a newly employed technology delivers qualitative benefits according to the employed competitive strategy. Due to the scarcity of resources and formal planning methods, we argue that strategic benefits should be assessed for each technology considered. This means a category named (strategy) is needed.

4.2 Flexibility

Flexibility is often seen as one of the most prevailing success factors of small businesses (Güttler, 2009). SMEs need to be flexible enough to react to their customers’ wishes as well as constantly changing market conditions. SME are only very rarely able to out-perform larger competitors on operational cost per item (due to smaller economies of scale), effectively forcing them into an always differentiated or focused competitive strategy[9]. As costumer demand and markets change significantly faster than in earlier days, every piece of information technology must behave like modeling clay. It must effectively fit into holes in the business processes as they appear, not fit into holes that already exist. We argue that the ability to enable flexible business models must be evaluated before a certain technology building is actually employed.

4.3 Risk

Risk is both, hard to handle and always there, especially for SME. Not only do they operate in comparable scarcity of resources, but mostly also without any risk documentation and risk mitigation plan that would allow them to approach risk strategically. Information technology is usually complex and can cause a great deal of additional risk for SME. Risk, however, isn't uniform. According to the ISO 31000, risk is abstractly defined as the “effect of uncertainty on objectives”. If risk becomes certainty, the result can either be personal, environmental, or financial damage. Information technology, unless used in safety critical systems, is mainly subject to risk that can eventually be measured in financial units. Risk can stem from data loss, broken statutory requirements, or simply from hampered business continuity. Regardless of the concrete technology employed, we propose a risk evaluation scheme according to the risk dimensions proposed by Poba-Nazou und Raymond for ERP- implementation projects as shown in Table 2.

[9]To stay with the archetypes of competitive strategy proposed by Porter.

Risk dimension	Definition
Technological	Linked to the data processing technologies required to support the ERP system, notably the operating system, the database management system, the client-server system, and the network.
Business	Internal and external coherence of the business model and processes after the implementation of the ERP system
Organizational	Derives from the organizational context in which the ERP system is implemented, including notably the firm's personnel and organizational structure
Contractual	Linked to the relationship with the business partners participating in the implementation of the ERP system
Entrepreneurial Managerial Financial	Linked to the owner/manager's and management team's attitude toward IS/IT. Derived from problems with cash-flow, software licensing costs, and software update costs
Legal risk	Related to open source license restrictions requiring a waiver of intellectual property (IP) rights in a company's own software which incorporates open source software or the violation of third-party intellectual property rights

Table 2
Risk categories according to Poba-Nzaou and Raymond
Source: (Poba-Nzaou and Raymond 2010)

As already mentioned, technologies in the field of "Green-IT" can either be hardware, software, or hybrid innovations. As such, innovation ranges from rather small items like CPUs to complex information systems like CEMISs. Due to the varied nature of Green-IT technologies, a certain technology can either involve anywhere from one to a few risk dimensions (CPU, Hypervisor) to almost all of them. As an extension from Poba-Nazou and Raymond, we propose to extend the legal risk dimension by fulfilling/breaching statutory requirements. In this case, legal risk can be mitigated by technology application (e.g. if "Green-IT" enables statutory compliance) or increased.

4.4 Cost/Benefit

Ever since the beginning of the second industrial revolution, investments have been mostly justified by balancing their expenses with their expected returns. This method is meaningful if a single or a few instances of a certain technology (e.g. a machine) may increase the mainline output to a certain extent. Information systems and information technology is usually support technology that enables the core business processes of a company. As already mentioned, it is almost always relatively complex in nature. As Brynjolfsen stated, returns on IT - be they monetary or qualitative - are often disseminated amongst the entire value chain or occur with a large time delay.

Nonetheless methods such as return on investment analysis (ROI) or life-cycle based cost analysis like the Total Cost of Ownership (TCO) analysis are still the most common tool to calculate the performance of investments on a solely monetary basis. Unfortunately even these simple cost calculation mechanisms are not used in most SMEs. Instead, the monetary side of investment decisions are based on assumptions and gut feelings rather than proper analysis.

As already mentioned, we strongly believe that investments must be justified by a mix of quantitative and qualitative decision factors. The TCO analysis is essentially a structured chart of accounts. From a methodological perspective it sums up cost items. While this is not wrong, monetary benefits such as cost reductions through energy savings are not covered in the standard model. We therefore propose to use an enhanced TCO analysis that takes theses monetary benefits into account.

5. Analytical Hierarchy Process

The Analytic Hierarchy Process (AHP) has been first proposed by the mathematician Thomas L. Saaty and since then it became one of the most widely used multi-criteria decision making (MCDM) tools (Chou et. al., 2004). The application of technology building blocks in the area of “Green-IT” is as multi-criteria decision problem, because qualitative factors such as flexibility, strategy and risk have to be combined with monetary aspects such as the cost and the monetary benefit of the technology. The weightings of the criteria may largely differ based on the concrete technology and the business conditions. The AHP has already proved its capability to support similar IT-related decisions (Vaidya and Kumar, 2006; Angelou and Economides, 2008), as well as Non-IT decisions (Coyle, G., 2004). Figure 1 shows an example decision tree.

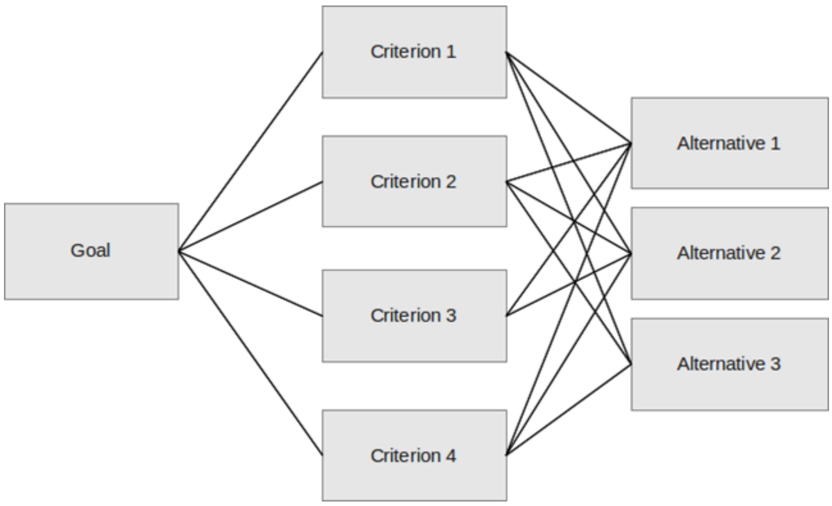

Figure 1
AHP decision tree schematic illustration

The AHP comprises the following four phases (Chang, 1996):

- Structuring of the decision problem (see Figure 1)
- Pairwise comparison on each level
- Compute priorities through normalized Eigenvalues
- Synthesis of different levels of priorities to a preference relation amongst alternatives

Saaty doesn't provide any hierarchies together with the methods but suggest to use standard decision hierarchies for each decision area. Although the AHP has been used for IT decision this hierarchy doesn't exist so far for “Green-IT” with special respect to the constraints of Small and Medium-Sized Enterprises.

There are 3 strong requirements for the application of the AHP (Jonen et. al. 2007):
- Reciprocity $a_{ij}=1=a_{ji}$ for all i,j=1,…,n
- Identity $a_{ii}=1$ for all i=1,...,n
- Transitivity $a_{ik}=a_{ij}*a_{jk}$ for all i,j,k=1,...,n

By applying this there will be a decision matrix has the format showed in Figure 2:

$$A = [a_{ij}] = \begin{Bmatrix} W_1/W_1 & W_1/W_2 & \dots & W_1/W_4 \\ W_2/W_1 & W_2/W_2 & \dots & W_2/W_4 \\ \dots & \dots & \dots & \dots \\ W_4/W_1 & W_4/W_2 & \dots & W_4/W_4 \end{Bmatrix}$$

Figure 2
Decision matrix format

The matrix has the constraints showed in Figure 3:

$$a_{ij} = W_i/W_j, a_{ji} = 1/a_{ij}, W = \begin{Bmatrix} W_1 \\ W_2 \\ \dots \\ W_4 \end{Bmatrix}$$

Figure 3
Decision matrix constraints

The evaluation is being conducted according to the ordinarily scaled evaluation scheme presented in Table 3:

Value	Likelihood	Realization of the goal
1	equally likely	equal
3	slightly (un)likely	moderate
5	noticeably (un)likely	strong
7	much (un)likely	very strong
9	extremely (un)likely	extreme
2,4,6,8	Interim values	

Table 3
Evaluation scheme according to Saaty, own representation according to Jonen et. al. 2007
Source: (Jonen et. al. 2007)

There are various ways to compute the Eigenvector (all Eigenvalues) of a matrix. The power method works well also for larger matrices. For the power method the sum per row is computed followed by obtaining the n-th root of this sum. This value is than normalized. The result offers a quite good estimate of the maximum Eigenvalue of a matrix λmax (Saaty, 1980).

If the preferences of the decision maker would be fully transitive the maximum eigenvalue λmax would equal the grade n of the evaluation matrix. Saaty argues that a certain level of inconsistency of the preferences of the decision maker is acceptable. The difference of the maximum Eigenvalue λmax and the grade of the matrix is a measure for the consistency of the decision makers preferences (Coyle, 2004).

$$CI = \frac{(\lambda_{max} - n)}{(n-1)}$$

The consistency index is defined by the following formula:

$$CR = \frac{CI}{RCI}$$

The consistency ratio is calculated by setting the consistency index in relation to a random consistency index which Saaty computed by means of large amounts of randomly filled matrices as shown in Table 4:

Size of the matrix	1	2	3	4	5	6	7	8	9	10
RCI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Table 4
Mean consistency index of randomly packed matrices according to Saaty
Source: (Saaty, 1980)

Saaty proposes that a consistency ration less than 0.05 is acceptable for matrices smaller than third grade, less than 0.08 for fourth grade matrices and less than 0.1 for fifth grade or larger matrices.

6. Evaluation scheme

From a logical perspective, there is hardly any reason why evaluation decisions in SMEs should differ from those in large enterprises. The best decisions are made if well elaborated criteria catalogs are used and tailored to the specific needs of the company. What needs to be evaluated differs in relation to the field of technology application. Almost every informed technology decision in companies regardless of their size should contains quantitative decision categories such as cost/benefit, risk, and qualitative categories such as flexibility and strategy.

	Cost / Benefit	**Risk**
Quantitative	Enhanced TCO analysis with monetary benefits	Technological Risk Business Continuity Risk Organizational Risk Contract Risk Owner Risk Legal Risk
	Flexibility	**Strategy**
Qualitative	Customer reaction time Impact on the transformation speed of the organization Impact on internal system complexity	Competitive Advantages Strategic fit towards sustainability strategy Strategic fit towards IT strategy Compliance

Table 5
Catalog of criteria to use with AHP

The restrictions (budget and time), the applied decision method (formal, semi-formal, or ad-hoc) and the category weightings significantly differ in SMEs as compared to large enterprises. Whereas decisions in large enterprises are often duly prepared by a team which aids management, SME decisions are frequently taken by the owner alone. Often entrepreneurial decision makers make gut decisions without applying any visible criteria catalog or decision method (Blili and Raymond, 1993).

Scarcity of resources and operational focuses force SMEs to concentrate on fewer strategic projects and investments. If decision methods are applied, they are often one-dimensional, monetary, and shortsighted, and risk is seldom evaluated. The AHP is a very useful method in evaluating alternatives multi-dimensionally in order to improve the overall business utility of technology application. As shown in section 5 we suggest using the AHP with the decision schema depicted in Table 5.

For technology building blocks in the field of "Green-IT", legal compliance and strategic fit with the sustainability strategy of a company needs to be evaluated.

7. Results and Outlook

Sustainability is an important strategic goal that more and more SMEs need to work on and are concerned about as well. Subjective decisions and/or one-dimensional cost-centric decision models are not useful in making complex decisions. This observation is not limited to large enterprises, but similarly applies to SMEs. Improper decision making might severely hamper the existence of small enterprises. It is almost irrelevant whether a purely cost-centric decision method is a life-cycle cost model like TCO or a discounted cash-flow method like the Return On Investment analysis (ROI). Even if the monetary dimension is regularly the most important decision category, especially for SMEs, decisions must be made considering and balancing quantifiable risks, and they must be aligned with the strategic perspective as well as the flexibility options of the specific company/technology.

A multi-criteria decision model like the AHP allows one to evaluate all these categories simultaneously. Because the weightings at a category level as well as at an attribute level are not totally subjective, but instead weighted through a pair wise comparison matrix/Eigenvector computation, the internal stability of a decision is high. Especially if compared to older scoring methods like the utility analysis proposed by Zangemeister (Zangemeister, 1976), the AHP is likely to improve the internal decision quality.

Devising the single decision catalog for "Green-IT" technologies would be largely meaningless, however. There is a significant difference for all relevant decision categories. If an SME for instance wants to substitute all of its desktop PCs with Thin Clients to progress on a reduced energy consumption strategy, it is strategically different from tracing its ecological footprints on all of its value creating activities in order to implement a proper sustainability reporting. Both, however, involve technology building blocks from the "Green-IT" space.

The proposed decision method has already proven its value for various complex decisions and environments. However, it comes at a cost. Decision makers have to compare sub-criteria and alternatives on each of the decision levels. On each level, (n*n-1)/2 decisions are necessary. Hence, our archetypal model requires 30 pairwise comparisons to compute the overall weighting vector. To evaluate n different alternatives on the lowest decision level, an additional ((n*n-1)/2)*14 pairwise comparisons are necessary.

Owing to the overall scarcity of resources and the operational focus of SMEs, it is doubtful whether the complexity and effort of the proposed decision method is too high to be applied for decision making in SMEs. This needs to be proven in separate and more concrete scenarios for single technologies.

Bibliography

Bergman, J. (2011): Effects of Climate Change Today, Website, http://www.windows2universe.org/earth/climate/cli effects.html. Last visited 13.01.2013.

Gantz, J. and Reinsel, D. (2011), Extracting Value from Chaos, Technical Report, International Data Cooperation, 2011.

Tiefenhoff, P. and Schiefer, D. (2010), Green-IT, Techreport, URL www.ihk-koeln.de/upload/green_it_mit_logo_1_0_12193.pdf, last visited 27.06.2013, 2010.

Goméz, Jorge-Marx (2009), Betriebliche Umweltinformationssysteme, Enzyklopädie der Wirtschaftsinformatik, Hrsg. Kurbel, Karl, Website, http://www.enzyklopaedie-der-wirtschaftsinformatik.de/wi-enzyklopaedie/lexikon/informationssysteme/Sektorspezifische-Anwendungssysteme/Umweltinformationssystem%2C-betriebliches/index.html, last visited 27.06.2013, 2009.

European Commission (2003), Empfehlung der Kommission vom 6. Mai 2003 betreffend die Definition der Kleinstunternehmen sowie der kleinen und mittleren Unternehmen Amtsblatt der Europäischen Union, Europäische Kommision, Pages 36-41, 2003

Porter, M.E. (1980): Competitive Strategy, Free Press, New York, 1980.

Drucker, P. (1986):The frontiers of management : where tomorrow's decisions are being shaped today Truman Talley Books, 1986.

Mintzberg, H. (1987): Five Ps for Strategy, The Strategy Concept I California Management Review, California Management Review, Volume 30, Pages 1-24, 1987.

Hunsdiek, D. und May-Strobl, E. (1986): Entwicklungslinien und Entwicklungsrisiken neugegründeter Unternehmen. Schriften zur Mittelstandsforschung. C.E. Poeschel, 1986.

Stonehouse, G. and Pemberton, J. (2002): Strategic planning in SMEs - Some empirical findings. Management Decision, Volume 40 Number 9, Pages 853–861, 2002.

Güttler, K. (2009): Formale Organisationsstrukturen in wachstumsorientierten kleinen und mittleren Unternehmen. Betriebswirtschaftlicher Verlag Gabler, Wiesbaden, 2009.

Poba-Nzaou, P. and Raymond, L. (2010): Managing ERP system risk in SMEs: A multiple case study, Journal of Information Technology, 2010.

Chou, Y., Lee, C. and Chung, J. (2004): Understanding m-commerce payment systems through the analytic hierarchy process, Journal of Business Research , Volume 57, Number 12, Pages 1423 – 1430, 2004.

Vaidya, O.S. and Kumar, S. (2006): Analytic hierarchy process: An overview of applications. European Journal of Operational Research, Volume 169, Number1, Pages 1 – 29, 2006.

Angelou, G. and Economides, A. (2008): A decision analysis framework for prioritizing a portfolio of ICT infrastructure projects. Engineering Management, IEEE Transactions on ACM, Volume 55, Number 3, Pages 479 – 495 , 2008

Coyle, G. (2004): The Analytic Hierarchy Process (AHP). Practical Strategy, 2004.

Chang, D.Y. (1996): Applications of the extent analysis method on fuzzy AHP, European Journal of Operational Research, Volume 95, Number 3, Pages 649 – 655, 1996.

Jonen, A., Lingnau, V., Sagawe, C. (2007): Aufbau eines kognitionsorientierten Risikocontrollinginstrumentes: Unterstützung der Risikobewertung mittels des Analytic Hierarchy Process, Beiträge zur Controlling-Forschung, Volume 12, 2007.

Saaty, Thomas L. (1980): The Analytic Hierarchy Process: Planning Setting Priorities, Resource Allocation. , McGraw Hill Higher Education, 1980.

Blili, S. and Raymond, L. (1993): Information technology: Threats and opportunities for Small and Medium-Sized Enterprises. International Journal of Information Management, Volume 13, Number 6, Pages 439 – 448, 1993.

Zand, B. (2013): Atmen kann tödlich sein, Website, URL http://www.spiegel.de/wissenschaft/natur/feinstaub-pekings-luftverschmutzung-erreicht-dramatische-werte-a-877150-druck.html, last visited 13.01.2013, 2013.

Zangemeister, C. (1976): Nutzwertanalyse in der Systemtechnik Wittemann, 1976.