Information systems architecture for a Sustainability (SusCRM) for Mobility

Wagner vom Berg, Benjamin
Marx Gómez, Jorge

Carl von Ossietzky University of Oldenburg, Department of Business Computer Science I / Very Large Business Applications

Abstract
The ecological dimension of sustainability in the meaning of consumption of natural resources is one important topic of our times. The transportation of goods and persons has a major impact on resource consumption and emissions. Electric vehicles are not solving these problems but they are offering a chance for a change of mobility behavior towards an eco-friendly mobility. This change of behavior needs new transportation offers, new business models and new information systems. Intermodal transportation and the switch from individual mobility with combustion engine cars to public transport is here a key factor. Also new offers like car-sharing and car-pooling are playing an important role. Mobility management and mobility marketing addressing this switch to sustainable transport modes on a municipal and on a company level. At the end the customer has to change his behaviour and has to accept the more sustainable offers. It is crucial that the customer and the mobility provider has knowledge about the customers specific mobility patterns, his behavior, his preferences and about costs and sustainability values of his mobility. Then it is possible to offer customer-tailored and more sustainable mobility alternatives and to motivate the customer with specific incentive schemes. Customer Relationship Management offers the tools and methods to win new customers, to bind existing customers and to change customer behavior. In this work we present a complete Sustainability CRM architecture that addresses the task of changing mobility behaviour to a more sustainable way and its prototypical implementation.

Introduction

Today, companies, governments and the public are recognizing that resources are limited (e.g. oil) and are facing different problems in the economic, environmental and social dimension which are resulting from our economic acting and our consumption behaviour [2]. Because of this, sustainability is growing into a major topic for companies as well as for customers.

In this paper we are following the most well-known and still valid definition of the Brundlandt commission for sustainability [10], using the triple bottom line model of sustainability [5] and taking the strategies of consistency, efficiency and sufficiency into account [14].

Coming to a sustainable economy based on market rules means on one hand the need for sustainable production and on the other hand customers that are buying sustainable manufactured products and align their consumption behaviour with the principles of sustainability [2]. When we take a look on information and communication technologies (ICT) for supporting sustainability most of the studies address the more efficient use of energy and other resources in the production process [11], [12], e.g. by corporate environmental management information systems (CEMIS) [19], [23]. However, when we look for ICT approaches that are directly addressing the change of consumption patterns we find a lack of studies.

Customer Relationship Management (CRM) as a part of marketing describes strategies as well as ICT systems as an instrument to build new and long-term customer relations. [13]. CRM is an instrument to influence customer behaviour as Kantsperger describes in his article „Modification of customer behaviour as the core duty of CRM", e.g. on basis of learning theory, instrumental conditioning, and model learning by using mechanisms of

reward and punishment [17]. In marketing several approaches to integrate ecological and social issues like Green marketing [9] and sustainability marketing [2], [18] already can be identified. While Green marketing is focusing on environmental aspects, sustainability marketing keeps environmental, social and economical aspects in mind. The managerial approach of sustainability marketing according to Belz and Peattie takes the intersection of socio-ecological problems and consumer wants as the root of all issues in marketing (values and objectives, strategy, marketing mix, marketing transformation) that have to be adapted to sustainability [2]. Scholl provides detailed research how to adjust marketing in case of sustainable services that replace property-based consumption patterns. One famous example for such a service is car-sharing. In his work Scholl already stresses the link to CRM and how the establishment of customer networks with collective consumer practices are able to strengthen the customer retention [21]. To support this idea it is crucial that the customer has all information about the sustainability of the product itself and especially the specific use of it. Also, the integration in social networks might be helpful to support sustainable use of the products, e.g. by comparing the individual sustainability performance with others.

These works already provide a foundation and basic ideas how to integrate sustainability into CRM on a strategic level and in a next step to derive requirements for CRM systems. In this paper we will present an information system architecture for a SusCRM that will take the functional aspects into focus based on the following definition:

"A SusCRM extends the sphere of influence of CRM by not only focussing on the economical dimension but also taking the ecological and social dimension into account. For this, SusCRM has to adjust and to extend the technics and methods of the traditional CRM approach based on a modified goal setting. One most important aim is to influence the customer in the way that he aligns his consumption patterns on the principles of sustainability. Furthermore, the business processes of CRM have designed to be sustainable."

The presented architecture is specialized for the use in the domain of mobility, but parts of it have also a generic character and can be assigned to other domains. Mobility, in the sense of moving persons and goods [29], has a huge impact in the sustainability context. 26% of worldwide CO2 emissions by combustion of fuel are coming from transportation and 35% of total energy consumption in Europe is coming from transportation with 71% by road traffic [6]. Switching to electric vehicles (EV) seems to have a huge potential for a fundamental change to a more sustainable transportation with less CO2 emissions and less energy consumption. But, also EVs have environmental impacts and furthermore technical shortages. So, a 1:1 substitution of conventional cars (CV) by EVs is both not sufficient according to sustainability, and on basis of today´s technology not possible [26]. Because of this, EVs need the support of special business models and using concepts as well as logistic solutions to be successful on mass markets [27]. Multimodal or intermodal transportation provides a logistic solution to compensate the technical shortages of EVs and a solution for moving more sustainable [1].

One definition for sustainable mobility is given by Gottschalk: "Sustainable Mobility is the ability to meet society's need to move freely, gain access, communicate, trade and establish relationships without sacrificing other essential human or ecological values, today or in the future." [8] An additional definition by Dangschat that also takes the principle of sufficiency into account states that the term 'sustainable mobility' is a collective term for all changes in every-day life, technological development and economical systems, which allows us to increase the mobility of persons to satisfy the needs of everyday life while decreasing the amount of traffic [3]. So, on the one

hand we need different offers of more sustainable transportation modes (e.g. train or bus) and their multimodal combination but on the other hand on the demand side there has to be the will to switch to sustainable transportation modes. But multi- and intermodal transportation means a big change for our moving behaviour. Planning our trips will be more complex depending on the number and kind of means of transport we combine. It is getting even more complex and different to our present moving behaviour when we try to move as sustainable as possible. This requires intelligent information systems for planning and organizing mobility [28].

Mobility Management as defined in the following and the included idea of mobility marketing addresses both tasks: "Mobility Management (MM) is a concept to promote sustainable transportation and manage the demand for car use by changing travellers' attitudes and behaviour. At the core of Mobility Management are "soft" measures like information and communication, organising services and coordinating activities of different partners." [7]. Mobility management is used on different levels e.g. on a municipal level but also on company level. Mobility Marketing deals with supplying target-group-specific information and consulting as well as providing incentives to confirm the behaviour of customers who already make use of sustainable mobility and also to convince customers to use sustainable means of transport [25], [22].

In Germany it was shown that direct marketing with the focus on sustainable mobility can effectively win new customers for public transport, e.g. the public transport provider Regional bus Braunschweig (RBB) increases the number of customers by 39% and the revenue by 42% [4]. Also it was shown that travellers are not informed correctly about their own traveller behaviour to choose the right vehicle or travel option according to sustainability [15].

So the integration of a SusCRM approach makes sense for mobility providers (e.g. public transport providers) but also in the way of a Citizen Relationship Management (CiRM) on a municipal level. Schellong already developed a model in 2008 that integrates CRM methods on a governmental administration level [20].

Architecture of a SusCRM for mobility

The aim of the architecture is to serve as a template for a CRM architecture that can be applied within a CRM approach of a mobility provider or within a CiRM approach on a municipal level.

The single components of the architecture are not necessarily "traditional" CRM components (like e.g. the operational CRM system), but can also provide concrete functions in the connected domains of mobility (travel assistance), or sustainability (sustainability calculator).

However based on the considerations above, CRM provides a suitable framework to combine the components in a complete architecture. The most important aim of this paper is to give a clear overview of the architecture and to take functional aspects into focus. Because of the limited space it is not possible to describe every component in detail even though there are already existing prototypes. The architecture is structured according to the subsystems of the general CRM architecture into three different layers. The generic subsystems are described as follows:

Communicative CRM: The communicative subsystem constitutes the interface to the customer and integrates different channels for the communication with the customer.

Operational CRM: The operative subsystem includes the different processes and functions for the main fields of marketing, sales and service automation of the CRM-System. The single automation components address administrative, analytical and communication supporting tasks. The operational CRM collects data and provides them for analysing purposes to the analytical CRM.

Analytical CRM: The analytical subsystem analysis the collected customer data with regard to the business processes. The central element is the Data Warehouse that collects all the available customer data from different sources like the operative CRM or external systems and databases. Figure one shows the architecture of a SusCRM for mobility with the three layers and the associated components.

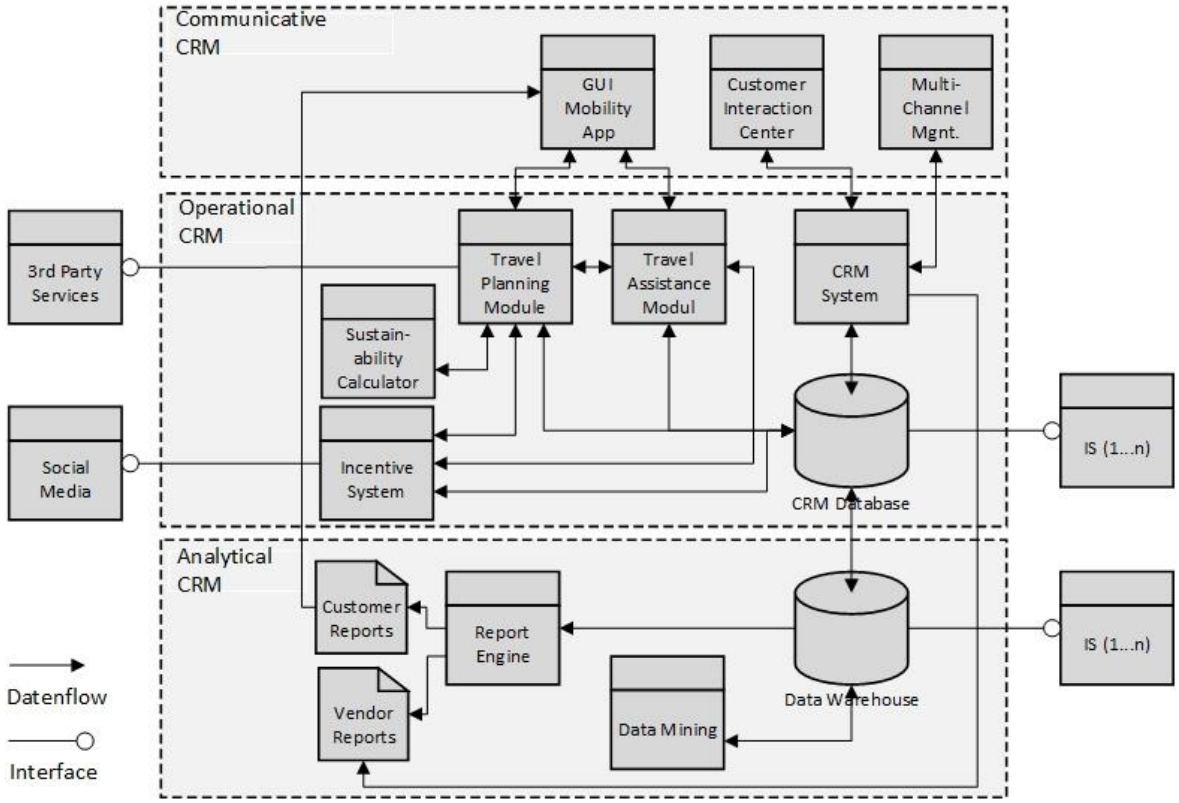

Fig. 1: Architecture SusCRM for Mobility

In the following the single components of every layer are described in detail.

Communicative layer

GUI (mobile app, or website)
The main communication channel to the customer is an app for mobile devices, and as an alternative a website. Providing a mobile application is crucial, because the user needs information everywhere, especially when he is on a trip. The app has both functions: providing information to the customer and collecting data about the customer. Information is provided for functions of travel planning, travel assistance, and customer reports, but also e.g. for special offers or advertisement. In the sense of a SusCRM the app is the main channel to influence customer behaviour towards more sustainability. Customer data (master and transactional) are collected by the use of the functions and by geo-positioning functions. All data are stored in the operational CRM database. The app should be adaptive according to costumer preferences and customer usage behaviour based on the collected data.

Customer Interaction Center (CIC)
The Customer Interaction Center (CIC) supports the personal communication with the customer in addition to the app over different communication channels (phone, e-mail etc.). Although the main channel should be the app, it is crucial to support personal communication in case of support

questions, or questions about services or contracts.

Multi-Channel-Management

The Multi-Channel management is important for the CIC, but also for "traditional" CRM functions like marketing campaigns. From a sustainable point of view communication about electronic channels like Internet and E-Mail should be preferred, but also phone or video conferences are proper channels. Resource intensive channels, like paper mailings or personal visits combined with travelling, should be avoided.

Operational layer

Besides classical components like the CRM system the operational layer of this architecture includes specific components for sustainability (sustainability calculator) and for the domain of mobility (travel planning and assistance module). These components are software components that are not necessarily be part of CRM, but they play an important role in the here introduced SusCRM architecture.

Operational CRM Database

The operational CRM database is a key component in the operational layer. The database stores all data produced by the components travel planning, travel assistance, sustainability calculator and incentive system that are generated by the interaction with the customer about the app. Also, other customer related data from external databases (external databases and services are not part of the architecture), or from the CRM system, are stored here. It is obvious that the entity relationship model (ERM) of traditional CRM databases with the core-entities account, contact and lead has to be extended by entities from the sustainability and mobility dimension to store all the needed data. Some new important entities are:

- Route: information about travel time, information about departure/destination, travel distance, number of passengers, calculated key performance indicator (kpi) for emission, energy consumption, costs, time etc.)
- Sub route: similar to route but necessary to split intermodal trips with different transportation types.
- Transportation type: information about the used vehicle (e.g. electric car) like costs/km, CO2 emissions/km for calculating the kpi´s in route and sub route.

Because of limited space it is not possible to describe the whole ERM in this article, even though there are already several prototypical implementations done.

The data in the operational database are processed to the data warehouse where they are used for knowledge discovery. Most of the analytical data (aggregated kpi´s, customer segments etc.) are written back in the operational database. Here they are not only used for classic CRM functions like marketing campaigns, but also by other systems of the operational layer, e.g. to calculate customer-tailored routes in the travel planning module.

Operational CRM system

The operational CRM system (e.g. Microsoft Dynamics CRM) provides all "classic" CRM functions for sales, marketing and service automation. In our case especially functions like campaign management or customer contact history are important. In addition to that the CRM system gives the CRM user access to all information in the operational CRM database in a structured way. All data should be shown in relation to the customer, e.g. customer master data (e.g. demographic information and preferences) or transactional data (requested and driven routes) as special history data. The Operational CRM system can also provide customizing functions to define new key figures or attributes to make changes to the operational database without programming or database design skills.

It is important to mention that on one hand in this architecture the CRM system provides important functions for human interaction to access and to interpret data or to communicate with the customer. On the other hand it is a proclaimed goal of this approach to automate processes of customer interaction (e.g. with the app) as well as processes of data interpretation and knowledge discovery with the analytical components.

Incentive System

The incentive system is a key component for directly influencing customer behaviour with different methods to motivate the customer in an intrinsic or extrinsic manner to move more sustainable. For this, the system includes e.g. a reward-based component realized as a bonus system where the customer can collect bonus points, e.g. by travelling with a sustainable mean of transport. With the bonus points, incentives can be purchased, e.g. get an electric car for a weekend cost-free. The incentive system uses also other incentive schemes like reporting-based and competition-based schemes. The customer can get reports with key figures about his own personal mobility (e.g. produced CO2 emissions in the last month) and he can share this information about social networks or with other users of the mobility app. The incentive system is already prototypical implemented.

Travel Planning Module

The Travel Planning Module supports the user in planning his multimodal and intermodal travelling by considering all means of transport (public transport, car, bus, bike etc.) and gives also information about the sustainability of the different alternatives based on the Sustainability Calculator. It is crucial especially in case of multi- and intermodal trips to make it as easy as possible for the user to plan his trips. He just should enter a minimal set of parameters (start, end, departure time) and gets back as a result a list of different alternatives with different (combinations of) means of transport for the trip. It is also crucial to provide results that fit perfectly to customer behaviour and customer preferences similar to recommender systems. For this the travel planning module needs (analytical) information that are provided by the operational CRM database. The main goal is here to find the most sustainable alternative according to the customer preferences and needs and to present it e.g. by highlighting or top listing. Besides information about sustainability the travel planning module has to provide route information (similar to google maps), information about the means of transport, about costs etc. To make an intermodal trip planning more convenient for the customer external services can be integrated, e.g. for directly purchasing a train ticket. The goal should be to make intermodal travel or travel by a car- sharing-service as easy as travel by a personally owned car in the dimensions of comfort and flexibility.

Travel Assistance Module

The Travel Assistance Module supports the customer, especially while he is on travel, by giving ad-hoc information, e.g. messages about delays of connecting trips or about traffic jams. The information can be based on external services, or also on messages of other users in a way of a “Mobility Twitter”. They are provided by the app via push-services. It is crucial that the customer only gets the information he really needs and doesn´t get an information overload. To achieve this, again information of the operational CRM database is needed to generate customer-tailored information. On the other hand we always have to know exactly the location of the customer, so the travel assistance module uses geo-positioning functions of the mobile device of the customer. The Travel assistance module is also already prototypical implemented.

Sustainability Calculator

The Sustainability Calculator calculates the sustainability of all different means of transport based on a set of key figures from the ecological, social and economic dimension, e.g. for resource consumption, or air pollution to build a total ranking in respect to sustainability. It is important to consider that route specific parameters (e.g. travel distance, number of travellers etc.) can influence the specific values of many key figures, so the ranking is not static, but has to be calculated for each route. To build a total ranking a multi-criteria decision analyses method is needed. In a prototypical implementation PROMETHEE II was used and classified to be eligible.

Analytical layer

The components of the analytical layer are very close to the classical components of Analytical CRM. In the following only specific functions are described.

Data Warehouse (DWH)
The DWH stores all data of the Operational CRM non-volatile and time variant. It is possible to add further data from external data sources, e.g. from an Enterprise Resource Planning (ERP) System or other DWH. The DWH gives possibilities for data aggregation and for calculating new key figures. It is also the data source for the reporting system and the Data Mining.

Data Mining
In order to support the user's sustainability it is important to understand and even better to predict his behaviour. Data Mining provides methods like clustering, classification and association analysis to gain knowledge from data. E.g. it is possible with Data Mining to build clusters of customers who are travelling multimodal like "pragmatic" (cost- and use-oriented), "car-affine" (hard to influence) or "eco-oriented" (target group for very sustainable modes of transport). The results of Data Mining are transferred back in the DWH and from here to the operational CRM database, where they are used for marketing campaigns or for offering better fitting mobility options in connection with the other operational components.

Reporting
Reporting is the tool to present results from the analytical processes with different representation forms like web-reports, dashboards etc. In our case we have two main target groups for the reports. There are customers, who get information about their personal mobility behaviour, e.g. travel statistics with information about emissions, costs and time. This is again done with the goal to motivate for altering the travel behaviour. These reports can also be extended to customer networks or social networks in the sense of the above described incentive schemes. On the other hand mobility vendors get reports with information about customers, use and acceptance of their products, and they can use the information to enhance their services and communication, again with the goal to make customers moving more sustainable.

Case study
Besides the architecture we want to introduce a case study with the "Schaufenster Elektromobilität Niedersachsen", a national joint-venture project of scientific and industrial partners funded by the German government to show solutions for integrating electric mobility in Germany. The Carl von Ossietzky University of Oldenburg is participating in the subproject "IKT Services" and leader of the work package "Customer-oriented mobility" that addresses the support of electric mobility in a multimodal concept under criteria of sustainability with the focus on customer needs. The project started in the beginning of 2013 and will run over three years. The project partners are well-known German enterprises like VW and T-Systems as well as important national scientific institutes like Deutsches Zentrum

für Luft- und Raumfahrt e.V. The here presented architecture will be applied in the work package of the Carl von Ossietzky University of Oldenburg.

There are already two possible scenarios how the architecture could be applied. One is the integration in the CRM-concept of the "uestra- Hannoversche Verkehrsbetriebe", one of the partners of the Schaufenster. The uestra is a local provider for public transport and the integration of the here shown approach might help to win new customers by moving people from motorized individual transport modes to their own offers. Existing customer relations might be strengthen by stressing the sustainability aspects of their offers. The second option is to offer a pure information service for sustainable mobility directly provided by the Carl von Ossietzky University of Oldenburg. This might be an interesting offer for people who are already aware of sustainability issues and such a service might help to make them moving even more sustainable. In both cases the relevant stakeholders have to be identified, a specific CRM strategy has to be developed and the possible changes in mobility behaviour have to be discovered.

Although the project just has started, some interesting observations can be reported that are relevant for the here presented ideas. First of all, it is obvious that companies are not willing to share customer data with other companies. In case of this project, where also multimodal mobility services (e.g. car-sharing combined with public transport services) are planned to be offered to the customer from different vendors this is highly relevant. It might be a serious problem that has to be solved on a contract basis as well as on a technical basis, what may have deep consequences for the CRM architecture and the work package "Customer-oriented mobility". Already existing strategies and concepts for hybrid services from different vendors, e.g. from Amazon market place might help and will have to be adapted.

Conclusions and Outlook

In this article we presented the idea of a SusCRM for mobility. An architecture was described that can be used as a template to implement a software architecture that can be applied from companies as well as municipal administrations.

The application of the model in the project "Schaufenster Elektromobilität Niedersachsen" will give the chance for an evaluation of the concept.

Several projects are planned in the context of the "Schaufenster". Furthermore projects are planned in the city of Oldenburg in the smart city context under participation of local companies, the municipal administration and the Carl von Ossietzky University of Oldenburg, e.g. for E-Bike sharing services.

References

[1] Arnold, H., Kuhnert, F., Kurtz, R., Bauer, W. (2010): Elektromobilität – Herausforderung für Industrie und öffentliche Hand. Retrieved April 2011 from http://wiki.iao.fraunhofer.de/images/studien/elektromobilitaet-herausforderungen-fuer-industrie-und-oeffentliche-hand.pdf.

[2] Belz, F M & Peattie, K (2009): Sustainability Marketing - a global perspective. Chichester, West Sussex: Wiley & Sons.

[3] Dangschat J, Segert A (01. 02 2011): Nachhaltige Alltagsmobilität – soziale Ungleichheiten und Milieus. Österreichische Zeitschrift für Soziologie, S. 55-73.

[4] De Boor, J. (2001): Ein starker Auftritt des RBB. In: Der Nahverkehr 05/2001.

[5] Deutscher Bundestag (1998): Konzept Nachhaltigkeit - Vom Leitbild zur Umsetzung, Abschlussbericht der Enquête-Kommission "Schutz des Menschen und der Umwelt" of 13th Deutschen Bundestages. Bonn: Universitäts-Buchdruckerei.

[6] EEA Energy Environment Agency (2011): Transport final energy consumption by mode. Retrieved April 2011 from http://www.eea.europa.eu/data-and-maps/indicators/transport-final-energy-consumption-by-mode/assessment.

[7] EPPOMM European Plattform on Mobility Management (2007): Mobility Management: a Definition – The Definition of Mobility Management and the Categorisation of Mobility Management Measures as approved by the MAX-consortium and EPOMM. Retrieved March 2012 from http://www.epomm.eu/docs/mmtools/MMDefinition/MMDefinition_english.doc.
[8] Gottschalk T, Toyoda S, Watts P (2001): The Sustainable Mobility Project. World Business Council for Sustainable Development.
[9] Grant, J (2007): The Green Marketing Manifesto. England: John Wiley & Sons Ltd.
[10] Hauff, V (Ed.)(1987): Unsere gemeinsame Zukunft: Der Brundtland-Bericht der Weltkommission für Umwelt und Entwicklung. Greven: Eggenkamp Verlag.
[11] Hilty, L M (2010): Information and Communication Technologies for a more Sustainable World. In Information and Communication Technologies, Society and Human Beings: Theory and Framework, D. Haftor and A. Mirijamdotter, Eds. IGI Global, Hershey, New York, 410-418.
[12] Hilty, L M, Lohmann, W, and Huang, E M (2011): Sustainability and ICT – An overview of the field. notizie di POLITEIA 27, 104, 13-28.
[13] Hippner, H & Wilde, K D (Ed.)(2006): Grundlagen des CRM: Konzepte und Gestaltung. 2nd Edition. Wiesbaden: Gabler Verlag.
[14] Huber, J (2000): Industrielle Ökologie: Über Konsistenz, Effizienz und Suffizienz. In: ifeu (2010). Datenbank Umwelt & Verkehr 2010. Retrieved November 2010 from www.ifeu.de.
[15] IBM Research (2012): Das Battery 500-Projekt: 800 km Reichweite für Elektroautos. Retrieved March 2013 from: http://www.zurich.ibm.com/news/12/battery500_d.html.
[16] Kaiser, M-O (2005): Erfolgsfaktor Kundenzufriedenheit: Dimensionen und Messmöglichkeiten. 2nd Edition. Berlin: Erich Schmidt Verlag.
[17] Kantsperger, R (2006): Modifikation von Kundenverhalten als Kernaufgabe von CRM. In Hippner. H & Wilde K D. (Ed.), Grundlagen des CRM: Konzepte und Gestaltung (pp. 291-304). Wiesbaden: Gabler Verlag.
[18] Kirchgeorg, M (2002): Nachhaltigkeits-Marketing. Integration bestehender Erkenntnisse oder konzeptionelle Erweiterung?. UmweltWirtschaftsForum, 10 (4), pp. 4-11.
[19] Rautenstrauch, C (1999): Betriebliche Umweltinformationssysteme. Grundlagen, Konzepte und Systeme. Springer, Berlin Heidelberg.
[20] Schellong, A (2008): Citizen Relationship Management. Frankfurt: Peter Lang.
[21] Scholl, G (2009): Marketing nachhaltiger Dienstleistungen – Bedingungen der Übernahme und Empfehlungen zur Vermarktung von eigentumsersetzenden Praktiken. Marburg: metropolis Verlag.
[22] Schreiner, M (2007): Multimodales Marketing nachhaltiger Mobilität als Teil des integrierten Mobilitätsmanagements. Mannheim: MetaGIS-Systems.
[23] Teuteberg, F & Marx Gómez, J (2010): Corporate Environmental Management Information Systems: Advancements and Trends. IGI Global.
[24] Timmers, P (1999): Electronic Commerce- Strategies and Models for Business- to- Business Trading. John Wiley & Sons, Chichester.
[25] Wappelhorst, S (2011): Mobilitätsmanagement in Metropolregionen. Retrieved December 2012 from: http://d-nb. info/1010758527/34.
[26] Wagner vom Berg, B., Köster, F., Marx Gómez, J. (2010). Elektromobilität: Zukunft oder Gegenwart? - Förderung der Elektromobilität durch innovative Infrastruktur- und Geschäftsmodelle. In Schermann, M. (Ed.), MKWI 2010 Working Conference on Automotive Services (pp.111-124). Norderstedt: Books on demand GmbH.
[27] Weidlich, A (2010): Geschäftsmodelle Elektromobilität. Paper presented at the Fünfzehntes Kasseler Symposium Energie-Systemtechnik 2010. Kassel: Fraunhofer IWES.
[28] Wissenschaftszentrum Berlin für Sozialforschung (2004): Die Mobilitätsmaschine – Versuche zur Umdeutung des Autos. Berlin: edition sigma.
[29] Zängler, T (2000): Mikroanalyse Des Mobilitätsverhaltens in Alltag und Freizeit. Springer, Berlin.