Contributions to Enterprise Content Management and Qualitative and Quantitative Decision Support

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Betreuer und Gutachter:	Prof. Dr. Michael H. Breitner
Weiterer Gutachter:	Prof. Dr. Jan vom Brocke
Vorsitzender der Prüfungskommission:	Jun.-Prof. Dr. Hans-Jörg von Mettenheim
Weiteres Mitglied (beratend):	Dr. Ute Lohse

I. Abstract

Decision-making is an important and yet also complex process. New technologies, increased interconnectedness, and digitalization provide access to tremendous amounts of data as input for decision making processes. Decision support is highly relevant in practice and in need of further research. Within this cumulative doctoral thesis, exemplary studies in the context of qualitative and quantitative decision support are presented and discussed based on the corresponding research papers. The thesis is thematically divided into three main parts. Part A revolves around qualitative data in form of enterprise content. To manage the huge amounts of particularly unstructured data, Enterprise Content Management (ECM) evolved as an integrated approach to Information Management (IM) on an enterprise-wide scale. In the context of several theory-induced and also practice-oriented research studies, it is indicated that ECM systems have the capabilities to support qualitative decision support and Knowledge Management (KM). Part B deals with expert opinions and survey-based decision support. Within two exemplary studies, information derived from qualitative and quantitative survey data, such as questionnaires and expert opinions, are used to promote decision support and making. Part C focusses on quantitative data and optimization-based decision support. Several real world applications are investigated and indicate that Decision Support Systems (DSS) allow complex decision making and problem solving based mostly on numeric and quantitative data. Decision support based on quantitative and also on qualitative data allows to prepare organizational decision making and can lead to better and less effortless decisions. Due to the ever-increasing creation of massive amounts of data, the relevance of decision support to gain technology-based competitive advantage will further increase in the future.

Keywords: Enterprise Content Management (ECM), Decision Support, Decision Support System (DSS), Optimization, Car Sharing, Green IS, Reference Model, Survey Research, Nexus of Forces, IS Governance, Grounded Theory.

II. Management Summary

Decision-making is an important task and essential for each of us on a daily basis. Good and timely decisions are to be prepared based on manifold kinds and huge amounts of data in order to find the best alternative. To make an important decision, rational decision makers gather all kinds of information from diverse sources to first prepare the decision and then select the best alternative based on the available information. New technologies, increased interconnectedness, and digitalization allow people to access tremendous amounts of data as input for decision making (Fichman et al., 2014; Herrera, 2007). The increasing amount of data is a gift, but also a curse since "information has gone from scare to superabundant" (The Economist, 2010).

Decision support based on qualitative and quantitative data is highly relevant in practice and in need of further research. Firms strive to analyze and make use of quantitative transactional data to improve decision making (Davenport et al., 2001). Qualitative and unquantifiable data is another important source of decision-relevant information and makes up the biggest part of the data since approximately 80% of the data in organizations is unstructured (Gartner Group as cited in O'Callaghan and Smits, 2005). In fact, enterprise content and unstructured documents are increasingly becoming a key business resource because it contains important, innovative, and decision-relevant information (Rickenberg et al., 2012a, 2012b). Qualitative information derived from subjective assessment of the complex and dynamic business environment belongs to the information needs of decision makers of modern organizations (Herrera, 2007). Expert opinions and know-how can be gathered e.g. by interviews and questionnaires within surveys and represents decisive qualitative and quantitative information.

Within this cumulative doctoral thesis, particular exemplary studies in the context of qualitative and quantitative decision support are presented and discussed based on the corresponding research papers. The thesis is thematically divided into three main parts: Part A revolves around qualitative data in form of enterprise content, Part B deals with expert opinions and survey-based decision support, and Part C focusses on quantitative data and optimization-based decision support. All research contributions can be consolidated under the umbrella of business decision aid and making.

PART A: To manage the huge amounts of unstructured data, Enterprise Content Management (ECM) evolved as an integrated approach to Information Management (Päivärinta and Munkvold, 2005). It enables the management of particularly unstructured content on an enterprise-wide scale (Rickenberg et al., 2012a). As it is highly relevant for practice, the market for software and consulting is booming (Andersen, 2008; Herbst et al., 2014; Wiltzius et al., 2014). In contrast to the significant attention from practitioners, ECM only received little consideration from scholars (Tyrväinen et al., 2006; Rickenberg et al., 2012a). As a relevant but emerging field in IS research, it has been largely ignored by the IS discipline (Simons and vom Brocke, 2014). Most authors state that few research has been conducted so far (Tyrväinen et al., 2006) and that scientific literature is very limited (Alalwan, 2012b; Grahlmann et al., 2012).

To set the basis for advancing knowledge and rigorous research, a systematic and coherent review of ECM literature in the IS domain is conducted which includes 68 articles in 2012 and an update of 58 articles in 2014 (chapter 2). Based on the framework for ECM research as introduced by Tyrväinen et al. (2006), the articles are reviewed, classified, and categorized and main topics were derived in a concept-centric way. The framework for ECM research is refined based on the reviewed literature and the application of coding techniques, see right hand side of Figure I. Implications for further research and practice are derived based on the reviewed literature and findings.

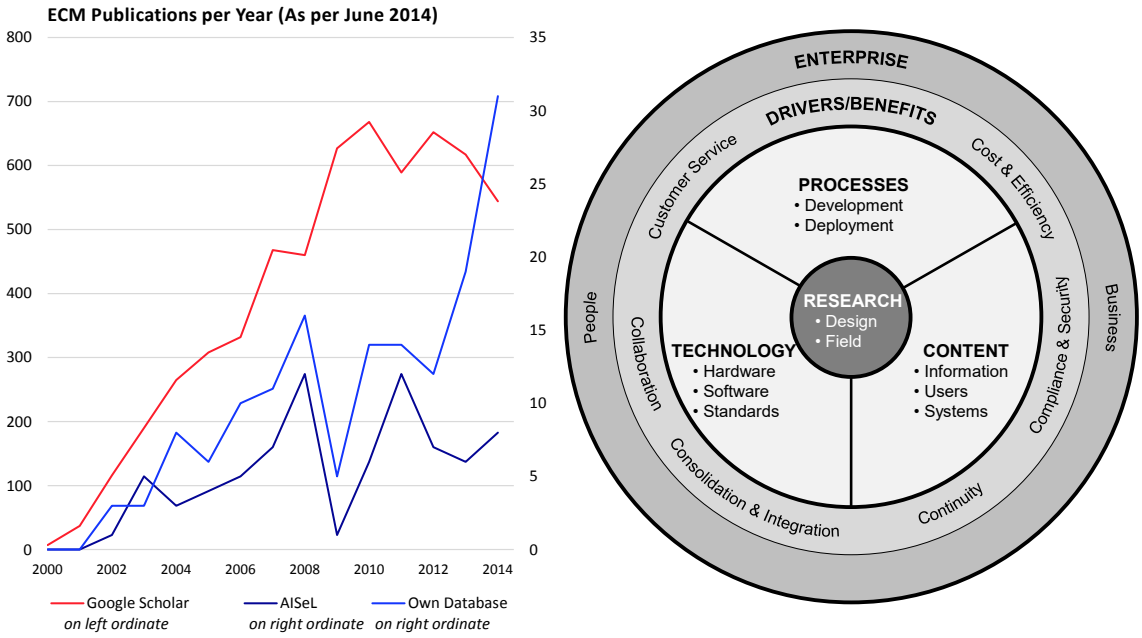

Figure I: **Number of ECM Publications and Extended Framework for ECM Research, Based on Rickenberg et al. (2012a).**

The comprehensive, in-depth review helps practitioners and scholars to get started with the complex and multifaceted topic of ECM. The body of literature of the emerging field is small but steadily growing, see the number of ECM publications per year on the left hand side of Figure I. The literature from the IS domain tends to be less technical than in the first years of research and focuses more on organizational aspects.

Companies still struggle with the identification, assessment, classification, and visualization of the huge amounts of content that are created at ever increasing rates each year. Towards these ends, a process-oriented approach that uses the business process structure as an entry point to enterprise content is presented (chapter 3). As shown in Figure II below, this comprises practical guidelines, the 7W Framework for content classification (left hand side), and different visual representations (right hand side) including a document map. The actual practical usefulness of a document map is shown by the assessment and use of it in an engineering company as per 2014. Based on this and in order to provide more business value, enterprise content can be assessed and classified based on the perspective of knowledge components to transform content into organizational knowledge. An approach is presented that applies a knowledge perspective on ECM in a knowledge-based framework for assessing, classifying, and managing enterprise content. The Knowledge-Based Content Management (KBCM) framework (chapter 4) consists of different research artifacts on different level of abstraction.

Category	Attribute	Attribute value
WHAT	Document Type Process Origin Destination Association Template	String: *GENERIC NAME* Classified: *PROCESS NUMBER/NAME* *Classified: *OWN CREATION, INTERN, EXTERN* *Classified: *OWN USE, INTERN, EXTERN* Classified: *ASSOCIATED WITH OTHER CONTENT*, no Classified: *EXISTING*, not existing
WORTH	Confidentiality Relevance	Classified: open, intern, confidential, (top) secret Classified: low, medium, high, very high
WHERE	Storage Location Archive Location	*Classified: *LOCAL, FILE SERVER, EMAIL, PAPER-BASED, INFORMATION SYSTEM (ERP, CRM, ETC,), OTHER* Classified: *KNOWN ARCHIVE*, unknown, none
WHICH FORMAT	Storage Format Archive Format Naming Convention Storage Convention	*Classified: .doc, .xls, .ppt, .pdf, image, plain text, paper, *OTHER* Classified: as storage format, *OTHER, none* Classified: *KNOWN*, unknown Classified: *KNOWN*, unknown
WHO	Owner Involvement	String: *PERSON* String: *PERSONS, DEPARTURES, COMPANIES*
WHEN	Creation Publication Archiving Deletion Creation Frequency Change Frequency Frequency of Use States	String: *GENERIC POINT OF TIME* Classified: *DATE KNOWN*, unknown Classified: *DATE KNOWN*, unknown Classified: *DATE KNOWN*, unknown Classified: low, medium, high Classified: low, medium, high Classified: low, medium, high Classified: in process, finished, approved, published, locked, active, inactive, *OTHER*, not appl.
WHY	Storage Reason Retention Period Audit-Proof Version Control	String: *GENERIC REASON* Classified: DURATION, none Classified: yes, no Classified: yes, no

SMALL CAPS: Further Specification needed/possible,
*: Multiple Choice, Underlined: Main Attribute

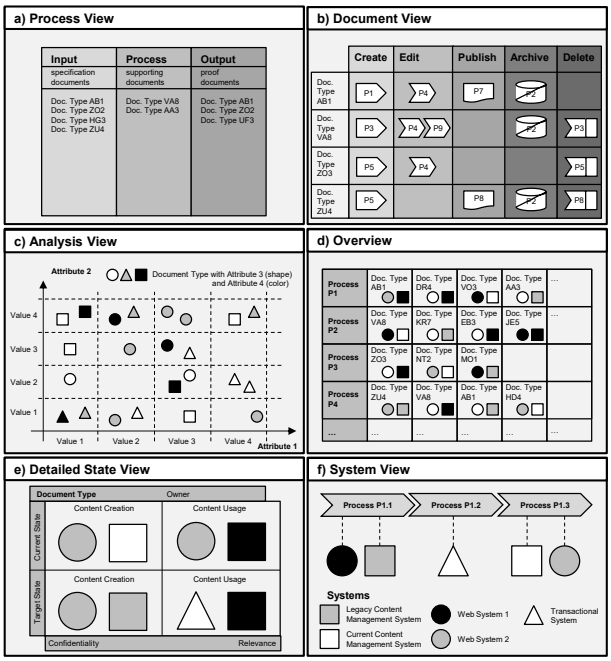

Figure II: 7W Framework and Visual Representations, Based on Rickenberg et al. (2012b).

From a theoretical point of view, the ECM research field and its current state are in need of thorough investigation, especially concerning its relevance, implications, and future development. Accordingly, the ECM research domain is analyzed, synthesized, and evaluated using grounded theory methodology to create theoretical foundations and investigate its status quo (chapter 5). An overview and formal description of the grounded theory is shown in the narrative framework for ECM research in Figure III.

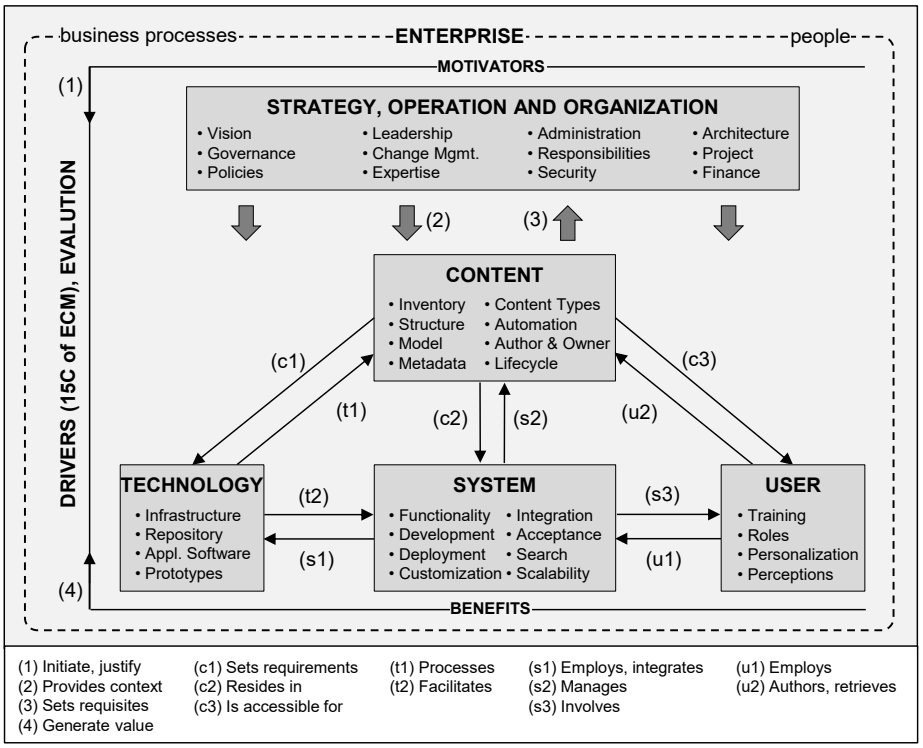

Figure III: Narrative Framework for ECM Research, Based on Rickenberg and Breitner (2014a).

ECM research is relevant but more rigorous research, further theory building, and discussions are necessary to increase its maturity and positively influence its future progress. Research topics need to be adjusted to address the enterprise-wide scope and the challenging, complex integration of preceding and related concepts into a holistic view, which represents a key characteristic and a main implication of ECM. To conclude Part A, ECM systems have the capabilities to support qualitative decision support, however, enterprise content is hardly used systematically to provide decision making information.

PART B: Deriving information from questionnaires and expert opinions, surveys are able to promote decision support and making. Survey research allows to gather information of a large group of people and is conducted to advance scientific knowledge (Pinsonneault and Kraemer, 1993). With varying degree of formalization and structuredness, both – qualitative and quantitative data from surveys – serve as an important input

for data analysis and synthesis, which then can enable survey-based decision support. Two examples are presented which focus on deriving information from survey data. The current era is shaped by the Nexus of Forces which comprises big data, social, mobile, and cloud computing as all-embracing trends. Based on qualitative survey methods employed in an iterative Delphi study, a reference model and initial insights are provided to address the challenges and influences that the interacting forces pose to organizations and governance structures (chapter 6). The IS governance reference model for the Nexus of Forces is shown in Figure IV. It encourages clear communication and provides IS researchers with a basis to develop specific models. Concerning IS practice, the model allows organizational decision makers to derive an effective IS governance implementation. As a result of consumerization pressure, corporate and IS governance structures need to be adjusted to increase the role of corporate governance regarding IS decisions. Hybrid governance approaches and federal archetypes are key areas for future research.

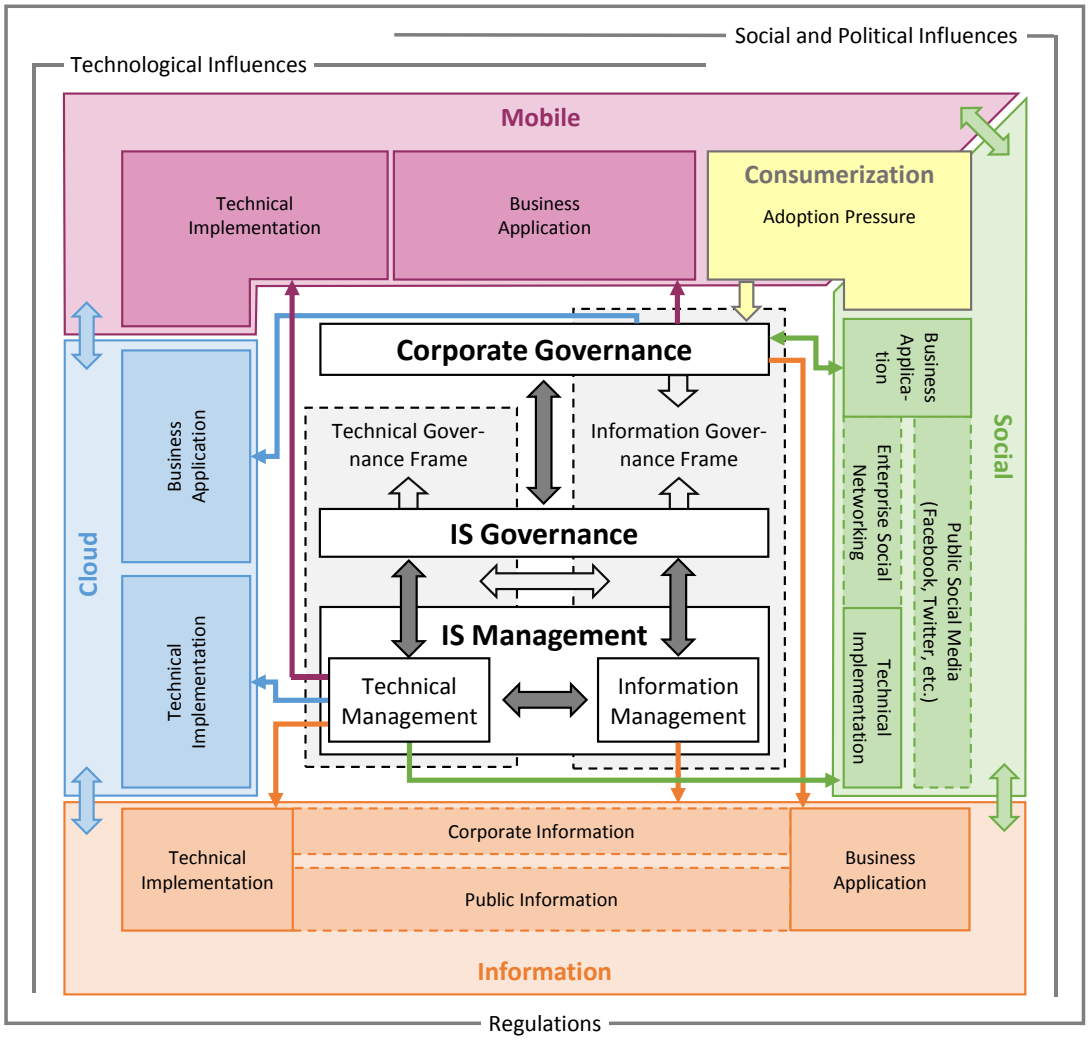

Figure IV: **IS Governance Reference Model for the Nexus of Forces, Based on Lebek et al. (2014).**

With regard to the abstract and high-level question of how IS can contribute to achieve the Millennium Development Goals (MDGs) and build a better world, decision support based on survey research methodology and a questionnaire is provided (chapter 7). Qualitative and quantitative survey data gathered from leading IS researchers indicates that with the right focus and alignment, IS practice and the underlying research domain has the potential to take on the big questions and can help to build a better world. Exemplary quantitative results concerning the MDGs are shown in Figure V.

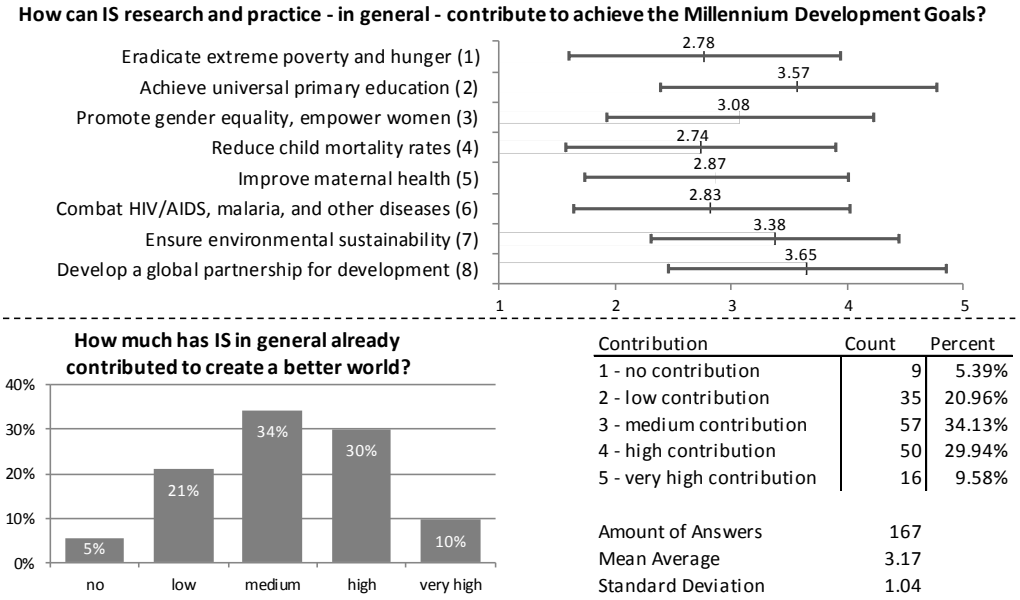

Figure V: Results of a Survey among IS Researchers on How to Build a Better World with IS, Based on Rickenberg et al. (2014).

The survey aims to provide a starting point, create awareness, and stimulate further discussions and research. Besides positive aspects, it also reveals challenges and critique concerning IS research. While IS research is currently mediocre at best, the IS community needs to step up and challenge established practices and habits to increase the relevance and impact. To conclude Part B, information derived from qualitative and quantitative survey data is able to contribute to decision support and decision making.

PART C: Focusing on mostly numeric data, Decision Support Systems (DSS) allow to analyze huge amounts of data and prepare organizational decision making (Huber, 1981), which can lead to better respectively less effortful decisions (Todd and Benbasat, 1992). DSS are “interactive computer-based systems that help people use computer communication, data, documents, knowledge, and models to solve problems and make decisions” (Power, 2002). Concerning optimization-based decision support with quantitative input data, several real-world examples of complex decision making and problem

solving are presented. These examples evolve from the application domains transportation and scheduling and are illustrated based on the implemented (prototype) DSS.

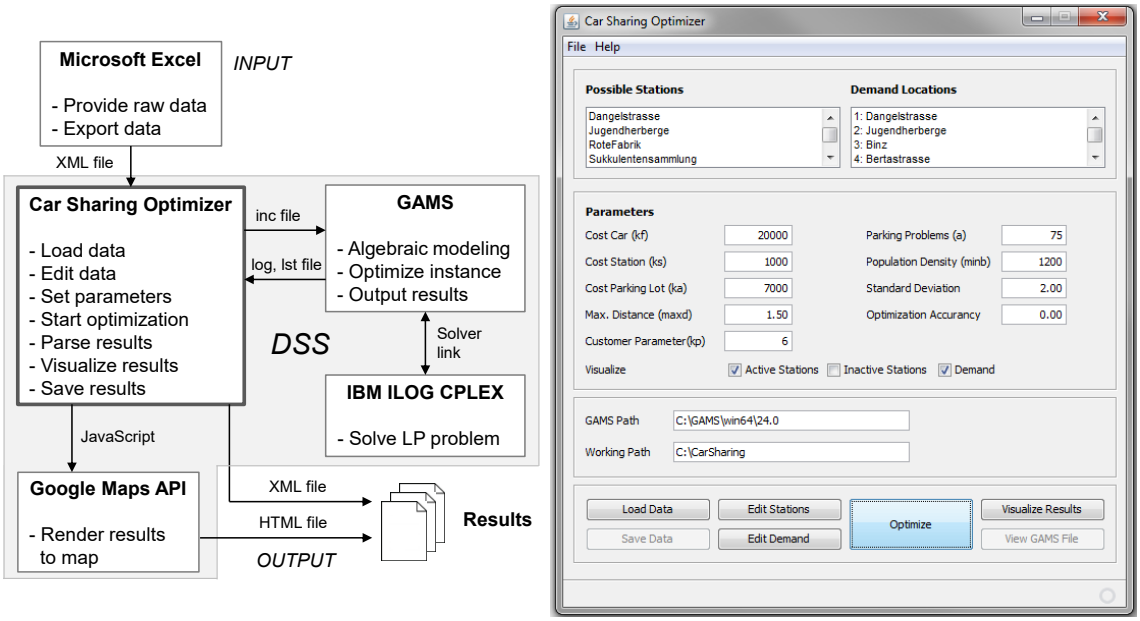

Figure VI: System Architecture and Data Flow and GUI with Data, Parameters, and Functions, Based on Rickenberg et al. (2013a) and Olivotti et al. (2014).

Car sharing is a sustainable mobility concept that allows urban individuals to share a car sequentially, but the positioning and sizing of stations is challenging. An optimization model is presented to determine the prime location and size of car sharing stations (chapter 8). To enable numerical solving and instant visualization, the model is integrated into the DSS OptCarShare 1.0, which is shown in Figure VI. Within two application examples with varying parameters, it is illustrated that the research artifacts provide decision support for planning car sharing stations and can thus contribute to environmental sustainability according to Green IS. Electric car sharing represents an approach to further increase the sustainability of car sharing, but its profitable operation still poses a problem. The existing optimization model and DSS are refined to match the specific characteristics and parameters of electric car sharing and further demonstrated and evaluated within an illustrative example (chapter 9). The benchmark results with the DSS OptECarShare 1.5 indicate that profitable operation of electric car sharing is possible nowadays. In the context of sustainable freight transport and scheduling of prototypes, further application examples and research questions about decision support by quantitative optimization are investigated briefly (chapter 10). To conclude Part C, DSS allow complex decision making and problem solving based mostly on quantitative data.

Based on the current trends of cloud, mobile, and social computing and the massive data streams, ECM will evolve in the future. Cloud and mobile ECM allow to access enterprise content from everywhere and at any time. Social computing aspects such as Enterprise Social Networking (ESN) enable social networking in the professional business context inside of organizations. A consolidation of ECM and ESN allows an integrative perspective on content, people, and processes. The Internet of Things, Industry 4.0, and sensor data will create even more massive data streams that can be analyzed, e.g. with big data approaches, to create information and additional value. All these trends coming from practice will be of growing importance within the next years and need to be analyzed from a theoretical point of view in further research. Innovating forces and technology waves, such as social computing, mobility, the cloud, and big data analytics impose dramatic changes to businesses, economies, societies (Goes, 2013). The Nexus of Forces which combines these four trends will have strong and broad impact on business organizations and all kinds of organizations, but also on people and societies in general.

Environmentally sustainable development and Green IS encompass important issues and are of increasing relevance for the IS research community. Efficient car sharing and especially electric car sharing networks can help to reduce emissions within cities and also decrease the total amount of cars in cities. Next to environmental issues, IS research should also put more emphasis on important contemporary societal issues and needs to take on the big questions and global challenges (Rickenberg et al., 2014). The promotion of social and sustainable goals and review metrics to measure the impact and contribution of IS research is needed. Thus, the IS research community can really take on humanity's grand challenges and strive to reach high level goals.

To conclude thematically, decision support based on quantitative and also on qualitative data allows to prepare organizational decision making and can lead to better and less effortless decisions (Todd and Benbasat, 1992). Due to the ever-increasing creation of massive amounts of data, modern organizations, consultants, scientists, and academics have to direct their attention to "[…] the generation of knowledge and intelligence to support decision making and strategic objectives" (Goes, 2014). Along these lines and as motivated here, the relevance of qualitative and quantitative decision support to gain technology-based competitive advantage will further increase in the future.

III. Table of Contents