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Balancing Evolving Logics: Business Model Change in the Leibniz Research Museums

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Balancing Evolving Logics: Business Model Change in the Leibniz Research Museums

Abstract

This study shows how stakeholders' evolving logics drive business model change over time. Using secondary data from the Leibniz research museums in Germany in a longitudinal content analysis, we relate logics as drivers of business model change in a context that is shaped by the interests of multiple stakeholder groups. Our findings illustrate how stakeholders' varying emphases on economic, cultural and political logics affect the content, structure and governance of the activities constituting the business models of the research museums. They lead to an increasing need for the demonstration of value creation and the identification of new sources of revenue. The strength of the impact of these logics depends on the individual abilities of the research museums to bargain for their business models. Overall, our study sheds light on the drivers of business model change in public organizations and the accompanying macro-level factors in the German science system.

Keywords: business model change, logics, research museums, value creation, science policy

1. Introduction

Museums are institutions that collect, archive, conserve, interpret and exhibit a society's culture (DeFillippi et al. 2007). For some decades, market-driven thinking has been nurturing the idea that museums must engage in strategic and entrepreneurial activities (Griffin 2008; Oakes et al. 1998). There is an increasing tension between the need to preserve cultural goods and the requirement to create value for diverse stakeholder groups (Alexander 1996; Coblence and Sabatier 2014; Eikhof and Haunschild 2007). Our knowledge on how this tension affects business model change – i.e. how the museums' activities and responses to their stakeholders' demands evolve (Foss and Saebi 2017) – is limited. We explore the drivers of business model change in the Leibniz research museums, which are important organizations in the German science system.

A business model is a configuration of interdependent activities that enable a museum to create and capture value (Coblence et al. 2014; Zott and Amit 2010). Existing studies mainly focus on business models in for-profit organizations and their potential to create economic value for customers (Zott et al. 2011). However, value creation can address diverse stakeholders – i.e. any person, group or organization with an interest in the organization – and it is not limited to business corporations (Massa et al. 2017). The business models of public museums, which are non-profit organizations, are a case in point (Coblence and Sabatier 2014; Greffe et al. 2017). These have been subject to change in the last decades. A turn from a traditional focus on curatorship and the exhibition of cultural goods towards entrepreneurialism is discernible (e.g. Camarero and Garrido 2008; Coblence et al. 2014; Scott 2009). All over the world, public expenditures for museums have come under sharp scrutiny because of budgetary constraints. Public museums must find additional sources of funding and ways to cut costs without lowering the quality of their cultural outputs (Camarero et al. 2011; Schmidt et al. 2017). This development leads to an increasing need to provide evidence for value creation (Eikenberry

and Kluver 2004; Scott 2009; Vicente et al. 2012). The perception of value generally depends on stakeholder logics, i.e. beliefs and assumptions about how a museum should behave. Thereby, museums are embedded in a political-administrative context comprising multiple stakeholder groups (Alexander 1996; Oakes et al. 1998; Schmidt et al. 2017). Over time, their evolving logics require re-configurations of the activities that constitute a business model (Berends et al. 2016). However, our knowledge on the drivers of business model change is limited (Foss and Saebi 2017). We fill this gap by investigating how evolving stakeholder logics drive business model change in public museums.

The empirical setting in this study is that of the eight research museums in the German Leibniz Association, a registered association named after the German philosopher Gottfried Wilhelm Leibniz (1646-1716). It connects more than 80 non-university research institutes that cover a broad range of disciplines, among them eight museums in the fields of history of the Earth, biodiversity, cultural history and history of technology. These produce and disseminate scientific knowledge (Leibniz 2016c). In contrast to other museums, they conduct rigorous collection-based research, which is capital-intensive and relevant for society (Leibniz 2014a). Based on a longitudinal content analysis of secondary data, we make two contributions. First, we examine the constraints that affect the internal decisions of the research museums and show that stakeholders' evolving logics are influential drivers of business model change. Second, prior literature points to a misalignment of cultural and economic logics (Eikhof and Haunschild 2007; Heidenreich and Plaza 2015). Our analysis illustrates that these logics are not necessarily contradictory. We observe a political logic which bears the potential for conflicts and promising opportunities for value creation.

The study proceeds as follows: first, we outline the components of business models, the drivers of change and the value created by museums. Second, we elaborate on our data and methods. Finally, we report our findings and discuss their implications.

2. Background

Business models are studied in various contexts that go beyond profit-oriented business settings. Like for-profit organizations, museums have business models (Massa et al. 2017). For example, Coblenz et al. (2014) studied business model evolution in the Montreal Museum of Fine Arts. Coblenz and Sabatier (2014) describe the Louvre's business model revision, and Greffe and colleagues (2017) specify types of business models in French museums.

Museums can purposively change their business models and thereby adapt to evolving circumstances and introduce novel ways to create value for stakeholders (Foss and Saebi 2017). Specifying a configuration of activities consisting of *design elements* and *design themes*, a business model explains how a museum creates and captures value from its outputs (Teece 2010; Zott and Amit 2007; Zott et al. 2011). Referring to design elements, activity content describes what fields of expertise a museum covers. Activity structure specifies how these fields are related. Activity governance defines who contributes to value creation and where. Four design themes generally connect these design elements and drive the perceived value that the business model generates: novelty (e.g. re-using the content of cultural goods for different purposes), lock-in (e.g. retaining sponsors and donors), complementarities (e.g. generating synergies across a museum's fields of expertise) and efficiency (e.g. cutting costs) (Zott and Amit 2010). These reflect an *economic logic* underlying customers' requirements to profit-oriented companies (Zott et al. 2011). They imply market-driven thinking, nurturing efficiency and the production of goods and services with quantifiable outcomes, such as revenues, costs and profits (Eikhof and Haunschild 2007; Teece 2010; Townley et al. 2003).

However, museums contribute to 'the preservation and interpretation of artefacts and sites that are viewed as unique and irreplaceable because the curators and historians say they are unique and irreplaceable' (Oakes et al. 1998: 268). They collect, preserve and study what they collect without any need for an external economic or political legitimization of these activities

(Heidenreich and Plaza 2015). Like other public organizations, museums require a broader view on value, which exceeds a primarily economic logic (Massa et al. 2017; Reay and Hinings 2009). Consistent with a *cultural logic*, the value of a museum's output depends on its symbolic meaning (DeFillippi et al. 2007; Oakes et al. 1998). Museums can be seen as an engine of societal progress in terms of knowledge production, education and innovation. They attract diverse audiences for various reasons. The outputs that museums produce rely on costly and ill-defined resources from many different origins. Their value depends on subjective experiences and individual conceptions of quality and originality (Townley et al. 2003). Museums create a regional identity, nurture cohesion among social groups and provide a public creative space that promotes knowledge exchange. They can improve health and well-being, increase the understanding of cultures and international relationships, and contribute to urban development (Camarero et al. 2011; Heidenreich and Plaza 2015).

These outcomes have the character 'of what economists call "public goods"; a circumstance in which the economic activity in question generates positive externalities or "spill-overs". As there is no good (private) business model that can support value capture, government funding and/or philanthropy is required and provided' (Teece 2010: 185). Public museums raise funds from, for instance, companies, banks, foundations, donors and sponsors, but they mainly depend on public funding. They produce knowledge, which serves the society and is of interest to science policy (Eikenberry and Kluver 2004; Teece 2010). Governmental and administrative bodies put pressures on the research museums and restrict the discretionary power and independence of museum managers (Vicente et al. 2012), creating a *political logic*. Public funding and political support must be justified in terms of, for example, efficient financial management, visitor satisfaction and recognition from peers (Camarero et al. 2011; Scott, 2009; Townley et al. 2003). As depicted in Figure 1, the business model-concept in museums thus comprises a multi-stakeholder perspective on value.

 Insert Figure 1 about here

3. Methods

Drawing on longitudinal data from the Leibniz research museums in Germany, we study how museums re-assess their activities and find novel ways to create value for their stakeholders.

3.1 Empirical setting

Germany comprises 16 states (*Länder*). Competences referring to science, research and education are divided between ministries and agencies on the federal level and between the federal level (*Bund*) and the states (*Länder*). The Federal Ministry of Education and Research (*Bundesministerium für Bildung und Forschung*, BMBF) is responsible for R&D policy and funding. Liaising with the state governments, it engages in the institutional co-funding – i.e., funds jointly provided by the federal government and the states – of non-university research institutes. These are organized within four associations: Max Planck Society, Fraunhofer Society, Helmholtz Association and Leibniz Association. Reflecting the German federal governance system, the Leibniz Association is funded to equal parts by federal and state governments (Edler and Kuhlmann 2008; Grimpe 2012).

The origins of the Leibniz research museums can be traced back to the foundation of the German Federal Republic in 1949. The West German states signed the ‘Königsstein Agreement’ according to which research institutes of supra-regional importance would receive funds from both the states and the federal government – i.e. institutional co-funding – if their needs exceeded the means of a single state (§91b German Basic Law). This agreement evolved into the ‘Blue List Partnership’ (according to the colour of a dossier). After the German reunification in 1990, many institutes in the former German Democratic Republic were included in the ‘Blue List Partnership’, which transformed itself in ‘Gottfried Wilhelm Leibniz

Science Association’ (chiefly, Leibniz Association) in 1997. It financially supports and monitors the activities of its members, among them the research museums (Leibniz 2016a). The Senate of the Leibniz Association evaluates their performance every seven years. In case of underperformance, a museum loses its status as a Leibniz institute and its access to institutional co-funding (Leibniz 2016b).

We adopted a multiple case study design (Eisenhardt 1989) including all Leibniz research museums. The *Deutsches Schiffahrtsmuseum* (German Maritime Museum) in Bremerhaven concentrates on German maritime history. The *Germanisches Nationalmuseum* (Germanic National Museum) in Nuremburg presents the history of art and culture of the German-speaking countries. The *Römisch-Germanisches Zentralmuseum* (Roman-Germanic Central Museum) in Mainz concentrates on pre- and early history and archaeology. The *Deutsches Bergbau-Museum* (German Mining Museum) in Bochum focuses on the history of mining. The *Deutsches Museum* (German Museum) in Munich concentrates on the natural sciences and technology. The *Museum für Naturkunde* (Museum of Natural History) in Berlin focuses on natural history. The *Senckenberg Museums* (Senckenberg Museums of Natural History), located in Frankfurt am Main, Görlitz and Dresden, explore biodiversity in the ‘System Earth’. The *Zoologisches Forschungsmuseum Alexander Koenig* (Zoological Research Museum Alexander Koenig) in Bonn is dedicated to natural history and zoology.

Although the business models of the research museums may differ in terms of, for example, market or product orientation (Camarero and Garrido 2008), they are comparable because of their high relevance for national science policy and their common aims and objectives. These are stated in a joint policy paper published by the German federal government and the governments of the federal states (GWK 2012). According to this policy paper, the collections of the research museums are unique. They are usable for scientists from Germany and abroad. The museums strengthen Germany’s reputation as an international centre of research. They

also aim to stimulate the interest in science and research among diverse social groups. Other types of museums in Germany are less regulated and have more leeway to experiment with diverse business models.

3.2 Data analysis

We collected data on the business models of the research museums by codifying their annual reports. These are suitable because, first, they provide comparable information through time and support our interest in the evolution of business models (Demil and Lecocq 2010). Second, this interest requires information on previous business models and changes made in the past. Interviews with executives may have been biased by retroactive sense-making and less reliable (Duriau et al. 2007). Third, because executives invest much time and effort in outlining the content of annual reports and use them to interact with external stakeholders (Dirsmith and Covalevski 1983), their validity is higher than that of primary sources (Duriau et al. 2007). Because this advantage also bears the risks of post-rationalization of events, self-promotion and impression management (Arndt and Bigelow 2000; Demil and Lecocq 2010), we complemented the annual reports with the evaluation reports by the Senate of the Leibniz Association including the responses of the research museums. Table 1 presents information on the research museums and the available data.

 Insert Table 1 about here

We content-analyzed all documents, using the software MAXQDA and following the steps suggested by Kuckartz (2014). First, we read all available documents, added notes and conceived of ideas for the coding scheme. It was based on the literatures on business models (e.g. Zott and Amit 2010), value (e.g. Townley et al. 2009) and museums (e.g. Alexander 1996; Camarero et al. 2011). It benefited from conversations with members of the museums, workshops in the *Deutsches Schiffahrtsmuseum* and the Leibniz Association in 2015, 2016 and

2017 and two expert interviews in July 2016. Second, drawing on the identified research gap, we developed first-order concepts for categorizing the data. We used the aforementioned literatures for structuring and interpreting the data. The longitudinal data allowed for the identification of contingent events and stakeholder influence. Third, referring to the first-order concepts, we coded the data for the first time. We analyzed the reports clause by clause to capture multiple codes embedded within single paragraphs or sentences. Fourth, we compiled the paragraphs and sentences that we had coded based on the same first-order concepts. Fifth, drawing on these compilations, we refined our coding scheme before and during the computer-aided content analysis and inductively developed sub-categories (second-order themes). Finally, we re-coded the data and applied our refined coding scheme. After having analyzed the business models of the research museums and their dynamics in isolation, we compared them in order to specify similarities and differences.

Based on our data, three periods are discernible. In the 1990s, the research museums promoted growth and expansion. They invested in large-scale projects and extended their collections and areas of expertise. In the 2000s, new challenges emerged, such as new technologies and an increasing demand for relevance. This decade was a period of changes in organizational structures, profiles and facilities. Since 2010, these changes have led to the claim for a new identity as a research museum, novel approaches to research and knowledge transfer, and the adjustment of governance structures and missions.

4. Logics as drivers of business model change

Over time, three logics and evolving emphases on them are discernible. The Supplementary Table S1 provides illustrative examples from the data for cultural, economic and political logics in the three pre-specified periods.

4.1 Cultural and economic logics

Consistent with a *cultural logic*, the research museums view themselves as collective memories. They contribute to social integration and the formation of a cultural identity. For decades, these aspects have taken centre-stage in their missions. Since the mid-2000s, the cultural logic, which is anchored in the missions of the research museums that were originally formulated at the time of their foundation, has become more future-oriented and market-driven, as, for example, the mission statements in the more recent annual reports of the *Deutsches Museum*, the *Museum für Naturkunde* and the *Senckenberg Gesellschaft für Naturforschung* reveal. The *Zoologisches Forschungsmuseum Alexander Koenig* emphasizes the social impact of its research, and the *Deutsches Schiffahrtsmuseum* stresses the importance of its collections for future generations.

The local and spatial character of the research museums has gained in importance. For example, the *Römisch-Germanisches Zentralmuseum* outlines in its annual report in 2015 that it aims to be a place of tranquillity and encounter. The *Museum für Naturkunde* views itself as an innovative centre of communication that shapes the scientific and social dialogue about the future of the planet and as an extraordinary location for events. The *Deutsches Museum* wants to be seen as an outstanding cultural event. The *Römisch-Germanisches Zentralmuseum* fosters the creation of a discernible trademark for archaeology. These examples illustrate that an *economic logic* has penetrated the cultural logic over time (Heidenreich and Plaza 2015).

The business models of all research museums are clearly novelty-centred (Zott and Amit 2007), because ‘showcasing science’ (Leibniz 2016c) relies on creativity and innovation (Coblence and Sabatier 2014). Since their foundation, the success of the research museums has depended on novelty. However, the emphasis on innovation has become more pronounced and market-driven over time. The *Deutsches Museum* is an illustrative case. Compared to the other research museums, it began early to emphasize an economic logic for its activities. In 1999, for example,

the *Deutsches Museum* reported that it tried to reduce the costs for the development of its exhibitions by forming alliances with renowned technology companies. Cooperation with industrial corporations and research institutes in Germany and abroad became part of its growth strategy and allowed the development of temporary exhibitions pertaining to new technologies. In the following years (2004-2010), which were characterized by the uncertain inflow of public funds, the *Deutsches Museum* maintained numerous alliances with companies and funding organizations. These were often jointly developed with the partner firms' marketing departments and used for advertising purposes. In recent years, new technologies for digitisation have nurtured the re-use of archival data. For instance, because the library of the *Deutsches Museum* has invested in a scanner to produce digital copies of fragile documents, it attracts additional users and visitors. This investment may create new sources of revenue. The *Deutsches Museum* thus illustrates that cultural and economic logics do not necessarily conflict with each other as Eikhof and Haunschild (2007) suggest. Instead, since the beginning of the 2000s, they have led to an extension of the activities of the research museums and higher pressures to justify their existence.

4.2 Political logic

Contingent events throughout the history of the research museums reflect an evolving political logic. In the late 1970s and early 1980s, a major *political change* for most museums was their membership in the Blue List Partnership. It implied joint funding by federal and state governments and a recognized status as a non-university research institute in Germany and abroad. The Blue List Partnership was only valid for museums in the Federal Republic of Germany. The *Museum für Naturkunde* was not included, because it was located in the German Democratic Republic. After the German reunification, the *Museum für Naturkunde* did not become member of the Leibniz Association before 2009.

Throughout their history, the research museums were influenced by political position papers. In 2006, the International Council of Museums (ICOM) published the *ICOM Code of Ethics for Museums*. It provides a broad definition of museums and guidelines for their conduct and performance (ICOM 2016). The ICOM standards though not legally binding provide guidance, but they do not differentiate between different types of museums. In 2009, the German museologist Bernhard Graf published a paper referring to the roles and tasks of the German research museums. It specifies guidelines for the work of the eight research museums and their funding by the Leibniz Association. The research museums serve the purposes of any other museum. To maintain their status as Leibniz institutes, they must be of supra-regional importance and of interest to national science policy. They are required to position themselves as the subject leaders in their research themes in Germany and abroad (Graf 2009). This paper has become the central guideline for strategic planning and performance evaluation. Harnessing science and technology to increase international reputation, developing collections into research infrastructures with specific access rights for diverse stakeholder groups, and bridging research and education have become salient demands. These were explicitly stated in another influential agenda published in 2012 by the Joint Science Conference (*Gemeinsame Wissenschaftskonferenz*, GWK) of the Federal Government and the states (*Länder*), a leading institution in German science policy (Edler and Kuhlmann 2008). These examples show that the political logic has become especially influential in the periods emphasizing the demonstration of relevance and a stronger focus on research.

Investments in construction and renovation have also affected the museums. The *Museum für Naturkunde* illustrates that opportunities to renew buildings and exhibition spaces largely depend on political contingencies and coordination challenges on and between the federal and the state level. Because of its location in the former German Democratic Republic, the *Museum für Naturkunde* could not start before 1990 to improve the infrastructure needed for its

collections which had been neglected for decades due to a lack of financial resources. Since the German reunification, intense construction and renovation works have continuously increased the exhibition areas and research facilities. Another example is the *Römisch-Germanisches Zentralmuseum*. In 2007, it was surprised by the unexpected announcement of the Ministry for Science of the state of Rhineland-Palatinate to erect a new building for the archaeological exhibitions. In 2011, the Economic Stimulus Package (*Konjunkturpaket II*) of the Federal Government allowed the *Römisch-Germanisches Zentralmuseum* investments in construction and renovation, but it also caused a temporary closure of the exhibition.

Sudden public-sector deficits constrain construction and renovation. For example, in 2005, the *Deutsches Museum* had to cope with an unexpected reduction of 6% of the funding originally guaranteed by the Federal Government. Because of contractual agreements binding the yearly amount of funding provided by the state of Bavaria to that guaranteed by the Federal Government, this led to a further reduction of 6% of funds provided by Bavaria. The loss of half a million euros hampered the development of the exhibitions of the *Deutsches Museum*.

Leading executive positions in the research museums have traditionally been characterized by long tenures of up to 30 years. In the last two decades, tenures have become shorter. *Executive succession events* have triggered change in all research museums over time. The *Römisch-Germanisches Zentralmuseum*, for example, used management successions in 2003 and 2004 to re-assess its six areas of competence and promote changes in its activities. The *Deutsches Bergbau-Museum* reported two changes in the management of the museum in 2012, namely the appointment of a new director and of a new head of the department of mining history. It also created a position as a head of knowledge transfer, leading to a new interface between research and public relations in a centralized department. These changes can be seen as a means to prepare the *Deutsches Bergbau-Museum* for a new era determined by the exit from subsidized coal mining in the state of North Rhine-Westphalia in 2018, which will require a

redefinition of the identity of the *Deutsches Bergbau-Museum* as a research museum. Moreover, since the beginning of the 2010s, the museums have increasingly been encouraged to appoint directors who simultaneously hold chairs at local universities, such as the *Deutsches Schiffahrtsmuseum*. These developments reflect the claim for a stronger focus on research that characterizes the 2010s and which is especially driven by a political logic.

5. Business models

The impact of the logics is reflected by changes in the business models over time. The Supplementary Table S2 includes examples for how the business models evolved in the last decades.

5.1 Activity content

In line with a cultural logic, the research museums fulfil the tasks of collecting cultural goods, doing research and transferring knowledge. They continuously expand their collections. The *Deutsches Schiffahrtsmuseum* heavily relied on purchases of all kinds of objects alluding to maritime history in the years subsequent to its foundation, thereby pursuing a purposive collection management. Similarly, since the 1980s the *Römisch-Germanisches Zentralmuseum* has bought many objects that researchers of the museum and other institutes have subsequently used, such as jewellery, books, journals and photographs. The *Deutsches Bergbau-Museum* has benefited from the generosity of individuals and organizations in the mining industry in the last decades. These have transferred documents, objects and artefacts to the museum by means of inheritance. The collections of the museums operating in natural history, the natural sciences or archaeology, such as the *Zoologisches Forschungsmuseum Alexander Koenig*, the *Museum für Naturkunde* or the *Römisch-Germanisches Zentralmuseum*, benefit from exploratory expeditions and discoveries. The *Museum für Naturkunde* acquired a paleontological collection from Berlin University of Technology in 2008. The *Senckenberg Gesellschaft für*

Naturforschung considers the collection of cultural goods, the integration of the collections of other institutes (e.g. universities or other museums) and the provision of access for different stakeholder groups as national tasks.

The collections form the core of the activities of the museums that have never ceased to emphasize the importance of their collection-based research. The museums would also do research without being driven by the Leibniz Association. For example, the *Museum für Naturkunde* has been a renowned research institute for decades. Its newly acquired status as a Leibniz institute in 2009 was the starting-point for a re-assessment of its research, leading to a transformation into four areas (evolution and geo-processes, collection development and biodiversity, digital world and information science, and science communication and knowledge management) until 2013.

The *Deutsches Schifffahrtsmuseum* also reveals the strong influence that external, predominantly political actors exert on the evolution of the research activities of the museums. Since its foundation, the *Deutsches Schifffahrtsmuseum* has not been completely free in its decisions regarding research. The discovery of a medieval merchant cog in the Weser River near Bremen triggered its establishment in 1971. It pre-determined its focus on wet-wood conservation. In 1987, the German Science Council suggested an extension of research themes, leading to the development of four areas in 1994. According to a recommendation included in the subsequent evaluation provided by the Science Council in 2000, these four areas were merged into two central themes that determined the research program for the next decade. This development reflects the claim for relevance that characterizes the 2000s. While the subsequent evaluation by the Senate of the Leibniz Association in 2007 did not cause any problems, the evaluation in 2014 raised many critical issues. The projects referring to the merchant cog had nearly been completed. The Senate deemed a new focus on maritime archaeology as problematic because of the museum's lack of financial and human resources. The establishment

of a cross-country competence centre for maritime archaeology would have been promising, but the *Deutsches Schiffahrtsmuseum* could not make this decision on its own. Governmental agencies on the state (*Senator for Education and Science* in the state of Bremen) and on the federal level (*Federal Ministry of Education and Research*) had to be involved but repeatedly delayed their decisions, although the Senate of the Leibniz Association encouraged the idea in its evaluation report in 2014. The *Deutsches Schiffahrtsmuseum* used this evaluation to reassess its activities and adapt their content to the prevailing political logic. By introducing the concept ‘People and the Sea’ in 2014, it explicitly aimed at contributing to the politically driven public discourse on the Anthropocene, the youngest epoch in the geological timescale.

A typical task of each museum is knowledge transfer and education. However, the annual reports from the 1970s to the late 1990s show that, in those decades, the museums conducted research without any ‘mention of a responsibility to ensure that people attend’ (Oakes et al. 1998: 267). In the last two decades, this situation changed, pointing to the need to demonstrate relevance and a strong focus on research. For example, in 2002, the *Senckenberg Gesellschaft für Naturforschung* established a communication and marketing department in order to create a brand for science, education and culture. Market research aimed at enhancing the understanding of the visitors’ preferences and the interests of stakeholders, donors and sponsors. The *Zoologisches Forschungsmuseum Alexander Koenig* established a *Centre for Public Relations and Exhibitions*, dedicated to knowledge transfer.

More recently, pressures for using new media for presenting collections and research and strengthening knowledge transfer have become discernible. The Leibniz Association increasingly requires novel approaches to digitize collections, open access for researchers in Germany and abroad, and new forms of experiencing cultural goods for visitors (GWK 2012). The *Deutsches Museum* is a pioneer. It has put emphasis on transferring knowledge to different stakeholder groups and drawing on various channels and technologies for this purpose for

decades. For example, it used the total solar eclipse in 1999 for advertising campaigns and increased media coverage, highlighting its research and its various competences. From early on, it has conceived of special events that allow for the active participation of the audience in experiments and other research-oriented activities in order to attract young visitors. For many years, young science journalists and curators have been invited to attend seminars focusing on the professional communication of science. The *Deutsches Museum* uses anniversaries, such as ‘100 Years of Driver’s Licenses’ (2009) or the ‘Year of Energy’ (2010), to organize special exhibitions and events for various target groups and stakeholders. Knowledge transfer has increasingly turned into a cultural event including the promise of a special experience for visitors.

5.2 Activity structure

The activity structure of the business models has been subject to considerable changes over time. Linking activities across departments and research themes did not take centre-stage in the 1980s and 1990s. However, after a period of growth, the museums had to restructure. The *Senckenberg Gesellschaft für Naturforschung*, for example, started planning and implementing projects spanning departments and research areas at the end of the 1990s. Until 2014, it was fundamentally reorganized. It established an internet-based collection management system that created a virtual network between nine geographically distant locations. Similarly, the *Deutsches Bergbau-Museum* and the *Deutsches Museum* pursued the creation of synergies and networks across research themes and functional areas.

According to the Senate of the Leibniz Association, other research museums were less successful in this regard. For example, this issue was raised in the evaluation of the *Germanisches Nationalmuseum* in 2015, although this museum had successfully expanded its collections, carried out innovative research projects and attracted diverse visitor groups in the years preceding this evaluation. In its evaluation of the *Römisch-Germanisches Zentralmuseum*

in 2007, the Senate of the Leibniz Association criticized a lack of coherence between the research themes. It recommended institutionalizing knowledge exchange between internal research groups, reflecting the claim for relevance pertinent in that decade. Again, in 2013, the Senate observed incoherence between the collections, research projects and exhibitions because of a lack of an overarching strategy. The reaction of the *Römisch-Germanisches Zentralmuseum* illustrates the power of the political logic represented by the Leibniz Association and the increasing focus on research characterizing this period of time. In 2014, it reorganized its structures. Under the label ‘RGZM-Archaeology’, in 2015, it presented a concept, which combined the researchers’ and the restorers’ competences and the museum’s infrastructure into a coherent program for science and education.

5.3 Activity governance

Changes in activity governance did not attract much attention before the 2000s. Being member of the Blue List Partnership and later on of the Leibniz Association as its successor organization implies clear requirements to activity governance. A separation of leadership and control is warranted by the establishment of separate executive and supervisory boards according to the standards of the Leibniz Association. The *Museum für Naturkunde* is a case in point. Prior to its inclusion in the Leibniz Association, the state of Berlin had to create a legal framework that guaranteed its status as an independent foundation (*Gesetz über die Stiftung Museum für Naturkunde Berlin*). The museum aligned its governance to the standards set by the Leibniz Association. It established a Scientific Council monitoring the museum’s activities in science and research and a Foundation Council. These councils and the newly appointed leading executives jointly developed a new organizational structure and by-laws that specified the principles underlying this structure.

The *Zoologisches Forschungsmuseum Alexander Koenig* illustrates that changes in activity governance can involve a change of organizational identity. Until December 2012, it had been

an institute of the state of North Rhine-Westphalia. With its transformation into a public law foundation, it had to re-organize its governance systems that were to include representatives of the responsible federal and state ministries, the University of Bonn and a Scientific Advisory Board comprising scientists from Germany and abroad. The members of the Directorate had to be appointed by an independent Foundation Board. With this transformation, the *Zoologisches Forschungsmuseum Alexander Koenig* underlined its endeavour to evolve into an institute of high importance to national science policy, illustrating the claim for a clear focus on research pertinent in the 2010s.

Governance systems that do not meet the expectations of the Leibniz Association can jeopardize the status as a Leibniz institute. For instance, in 2013, the Senate of the Leibniz Association criticized that the *Römisch-Germanisches Zentralmuseum* had not managed to sufficiently separate boards for advisory and supervision purposes. This lack of compliance fostered the decision that the *Römisch-Germanisches Zentralmuseum* would be re-evaluated in three instead seven years.

6. Value creation

The research museums design and change their business models to increase the value of their outputs for multiple stakeholder groups. The analysis focuses on the evolution of cultural, intellectual, social and economic dimensions of value (Townley et al. 2009). Cultural value describes the symbolic meaning, authority and expertise that stakeholders attribute to the museums' collections, exhibitions and engagement in science and research and their significance for society. Intellectual value denotes the ideas and creative outputs generated by the research museums. It is the outcome of purposive creative endeavour and intellectual effort. Its creation requires considerable investments in money, time and personnel. Social value results from the networks and collaborative relationships that a research museum establishes

and maintains. Economic value is the transformation of these three dimensions of value in measurable and quantifiable revenue streams. The Supplementary Table S3 reports exemplary indicators for each dimension.

6.1 Cultural value

A museum's cultural value consists of its capacity to innovate, outreach and education programs. For decades, visitors have been of limited importance to most research museums. The *Deutsches Museum* is an exception, as revealed by its efforts to transfer knowledge into the society. In recent years, however, political forces claiming a stronger connection between science, research and the demands of different stakeholders have led to a reconsideration of the tasks and identities of the research museums. For example, a decreasing number of visitors forces the *Deutsches Schiffahrtsmuseum* to conceive of new strategies to increase its attractiveness. The *Museum für Naturkunde* proudly presents its growing visitor numbers. The *Senckenberg Gesellschaft für Naturforschung* discusses their evolution. The *Deutsches Bergbau-Museum* has begun to promote itself as part of the Ruhr Metropolis. The *Zoologisches Forschungsmuseum Alexander Koenig* emphasizes its new status as an institute of supra-regional importance. In doing so, the *Deutsches Bergbau-Museum* and the *Zoologisches Forschungsmuseum Alexander Koenig* re-define their organizational identities. They stress the symbolic meaning of their research themes and their attractiveness and relevance for society. Thereby, it is important to note that the museums' efforts to stress cultural value have become especially pertinent in the periods placing relevance (the 2000s) and a focus on research (the 2010s) at centre-stage. Both an economic and a political logic act as strong drivers behind these efforts.

6.2 Intellectual value

A museum's intellectual value comprises, for example, publications and the number of Ph.D. students. The growing demand for enhancing the research museums' international reputation

have led to pressures to increase the efforts to publish in refereed journals. A comparison of the changes in the number of articles in refereed journals between two evaluations of the Leibniz Senate reveals that the *Deutsches Museum*, the *Römisch-Germanisches Zentralmuseum* and the *Zoologisches Forschungsmuseum Alexander Koenig* are particularly successful in meeting this expectation. The *Senckenberg Gesellschaft für Naturforschung* is a special case. The increase in its publications can be due to its acquisition strategy. Both the *Deutsches Schiffahrtsmuseum* and the *Germanisches Nationalmuseum* have relatively low numbers, whereby the *Germanisches Nationalmuseum* shows a considerable increase in the number of articles in refereed journals. The *Deutsches Bergbau-Museum* reveals a decrease. Books, articles in non-refereed journals and publications for local stakeholders or touristic purposes have become less important over time. This development reflects the political logic represented by the Leibniz Association and its definition of desirable research outputs.

The research museums have increased their investments in young researchers, as the *Deutsches Bergbau-Museum* illustrates. The criticism of the Senate of the Leibniz Association that there had been just one doctoral student at the end of 2005, nurtured an increase in the number of doctoral students of up to ten in 2012. Cooperating with the Ruhr University of Bochum, the *Deutsches Bergbau-Museum* successfully applied for funding by the Leibniz Association of a graduate school focusing on raw materials, innovation and technology of former cultures. It opened in 2011 and started with eleven doctoral students. The other research museums also increased their numbers of Ph.D. students over time. For example, the *Deutsches Schiffahrtsmuseum* reported one doctoral student in 1991, three doctoral students in 1997, ten in 2007 and twelve in 2015. In the *Römisch-Germanisches Zentralmuseum*, this number ranged from ten in 2005 to 25 in 2013. The *Museum für Naturkunde* increased the number of doctoral students from 47 in 2011 to 52 in 2015. As these developments started at the beginning of the

2000s and have since then been driven by the Leibniz Association, they reflect the increasing impact of the political logic.

6.3 Social value

Over the three specified periods of time, all logics have fostered the need for the creation of social value. Inter-organizational and personal relationships with local universities and other research institutes in Germany and abroad are at the core of a museum's social value creation. Over time, the research museums have maintained more or less intense external relationships, ranging from collaborative research and lectures to the joint appointment of scientific personnel. The *Römisch-Germanisches Zentralmuseum*, for example, has never ceased to conduct archaeological excavations with researchers and students of the University of Mainz and the Universities of Applied Sciences in its neighbourhood. Teaching at universities has a long tradition for the *Deutsches Schiffahrtsmuseum*. Examples range from lectures on maritime archaeology and the arming of medieval ships at the universities of Gießen and Hamburg in 1980 to seminars on wet-wood conservation in Hamburg and Oslo in 1999. The current managing director of the *Deutsches Schiffahrtsmuseum* holds a position as a professor of maritime history at the University of Bremen. The *Germanisches Nationalmuseum*, that has established ties with local economic and scientific networks in Nuremburg and other neighbouring areas for years, was criticized for a lack of cooperation. In the evaluation report (2015), the Leibniz Association recommends joint appointments of chaired professors at local universities. The *Deutsches Museum*, though having been one of the most renowned museums of technology and natural sciences all over the world for decades, is to increase the number of international exchanges of researchers.

On a local level, relationships with companies and banks in the same region are pertinent. These organizations often have a long tradition in providing financial and non-financial support. The industry in which a company operates and the topical focus of a research museum are related,

as the *Deutsches Bergbau-Museum* with its partnerships with companies in the mining industry, the *Deutsches Museum* with its alliances with high-technology firms and the *Deutsches Schiffahrtsmuseum* with its relationships with shipyards in Northern Germany illustrate. The influence of local actors is stable across all museums over time, but the need to emphasize the effectiveness of these relationships for strategic purposes has increased since the end of the 1990s. An economic logic is discernible. It supports the pursuit of a cultural logic. For example, in 2000, the DM cooperated with the airport operator Flughafen München GmbH to provide an ‘aviation ticket’, permitting visitors a price reduction for the entry into the museum, its flight wharf Schleißheim and its special exhibition on aviation at Munich airport.

The importance of local supporters’ associations varies among the research museums. For instance, the supporters’ association of the *Deutsches Schiffahrtsmuseum* was reported to be one of the largest associations of that kind in Germany in 2009. Several local associations of smaller sizes support the *Senckenberg Gesellschaft für Naturforschung*. The *Zoologisches Forschungsmuseum Alexander Koenig* relies on two associations with different focal points. One of them has been providing support for research projects and the museum’s library since its foundation in 1978. The other association was established in the 2000s, supporting the development of a new permanent exhibition entitled ‘Our Blue Planet’.

6.4 Economic value

All research museums rely on institutional co-funding. The economic viability of the research museums also depends on third-party funding (see Supplementary Table S3, part D (a) and (b)). According to the Leibniz Association, third-party funding indicates the capacity to innovate and strengthens the reputation of a research museum as a non-university research institute (Leibniz 2014b). It enhances productivity, efficiency and opportunities for collaborative projects (Grimpe 2012). Third-party funding is thus important for the creation of intellectual value and reflects both an economic and a political logic.

The impact of public funding organizations in Germany (e.g. *Deutsche Forschungsgemeinschaft*, which is the main funding body for academic research in Germany, cf. Grimpe 2012) and abroad (e.g. grants provided by the European Research Council) has steadily increased in the last two decades. The *Museum für Naturkunde* and the *Senckenberg Gesellschaft für Naturforschung* show considerable increases in third-party funding over time, whereas the *Zoologisches Forschungsmuseum Alexander Koenig* and the *Deutsches Museum* reveal decreases. The *Deutsches Museum*, though having an outstanding reputation and not suffering from a lack of financial resources as its total revenue illustrates, is expected to increase its efforts to apply for third-party funding. It has high miscellaneous revenues, which have steadily grown for years. The *Germanisches Nationalmuseum* and the *Senckenberg Gesellschaft für Naturforschung* also report an above-average increase in their miscellaneous revenues. For these three research museums, this may mean that they can offset a lack of institutional and third-party funding with financial resources from alternative sources.

The impact of foundations does not differ across the research museums over time. Providing financial resources for specific projects, exhibitions or dedicated personnel, they range from small and locally based foundations that follow a mainly cultural logic (e.g. Prinz Maximilian zu Wied-Foundation supporting the *Römisch-Germanisches Zentralmuseum*, Wolfgang Ritter-Foundation concentrating on the *Deutsches Schiffahrtsmuseum*) to large and financially powerful foundations. The latter are of supra-regional importance and have their own political agendas, which are reflected by their diverse funding programs for research and science (e.g. Volkswagen Foundation, Fritz-Thyssen-Foundation).

The examples illustrate that economic value creation has been driven by a growing pursuit of a political logic since the end of the 2000s. An increasing influence of the economic logic has been discernible since the end of the 1990s. The cultural logic exerts a minor impact over time.

7. Interdependencies and bargaining power

The analysis of the evaluation reports provided by the Senate of the Leibniz Association in conjunction with the responses of the museums to these reports reveals differences in bargaining power. These responses are attached to the evaluation reports. They show that, within the Leibniz Association, some research museums are more likely to bargain for their business models than other ones because of differences in interdependence and their embeddedness in diverse political and economic settings (Pfeffer and Salancik 1978). The research museums apply different strategies to cope with the recommendations and critique of the Leibniz Association.

A comparison of the *Deutsches Schiffahrtsmuseum*, the *Germanisches Nationalmuseum* and the *Deutsches Museum* illustrates this point. The *Deutsches Schiffahrtsmuseum* is located in the state of Bremen, one of the poorest federal states in Northern Germany. The *Germanisches Nationalmuseum* and the *Deutsches Museum* are based in economically prospering Bavaria in Southern Germany. The *Deutsches Museum* is embedded in the well-developed scientific and industrial landscape in Munich, the Bavarian capital. In 2014, the *Deutsches Museum* had a budget of approx. 86 million euros. A negative evaluation would not decrease its reputation. Its survival would not be at risk without the Leibniz Association. The *Deutsches Schiffahrtsmuseum*, having a yearly budget of about five million euros and suffering from severe budgetary constraints on the state level, needs the Leibniz Association to sustain its reputation as a non-university research institute and the inflow of financial resources. In its responses to the evaluations, it is markedly defensive referring to the recommendations of the Leibniz Association, carefully re-assesses its activities and promotes substantial changes based on the recommendations. The *Germanisches Nationalmuseum*, which was repeatedly criticized for not being fully compliant with the standards set by the Leibniz Association, is less defensive. Indeed, the *Germanisches Nationalmuseum* is successful, for example, in terms of

the relevance of its collections for local stakeholders and the attraction of diverse visitor groups, which has led to an increase in miscellaneous revenues, such as donations.

The responses of the research museums to the evaluation reports of the Senate of the Leibniz Association reveal weaknesses in the German science system (Edler and Kuhlmann 2008), which impede value creation and capture. For instance, in its response to the evaluation report (2007), the *Deutsches Bergbau-Museum* explains that, due to the constraints imposed by the German federal governance system, it cannot freely choose a candidate for a leading position, such as the chairperson of the Scientific Council. It had to follow the demands of the government of North-Rhine Westphalia. In its response to the evaluation report (2014), the *Deutsches Bergbau-Museum* agrees to the claim to increase third-party funding, but it has difficulties in securing funds for interdisciplinary research. German funding organizations prefer applications, which do not challenge the borders of disciplines. Similarly, in its response to the evaluation report (2008), the *Germanisches Nationalmuseum* complains that organizations providing third-party funding for museum-specific projects or cultural history hardly exist.

Resource scarcity prevents the research museums from meeting the expectations of the Leibniz Association regarding activity content. Digitization is a case in point. In its response to the evaluation report (2013), the *Zoologisches Forschungsmuseum Alexander Koenig* explains that it would need funds for ten full-time employees for 40 years to achieve a complete digitization of its collections. Other recommendations of the Leibniz Association do not fully reflect the disciplinary particularities of a research museum, as illustrated by the response of the *Römisch-Germanisches Zentralmuseum* to the evaluation report (2013). Generally, the collections enable research. However, the well-documented archaeological collections of the *Römisch-Germanisches Zentralmuseum* are an outcome of research. In contrast to the other research

museums, it hardly relies on its own collections in its ongoing projects but seizes opportunities to increase its collection of copies of archaeological finds from all over the world.

8. Discussion and implications

The goal of this study was to examine logics as drivers of business model change. The findings show that, in the 1990s, a cultural logic was dominant. It nurtured the use of business models that stressed cultural and social value. The 2000s were a period characterized by an increasing demand for relevance, the introduction of new technologies and uncertainty in public funding. These issues enabled the questioning of the prevailing cultural logic, which was increasingly penetrated by an economic logic. The alignment of these logics provided new opportunities for value creation and mitigated financial uncertainty. In this period, a political logic emerged. It shaped the understanding and importance of intellectual value. In conjunction with the increasingly pertinent economic logic, it promoted cultural and economic value creation. Since 2010, the museums have been urged to strengthen their focus on cutting-edge research. This development has been driven by an increasingly dominant political logic. The importance of the cultural and economic logics and their interplay have not changed. The business models still aim at cultural, intellectual and economic value. Throughout the three periods, social value has been important. The analysis shows that this dimension of value is special, because it facilitates the creation of cultural, intellectual and economic value. This circumstance explains that business models aiming at social value creation are in line with all identified logics.

Overall, the study makes two contributions. First, it adds to the discussion on macro-level factors affecting business model change (Foss and Saebi, 2017) and sheds light on the political-administrative context in which business model change takes place (Schmidt et al. 2017). The embeddedness in diverse political and economic landscapes as an outcome of a federal governance system shapes their leeway to change their business models. The latter ‘depends

on multiple factors such as the characteristics of the museums themselves (size, type of collection, available human and financial resources, etc.) as well as the institutional, legal and social environment in which they operate' (Vicente et al. 2012: 651).

Second, cultural and economic logics do not necessarily conflict with each other. Possibly, on the individual level, concomitant logics create unsolvable conflicts (Eikhof and Haunschild 2007; Reay and Hinings 2009). On a superordinate level, their combination provides chances to seize novel opportunities for value creation. This insight may reveal an opportunity for business corporations to re-assess their understanding of value creation. If they do not only address customers as the main stakeholder group but adopt a holistic view that considers societal challenges which go beyond an economic logic, their business models will embrace a wider audience's claims and may be more sustainable. However, a political logic can cause conflicts either by determining a direction of business model change that contradicts the actual needs of an organization or by impeding necessary change.

This study also has limitations. First, it does not probe potentially circular relationships. Possibly, the research museums do not only react to the logics which are pertinent in their environment. One of their salient tasks is the production of knowledge and innovation, which enables them to progressively change their business models (Coblence and Sabatier 2014) and which in turn may shape their stakeholders' logics. Longitudinal case studies including multiple data sources could be revealing in this regard. Second, this study concentrates on the organizational level of analysis. It does not allow examining how individual members of the research museums perceive the logics and their impact. Business model change 'produces both winners and losers internally' (Foss and Saebi 2017: 219). Future research could use multi-level analyses including primary data. These could show how logics create tensions on and between the individual and the organizational level and reveal how their interplay on different levels affects business model change.

The study illustrates that cultural and economic logics can complement each other. The political logic implies challenges for museum management. On the one hand, political stakeholders have demands that drive business model change. On the other hand, sometimes they do not fully embrace the particularities of the research museums. They outline expectations that the museums cannot meet, for example, because they lack the necessary financial resources. In addition, the vertical coordination between the federal and the state level in Germany can hamper promising initiatives. It shows the weaknesses of the German multi-layered science system, which reflects the federal governance system in this country (Edler and Kuhlmann 2008).

Finally, the Leibniz Association emphasizes the importance of the pursuit of collective objectives over individual goals. Traditionally, the Leibniz research museums hardly collaborate among each other, although working together more closely would help them ‘retain their unique values, focus on service and advocacy, and maintain civic involvement’ (Eikenberry and Kluver 2004: 138). Reay and Hinings (2009) show that collaboration effectively promotes the stable co-existence of competing logics. Museum managers should discuss their needs and contributions with policy-makers and executives in the Leibniz Association. This could lead to an increasing fit between the association and the research museums. It may also help the research museums identify promising avenues for future collaborative activities.

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Figure 1.
BUSINESS MODEL CHANGE IN MUSEUMS

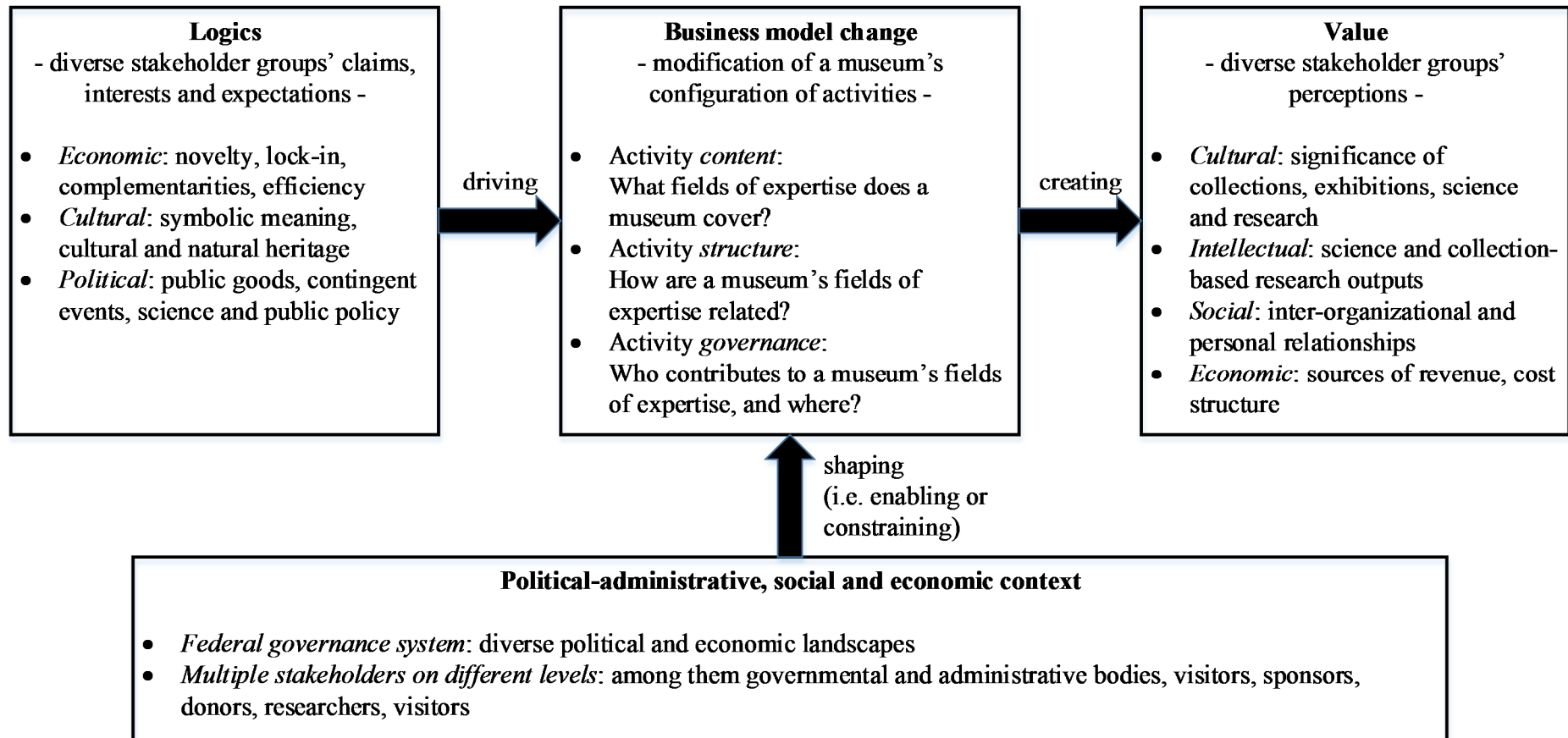


Table 1.
OVERVIEW ON THE LEIBNIZ RESEARCH MUSEUMS

Museum (federal state)	Founding year	Employees	Topical focus	Institutional co-funding	Observation window	Annual reports	Leibniz evaluation reports (recommendation)
<i>Deutsches Schiffahrtsmuseum – Leibniz-Institut für Deutsche Schiffahrtsgeschichte</i> , Bremerhaven (Bremen)	1971 (opening in 1975)	2005: 77 2013: 73	German shipping history and maritime archaeology	1980 Blue List, 2000 Leibniz	1979-2015	35 (excl. 2001 and 2002)	2007 (further funding), 2014 (further funding but with reservations), next evaluation in 2018 (earlier than usual)
<i>Germanisches Nationalmuseum</i> , Nuremberg (Bavaria)	1852	2006: 206 2013: 211	history of art and culture of the German-speaking countries	1977 Blue List, 2000 Leibniz	2013	1 (incl. chronicle and press releases)	2008 (further funding), 2015 (further funding), next evaluation in 2021
<i>Römisch-Germanisches Zentralmuseum – Leibniz-Forschungsinstitut für Archäologie</i> , Mainz (Rhine-Palatinate)	1852	2005: 153 2012: 171	pre- and early history	1977 Blue List, 2000 Leibniz	1998-2015	16 (excl. 2013 and 2014)	2007 (further funding), 2013 (further funding but with reservations), next evaluation in 2016 (earlier than usual)
<i>Deutsches Bergbau-Museum - Leibniz Forschungsmuseum für Georessourcen</i> , Bochum (North Rhine-Westphalia)	1930	2005: 84 2012: 143	history of mining	1977 Blue List, 2000 Leibniz	2000-2012	13	2007 (further funding), 2014 (further funding), next evaluation in 2021
<i>Deutsches Museum</i> , Munich (Bavaria)	1903	2001: 378 2009: 479	natural sciences and technology	1950 Königsstein Agreement, 1977 Blue List, 2000 Leibniz	1999-2014	15	2003 (further funding), 2010 (further funding), next evaluation in 2017
<i>Museum für Naturkunde – Leibniz-Institut für Evolutions- und Biodiversitätsforschung</i> , Berlin	1810	2011: 252 2016: 250	natural history	2009 Leibniz	2002-2015	11 (excl. 2010)	2013 (further funding), next evaluation in 2019
<i>Senckenberg Gesellschaft für Naturforschung</i> , Frankfurt (Hesse), Görlitz and Dresden (Saxony)	1817	2004: 258 2012: 745	biodiversity in the ‘System Earth’	1954 Königsstein Agreement, 1977 Blue List, 2000 Leibniz	2004-2014	11	2006 (further funding, integration of newly acquired entities), 2014 (further funding), next evaluation in 2020
<i>Zoologisches Forschungsmuseum Alexander Koenig – Leibniz-Institut für Biodiversität der Tiere</i> , Bonn (North Rhine-Westphalia)	1912 (opening in 1934)	2005: 101 2012: 108	natural history and zoology	1950 Königsstein Agreement, 1977 Blue List, 2000 Leibniz	2004-2014	11	2007 (further funding), 2013 (further funding), next evaluation in 2020

Supplementary Data

Table S1. ILLUSTRATIVE DATA FOR LOGICS

2 nd Order Theme: ECONOMIC LOGIC	First period The Deutsches Museum tries to reduce the costs for the development of exhibitions by cooperating with partners from industry and business. Thus, BMW could be acquired as a founding member of the new traffic centre. In that vein, BMW will show the new special exhibition “Clean energy – driving with energy from water and the sun” within a worldwide EXPO-project in Hall II in June 2000. [DM 1999] In cooperation with the FEUERSCHIFF Gesellschaft für Medienproduktion GmbH, Bad Dürkheim, a video film entitled “From Fur Boats to Container Ships“ was produced, focusing on the exhibitions of the DSM (Stölting, Ellmers). Since December 1992, it has been shown in the DSM and sold as a video tape. [DSM 1992] Second period Contributing to the SYNTHESYS-Project, the Museum für Naturkunde has opened the door to research funding on the European level. [MfN 2004/2005] Third-party funding could be increased in the last three years. However, the total amount of third-party funding is too low for a research institute of that size and should be further increased. Especially the applications for DFG-funding are very heterogeneous. Successful working groups should receive further incentives from the program budget. [SFN evaluation 2006] Third period Since December 2013, the DFG has funded the cross-linking of contents of databases from different museums of the Humboldt-Ring. [ZFMK 2013] Especially on the European level, joint projects that have been initiated within existing networks and are co-financed by the European Commission, have been playing an important role for the Deutsches Museum for years. In that context, the focus lies on raising funds from third parties and enhancing visibility for European decision-makers. The joint development of exhibitions rather bears the chance to significantly reduce the amount of human and financial resources for the project partners. [DM 2013]	1 st Order Concept: Efficiency
	First period For the TOMBA-Project, database-structures and the first Internet-based query screens were designed. [RGZM 1998] Since 9 May 1997, the DSM has had access to e-mail and the internet. On the homepage of the DSM, every 14 days a new report on the work of the DSM is published. [DSM 1997] Second period Within the project, the image database was refined. Together with the ten cooperating teams, common criteria for the selection of finds were defined during the first workshop. Moreover, translations help to make the database usable in the languages of the ten involved countries. [RGZM 2003] Children can use a moving information source in the exhibition. It provides illustrations and texts especially written for children, that explain the theme “preparation”. Young and old visitors can use a novel information bank. There, they have access to information charts and can collect information on exciting details about preparation. [MfN 2002/2003] Third period Large illustrations were integrated into each section as educational media. The number of objects was reduced, some stations were modernized by presenting the objects in a slightly different way. [GNM 2013] According to the RGZM, web-based publications become increasingly important. The directorate explicitly supports this publication type. Furthermore, several scientific databases were published online within EU-projects, which the RGZM had initiated and coordinated in the last years. [RGZM evaluation 2013]	1 st Order Concept: Novelty
2 nd Order Theme: CULTURAL	First period The mandate of the DSM consists of 1. collecting, 2. studying, and 3. exhibiting the German maritime history in all its facets. [DSM 1992] Second period The task of the DBM as an interdisciplinary research institute for mining history is the study of the linkages between the extraction and the subsequent processing of raw materials and their social and cultural developments. Within these areas, the museum covers the period from pre-history to the presence. [DBM evaluation 2007] The work of the RGZM primarily consists of doing research on pertinent scientific questions, developing new research methods and formulating new approaches to research. [RGZM 2006] Third period The Museum für Naturkunde as a Leibniz research institute has three fundamental tasks: preserving and developing the 30 million objects of its collections, doing research based on these collections and, acting as a bridge between science and the public, transferring the results of science and research into the society, in order to enable and strengthen responsible behaviour. [MfN 2011]	1 st Order Concept: Mission

2 nd Order Theme: POLITICAL LOGIC	Senckenberg's mission is to perform integrative natural history research (1), to maintain and develop natural history collections as research infrastructures for the international scientific community (2), to communicate the results of its research to the public through its museums, exhibitions and publications (3), to educate in the fields of natural history research and scientific collection management (scientists and technicians) (4). [SfN evaluation 2014]	1 st Order Concept: Cultural heritage
	First period The objective of the foundation is achieved by 1. collecting and preserving artefacts of interest to the German maritime history, 2. studying the German maritime history, 3. presenting the German maritime history to the public. [DSM 1996] Second period Accordingly, the collections in geoscience and zoology are of high traditional value. The entomological collection comprising about five million preparations has the so-called primary types of more than 13,500 species, hence those objects that helped to describe the respective species. [SfN 2009/2010] The Römisch-Germanisches Zentralmuseum as an archaeological institute is unique in the German scientific landscape. Because of its national significance, it receives the majority of its budget from the federal government and the states. [RGZM 2006] Third period Central elements that distinguish the Museum Koenig from other institutes and that are to be extended, are a) its own expertise in taxonomy [...], b) the integration of taxonomy into overarching research questions [...], c) research in molecular biodiversity with a strong component in bioinformatics and the use of the methods in all sections of the institute, d) filling the gap between the available knowledge on species and concrete applications in ecology and business, which requires the attraction of further external expertise. [ZFMK 2012]	
	First period On 4 October 1990, the DSM extended its competence until the Oder/Neiße border because of the German reunification. The Board of Directors immediately selected two representatives from the new states as members of the board. [DSM 1990] In 1995/6, the Wissenschaftsrat (German Council of Science and Humanities) evaluated the Museum in the process of restructuring research institutions after German reunification. The aim was to establish whether the Museum met the requirements for receiving joint funding from Federal and Länder Governments and whether the Projektgruppe Entomologie, Eberswalde (Entomology Project Group), evaluated at the same time, should be integrated into the Museum für Naturkunde. The evaluation report was positive on both issues. [MfN evaluation 2013] Second period In May 2002, the report of an expert commission was published. Drawing on this, the Senate of the state of Berlin adopted a law for the Museum für Naturkunde, which replaced the institutional structure with a vertical structuring into the sections research, collection and exhibition. [MfN 2002/2003] Unfortunately, the federal government had decided to continue its cost-saving measures in 2005. Thus, in accordance with the contract, the free state of Bavaria also had to reduce its budgetary support. For the daily operations, about half a million Euros were missing. [DM 2005] Third period In 2012, the White Paper on the research museums of the WGL was published. It specified the tasks of the research museums from a policy perspective and the policy-makers' expectations. Therefore, the overarching concept of the RGZM was re-evaluated in an externally supported strategy process that started in 2012. This process focused, for example on the mission statement, the organizational structure and improvements in information processing. [RGZM evaluation 2013] The end of coal mining in Germany raises questions of how to cope with the sources and remains of this important industry. The DBM and other actors in coal mining rightly consider this as a task of the research museum. Put differently, the DBM is to evolve into the "memory of German coal mining". [DBM evaluation 2014]	1 st Order Concept: Contingent events
	First period After more than 30 years of work for German maritime history, Director Gert Schlechtriem who was one of the initiators of the Deutsches Schiffahrtsmuseum retired. His position was in the Board of Directorate was not refilled; the resources were used, for example, to increase the editorial department. [DSM 1992] Second period According to the RGZM, the change of the entire Directorate and the leading executives of the sections "Paleolithic" and "Ancient Seafaring" in 2003 and 2004 enabled the reassessment of the six previous research areas. This reassessment was supported by the Scientific Council (= evaluation commission of the RGZM). [RGZM evaluation 2007] Third period Since 5 December 2012, for the first time in its history that stretches back almost 200 years, the Senckenberg Gesellschaft für Naturforschung has a female president. The Administrative Board appointed Dr. h.c. Beate Heraeus as the successor of Dietmar Schmid. Mr. Schmid and Emmerich Müller keep their seats in the Administrative Board. Mr. Müller resigned from the Advisory Board. Mr. Carsten Kratz, head of operations of Germany of the Boston Consulting Group, was appointed as vice president. [SfN 2011/2012]	1 st Order Concept: Executive succession

First period

The renovation of the facade of the Scharoun Building was terminated in October, such that the large special exhibition hall could be used again. But it was as early as December that, again, water entered the walls into the offices on the West side. [DSM 1999]

Second period

The urgent restorations of the museum ships “Seute Deern” in 2001/2002 and “Grönland” in 2004/2005 required cost-cuttings in other sections and considerable donations. [DSM evaluation 2007]

Since the establishment of the Documentation Centre for Mining History (montan.dok) with the sections mining archive, library/photo library and collections in the Deutsches Bergbau-Museum Bochum (DBM) in 2001, the storage system has radically been reorganized. [DBM 2003]

Third period

The growth of the collections and the library as well as the increase in personnel required the renting of substitute buildings to create additional office workstations. The so-called “sunny villa” providing approximately 40 office workstations is located diagonally opposite the museum (Adenauerallee 131) and was available in May 2010. [...] Simultaneously, the ZFMK and the state government negotiated an agenda that was finally approved and that paved the way to a new building. [ZFMK 2010]

Table S2. ILLUSTRATIVE DATA FOR BUSINESS MODELS

2 nd Order Theme: ACTIVITY CONTENT	First period The acquisition of objects mainly focused on paintings and graphics related to shipping and the special exhibitions. The most important purchase comprised major parts of the of the wall-panelling of the first-class smoking salon of the fast steamer Crown Princess Cecilie (1907). Because of the purchase of wooden boats the number of original vessels increased to 75. Despite the insufficiency of the museum's own funds, considerable donations helped to achieve good results. [...] The archive recorded an increase of 1,457 materials of all kinds; the library added 2,005 volumes (among them 264 volumes of journals), leading to a total of 20,000 volumes, whereby donations and the exchange of volumes also played a major role. [DSM 1979] For the pre-historical collections, the institute purchased an ensemble of Hellenistic silver jewellery, consisting of two bracelets and three bow joint brooches [...]. [RGZM 1998] Second period The inheritance of the master-builder of the Zeche Zollverein XII comprises 308 dossiers with original drafts, which are not only interesting for research on architectural history. [DBM 2002] Adding more than 100,000 series, the scientific collections of the Senckenberg Forschungsinstitut have considerably increased. [SfN 2007/2008] Third period The ZFMK has unique infrastructures for these tasks: the scientific collections of animal species from all continents, the collection of tissue and DNA samples (Biobank), special libraries, laboratories for morphology and molecular genetics, an effective IT centre as well as exhibition halls and studios for the production of exhibits. [ZFMK 2013] At "Alt-Senckenberg", the size of the collections increased from 22 million to approximately 35 million objects. Thus, Senckenberg is one the biggest research institutes for natural sciences all over the world. [SfN 2009/2010]	1 st Order Concept: Collection
	First period Maritime archaeology: nine new ship finds in diverse federal states were scientifically supervised. The reconstruction of the Bremen merchant cog was terminated; the ship was measured and the construction of a conservation tank was prepared. Older ship finds stored in the museum were measured, drawn and eventually prepared for conservation. [DSM 1979] Capacity to preserve and conserve the rich collections of historical objects, books and archive materials as well as the preservation of the approximately 100-year old buildings [DM 1999] Second period According to the focal points and the international importance of the collections, research on the arts and culture of the Middle Ages and the Early Modern Period was given priority. [GNM evaluation 2008] Senckenberg contributes to high quality standards in taxonomic research in Germany. Thus, it successfully prevents universities from reducing research on biodiversity, which is an essential discipline. The overarching concept of Senckenberg – describing, understanding and preserving biodiversity – is successfully reflected by its broad work program. Senckenberg is well on track to distinguish itself as a centre of excellence for biodiversity, ecology and evolution and to take a leading role in biogeodiversity. [SfN evaluation 2006] Third period The choice of focal points in research reflects that since 2006 even more emphasis has been put on relevance for society. [RGZM evaluation 2013] The consideration of more recent research on regional industrialization reveals numerous points of reference, such as the interplay of regionalization and globalization, the importance of enterprises/entrepreneurs as actors in industrialization and finally the interpretation of industrialization as an "institutional revolution". For the conception of space and region, recent concepts of a "spatial turn" within the historical sciences can open new opportunities. Similarly, actor-centric approaches to corporate history can complement the view of mining entrepreneurs as a group of actors. [DBM 2012]	1 st Order Concept: (Basic) research
	First period The contribution of the museum to this once-in-a-hundred-years event had an enormous advertising impact. The expertise of the museum was highly appreciated by many TV and radio programs as well as many press releases in Germany and abroad. In addition, 18,000 flyers, 1,400 posters (over the entire city) and 5,500 sun filter glasses, information provided by the Sofi and our visitor service directed the attention to this event. [DM 1999] The guiding services, which have been implemented shortly after the opening (of the museum) and which is self-sustaining, have proved to be effective and were extended. Guided tours in German, English and French can be offered. Written guide sheets for migrant workers were published in Turkish and Serbo-Croatian. Further worksheets were developed for school classes, and teachers were advised. [DSM 1980] Second period As in previous years, the archive management offered advice regarding general questions on economic archiving of mining-related materials and content-related questions on the materials stored in the mining archive. In addition, guided tours and presentations of montan.dok and the mining archive were provided. [DBM 2005]	1 st Order Concept: Knowledge transfer

	The creation of publicly visible platforms for the partners from business and industry will also be implemented profitably and according to the requirements of the organization in the next year. [DM 2004] Third period The establishment of a Centre for Public Relations and Exhibitions strengthened the knowledge transfer in the ZFMK. The museum school and the visitor service provide convincing and important educational services. [ZFMK evaluation 2013] The GNM offers scientific consulting services, for example in terms of reviews or diverse memberships in councils. Target groups comprise national and foreign culture and research foundations, culturological institutions on the local, state and federal level, institutions focusing on the preservation of public and church monuments, museums, archives and institutes involved in exhibitions, the media and science journalists, historical associations, art trade, justice and private individuals. Furthermore, all researchers regularly provide advice – either in written form, via phone or personal – regarding the collections and referring to questions on the research pursued by the museum. About 1,100 hours per year are invested in these consulting services. [GNM evaluation 2015]	
2 nd Order Theme: Activity Structure	Second period The large number of projects bears the risk of over-diversification. A stronger bundling of single projects and the establishment of systematic links between the various topical areas, especially by drawing on cross-disciplinary questions and methods, could be beneficial in enhancing the internal coherence of the work program and emphasizing the uniqueness of the GNM among the other museums. [GNM evaluation 2008] Whenever possible, the research projects of the institute are interdisciplinary and draw on the available equipment; they are thus often collection-based. There are also theory-driven projects focusing on joint cross-disciplinary questions. The research projects of the institute are – whenever the research questions allow for this – inter-departmental and also include external researchers and other institutions. [RGZM evaluation 2007] Third period The new structure bundles the architectural, technical and administrative capacities of the museum in order to meet the internal requirements – renewal of exhibitions, implementation of construction works, etc. – and the external requirements – for example referring to approval procedures, where-used lists, etc. – and implement them adequately. [DM 2011] This is the task of the research area “Digital World and Information Sciences” of the Museum für Naturkunde Berlin. Drawing on a cooperation of the library, information and communication technology, digitization research and biodiversity informatics, it studies processes and methods of object digitization, information networks, data analysis and data publication. In cooperation with the other research areas and external partners, innovative approaches to research projects, data analysis and digital collaboration are developed and implemented. [MfN 2014] The Senate asks the GNM to provide a strategic concept including concrete means for the development of the research museum, which considers all aforementioned aspects – collection, research and education – and their systematic conceptual links until 30 June 2016. [GNM evaluation 2015]	1 st Order Concept: Relating and linking activities
2 nd Order Theme: ACTIVITY GOVERNANCE	Second period According to the statutes, the RGZM is a public foundation that has an Administrative Board and a Directorate. The Administrative Board comprises the Chairperson and 18 additional members, among them eleven researchers that are elected by the Administrative Board, a representative of the Federal Government, two representatives of the Ministry of Science of Rhine-Palatinate, a representative of the city of Mainz, a member of the supporters’ association of the RGZM, the President of the DAI and the First Director of the Roman-Germanic Commission. They serve for a period of six years. A re-election or reassignment, respectively, is legitimate. The tasks of the Administrative Board comprise, for example, the establishment of guidelines for the Director’s work, budgetary decisions, suggestions for the appointment of the Directorate and – since a change of the statutes on 19 February 2002 – the election of the members of the Evaluation Commission. [RGZM evaluation 2007] The reviewers state the lack of a board that has an advisory function similar to the Scientific Council. In that vein, one must note that the ZFMK is one of the rare state institutes in the Leibniz Association. Hence, the Ministry of Science of the State of North-Rhine Westphalia alone fulfils the advisory function. [ZFMK evaluation 2007] The General Assembly elects the Administrative Board, the members of which appoint the members of the Executive Committee. [...] The Executive Committee consists of the President, the Vice President, the Treasurer, the Director of the research institute and the Honorary President. Two members represent the association externally, among them either the President or the Director. [SfN 2004] Third period The Museum is divided into three departments and a directorate (including the administration; see appendix 1). The Director General and the Managing Director are appointed by the Board of Trustees after being nominated by a selection committee. Both were appointed in 2011 on five-year, renewable contracts. The departments are: Department for Collections, Department for Research Infrastructure, Department for Exhibitions and Public Education. [MfN evaluation 2013]	1 st Order Concept: Coordination and control

With the transformation of ZFMK into a public law foundation, the institute will acquire a supervisory body, the Foundation Board. The Board will consist of up to eleven members, including representatives of the responsible Federal and Land ministry, the University of Bonn, and the Scientific Advisory Board. ZFMK's Scientific Advisory Board (SAB) is composed of five or six scientists from Germany and abroad with special expertise in species-based biodiversity research. At least one of the members is a professor at the University of Bonn. Members are proposed by the ZFMK Directorate and will be appointed by the Foundation Board in the future. They serve for five years. SAB carries out a regular evaluation of the institute every two years, including an onsite visit of two or three days. The bylaws relating to SAB will have to be adapted to conform to the new legal status of the institute. The Directorate is composed of the scientific director, two vice-directors (the head of administration and the head of the Centre for Molecular Biodiversity Research) as well as the heads of the other departments (seven members in total). Every four weeks, the Conference of Principal Investigators meets to discuss research developments at the institute. The administrative vice director, the head of the IT group, and, on occasion, the leaders of larger research projects are involved as well as representatives of the doctoral candidates and the technical staff. The Staff Council has legal status defined by a law of the Land North Rhine-Westphalia. Its task is to represent the interests of the employees. If necessary, meetings of the entire staff take place, as occurred recently in connection with ZFMK's change of legal status [ZFMK evaluation 2013]

Second period

The DFG-standards for quality assurance are the basis of the scientific work of the DSM. The geographer Reinhard Hoheisel-Huxmann has been elected by the researchers as the ombudsman to safeguard compliance with the rules and principles for the work of the DSM according to the requirements of the WGL. In 2006, there were no complaints. Moreover, the responsible boards regularly evaluate and assess the research of the Deutsches Schiffahrtsmuseum. [DSM 2006]

Quality assurance and budgeting are divided between several levels: the heads of the internal and external departments and the general director evaluate the projects and allocate funds. High performance is guaranteed by the continuous and intense discussion among colleagues and the work meetings of the heads of the departments and the research areas with their employees. Internationally, meetings including international researchers are organized, that focus on specific projects. The next stage of quality assurance comprises counselling provided by the Evaluation Commission and the Administrative Board. [RGZM evaluation 2007]

Third period

Scientific Quality Assurance for all analytical research output is regularly monitored. International compatibility in terms of data quality is checked through standardization and calibration, through employment of international reference materials, and round robin laboratory inter-calibration. The availability of the necessary international reference materials was also checked during the evaluation period and resulted in the acquisition of additional standards and, in some cases, in the re-evaluation of their suitability for various applications. Data and samples employed in original research are retained for periods of at least 10 years, or are appropriately integrated into the research collections in the form of physical samples or digitals for permanent storage and long-term access. [MfN evaluation 2013]

Referring to the exhibitions, project-based, externally hired advisory boards support quality assurance. The Scientific Council evaluates science and research. Another measure for quality assurance is the implementation of a cost and performance accounting system and the introduction of program budgets. [DM evaluation 2010]

Table S3 (continued)

Part D: economic																
year	(a) institutional co-funding (in TEURO)								(b) third-party funding (in TEURO)							
	DBM	DM	DSM	GNM	MfN	RGZM	SfN	ZFMK	DBM	DM	DSM	GNM	MfN	RGZM	SfN	ZFMK
1999		18258								77						
2000		18114								135						
2001		17864								226						
2002							16791								2387	
2003	5153		3913	14377		5366	19551	3984	402		154	973		1023	2176	2470
2004	5161		3806	14351		5437	15794	5400	569		70	579		1729	2094	2033
2005	5084		3966	13913		5292		5805	589		26	404		883		1318
2006		18546								610						
2007		19222								1033				1312		
2008		20778								707				1851		
2009					9810			4455						2584		816
2010	6398				14899	7538	25148	5125	1010					2475	2089	8372
2011	9738		5189	17005	12787	7589	28672	5367	779		450	2444	2864	1446	16750	1386
2012	9620		5036	18264		8589	30279		612		68	1462	3386	1334	13344	
2013			5960	18082							325	563	3911			
2014													4078			
2015					1592								4979			
Changes over time (in percent of total revenue, average values) – comparison between two evaluations by the Senate of the Leibniz Association																
1	77%	61%	79%	85%		70%	74%	67%	8%	39%	2%	4%		16%	10%	26%
2	67%	35%	77%	56%	74%	48%	47%	66%	8%	1%	4%	5%	17%	10%	21%	12%

Table S3 (continued)

Part D: economic																
year	(c) services (in TEURO)								(d) miscellaneous (in TEURO)							
	DBM	DM	DSM	GNM	MfN	RGZM	SfN	ZFMK	DBM	DM	DSM	GNM	MfN	RGZM	SfN	ZFMK
1999		108								10135						
2000		174								12579						
2001		200								11658						
2002							981								829	
2003	241		133	814		143	894	5	810		685	1711		839	841	94
2004	194		139	736		146	1047	11	839		652	784		881	1427	128
2005	168		117	701		122		4	895		703	908		1181		145
2006		657								28357						
2007		602								27066						
2008		523								33417						
2009					1373			3					1997			580
2010	4375				1412	143	0	4	64				3735	517	12995	687
2011	1824		321	668	1309	145	0	2	42		872	5722	2744	1188	5974	740
2012	1711		315	2629		162	0		41		751	7675		597	9259	
2013			287	837							368	9891				
2014																
2015																
					2016											
Changes over time (in percent of total revenue, average values) – comparison between two evaluations by the Senate of the Leibniz Association																
1	3%	1%	3%	4%		2%	4%	1%	13%	38%	14%	7%		13%	4%	2%
2	25%	1%	5%	4%	9%	1%	0%	1%	1%	54%	10%	24%	13%	5%	17%	9%

Notes:

Referring to economic value, comparable numbers for all research museums are not available for the years preceding 1998/1999. Moreover, comparable data for the selected indicators are not available for all years. Therefore, we especially draw on the information included in the evaluation reports provided by the Leibniz Association. Ticket revenues, which are a small fraction of a research museum's total revenue only, need not be reported separately. Either they are included in revenues from services or in miscellaneous revenues. Services include, for example, licensing, patents, consulting or publications. Miscellaneous revenues comprise, for example, donations, membership fees, merchandising or rental income.

Acronyms: DBM - *Deutsches Bergbau-Museum*, DM - *Deutsches Museum*, DSM - *Deutsches Schiffahrtsmuseum*, GNM - *Germanisches Nationalmuseum*, MfN - *Museum für Naturkunde*, RGZM - *Römisch-Germanisches Zentralmuseum*, SfN - *Senckenberg Gesellschaft für Naturforschung*, ZFMK - *Zoologisches Forschungsmuseum Alexander Koenig*.