Towards Identifying the Business Value of Big Data in a Digital Business Ecosystem: A Case Study from the Financial Services Industry

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Abstract. In today's increasingly digital business ecosystem, big data offers numerous opportunities. Although research on big data receives a lot of attention, research on the business value of big data is scarce. The research project presented in this article aims at advancing the research in this area, focusing on the identification of opportunities towards determining the business value of big data. The goal of the research project pursued is to develop a framework that supports decision makers to identify opportunities for attaining business value form big data in the financial services industry. The proposed framework was constructed based on information collected by performing an in-depth literature review and interviews with experts in the area of big data and financial services industry, and it was empirically validated via a questionnaire sent to experts. A comparative analysis was also performed, emphasizing the strengths of the proposed framework over existing approaches.

Keywords: Big data · Business value · Financial services industry · Case study · Digital business ecosystem

1 Introduction

The business world is rapidly digitalizing, creating new opportunities for companies [1]. Data and information are currently becoming primary assets for many organizations [2], which make extensive use of information and communication technologies (ICT) to collect, store and process digital data. This trend and the recent ICT developments determined the use of the term big data, which involves storing and analyzing data, and transforming data into knowledge (and information) that ultimately contribute to the value of an organization. Characterized by the enormous volume, variety, and velocity of data [3–6], big data brings numerous opportunities for businesses in today's increasingly digital business ecosystem. Examples of applications of big data in commerce and business, society/administration, and scientific research are illustrated in [7]. Analytical tools coming from big data can make complex insights easier to understand and make

W. Abramowicz et al. (Eds.): BIS 2016, LNBIP 255, pp. 28–40, 2016.
DOI: 10.1007/978-3-319-39426-8_3

this information immediately ready to use at every point in the organization and at every skill level [8]. The potential of big data to create value is also emphasized in a recent report by McKinsey Global Institute [9].

Although the potential of big data to generate value is recognized, the review of previous studies revealed that this topic is not extensively explored, and, in general insufficiently understood. Most studies are focusing on technological aspects of big data, neglecting business-related aspects. The business value of big data is of high relevance especially for the financial services industry. In fact credit card companies represent one of the main investors in big data [10]. Banks make use of big data analytics for customer segmentation and profiling, product cross selling based on the profiling, spending patterns of customers, channel usage, sentiment and feedback analysis and security and fraud management [11]. However, banks are struggling to profit from increasing volumes of data [12]. Additionally, a comprehensive approach to identify the potential value of big data that can support stakeholders or decision makers in the financial services industry is not yet available.

The research project presented in this article addresses this gap. The goal of the research project pursued is to develop a framework that supports decision makers to identify opportunities for attaining business value[1] out of big data in the financial services industry. The proposed framework was constructed based on information collected by performing an in-depth literature review and interviews with experts in the area of big data and financial services industry, and it was empirically validated via a questionnaire. A comparative analysis was also performed, emphasizing the strengths of the proposed framework.

This paper is structured as follows. Section 2 presents the methodology followed. Relevant concepts are referred next. The proposed framework is described in Sect. 4. The case study validation is presented next. A comparative analysis of the proposed framework with existing approaches is then discussed. The paper concludes with a section summarizing the results and addressing the needs for future research.

2 Methodology

The main research question that guided this research work is: *How can the business value of big data be determined in the area of financial services?*

The research approach developed to answer this research question is illustrated in Fig. 1, following a design science approach [13]. Firstly, the environment is established. In this research study, the need of the design of a framework illustrating the business value of big data in the financial services industry is posed. The knowledge base is used as a foundation to build the artefact, which is the actual conceptual framework. A document study (Step 1) and interviews (Step 2) are performed to build the first draft of the conceptual framework that indicates how business value can be created from investing

[1] Within the scope of this research project, the term business value refers to the financial gains (e.g., expressed in monetary units, such as increased profit), and non-financial gains (e.g., competitive advantage, productivity enhancement) of an organization.

in big data (Step 3). Interviewees were chosen based on their affiliation with business intelligence and big data. This process was repeated multiple times to refine the developed framework. The knowledge base is also used to provide methodologies for the evaluation step (Step 5). In the first three steps the elements for the framework are selected. The validity of the cause and effect relations is verified via a questionnaire. The survey, with the conceptual framework as input, is only distributed to persons with knowledge on business intelligence and big data. The results of the survey are processed in the final framework in consultation with experts. As a last step, the developed framework is empirically validated. Step 5 also served to gain practical insights with respect to the use of the proposed framework in practice. Altogether, the last part of the research project concerned the analysis of the results, final refinement of the framework and the elaboration of a set of recommendations for future research work.

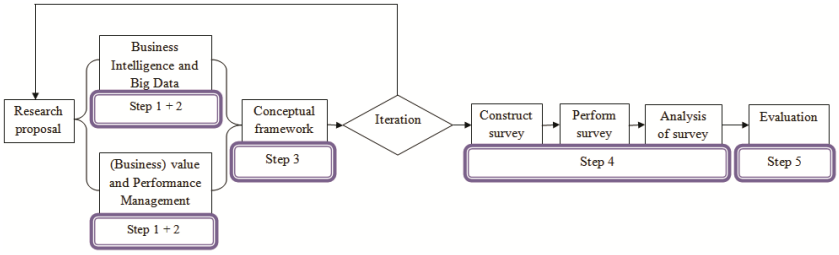

Fig. 1. Research methodology

3 Business Value and Big Data: An Overview

In basic terms, big data refers to datasets that are large in volume, diverse in data sources and types, and created quickly, resulting in bigger challenges in harvesting, managing and processing them via traditional systems and capabilities [14].

Companies must undergo substantial changes in order to make use of big data, which requires a significant investment in technology, and the formulation of an adequate strategy within the organization [15]. Numerous challenges are associated with big data, e.g., difficulties in data capture, data storage, data analysis and data visualization [7]. Designing, developing, and implementing data management systems that live up to the access and speed requirements is a highly complicated process [10]. Big data solutions become actually successful only when people, processes, and technology are integrated [10, 16–18].

Big data gets increasing attention in the financial services industry because accurate, consistent management of both financial data and customer information is essential to be successful in this industry [10]. The variety of data can have an impact on organization's risk measurements and its trading and investment performance. According to [5], using big data can translate into operational, financial, and business gains, and quicker access to cleaner, more relevant data to drive insights and optimize decision making. An additional benefit for this sector refers to the use of big data analytics for regulatory compliance [10]. The impact of big data analytics in the banking sector in India is

discussed in [11], with emphasis on six aspects: customer segmentation and profiling, product cross selling based on the profiling, spending patterns of customers, channel usage, sentiment and feedback analysis and security and fraud management. However, a comprehensive approach to identify the business value of big data in this sector that can be used by decision makers is not provided.

As emphasized in [19], the ultimate role of data is to support decision making. Executives now want to run businesses on data-driven decisions, to understand optimal solutions based on complex business parameters or new information and they want to take actions quickly [8]. The utility of big data for data-intensive decision-making is emphasized in numerous works, e.g., [7, 20]. Researchers, policy and decision makers have to recognize the potential of harnessing big data that can generate growth in their fields, and the potential benefits it brings, including: increase in operational efficiency, identification and development of new products and services, identification of new customers and markets [7]. Companies can significantly improve their business performance simply by focusing on how operating data can inform daily decision making [21]. Top-performing organizations actually use analytics five times more than lower performers [8]. A reason for which companies do not make better use of data analytics might be that their management practices have not caught up with their technology platforms [22]. Besides the technological shift, the difficulties related to the cultural shift made by adopting an evidence-based decision making tool needs to be considered.

Research on economic and business-related aspects of big data is scarce. Although several approaches are available to measure value (e.g., value of IT, value of business intelligence, such as: [23–25]), scarce research focuses on the business value of big data. Banks are striving to profit from increasing volumes of data [4]. Benefits of big data are described, but no concrete process or framework is advanced that shows how business value can be created from investing in big data. However, the importance to understand the business value of big data is highly emphasized, e.g., [24, 26]. Preconditions that need to be met to create business value for a specific environment are discussed in [27]: technical development and project management, strategic alignment, process engineering, change management. Three main ways for performance assessment are identified in [28]: performance indicators, benchmarking methods and frameworks for performance assessment. In the context of big data, frameworks are recommended to be used to capture the (potential) business value of big data, representing the most qualitative method for performance assessment.

Several performance measurement frameworks were identified and examined considering the scope of this research work: the Balanced Scorecard of Kaplan and Norton [29, 30], Performance Pyramid of Lynch and Cross [31], Kanji's Business Scorecard [32], and the Performance Prism [33]. These performance frameworks all have predefined measurements that are used to compare the organization's results with predefined standards. The Benefit Logic Model developed by Capgemini [34] was also analyzed in this project. Traditionally, the Benefit Logic Model was used to define a cause-effect diagram that shows how solutions contribute to cash flow generation. The final solutions presented on the left side of the model are linked to the drivers presented in the middle of the model that represent the cause and effect relations to reach the final goal. Only the solutions and drivers that are mentioned more than once are used in the

conceptual framework. This final goal is presented at the right side of the model, which is cash flow generation in the traditional diagram. Cash flow generation can be created by increasing revenue or decreasing costs. Breaking down these two sides into smaller parts will lead to improvement opportunities that can be reached by implementing the solutions [16].

Although the (potential) benefits of big data and analytics are generally recognized, a key adoption obstacle remains the lack of understanding of how to leverage analytics for business value. This research work covers this gap by advancing a value framework for investing in big data, following the Benefit Logic Model by Capgemini [34]. This model is chosen as a basis for the development of a value framework of big data for the financial services industry because of the clear overview, the focus on value, and the structured approach of the model. The Benefit Logic Model describes how value can be created without quantifying it, which makes it very usable for this study. Moreover, with the Benefit Logic Model it is possible to provide insight into the value of big data without other elements, e.g., infrastructure, actors.

4 Framework Design and Validation

4.1 Data Collection

The conceptual framework developed and presented in this article was elaborated after pursuing an in-depth literature review (using various retrieval systems e.g. ABI/Inform, ScienceDirect, and Emerald) and interviewing experts in the fields of financial services and big data[2]. The key design issue was capturing the value of investing in big data for the financial services industry. The information from the document study was used as input to define the questions for the semi-structured interviews. Specific information about factors that influence the value of big data was also considered, e.g., drivers leading to positive cash-flow, solutions that could be implemented right away. The structure of the interview and examples of questions in each category are provided in the *Appendix*.

4.2 Framework Elements

The collected information determined the identification of preconditions, drivers and solutions that need to be implemented to gain value from investing in big data in the financial services industry. These elements were included in the first draft of the conceptual framework that shows the cause and effect relationships between all the factors. Two iterations were performed to optimize the quality of the conceptual framework and to ensure the focus on big data and financial services industry.

[2] In total eight semi-structured interviews with experts in the field of financial services and big data were conducted. Semi-structured interviews were used because they give the companies' perspective on this topic and could confirm insights that come from the document study. The purpose of the interviews was to acquire information about their vision on big data, possible approaches to assess the business value of big data and the potential benefits an organization would gain by investing in big data.

Three preconditions that have to be met at all times in order to gain value from the investment were included in the framework: privacy, security, and compliance to regulations. The solutions that have to be implemented to gain value refer to: installing the hardware and software required by big data, performing analytics and applying visualization techniques, creating a project team to create culture, methods, and provide training, and attracting new employees who fit best with a big data environment. It is important that the hardware and novel software tools are used in combination with the existing IT landscape to be efficient and cost-effective, and the new processes derived from using big data techniques are synchronized with the current processes to ensure that inter- and intra-organizational business processes are executed without errors. Note to neglect is that employees and management need to change the mindset to a new way of working with big data and that they need specific trainings to use the new technology. When employees are trained to work with big data and master it, they will probably be more satisfied, leading to a decrease in employee costs. The relation between attracting new employees, employees' satisfaction, and decrease in employee costs is the only relation not shown in literature, being based only on information from the interviews. All the other relations are supported by the document study and interviews with experts.

The drivers for value were also identified. Only the solutions and drivers that were mentioned more than once were included in the framework. The driver 'event-driven marketing' was combined with the driver 'customized offering' because both aim at providing a personalized offer for a customer. The drivers 'real time information delivery', 'increase of agility/velocity', and 'discovering the total experience of customers' are linked to the driver 'process insight' because they all refer to the same factor. This driver includes (real-time) insights in the behavior of customers and processes and delivers the information as fast as possible. The solution 'change in mindset of employees' was combined with the solution 'investing in change management' since it is actually a part of change management.

4.3 Case Study Validation

To validate the developed framework, a case study was performed. The collected information allowed the refinement of the developed framework. The case study analysis was performed through a questionnaire. Every question included in the questionnaire corresponded actually to a line of the framework, indicating to what extent the respondent agrees with this linkage between two factors. All questions are presented with the key design issue of capturing the value of big data in the financial services industry. The questions were closed questions with the answering options based on a five point Likert scale going from 'strongly disagree' to 'strongly agree'. Additionally, personal information was requested to characterize the sample. At the end of the questionnaire it was possible for respondents to provide comments.

51 experts responded the questionnaire, from which 19 completely filled in the questionnaire. To check if the missing data of the respondents is random or systematic, the Little's MCAR $\chi 2$ test was performed. The significance of the test is 1,000 (> 0,05), which means that the missing data is completely at random. Therefore it is only possible to use regression based methods to fill in the missing values [35]. The cases with more than 15 %

of missing values had to be deleted because completing them would cause too much bias [35]. The questionnaire contains 69 variables. Thus, the cases with more than 10 missing values were deleted. This resulted in a deletion of 24 cases, leaving 27 cases of which 8 were incomplete. These 8 cases were completed using the regression based method mean substitution to have a slightly bigger dataset. Accordingly, the blank spots were replaced by the mean of that variable based on answers from other respondents. Ultimately, a dataset of 27 complete cases was constructed and used for analysis.

4.4 Characterization of Respondents

The respondents were asked to provide information about certain demographics, such as: gender, age, nationality, education, current industry sector, current company, job status, and the number of years they worked at the current organization. From the 27 respondents, 21 are males (77,8 %), and 12 respondents belong to the category 21–35 years old (44,4 %), 11 belong to the category 36–50 (40,7 %), and 4 belong to the category 51–65 years old. This division relates to the range of the working population. 20 respondents were Dutch (74,1 %), 6 Indian, and 1 was Norwegian. For the 27 respondents, 3 completed high school, 9 achieved a bachelor degree, and 15 accomplished a master degree. This means that 88,9 % of respondents belong to the category higher education, which is not a representation of the working population. 20 respondents currently work in the financial services industry (74,1 %), 2 in retail, 1 in care, and 4 are consultants in the IT sector (14,8 %). For the 27 respondents, 2 are first level supervisor, 5 are in middle management, and 20 have non-managerial jobs (74,1 %), which means that top management is not represented in this dataset. For the 27 respondents, 1 works at the current organization for less than 1 year, 10 work for 1–2 years at the current organization (37 %), 4 work for 3–5 years at the current organization, 4 work for 6–10 years at the current organization, and 8 work for more than 10 years at the current organization.

4.5 Reliability and Validity

The reliability of the data was tested with the reliability coefficient Cronbach's Alpha [35, 36]: $\alpha = 0{,}983$ and remains around 0,983 when a construct would be deleted. All the relations, in both directions, are included, which results in 6o items that are used to calculate Cronbach's Alpha. The validity of data represents if a measure assesses the construct that it is intended to measure [35, 36]. Convergent validity and discriminant validity are commonly used. A correlation matrix was used to test them. A correlation matrix provides the strengths of a relationship between two variables without providing a direction of the relationship. Because the data set contains only 27 cases, it was not possible to assume that the data is normally distributed. Therefore normality tests have been performed to test the normality of the data and it was chosen to use Spearman's correlation coefficient to check the validity of the data, because this coefficient does not require data to be normally distributed [35]. Because the proposed relationships between variables are directional (the relations between cause and effect are tested one-directional), a one-tailed test was used [35]. By analyzing the correlation matrix, it was

concluded that the variables that should have a strong relationship correlate highly and variables that should not have a relationship correlate on a low level. Though, three correlations are striking. Firstly, the processes payments, savings, financings, investments, and insurances correlate highly with each other for variables such as customized deals and synchronizing IT, often a correlation of 0,9 or higher.

This is not a problem for the validity; however it could be a signal that the processes should be combined into one variable. The second correlation that is noticeable is the relation between cross-selling and retention of the customer, which is quite low while it was expected to be high. The last correlation is the relation between the employee costs and costs in general, which is actually lower than expected. Although these last correlations indicate that the discriminant validity is affected, overall the correlations do not show many deviations. Therefore, the requirements of convergent and discriminant validity are met.

4.6 Value Framework for the Financial Services Industry

The results obtained determined the development of the final version of the framework: Big Data Value Framework for the Financial Services Industry portrayed in Fig. 2. This framework supports decision makers to identify opportunities for attaining business value out of big data in the financial services industry. The elements and arrows illustrate how value can be obtained from each solution. The links are independent of each other, indicating that reaching a goal is already possible when meeting one of the sub goals.

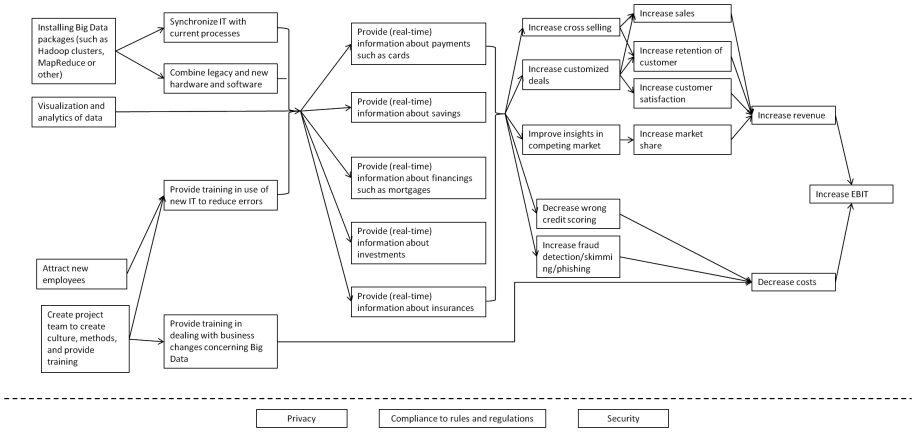

Fig. 2. Conceptual framework for identifying opportunities to attain business value out of big data [16]

The solutions that are presented in the framework and have to be implemented to gain value were grouped on the left side of the framework. The drivers that are representing the cause and effect relations to eventually get to the final benefit (increasing EBIT) are shown in the middle of the framework. The implementation of the solutions supports the access to accurate real-time information related to the main processes in

the financial services industry: payments, savings, financings (credits, lending, and mortgages), investments, and insurances. It also provides support to decision makers, improving the accuracy of decisions. These more complete insights will lead to an increase in better targeted marketing (e.g., cross selling, customized deals), better insights in the competing market, and it also decreases wrong credit scoring and stimulates fraud detection. When customers are better targeted with marketing it is likely that the sales, the retention of customer, and the satisfaction of customer will increase because the customer gets an individual treatment. Moreover, better insights in the competing market can lead to an increase in the market share because an organization now has information on how to improve the organization to outperform the competition. All together this will lead to an increase in revenue.

Table 1. Comparison of Value Framework.

Framework/ Approach	Basic elements/ dimensions	Main strengths for big data value assessment	Main weaknesses for big data value assessment
Balanced scorecard [20, 21]	Four perspectives (Customer, financials, internal business processes, learning and growth) which are linked to vision and strategy	-Customer, financial, learning and growth dimensions, and their relations with strategy and vision is relevant for big data; -Identification of different objectives and measures	Technology is not addressed
Performance prism [33]	Five perspectives: stakeholder satisfaction, stakeholder contribution, strategies, processes, capabilities	Focus on stakeholders to indicate what they need from the big data technology	Extensive focus on processes, which is not of (high) relevance for big data
Value Framework for the financial services industry	Costs and revenue, technology, learning and growth, internal business processes, customer relationship management	-Focus on big data	Costs and revenue, technology, learning and growth, internal business processes, customer relationship management

At the cost side, the decrease in wrong credit scoring will decrease the overall costs because credits are provided based on real insights in behavior and not on predetermined categories. Together with an increase in fraud detection and a decrease in employee costs the overall costs will decrease. The increase in revenue and decrease in costs will eventually lead to a positive cash flow generation.

The preconditions that have to be met at all times are privacy, compliance to rules and regulations, and security. These preconditions are independent of the solutions, drivers, and final goal. Personal information should only be used when rules are not trespassed and the person accepts that the organization uses the information. Moreover, an organization should be compliant to the rules and regulations that are defined. Especially in the financial services industry there are many different rules which change constantly. Last, the security of information should be optimal at all times to make sure it will not be used by non-authorized persons.

5 Comparative Analysis and Discussion

The proposed framework was compared to other two approaches for value assessment: the Balanced Scorecard [29, 30], and Performance Prism [33]. The main elements of each approach are summarized in Table 1, and the main strengths and weaknesses for big data value assessment are indicated. The main strengths of the framework advanced in this article compared to the other two approaches are: (i) it addresses technology-related aspects which are of high importance in the context of big data, (ii) it provides support in identifying value creation from an investment, (iii) supports a cause-effect analysis between the elements included in the framework, (iv) it was constructed explicitly to address the specificities of the financial sector, which is targeted in this research project.

6 Conclusions and Future Work

Most organizations nowadays are fundamentally dependent on their data and information handling services and tools. Big data services are evolving in an ecosystem in which diverse technologies, market needs, social actors and institutional contexts fuse and change over time [37]. Research on big data focuses mainly on technological aspects (e.g., data interoperability, algorithms, development of tools), and research on business-economic aspects is scarce. Although big data is associated with numerous benefits, the literature review performed showed that a value framework for big data, in general, or for the financial services industry, is not yet available. The Big Data Value Framework for the Financial Services Industry advanced in this article (illustrated in Fig. 2) represents a step towards overcoming this gap. It embeds elements gathered from an in-depth literature review and interviews with experts in the areas of big data and financial services industry, and it was validated by industry representatives. Accordingly, the solutions (e.g., installing the hardware and software, create project team) and the drivers (e.g., customized deals, cross selling, fraud detection) will lead to an increase in revenue and

decrease in costs. However, the preconditions privacy, security, and compliance to rules and regulations have to be met at all times to generate business value.

Although the research work performed was accurately conducted and follows a well-defined methodology, some limitations of the present work can be identified. Only eight interviews are performed which provide insights in the opinions of eight experts. This also holds for the information collected via the questionnaire. With only 27 respondents (experts in the areas of big data and financial services industry) the framework cannot be generalized. However, it can be used as an indication of which variables have an influence on the business value of big data.

Future work will focus on the development of drivers at the cost side of the proposed framework. Mainly drivers for the revenue side were identified from the interviews and questionnaire, whereas the drivers of the cost side lagged behind, which might be caused by the respondents' focus on revenue instead of costs. It is also intended to develop specific metrics for the variables included in the framework to quantify the gains from investing in big data.

Appendix: Excerpt of Interview Questions

General

- For how long do you work at the current organization?

Business Intelligence

- What is your definition of business intelligence?
- What are the core elements of business intelligence?

Big Data

- What is your definition of big data?
- What are the core elements of big data?
- To what extent is it possible that big data provides new insights in information needs compared to business intelligence?

Value of Business Intelligence and Big Data

- Which measuring methods do you think are appropriate to measure the business value of big data?
- In which parts of the financial services industry does big data provide business value?

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