2 Research Design

Overview: Chapter 2.1 presents the general goals and a generic research concept of this dissertation, as well as underlying assumptions. Chapter 2.2 provides the rationale for the case study method used for explorative research. Chapter 2.3 gives in-depth reasoning to the selected sample. Chapter 2.4 shows how empirical data was acquired and subsequently analyzed.

Research designs define the type of research study, its research questions, hypotheses, variables, methodologies used, and data collection methods. The research methodology should be selected with the purpose of maximizing research validity (Black, 1999; Yin, 1989). The choice of research design and methodology depends on the research question. The research question of this study is explanatory in nature, as it seeks to identify background information on *how* specific phenomena take place, and how this affects decision-making. This dissertation applies an explorative approach. To recall the research question:

> *How can a historical perspective on innovation qualify and extend our evaluation of current-day China as an emerging hub of innovation?*

In particular, this dissertation seeks to provide a better understanding of the emergence of innovation from a historical perspective, and applies the resulting insights to the context of innovation in Strategic Emerging Industries in China today. Therefore, the explorative approach is pertinent to the research focus on the discovery of relevant relationships and results in theoretical and practical implications. Apart from the historical analysis, firm-level evidence is collected and analyzed based on the relevant scientific literature and evaluated based on the results of the historical analysis.

2.1 Research concept

The present research is targeted at establishing a better understanding of emerging market innovation – with an empirical focus on China – from a historical perspective. Despite its high importance for management and scientific literature, empirical research to date has not yet critically assessed the burgeoning phenomenon of R&D and innovation in China from a historical perspective. Thus, while some previous contributions use historical anecdotes and evidence

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peripherally, a thorough historical perspective is currently missing. This dissertation seeks to fill this gap in the literature and is rooted in two literature streams.

First, it builds on the literature on the history of innovation, illuminating the evolving nature of innovation from a historical perspective and focusing in particular on economic, institutional and political, as well as sociocultural aspects of an evolving innovation context. This serves the purpose of expanding existing perspectives on innovation in emerging markets, and particularly in China, by including historical elements that can help inform our present views, an aspect that has been almost completely neglected in previous contributions.

Second, it applies this historical understanding of innovation to the current-day phenomenon of innovation in China, focusing on comparable economic, institutional and political, as well as sociocultural aspects the Chinese innovation context, building on relevant literature on global R&D and innovation management, as well as institutional theory.

This dissertation uses historical methods to understand innovation in the past, as well as field research to understand innovation in present-day China. It thus aims at contributing to existing literature and theory and assumes that research is an iterative learning process that can create knowledge based on theory and practice, rather than validating hypotheses solely derived from theory (Berg & Lune, 2004; Bonoma, 1985; Eisenhardt, 1989). Based on data analysis, observable elements and their interrelations are revealed, reflecting empirical data on theory with new perspectives of reality by using differentiation, abstraction, and changes in perspective, thus enhancing alternations and theory building (Skorna & Widenmayer, 2010; Widenmayer, 2012, p. 32). Throughout the research process, empirical data is connecting and disconnecting with existing literature, resulting in theory expansion (Mintzberg, 2005). Finally, as a result of the research process, propositions are developed that extend existing theory.

2.2 Research method

As outlined above, this dissertation follows an explorative research design, based on the type of research question, as well as the multifaceted and novel character of the phenomenon and relationships studied. This dissertation seeks to develop theory from the application of historical research to selected case studies, conducting an in-depth analysis of innovation history, and applying the resulting insights to case studies, which follow a multiple-case design (Eisenhardt, 1989; Yin, 1989). According to Yin (1989), a case study “is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, over which the investigator has little control, especially when the boundaries between pheno-

menon and context are not clearly evident" (Jin, 2005, p. 49). Comparative case studies build theory in a post-positivist manner.

The use of historical research designs

Historical research in innovation can be seen as a narration of events through time in which their sequence is described. Historical research requires the "analysis and explanation of the causes and consequences of events with particular concern for change" (Savitt, 1980, p. 53) and it should explore and analyze the subtle relationships between historical innovation events and the underlying economic, political-institutional, as well as sociocultural context.

Historical research designs are used to gather, verify, and synthesize evidence from the past to establish facts that defend or refute a hypothesis. For this purpose, scholars can use historical evidence based on primary, as well as secondary sources. It is important to note that in historical research, it can be difficult to draw a precise line between primary and secondary sources of evidence (Savitt, 1980, p. 55). For instance, primary sources that are commonly used, e.g. historical public records, were collected by individuals at the time, rather than the history scholar. Primary sources typically used include government or other public records, corporate records, diaries, pictures, visual or audio recordings, and maps. Secondary materials include, but are not limited to, textbooks, journal articles, newspapers, biographies and other media such as films or tape recordings. Historical materials can provide important contextual background to increase understanding of a research problem. In order to achieve relevant results, the sources used must be both authentic and valid (Savitt, 1980; University of Southern California, 2014).

Historical perspectives can be defined as being *descriptive* and *comparative* (Savitt, 1980, p. 53).

They are *descriptive* because they begin as narratives of events in a specific time period, for example the period of the Industrial Revolution. Particular events are identified and described based on their specific characteristics. The subsequent analysis then provides explanations, relationships, and consequences of the events. In some cases, the insights gained from historical analysis can serve as a basis of prediction, when extrapolation to future cases is desirable and realistic (Savitt, 1980, p. 53).

Historical perspectives are also *comparative,* e.g. when events in a single place are compared over a specific time period, or when events at different places are compared in the context of chronological time – for example, at the same time, or over a specific period of time. While the former approach is part of traditional, chronological historical research, the latter example is also an example

of historical study. Furthermore, it is important to note that the use of comparison is part of the historical perspective, even though it is only a method and not historical research itself (Savitt, 1980, p. 53).

Following the historical analysis, this study uses a *case study approach*, to increase understanding about innovation in Strategic Emerging Industries in China, based on the preceding historical analysis. Cases studies are in-depth and holistic inquiries of single or few incidents or cases of a phenomenon ("how" and "why" rather than "how much/often"). They are studies in their real-life context and may combine different methods (e.g. qualitative and quantitative) as appropriate. As a positivist and interpretive study type, they are generic research strategies aimed at producing memorable examples of important management issues and concepts.

Justifying the use of the case study approach

According to the relevant literature, the use of case studies as a qualitative research approach can be justified for this study based on the following main considerations:

First, case studies are used in particular when identifying contextual information on "how" specific phenomena occurred and what explains the resulting decision-making. Therefore, previous contributions suggest that the case study method is appropriate when 'how' or 'why' questions are being asked about a contemporary set of events over which the investigator has little or no control (Yin, 1989). This is true for the main research question addressed in this dissertation.

Second, choosing a case study approach is also sensible as it allows for the study of multifaceted phenomena, such as the emergence of innovation in its historical text, through a collection of data in natural settings, rather than relying on "derived data" (Bromley, 1986, p. 23). In addition, the using case studies allows for the integration of a variety of sources of evidence including documents, interviews and observations and thus strongly increases the comprehensive treatment and understanding of the topic (Yin, 1989).

Third, purely quantitative research approaches such as surveys typically involve a larger sample size, potentially resulting in higher levels of generalizability of results. However, the complexity and also sensitivity of some topics addressed and materials analyzed – in particular company level assessments of Chinese innovation-related government policies - excluded quantitative approaches such as online-based surveys. In addition, previous studies have shown that in Mainland China, managers typically prefer face-to-face interviews to questionnaires. Response rates for the latter thus tend to be very low in international

comparison. Therefore, in China, it is often necessary to establish personal relationships (‘guanxi’) with respondents in order to receive qualified responses (Harzing, 2006).

Fourth, using a case study approach allows for interviews to be less structured than surveys in order to gain more comprehensive understanding of the topic, enabling the author to integrate discussions of issues arising spontaneously in the conversation, an important aspect in developing an understanding of new perspectives on theoretical phenomena as pointed out by Eisenhardt (1989) and Corbin & Strauss (1994).

Fifth, the multiple-case approach allows for comparison across sites, which reveals idiosyncratic characteristics of each site, increasing the robustness of findings (Miles, 1979) and in using this approach, this dissertation seeks to identify those characteristics and theoretical mechanisms that determine how firms conduct innovation in the context of China, based on a historical perspective.

Nevertheless, one of the main drawbacks of the case study method is the narrow and idiosyncratic representation of research results, which can make it difficult to provide an adequate generalization of insights (Jin, 2005, p. 49). To improve the validity and generalization of the research results of cases studies, a number of previous contributions have provided detailed guidance on how to perform case study research in order to minimize such drawbacks, and at the same time build on the unique strengths of the case study method in enabling the analysis of complex and multifaceted phenomena (Eisenhardt, 1989; Yin, 1989). The following sections describe how these recommendations were implemented in the present study.

Based on limited previous academic research, in-depth data on four case studies was collected. The cases were chosen deliberately on the basis of theoretical considerations following Eisenhardt (1989), as choosing the case studies randomly is neither necessary nor preferable and extreme examples are most appropriate when seeking to extend theory. Instead, it makes sense to deliberately choose cases, so that the ”process of interest is transparently observable“ (Eisenhardt, 1989).

Following Yin (2014), several measures were taken in order to increase the most important criteria for qualitative empirical research, validity (construct, external and internal) and reliability of results (Yin, 2014). Multiple sources of evidence were used including semi-structured material based on interviews, firm-internal documents, desk research and press clippings. Data triangulation was used to increase internal validity. Processed interview data was subsequently confirmed in follow-up interviews.

External validity confirms that the findings can be generalized within the frame of the conducted research (Yin, 2014). The data was processed to allow for a clear chain of evidence between questions asked, data collected and conclusions drawn. Concepts and theories emerging from data were compared with the literature for generalization and theory building from cases in order to increase internal validity of causal relationships (Yin, 2014). Lastly, reliability ensures that another researcher would be in the position to conduct the same research successfully, using the same procedure at a later date (Eisenhardt, 1989; Yin, 2014). It is therefore important to describe data collection and analysis in detail and in a transparent way. The following sections illustrate in detail how the quality criteria are addressed and how rigorousness of research is assured.

2.3 Sample selection

This section first outlines the rationale guiding the historical analysis, as well as the sample selection for the case study research.

Historical analysis: sample selection

As outlined in the literature review on historical drivers of innovation, innovation systems evolve over time and differ based on different industries and geographies. They are also marked by different speeds and levels of dispersion in different time periods and locations. Therefore, it is difficult to construct overarching schemata of innovation from a historical perspective that provide complete consideration to nuances and evolutions in the innovative environment over time. It is thus necessary to define a specific focus – e.g. based on time periods, technologies considered, or geography – in order to operationalize any potential historical perspective on innovation.

Indeed, a number of historians and innovation scholars have defined "taxonomies of epochs" (Bruland & Mowery, 2004, p. 1) to identify commonalities and patterns in the history of innovation, structuring their approach long different dimensions.

One way of doing this has been to center taxonomies around "critical technologies" that have defined whole periods. One example briefly mentioned above is the wave theory proposed by Schumpeter. In his two-volume, 1,095-page seminal work on "Business Cycles", Schumpeter (1939) develops this theory, building on earlier prominent business-cycle theorists including Clement Juglar, Joseph Kitchin, and Nikolai Kondratieff. In doing so, he focuses on five industries that led the process of economic development - cotton textiles, rail-

roads, steel, automobiles, and electric power – and emphasizes three institutional innovations crucial to the rise of capitalism: the factory, the corporation, and the modern financial system. Other contributions have deprioritized the wave theory perspective, focusing instead on a few key technologies driving economic growth (Bruland & Mowery, 2004, p. 1).

However, it is easy to overstate the importance of individual, "critical" technologies while downplaying the role of other types of innovation that that also matter. This study seeks to move beyond the description of individual key technologies that have been seen as defining whole innovation epochs. It illustrates the evolution of innovation from a multi-sector perspective that takes into account different innovation modes, institutional processes, and organizational forms. In particular, the present research is based on an innovation system approach (the latter being outlined in the literature review section of this thesis) to describe an innovation context evolving in subsequent time periods. This approach shows the evolving nature of innovative activity, the underlying institutional framework, as well as underlying flows of knowledge in emerging industrial economies such as Britain and the United States in their respective time periods (Bruland & Mowery, 2004).

The historical analysis includes three distinct time periods: the First Industrial Revolution between about 1760 and 1850; the Second Industrial Revolution, which occurred from the second half of the nineteenth to the first half of the twentieth century; and lastly what some scholars consider to be the "Third Industrial Revolution" following World War Two, a time period that has been marked by the dominance of the United States, and increasingly also by the globalization of R&D and innovation (Fagerberg et al., 2006, p. 350). This encompasses the emergence of innovations based on the use of coal in Great Britain of the 18th century, the improvement of property rights and a greater awareness of the value of innovation as an end to itself over time and thus - in the words of philosopher A.N. Whitehead – an emerging notion of the "art of innovation" (Whitehead, 1925). In particular the third time period discussed, the time after the World War Two, illustrates the importance of private and public institutions in relation to innovation to this day.

The rationale for choosing these periods is provided in the following section.

Most importantly, it is important to note that invention and innovation did occur much earlier than the Industrial Revolution in the 19th century. However, as previous contributions have shown, a number of geographic, economic, institutional and sociocultural factors allowed for the Industrial Revolution to occur first in Britain, as a first instance of substantial economic growth on a broad basis resulting in increased productivity, embedded in an increasingly

formal and supportive institutional environment (e.g. Crafts, 1977; Landes, 2003; Mokyr, 2010). Only the particular context of the Industrial Revolution provided an environment in which sustained innovation-based development could emerge (Bruland & Mowery, 2004, p. 2).

Thus, the selection of the three particular time periods and locations does not seek to understate the importance of other inventions and innovations in other time periods and geographies. Indeed, the historical and cultural context of Britain, Western Europe and the United States is remarkably different from the one encountered in China. While this may suggest that a comparison of China with the historical experience of other (e.g. Asian) and more similar economies would be most appropriate, the selection of the three time periods (and regions) outlined above is more suitable, as it allows for an evolutionary analysis of innovation systems in different time periods and regions that were interrelated and spread to other parts of the world including Asian economies.

Furthermore, the time period of the Industrial Revolution is well documented and numerous previous contributions have illuminated it from different perspective. This is helpful for this study, as it allows for a specific analysis of innovation from a historical perspective that can then be transferred to the new phenomenon under consideration, the context of innovation in China's Strategic Emerging Industries.

Indeed, it is difficult to speak of such kind of a coherent innovation system that includes different stakeholders such as individual inventors and innovators, government institutions and policies, and organizations such as companies before the time of the Industrial Revolution. Furthermore, the choice of three broadly related subjects of analysis – in terms of geography, as well as subsequent time periods - allows for a comparative analysis of innovation taking place in an evolving context of influencing environmental factors. The Industrial Revolution occurred first in Britain and then spread to continental Europe and the United States. Therefore, the subsequent two sections are naturally focused on these regions. As innovation subsequently - and in particular after the Second World War – also emerged in other regions such as Asia, the relevant sections also include important insights from innovation occurring in these regions.

Theoretical sampling: company case study selection

According to Eisenhardt, the case selection is a crucial element of building theory from cases (1989, p. 536). Similar to hypothesis-testing research, the concept of a population is important, as it defines the set of entities from which the research sample is to be drawn. Furthermore, the selection of an appropriate population controls extraneous variation and helps to define the limits for generalizing

the findings. According to Eisenhardt (Eisenhardt, 1989), it makes sense to choose cases "in which the process of interest is transparently observable" (p.537). In theoretical sampling, one should choose cases that are likely to replicate or extend the emergent theory. The approach to sampling the firms analyzed in this paper followed Eisenhardt in that "the goal of theoretical sampling is to choose cases which are likely to replicate or extend the emergent theory" (Eisenhardt, 1989).

In contrast, traditional, within-experiment hypothesis-testing studies rely on statistical sampling, in which researchers randomly select the sample from the population (Eisenhardt, 1989). This is in line with the overall goal of this dissertation, which seeks to advance or develop existing or new theory instead of theory testing on a broad scale (Eisenhardt, 1989; Yin, 2014). As Pettigrew (1990) notes, given the limited number of cases which can usually be studied, it makes sense to choose cases such as extreme situations and polar types in which the process of interest is "transparently observable".

The case studies were selected through the following process.

A preliminary list of companies operating in Strategic Emerging Industries (SEI) in China was compiled, based on previous interviews conducted with 27 companies in China in the context of a research project in cooperation with *IP Key*, a three-year-project (July 2013 - June 2016) based in Beijing, China, implemented by the Office for Harmonization in the Internal Market in partnership with the European Patent Office (IP Key Project, 2015). This list of companies was then short-listed to those four companies with the largest potential for learning with respect to the phenomenon studied in this dissertation. To facilitate this process, additional interviews were conducted with representatives of two international intellectual property law firms (one headquartered in Beijing, China, the other one headquartered in Sydney, Australia), the German and US Chambers of Commerce in Shanghai, as well as with a senior editor of China Daily News in Beijing, representing China's leading English speaking newspaper.

The companies selected for the in-depth case study sample are Siemens AG, Bayer Material Science, BYD-Daimler, and Haier Group. While Siemens and Bayer Material Science are headquartered in Germany, BYD (based in Shenzhen) and Haier Group (based in Qingdao) are based in China. These four case studies were chosen based on the following criteria.

First, the companies are operating in at least one Strategic Emerging Industries (SEI) in China, as outlined earlier.

Second, the selected companies have an R&D unit in China and have built up significant R&D activities in Mainland China. Further, as the focus of the attention was mainly on China's innovation context rather than individual firm strategies, the headquarter location of firms was not a selection criteria. Instead,

following Yin (1989), cases were selected as to be interesting and relevant to the study objective and to increase external validity to represent a large range of situations to which the study can be generalized.

Third, the companies have a global footprint in terms of sales, production and R&D, putting them in a position to consider and compare different R&D locations globally. They have established structures and a longstanding history in global management enabling global development.

Fourth, the companies are of sufficient size and leading players in their respective industries in China, potentially making them susceptible for the influence of Chinese industrial and innovation policies.

Fifth, the company headquarter location may be either in China or another country.

Sixth, using two cases from the same or related industry (i.e. Siemens and Haier) or with comparable histories (i.e. longstanding industrial corporations such as Siemens and Bayer), in addition to within-case analysis, it is possible to identify cross-case patterns and similarities and differences, which increases external validity and helps in breaking "simplistic frames" (Eisenhardt, 1989).

Seventh, all companies selected use technological as well as business model innovation to be industry leaders, building on their respective competitive advantages.

Although there are no specific scientific recommendations regarding the number of case studies in qualitative research, in the relevant literature, between three and ten are regarded as sufficient for theory development (Eisenhardt & Graebner, 2007; Widenmayer, 2012, p. 40). For this dissertation, four case studies were selected that offer interesting insights into the emergence of innovation in the context of China. The following table provides an overview of these companies. Detailed information about the case units is presented in Chapter 5.

Table 1: Selected case studies of dissertation (source: latest annual report)

Company	Industry sector	HQ location	Revenues (2013)	Employees	Distribution of revenues
Bayer Material Science	Polymer materials	Leverkusen (Germany)	EUR 11.2bn	14,300	Europe: 39% Asia/Pacific: 27% North America: 22% Latin Am/Mid-East: 12%
BYD-Daimler	Automotive	Shenzhen (China) / Stuttgart (Germany)	BYD: CNY 49.8bn (EUR 6.1bn) Daimler: EUR 118bn	BYD: 159,000 Daimler: 274,600	*BYD* China: 86% / India: 2% Europe: 2% / USA: 4% Other: 6% *Daimler* Western Europe: 35% NAFTA: 28% / China: 9% Other Asia: 12% / Other: 16%
Haier	Consumer Electronics Home Appliances	Qingdao (China)	CNY 180.3 (EUR 21.9bn)	55,800	n.a.
Siemens AG	Conglomerate (Industry, Health-care, Infrastructure)	Munich (Germany)	EUR 75.9	362,000	Europe: 53% Americas: 28% Asia, Australia: 20%

2.4 Case study data collection and data analysis

2.4.1 Data collection

The empirical research and data collection on the four case studies was conducted between September 2013 and December 2014. In terms of methods or research "tools", data were collected using semi-structured, in-depth personal interviews, archival documents, and on-site observations. According to Yin

(1989) and Eisenhardt (Eisenhardt, 1989), the triangulation of data gathered with different methods can increase construct validity, by reducing the limitation of using a single method, thus strengthening theory development. The following table provides information about the data sources for each of the four case studies.

Table 2: Data sources of the four case studies

Company	**# Interviews**	**Interviews / Location**	**Archival documents**
Bayer Material Science	5	5 in Shanghai, China (personal)	Annual reports; websites; business plans; patents; company presentations; organization charts; press releases; new clippings
BYD-Daimler	4	3 in Beijing, China (personal) 1 via telephone	Annual reports; websites; business plans; patents; company presentations; organization charts; press releases; new clippings
Haier	3	1 in Shanghai, China (personal) 2 via telephone	Annual reports; websites; patents; company presentations; organization charts; press releases; new clippings
Siemens AG	5	5 in Beijing, China (personal)	Annual reports; websites; business plans; patents; company presentations; organization charts; press releases; new clippings

Interviewees were either native German, Chinese or English speakers; for comparability reasons, all interviews were conducted in English. Respondents were chosen based on their experience related to R&D as well as the innovation context of China.

The author personally conducted individual, open-ended, and semi-structured (also referred to as 'focused') individual interviews. Semi-structured interviews can lead to more flexibility and the possibility to make adaptations; they can also create a more free and open atmosphere for the interviewer as well as the respondent (Yin, 2014). The interviews asked for both past and present data to create greater depth of understanding of how events had evolved over time.

The interviews were organized following the same semi-structured interview guide consisting of several open-ended questions that allowed the informant to relate his or her experience (the interview guide can be found in the

appendix). In most cases, respondents were senior R&D managers. Personal interviews lasted between 60 and 130 minutes; phone interviews lasted between 40 and 90 minutes. At the end of each interview, interviewees were asked to name further colleagues who may be able to provide further information on innovation-related activities in China ('snowball sampling'). Due to the sensitivity of issues addressed in the interviews, the interview participants requested that their personal names be removed in the final study for confidentiality reasons.

The author tried to control for potential respondent bias by not discussing any elements of emerging theory with respondents and by maintaining a neutral presence during company visits and interviews. Further, to reduce bias from recall and rationalization, the author triangulated the collected interview data with both firm-internal data sources and external analyses from third parties, as provided in the table above. Using these procedures and additional materials was done in order to reduce potential respondent bias. Additional materials used for data triangulation included annual reports; websites; business plans; patents; company presentations; organization charts; press releases; and new clippings. Further interviews were conducted and materials gathered until there was no more marginal improvement of understanding and theoretical saturation was thus reached (Eisenhardt, 1989).

2.4.2 Data analysis

All semi-structured interviews were recorded with detailed interview notes. Due to the sensitive nature of information shared in the context of R&D facilities in China, it was not possible to tape record the interviews for subsequent transcription. The data received from the interviews were compared with the information received from non-personal sources. If discrepancies emerged, these were clarified with representatives of the specific company. Interview data were first entered into word processing software and subsequently entered into a case database, together with all other company-related data. Afterwards, this material was used to compile individual case histories of 10-15 pages in length including data from the interviews, as well as third-party information. While analyzing interview notes and other documents, the author iteratively compared the case materials with theoretical contributions to compare and relate emerging theory with the data, also by developing tentative propositions to describe emerging themes (Eisenhardt, 1989).

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