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# The evolution of business models towards sustainability and digitalization: Their historical development, current trends and a case study in the EIMI

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## Abstract

Business Model is an essential tool for firms to be successful and is widely used, however, there is still no definition of BM agreed by all the scholars. Furthermore, its development towards digitalization and sustainability with the industrial implication of current academic trends in Energy Intensive Manufacturing Industries (EIMI) are little discussed. To have a comprehensive understanding of BM development and evolution, its turns towards digitalization and sustainability, and its implication on EIMI, a Systematic Literature Review (SLR) with text-based and bibliometric analysis, and a case study in EIMI were done. Various BM-related publications from 1941 till 17.09.24 were analyzed. It was discovered that the evolution of BM is closely related to the evolution of government regulations and technological innovation, and the adaptation of new technologies to realize Sustainable Business Model Innovation (SBMI) and Digital Business Model Innovation (DBMI) is crucial for EIMI to remain competitive nowadays. Through a general understanding of BM development, updating the current trend, and a case study, this thesis aims to bridge the impact of Sustainable Business Model (SBM) and Digital Business Model (DBM) on EIMI and draw the attention of scholars to develop further research in this field.

## Keywords

Business model, Business model innovation, Business model evolution, Sustainable business model, Digital business model, SLR, academic trend, case study, EIMI

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## List of abbreviations

- AI – Artificial Intelligence
- BM – Business Model
- BMC – Business Model Canvas
- BMI – Business Model Innovation
- DBM – Digital Business Model
- DS – Digital Servitization
- DT – Digital Transformation
- EIMI – Energy Intensive Manufacturing Industries
- I4.0 – Industry 4.0
- IoT – Internet of Things
- IT – Information Technologies
- OI – Open Innovation
- SBM – Sustainable Business Model
- SLR – Systematic Literature Review
- SMEs – Small and Medium-Sized Enterprises
- TBL – Triple Bottom LineUSA – United States of America
- VC – Venture Capital

# 1. Introduction

All businesses employ a particular Business Model (BM) and the success of a firm relies on its BM design, which although being frequently mentioned, it is rarely analyzed. Consequently, BM concepts are often poorly understood and ill-defined with fuzzy edges (Foss & Saebi, 2017, p. 222; D. J. Teece, 2010, p. 190, 2018, p. 40). On top of that, BM provides a pathway for firms to realize technological and sustainable innovation and to convert them to value (Bouncken et al., 2021, p. 1; Nosratabadi et al., 2019, p. 1). This has led to high interest in the development and implementation of digital and sustainable BMs in both academia and industry. Consequently, understanding how BMs have evolved, identifying the key drivers of change and examining their shift towards sustainability and digitalization have become essential questions for scholars and business leaders.

Moreover, there is little research specifically focused on Energy-Intensive Manufacturing Industries (EIMIs) Sustainable Business Model (SBM) implications. EIMI includes the metal industry, the chemical industry, the minerals and materials industry. As one of the essential producers in the European economy, EIMIs generated around 20 percent of total German greenhouse gas emissions. With the drivers including adapting to the decarbonization goal by 2050, responding to the customers' need for low-carbon products, investors' expectations and regulatory requirements, EIMIs is facing huge pressure on integrating sustainable goals (Mais & Bauernhansl, 2024, p. 1,2). To address this gap, EIMI's SBM and Digital Business Model (DBM) implications has addressed as another research focus in this thesis.

Thus, four research questions are made to respond to these research gaps. First, how have the research streams and areas of focus shifted in studies of general BM over time? Second, how have the keywords and terminology related to SBM and DBM evolved? Third, shifting factors towards SBM and DBM and how does it affect the overall EIMI industry? Fourth, to what extent do identified trends in SBM and DBM align with the BM of an EIMI case study?

A SLR and text-based as well as bibliometric analysis based on conference and journal articles in Scopus, WOS and IEEE with the search string of “business model” OR “business strateg\*” were conducted. Starting with the earliest article found which was published in 1941 till 17.09.2024, the top ten cited publications of every decade were used for literature screening, eventually, 69 out of 174 articles were used for detailed reading.

Finally, a case study of BASF, the world's leading chemical company, was conducted focusing on its Business Model Canvas (BMC) analysis and SWOT analysis to consider the practical case of how companies adapt academic research trends to their BMs.

The remainder of this paper is structured as follows: in the theoretical background, a brief literature review of several most cited definitions of BMs and BMI was presented to give a basic understanding of current BM frames. Methodology described the research methods used in this research and its process in detail. The Results chapter includes four sections. The first section provides the SLR and text-based analysis results of general BM development, with publication counts, top-cited, countries and keywords analysis. The second section mapped important terminologies and keywords of SBM and DBM through the second SLR. The third section zoomed in and examined the shifting factors of BMs towards SBM and DBM with literature research and its effects on EIMI. And fourth, a trend identification of current research trends and a case study of BASF were done to present the practical application of SBM and DBM in the industry. In the end of this thesis, a conclusion provides the overall contribution of this thesis, its limitations and future research directions.

## 2. Theoretical background

In this chapter, an overview of BM definitions and Business Model Innovation (BMI) definitions are presented.

### Top cited Business Model and Business Model Innovation definitions

Although the BM is a wide concept that rapidly adapts as one of the key factors to operate a successful business, however, there is no common definition that is agreed upon overall by the scholars, and often falls as an unclear conceptual word (Magretta, 2002, p. 86,92). The lack of clarity in the definition of BM is one of the reasons that promote the dispersion focus of the BM (Zott et al., 2011, p. 1023). To provide an overall understanding of the BM, six BM definitions from the most cited publications in the SLR datasets articles are presented in Table 1.

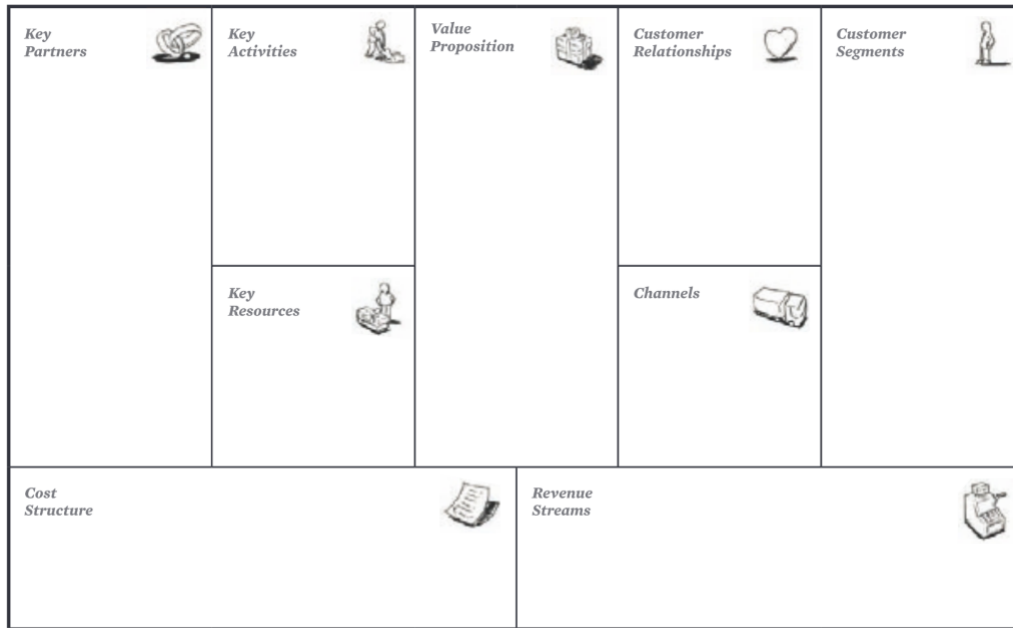
Table 1. Selected BM definitions

Authors	Definitions
(Chesbrough, 2003, p. 64,65)	The functions of a business model are as follows: 1. To articulate the value proposition, that is, the value created for users by the offering based on the technology 2. To identify a market segment, that is, the users to whom the technology is useful and the purpose for which it will be used 3. To define the structure of the firm's value chain, which is required to create and distribute the offering, and to determine the complementary assets needed to support the firm's position in this chain 4. To specify the revenue generation mechanism(s) for the firm, and estimate the cost structure and target margins of producing the offering, given the value proposition and value chain structure chosen 5. To describe the position of the firm within the value network linking suppliers and customers, including identification of potential complementary firms and competitors 6. To formulate the competitive strategy by which the innovating firm will gain and hold advantage over rivals
(Osterwalder et al., 2010, p. 14)	A business model describes the rationale of how an organization creates, delivers, and captures value
(D. J. Teece, 2010, p. 173)	A business model defines how the enterprise creates and delivers value to customers, and then converts payments received to profits.
(Osterwalder et al., 2005, p. 5)	A business model is a conceptual tool containing a set of objects, concepts and their relationships with the objective to express the business logic of a specific firm. Therefore we must consider which concepts and relationships allow a simplified description and representation of what value is provided to customers, how this is done and with which financial consequences.
(Magretta, 2002, p. 90)	"Business modeling is the managerial equivalent of the scientific method—you start with a hypothesis, which you then test in action and revise when necessary."
(Amit & Zott, 2001, p. 495)	"A business model depicts the design of transaction content, structure, and governance so as to create value through the exploitation of business opportunities. We propose that a firm's business model is an important locus of innovation and a crucial source of value creation for the firm and its suppliers, partners, and customers"

On the other hand, to achieve growth in revenue, improve profit (Amit & Zott, 2012, p. 41) , and stay competitive in certain trendy fields such as sustainability (Geissdoerfer et al., 2018, p. 401), companies address the effort to innovate their business models. The generic configurations that catalyze BMI can be categorized into four main scenarios in the industry: First, Star-up, in which a new BM is created from none. Second, an existing BM can undergo a transformation and be innovative again. Third, an additional BM is created and co-existed with the previous BM. Finally, An additional BM is integrated and fused with the existing BM (Geissdoerfer et al., 2018, p. 407). Two top cited definitions of BMI in the SLR sample publications were “Business model innovation is about creating value, for companies, customers, and society. It is about replacing outdated models.”(Osterwalder et al., 2010, p. 5) and “Business model innovation can itself be a pathway to competitive advantage if the model is sufficiently differentiated and hard to replicate for incumbents and new entrants alike.”(D. J. Teece, 2010, p. 173) .

A powerful tool for identifying a company's new or existing BMs, called the Business Model Canvas, which was used for the case study analysis in this thesis. It consists of nine key elements (Osterwalder et al., 2010, p. 20,22,26,28,30,34,36,38,40,44) and can be visualized as Figure 1:

- Customer segments (CS): Defines the groups of people or organizations a firm target and serves.
- Value Proposition (VP): Represents various products and services that create value for specific customer segments.
- Channels (CH): Describes how a firm reaches and communicates with its customer segments to deliver the VP.
- Customer Relationships (CR): Defines the type of relationships a company establishes with its customers.
- Revenue Streams (RS): Outlines how a company generates revenue from its CS.
- Key Resources (KR): Identifies the essential assets required for the BM to function.
- Key Activities (KA): Defines the critical actions a company must take to operate its BM effectively.
- Key Partnerships (KP): Represents the network of partners and suppliers that support the BM.
- Cost Structure (CS): All costs associated with operating the BM.



*Figure 1 The Business Model Canvas*

Broadly speaking, a BMI is about the future, creating new values and staying competitive. To further understand how the BM and BMI play a role in shaping the economic environment nowadays, a systematic literature review on the evolution of business models since 1941 was conducted and analyzed. And a case study was conducted to evaluate the alignment of BM trends with a real-life example.

### 3. Methodology

To answer the research questions of historical development, overviewing the evolution, examining the shifts, and identifying terminologies of BMs, a systematic literature review (SLR) was conducted. A SLR is a kind of research method to identify strong relevant results in the research field while providing a broad perspective and minimizing bias (Snyder, 2019). Since the purpose of this research is to identify the direction and turns for the evolution of BMs, SLR can provide a broad aspect of relevant research within the field of BM while giving details of selected papers. Every ten years a section was set as an anchor point to monitor the changes in BMs.

To give a more complete overview of the academic research evolution of BM, VOS Viewer was used for visualizing keywords and terms networks. The general keywords were identified by co-occurrence analysis in which the total number of the keywords among all the publications were counted and displayed in map format (van Eck & Waltman, 2022, p. 37). In addition, to give some historical content relevant to the change of BM, additional literature research was done. The statistical information of articles including public year, citation count, public countries, and research methods was also presented.

For the current trend, the recent five years of publications on Scopus from 2020 to 16.01.2025 with the search strings “sustainable business model” and “digital business model” were used as datasets for VOS bibliometric analysis to identify the keywords. Since a decade was already used as the unit for evolution monitoring, five years was used as a period to identify the recent trend with up-to-date publications. A case study of BASF was then focused on its BMC and SWOT analysis to cross-examine with the result from VOS analysis and keywords shift results from SLR.

#### 3.1 Data Collection

To conduct the bibliometric analysis and SLR process, IEEE, Scopus, and Web of Science were used to collect peer-viewed articles and conference papers.

Both Scopus and Web of Science covered a large range of research fields. Scopus provides a great historical depth with records backdated to 1788 (Scopus, 2024) which can provide reliable references and build a wide landscape for the evolution of BMs. IEEE is a leading journal in the field of electrical

engineering, computing, biotechnology, telecommunications, power and energy, and dozens of other technologies with a large number of conference papers (IEEE, 2024). To gain a technical point of view regarding the evolution of general BMs and DBMs along the technologies development, IEEE is considered one of the best sources.

The search was conducted on 17.09.2024 with the search string of "business model" OR "business strateg\*" with the Document title and Abstract field only within journal articles and conference papers. "Business strategy"(BS) was included in the search string since the concept of BM described a more generic approach than business strategy, however, strategic analysis is essential for BM designing (D. J. Teece, 2010, p. 179). Furthermore, the term BS was more often used in early relevant articles (Cook, 1968; Grinyer, 1971; Nourse, 1941). Therefore, to give a comprehensive overview of BM, including BS in the search string is necessary. All BM- and BS-related articles published in the selected databases up to the search date were collected and categorized by decade to analyze keyword usage, trends, and shifts in focus over time. Firstly, the publications were used for text-based and bibliometric-based analysis to identify the relationships between terms and keywords. The duplicated articles within different databases were removed with Python-based scripts. Then for the SLR, the top 10 cited articles per database per decade, starting from the earliest available publication, were collected and filtered using the PRISMA process. Backward research was done to fill the gap of the missing important literature from the databases. Therefore, the academic approach through time on BMs development can be synthesized and evaluated. From the same dataset, the publications related to SBM and DBM were used for identifying the terminology and keyword evolutions of SBM and DBM. Additional backward research was also done. Google Scholar was used to get a broader range of literature for literature research.

To identify the current academic trends of SBM and DBM, the articles from 2020 to 16.01.2025 in the database Scopus were used for the bibliometric analysis. BASF's official website, BASF Factbook2024, and BASF Report 2023 were the main resources for the case study since they are the most relevant resources to understand the BMs of BASF.

### 3.2 Systematic Literature Review process

The SLR process followed the PRISMA framework for reporting systematic reviews and meta-analyses (Moher et al., 2009). Initially, 174 articles were identified from the top 10 most cited articles across three databases. After removing duplicates (n = 21), 153 articles remained.

To ensure relevance, articles were excluded based on specific criteria. These included articles that focused solely on certain technology implementations without BM implications (n = 22), those centered only on corporate strategies and management control (n = 11), specific case studies without BM evolution aspects (n = 12), historical economic models with a primarily mathematical approach (n = 5), studies focused on organizational sustainability (n = 6), articles addressing only IT strategies (n = 8), publications focused on digital technologies without BM implications (n = 8), those irrelevant to the research questions (n = 4), and articles that were not retrievable (n = 5). Additionally, after further reviewing the articles, several publications were removed as they did not fit the research topic (n = 8). To complement the analysis, key publications relevant to BM development were added (n = 6). The added important publications including magazine articles from Harvard Business Review and books, which were excluded from the search filters. In total, 69 publications were included to answer RQ1.

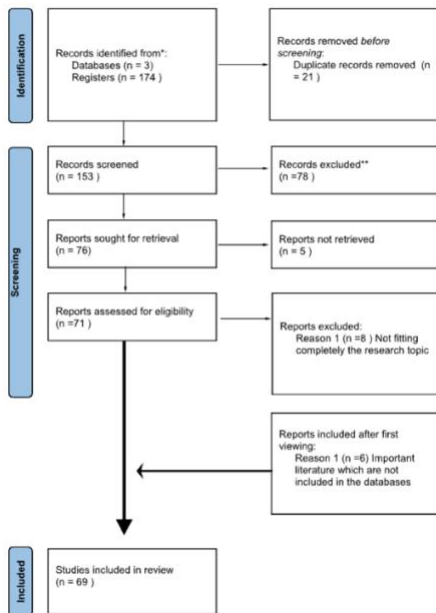


Figure 2 RQ1- PRISMA flow diagram

To answer RQ2, with the same top 10 cited publications from three databases, the relevant publications to DBM or SBM were selected. The publications that could not be retrieved (n=1) and those did not fit the theme after content review (n=5) were removed. Important publications including organizational announcements and books were included (n=4). Finally, 25 publications were included.

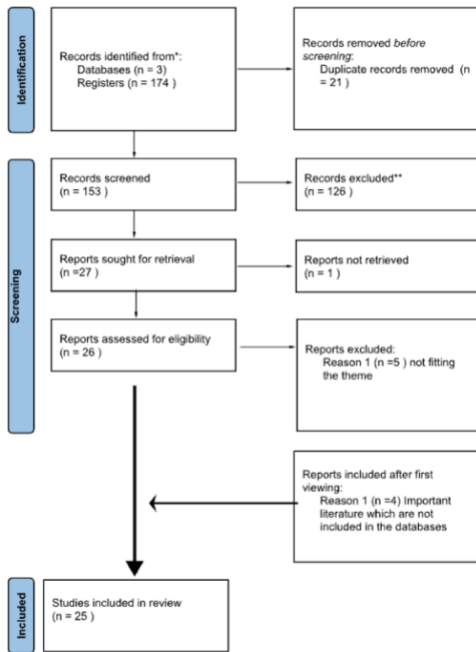


Figure 3 RQ2 PRISMA flow diagram

### 3.3 Text based and bibliometric based analysis

VOS viewer was selected as the tool for constructing and visualizing bibliometric networks since it is both technically robust and relatively simple to use (Kirby, 2023, p. 12; VOSviewer - Visualizing Scientific Landscapes, n.d.). The text data were used to construct a network of co-occurrence links between different terms which were identified by natural language processing algorithms in VOS viewer. Bibliographic data were used for constructing the network of co-occurrence keywords and their frequency. Eventually, the keywords and terms were presented as a map of network visualizations (van Eck & Waltman, 2022, p. 3,27).

Firstly, in each decade, the text data analysis was done to examine the relationships between different academic terms. Secondly, the bibliometric analysis was done to identify the co-occurrence keywords of each decade and current trends for the past five years.

### 3.4 Case study

A case study is an empirical tool for exploring a phenomenon in depth within its real-world context, particularly when the boundaries between the phenomenon and its context are unclear (Yin, 2009, p. 18). Therefore, to assess the extent to which EIMI BMs align with identified SBM and DBM trends, a case study was conducted. By examining practical examples through annual reports, official website information, and other relevant sources, including digital platforms, key business activities were identified and aligned with the trends identified. BASF SE was selected as the case study in EIMI to analyze this alignment in practice. As the world's largest chemical company (Financial Times, 2024) BASF places a strong focus on sustainability, innovation, and digitalization (BASF, n.d.-s), making it an ideal subject for studying SBM and DBM implications in EIMI. To better understand and analyze BASF's BM and business activities, the BMC and SWOT analysis were employed. Since BMC provides a structured approach to evaluating BM components in detail, and the SWOT analysis helps assess BASF's BM by examining its strengths and weaknesses and identifying potential opportunities and threats (Osterwalder et al., 2010, p. 20,22,26,28,30,34,36,38,40,44,216).

### 3.5 Artificial Intelligence (AI) tools usage

AI tools were used in this thesis for the purpose of assisting research, including processing bibliographic datasets, conceptual inspiration, assisting in understanding partial publications, and grammar correction for text writing. The list of tools is listed in the Appendix.

## 4. Results

The following chapters present: First, the result of BM evolution based on SLR, text-based, and bibliometric analysis. Second, the terminologies and keywords of SBM and DBM evolution based on SLR results. Third, the shift factors of BMs towards sustainability and digitalization, and their impacts on EIMI BMs. Finally, academic trends in SBM and DBM were identified based on the previous results and an addition bibliometric analysis of Scopus search results, followed by an alignment analysis with a case study's BMC.

### 4.1 Development of Business Models since the 1940s

70 articles, journals, and books published between 1941 and 17.09.2024 from Scopus, Web of Science, and IEEE Xplore were included in the review process. Starting from the earliest publication in the sample article in 1941, the search results per every ten years were divided into a session for text analysis for keywords identification and literature review. Statistical analysis methods were applied, including keywords identified by co-occurrence analysis, top cited papers through all decades, publication countries, and overall research methods of the paper to provide a comprehensive view of BM evolution.

#### **1941-1961**

The year of 1941 corresponds to the middle of the Second World War. To control inflation, the United States of America (USA) government published the price policy and Nourse (1941) gave the first in-depth analysis of it. The term 'business strategy' was mentioned and interpreted as a military strategy in the field of business, which included general types of goods produced, the range of styles, financing, and organization of business. Its relationship with pricing policy was then further discussed, which could affect a company's major and long-term decisions on the level of prices, but it was not rapidly used in the article. Overall, the author believes the line between minor strategy and major tactics was difficult for managers to distinguish.

In the article, term 'commercial tactics' was used and closely related to BS. It was mentioned as an essential factor to achieve the success of the strategy under specific conditions. The commercial tactics were related to a wide range of production techniques, open marketing practices, consumer income

categories, consumer tastes, attitudes and spending habits, and propensities that could affect the decision-making process of product price setting(Nourse, 1941).

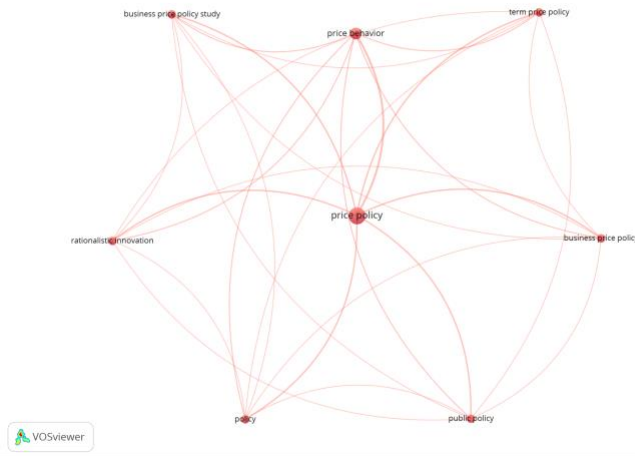


Figure 4 Text analysis result 1941-1961

From Figure 4, a text analysis map indicates that the article focused on the relationship between the pricing process and government policy.

## 1962-1971

In the 1960s, the United Nations (UN) set a minimum growth target of 5 percent per year for less developed countries and declared the "Development Decade". In the first half of the decade, the member countries of the Organization for Economic Cooperation and Development (OECD), including the USA, Canada, Western Europe and Japan achieved a 50% increase in aggregate output for all member countries combined, or an average annual growth of 4.1%. In particular, Western Europe and Japan achieved more than 5% annual output growth in the first half of the 1960s (Council of Economic Advisers, 1967, p. 170,171). Despite the great economic recovery from the war, tensions between the USA and the Soviet Union increased which almost led to World War III. Meanwhile, the original concept of SWOT analysis, called the SOFT (Satisfaction, Opportunities, Faults, and Threats) approach, was introduced in 1965 as a tool to be used in one of the earliest strategic planning frameworks (Puyt et al., 2023, p. 1,2).

The concept of 'Parallel decision making' that continuously surveyed change in a firm's environment and operating process to identify threats and opportunities began to spread and play a role in the strategic decision-making process. The systematic approach for strategic decision was frequently

adopted within the context of parallel decision making and has been called ‘corporate planning’, ‘long-range planning’ or ‘business strategic planning’. Based on previous research by H. Igor Ansoff (1968), Grinyer categorized and created a new conceptual model of strategic planning which presents the environment of the decision makers, as shown in Figure 5. The model aims to contribute to the design of more effective procedures or programs in a firm. Secondly, by addressing the basics of the planning process, the model helps strategic planning organizations to facilitate decisions (Grinyer, 1971, p. 199,200,206).

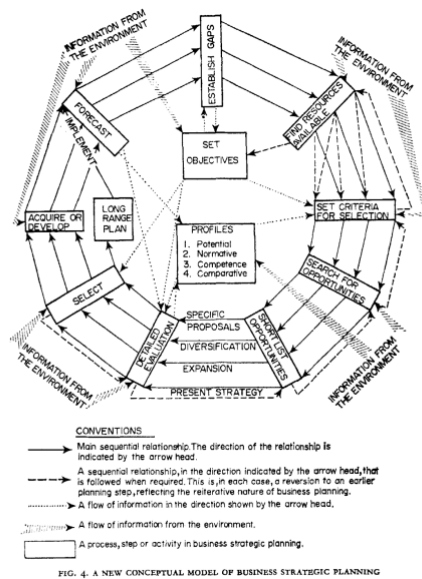


Figure 5 A new conceptual model of business strategic planning(Grinyer, 1971, p. 206)

To learn about the technical-economic system uncertainties, Cook built an expected value business model using the mathematical approach to describe the characteristics of the business and to assist managers in uncertainty analysis. A function of probability density function for profit outcomes was presented as in Figure 6. The ‘deterministic model’ or ‘expected value business model’ is used in the sensitive phase for determining the key parameters influencing the outcome (Cook, 1968, p. 343,353).

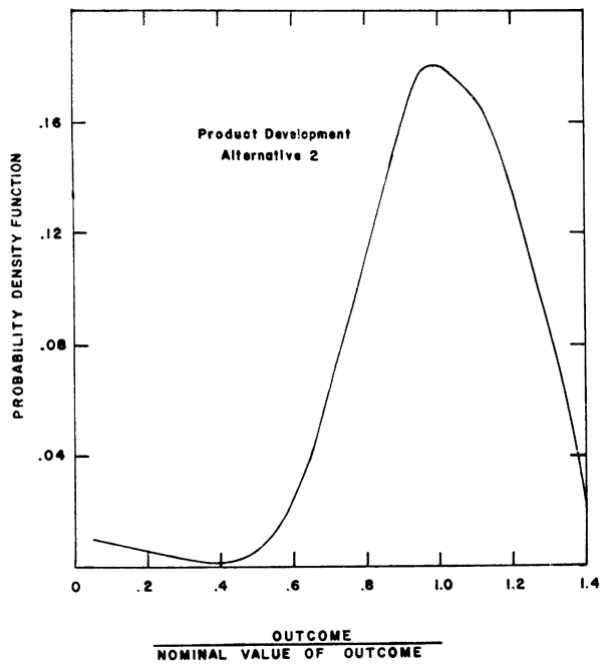


Figure 6 Probability density function for profit outcomes (Cook, 1968, p. 353)

The result of text analysis in Figure 7 revealed factors for outcome prediction, including decision analysis, time value, uncertainty issue and other parameters. The deterministic model has been used as a tool to facilitate comprehensive analysis.

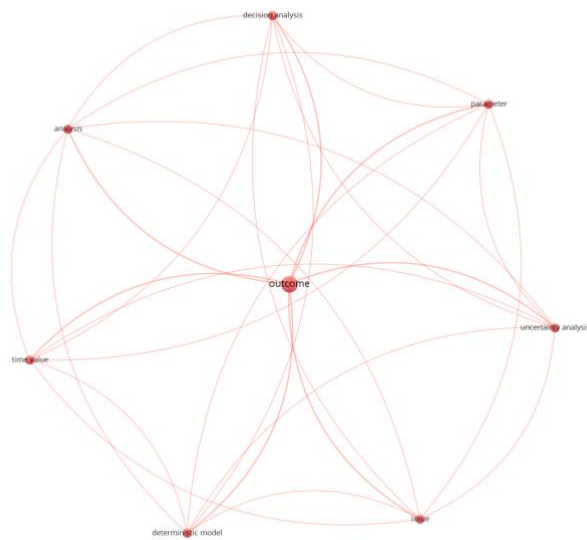


Figure 7 Text analysis result 1962-1971

## 1972-1981

### BM theories development

In the early 1970s, the term BM appeared and started rapidly being used in articles, referring to mathematical approaches and modeling as in the 1960s.

Duersch (1975) mentioned:

A business model is developed, based on the ideas of behavioral modeling, and two typical businesses are simulated including representations of environments and management strategies. The model is intended as a flexible framework for simulations useful in planning and is easily modified to represent particular situations, operating criteria, and available information.

(Duersch, 1975b, p. 55)

He further elaborated that behavior modeling, which considered people as a major role in social system has gaining favor over the traditional techniques. It is constructed through observation of the existing procedures, decision roles managers applied, quantification of management judgements and usage of accounting rules for measurement. The business modeling research has further elaborated to a bigger range of social system approaches, including market share performance, cost models and investment relations (Duersch, 1975b, p. 55). Followingly, Duersch used the developed models to conduct computational experiments to examine the environment, management strategy, BM inaccuracies and uncertainties of the performance of combined businesses versus individual business (Duersch, 1975a, p. 101).

Boston Consulting Group published two articles in 1976 and 1977, including conceptual frames developed under inflation, recession, and unemployment environments. The author suggested fundamentals such as market position relative to competitors for strategy development shall be focused (Hedley, 1976, p. 2,11). Followingly, the essential roles of relative competitive position and growth were once more emphasized. A business portfolio was provided as a superior tool for developing the differentiated strategic business objectives and creating unique business opportunities, as can be seen in Figure 8 (Hedley, 1977, p. 9,10).

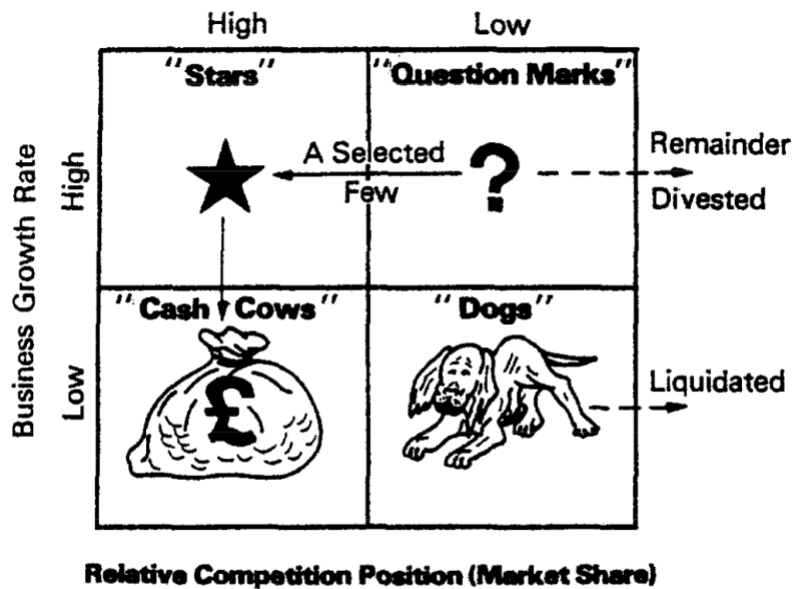


Figure 1. The business portfolio or growth—share matrix.

Figure 8 The business portfolio or growth-share matrix(Hedley, 1977, p. 10)

In 1979, Porter’s Five Forces theory was published and has brought a significant influence in the business researching field. Based on case studies, Porter categorized five main forces as the basic factors influencing the state of competition, including threat of new entrants, bargaining power of suppliers, bargaining power of buyers, threat of substitute products or services, and competing with existing competitors. The forces help companies to identify their weaknesses and strengths, and strategists can position the company to provide its best defense against the competitors. By balancing the forces and using the forces to predict the market shifting as presented in Figure 9, firms can

improve their position and win the lead (Porter, 1979, p. 2,3,6,8,9,10).



Figure 9 Exhibit Forces governing competition in an industry (Porter, 1979, p. 6)

From the social sciences point of view, researchers took the influence of corporate culture into consideration and developed a matrix that helped companies identify their tasks and relationships. The matrix aims to support the firms to create a better match of its corporate culture and business strategy (Schwartz & Davis, 1981, p. 32,34,3648). In addition, the term ‘Technological strategy’ appeared in 1981, under the discussion of R&D and resourcing for the development of new technologies (Frohman & Bitondo, 1981, p. 59,61,67).

## European Communities

In 1957, the European Economic Community (EEC) was founded with six initial member countries, including France, Germany, Italy, Luxemburg, the Netherlands, and Belgium. The purpose of EEC was to ensure people, goods, and capital can circulate freely within the member countries (Trans European Policy Studies Association (TEPSA), 2023), and eventually led to the European single market starting from 1993 till now (European Union, 2023). In the 1970s, three more countries including the UK, Ireland, and Denmark joined and further expanded the community (European Union, n.d.).

With the expansion of the European communities, researchers based in Europe published papers focusing on its own economic situation. French researchers made a mathematical approach to BM on an inflationary economy to present the situation of most Western European countries (Lesourne &

Leban, 1977, p. 265). West German and French researchers conducted an empirical study on more than 200 Companies in the Federal Republic of Germany ,and proposed a framework on structural and procedural aspects of the long term planning system (Keppler et al., 1979, p. 69,88).

For this decade as presented in Figure 10, five main clusters emerged in the text analysis result. Under ‘Combination’, there are strong links between management strategy, simulation, and performance. ‘Process’ connects with procedure, resource, decision, and profitability. EEC, EFTA, Europe, world, and capital are connecting. For ‘Long-range planning’, implementation, relative competitive position, individual business, strategy development, implication, and future are all in the same cluster. ‘On-Line banking system’ appeared as a cluster because a publication discussed the on-line banking system intensively.



Figure 10 Text analysis result 1972-1981

## 1982-1991

Starting from the 1970s, computer technology became more mature and slowly developing from organizational usage to personally accessible devices. Companies including Apple, IBM, and Texas Instruments released models of personal computers (Computer History Museum, 2024).

In the 1980s, the research streams shifted to search for factors that affect a company’s success on the structure and process level. The concept of “BM” detached completely from mathematical modeling

and transformed. Due to the accessibility of personal computers and spreadsheets, a more analytic approach to business planning is enabled and the behavior of business can be modeled (Magretta, 2002, p. 89).

### **Technologies and innovations**

The rapid development of technology pushed the discussion and research to target innovative firms and technology transfer. Teece focused on the reason why innovative firms often fail to profit from their innovation. He pointed out the problem that innovative firms often had problems with the integration of complementary assets, including competitive manufacturing, distribution, service, and complementary technologies, and eventually lead to failure (J. Teece, 1986, p. 285,287,290,304).

Through case studies, an overall evaluation checklist of technology transfer was released by Ounjian and Carne. The researchers discovered business strategy plays an important role in the success of the technology transfer and long-term stability of management is the key to achieving technology transfer projects. Staying long-term stable management avoids the updating of the organizational changes, tracking efforts of responsible people for technology transfer, and extra involvement in the educational process (Ounjian & Carne, 1987, p. 194,198,199,200).

### **Porter's 5 forces and value**

Many researchers built their studies based on Porter's theories (1980). Miller developed a model related to several dimensions of business-level strategy to the environment and structure in undiversified firms (Miller, 1987, p. 55), and White examines the theory in organizational performance through empirical research (White, 1986, p. 217,229,230). Chrisman, Hofer, and Boulton tried to build a new BS classification system by fusing the work of Porter and Abell's theories both published in 1980 (Chrisman et al., 1988, p. 413).

In 1985, Porter introduced the concept of "value" and "value chain". Value is what buyers are willing to pay and value chain is a tool for systematically examining all the activities that a firm requires to convert raw material to finished product. They are necessary to analyze the competitive advantages. A firm was defined as collective activities of design, product, market, delivery, and support of a product, which could all be represented by a value chain. The amount that buyers were willing to pay for what a

firm provides to them was value. It was measured by total revenue that reflects the price of the product in a firm and the units it could sell. To create value for buyers that was more than the cost they spent was the goal of any generic strategy. Five generic categories of primary competing activities were identified, namely inbound logistics, operations, outbound logistics, marketing and sales, and service, as visualized in Figure 11. Four competing support value activities, namely procurement, technology development, human resource management, and firm infrastructure. By examining each process in detail, a firm might find a way to generate maximum value for the customers and minimize the production cost (Porter, 1985, p. 36,37,38; Tradi, 2024).

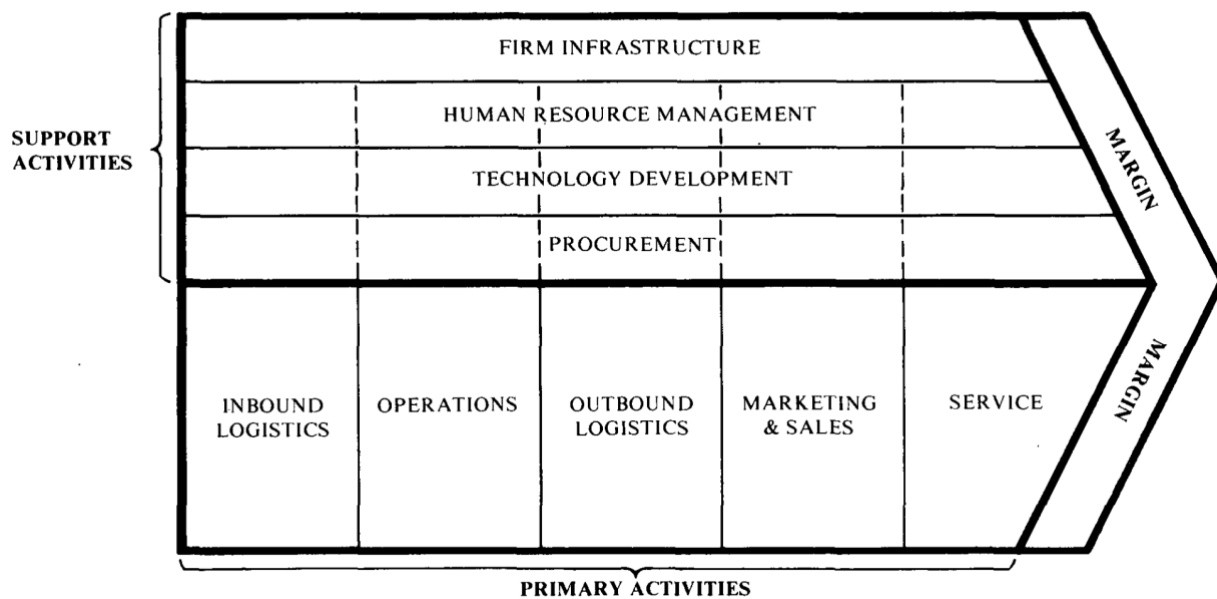


Figure 11 The generic value chain (Porter, 1985, p. 37)

### BS developments

A growing interest in BS management which especially focused on the field of environmental and structural factors was identified. Miller found a selective association between Porter's strategies and the structural and environmental dimensions. Strategy, structure and environment should be closely aligned for good performance. Furthermore, the right strategy for the structure was necessary for implementation, in addition to environment and strategy alignment, to bring success to companies (Miller, 1988, p. 280,303,304). Håkansson and Snehota brought out the adaptation of networking concepts focused on organizational environment BS management, which discussed organizational

boundaries, organizational effectiveness determinants, and BS managing process (Håkansson & Snehota, 1989, pp. 187, 198, 199). Miller concluded that even though it could not be claimed that strategies caused the adoption of certain structures, particular strategies, and structures appear together in certain types of environments which might be due to configure affinities or complementarities (Miller, 1987, p. 55,70).

Based on data-based analysis, Galbraith and Schendel categorized six strategy types for consumer products including harvest, builder, cashout, niche or specialization, climber, and continuity. Four strategy types for industrial products, namely low commitment, growth, maintenance, and niche or specialization (Galbraith & Schendel, 1983, pp. 153, 171). The development of BS was further refined compared to the Business Portfolio (1977). To analyze the cost of implementing strategies, Barney introduced a market where the necessary resources for strategy implementation were acquired. The research concluded that firms who implemented product market strategies and sought above-normal returns had precise expectations about the strategies' future values and provided enough resources to implement them (Barney, 1986, p. 1231,1239,1240).

### **Venture Capital (VC)**

Strategies and characters affecting venture performance were determined, Sandberg and Hofer found out that the interactive effect of industry structure, venture strategy, and Entrepreneurs have the most important impact on the venture performance. The differentiated strategies outperformed focused strategies, which means successful new ventures must have some kind of unique selling proposition other than the price. On the other hand, the bibliographical characteristics of the entrepreneurs had very little impact on it (Sandberg & Hofer, 1987, p. 5,6).

Compared to the 1940s to 1970s, article and journal amounts related to BM and BS had a very fast growth, more than ten times articles were used for the text analysis. Four clusters appeared in the analysis result as presented in Figure 12, and the focus of the cluster included technology, process, model, and entrepreneur. “BM” occurred a total of 29 times which has a strong connection with planning, process, approach, information, implementation, system, change, cost, and structure. “Technology” occurred 185 times and linked with 56 other keywords, including innovation, product, manufacturing, system, integration, process, implementation, planning, approach, and strategic

planning. It was also linked strongly with risk. “Computer” appeared as a weak signal with 18 times occurrence, which connected to change, product, manufacturing, system, integration, process, and planning.

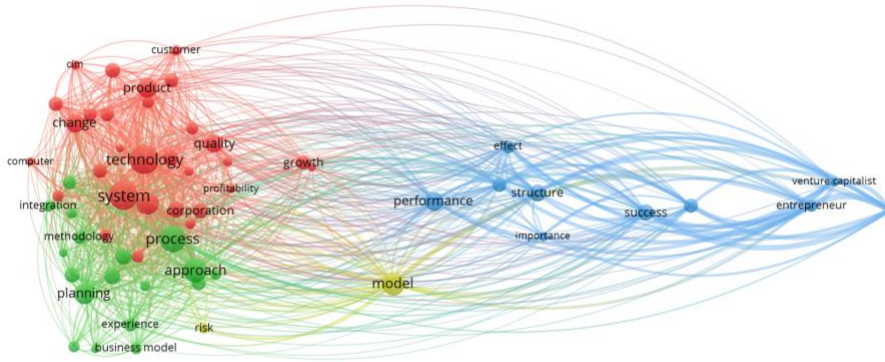


Figure 12 Text analysis result 1982-1991

Overall, the result indicated that technology development had pushed the change of the economic field to innovate. VC welcomed its first boom in the 1980s, and the US economy had a fundamental change of graduates shifting from large firms to smaller firms. The small business and innovative companies rose dramatically, by the end of the decade over 1.3 million new businesses were born annually. As the entrepreneurs and small firms tended to be more innovative, it could explain the result of BM booming (Gompers, 1994, p. 1).

### 1992-2001

In 1989, the World Wide Web was invented in Geneva by Tim Berners-Lee and went public in 1993 (Ida, 2021, p. 11). The information revolution started with the growth of the global communication network and changed the way we lived and worked (Archives of IT, 2024), and technologies have been a major driver of the integration and interdependence of the global economy (Weisblat, 2019, p. 2).

## E-business and Information Technologies (IT) strategy

A strategic alignment model brought out four fundamental areas for strategic choices that conceptualize and guide through the emerging IT strategic management, namely BS, IT strategy, organizational infrastructure and processes, and IT infrastructure and processes (Henderson & Venkatraman, 1999, p. 472).

Amit and Zott developed a potential value creation model as shown in Figure 13 with four dimensions related to e-businesses, namely: efficiency, complementarities, lock-in, and novelty. The main revenues generated by E-business were subscription fees, advertising fees and transaction fees. Based on Porter's theory in 1985, as mentioned above, the term and concept of 'value' has become a foundation for the development of BM theory. However, they mentioned that "no single entrepreneurship or strategic management theory can fully explain the value creation potential of e-business. Rather, each of the theories offers an important insight into one aspect of value creation in e-business" (Amit & Zott, 2001, p. 493) which indicates that there was space for further innovation of business models, especially for e-business. They believed that a business model represented the design of transactional content, structure, and management to create value by exploiting business opportunities. Therefore, a BM construct was created based on them that could be used as a unit of analysis for value creation research and enabled the integration of theories for e-business. It was emphasized that the business model was an important focus of innovation and a critical determinant of value creation for the firm with its suppliers, partners, and customers (Amit & Zott, 2001, p. 493,494,495,496,503,504,505,515, 516).

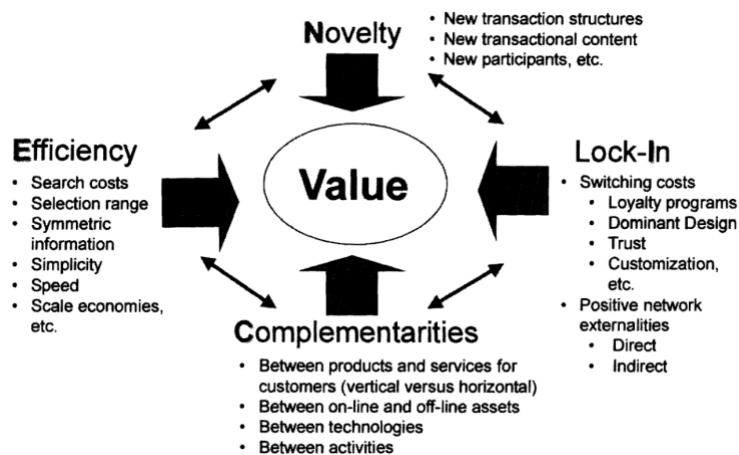


Figure 13 Source of value creation in e-business(Amit & Zott, 2001, p. 504)

## **Social changes and BM research growth**

In the USA, there have been 1 million immigrants a year since the 1990s (Matin, 2014), which caused the increase of cultural diversity in the workforce. Richard conducted research regarding the interaction between BS and racial diversity in firm performance measured on productivity, return of equity, and market performance. The results showed that cultural diversity can add value and contribute to a company's competitive advantage in certain contexts, highlighting the importance of human capital as a strategic asset (Richard, 2000, p. 164,174).

Interestingly, researchers found that the rise of the term BM has a positive relation with the rise of technology-heavy company stock markets in NASDAQ. It was found that the appearance of the term BM in business journals followed the pattern that assembled the shape of the NASDAQ market index, especially between 1999 to 2003. The decrease in cost due to cheap and available information technology followed by increasing business design choices led to blurring the industry boundary, consequently, the BM became an option as a new industry unit of analysis. (Osterwalder et al., 2005, p. 7,8).

The result of text analysis was four clusters that consisted of three main clusters and one smaller cluster connected to all the clusters as shown in Figure 14. The most occurring keyword was BS, occurring a total of 1898 times among 2497 sample papers. BS was connected to keywords including BM, service, web, internet, e-business, evolution, network, system, integration, application, world, innovation, information system, and information technology. BM connected to most of the same keywords as BS, besides "Alignment", it also appeared as less occurrence and weaker link strength than BS. But this might show the sign of its splitting into two different terminologies. An interesting new term "New BM" occurred, which connects to the internet, service, system, model, product, customer, and market. This term might be seen as a sign of "BM innovation".

Five times more publications compared to the last decade were used for the text analysis, it shows that BS and BS have become important research topics. An Asian country, Japan appeared for the first time.



and how to deliver value to the customer at a reasonable cost. A successful BM is better because it offers more value to the customer or even completely replaces the old standard. New business models were made as the variant from the generic value chains underlying all businesses, which could be divided into two parts, product making relevance and product selling relevance. It could be product innovation or process innovation. Under a certain context, BM could be seen as the scientific method that plays as a hypothesis that firms test in action and revise when needed. As a planning tool, BM focused on how the elements of the system fit into a working whole. Magretta mentioned that the terms 'BM' and 'Strategy' were under very careful usage, yet a clear definition was necessary for organizations to avoid more confusion and difficulty while using these fundamental concepts (Magretta, 2002, p. 86,87,88,89,90,91,92). In addition, high quality publicity was considered necessary and critical by customers under the development of the Internet, which shaped the development of different BMs. The researchers classified nine different types of Web-based enterprise BMs and their application for utility services (Rappa, 2004, pp. 35, 36,37, 38).

A nine-business model building block as Table 2 was proposed by Osterwalder, Pigneur, and Tucci. It is a conceptual tool containing a set of elements and their relationship which enables the expression of business logic of a firm. They believe BM is a blueprint that captured, visualized, understood, communicated, and shared the business logic which allowed the designing and realization of the firm's business structure and system (Osterwalder et al., 2005, p. 4,18).

Table 2 Nine Business Model Building Blocks(Osterwalder et al., 2005, p. 18)

<b>Pillar</b>	<b>Business Model Building Block</b>	<b>Description</b>
Product	Value Proposition	Gives an overall view of a company's bundle of products and services.
Customer Interface	Target Customer	Describes the segments of customers a company wants to offer value to.
	Distribution Channel	Describes the various means of the company to get in touch with its customers.
	Relationship	Explains the kind of links a company establishes between itself and its different customer segments.
Financial Aspects	Value Configuration	Describes the arrangement of activities and resources.
	Core Competency	Outlines the competencies necessary to execute the company's business model.
	Partner Network	Portrays the network of cooperative agreements with other companies necessary to efficiently offer and commercialize value.
Financial Aspects	Cost Structure	Sums up the monetary consequences of the means employed in the business model.
	Revenue Model	Describes the way a company makes money through a variety of revenue flows.

According to them, three categories of BM which are hierarchically linked to one another could be classified as shown in Figure 15. First, an abstract real-world business-dominated BM concept was described. Second, abstract classification schemes which could be categorized as BMs with common characters were introduced. Third, a particular real-world business case was conceptualized into BM. The authors believe that all three categories of BMs are not mutually exclusive and meaningful, but to achieve a comprehensive approach it is better to be hierarchically linked. Furthermore, in addition to BM design, strong management and implementation skills are still required to achieve business success(Osterwalder et al., 2005, p. 8,9,13).

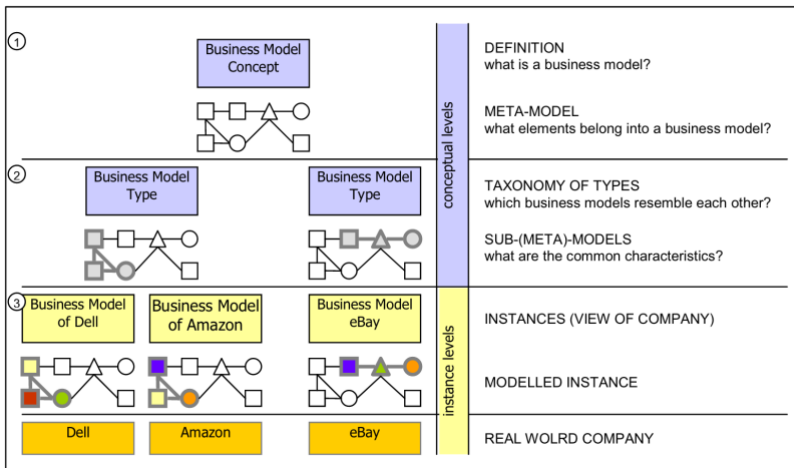


Figure 15 Business model concept hierarchy(Osterwalder et al., 2005, p. 9)

Johnson, Christensen, and Kagermann argued that established companies may have difficulty growing through BMI because they don't have a comprehensive understanding of their existing BM to determine whether it should follow or hinder new opportunities. They defined that BM consists of four elements: Customer value proposition (CVP), Profit formula, Key resources, and Key processes, which form the building blocks of any business, as presented in Figure 16. By identifying existing BM components, company executives can then evaluate how well the same model can be used for different CVPs and whether new construction is needed (Johnson et al., 2008, pp. 1, 5, 6, 8).

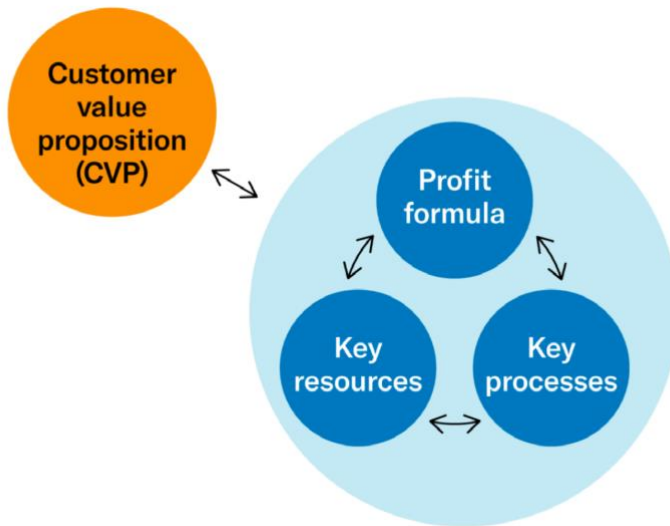


Figure 16 The element of successful Business Model(Johnson et al., 2008, pp. 1, 5, 6, 8)

Zott and Amit described BM design as the key decision for new firm entrepreneurs and a crucial task for managers to modify their old BM to fit the future. A set of activity systems was presented as a

toolbox to address the key issues within BM design. It includes design elements of content, structure and governance and design themes of novelty, lock-in, complementarities and efficiency as mentioned in their previous publication (2001) (Zott & Amit, 2010, p. 216,220,221,222). Researchers later conducted a literature review and again pointed out that scholars did not agree on a definition of BM, however, four common themes emerged, including BM as a new unit of analysis, BM frameworks in a system level, firm activities roles included in proposed BMs, and BMs focus on explaining value creation. The research findings suggest a shift towards a conceptual consolidation of the BM research field (Zott et al., 2011, p. 1019,1034,1036,1037,1038).

### **Business model innovation**

In the same decade, Chesbrough and Rosenbloom explored the role of BM in capturing value from early-stage technology, they stated that a successful BM should connect the technology potential with economical value realization. They also mentioned that BM was probably the most discussed but least understood term on the internet. A BM is defined as a method of doing business and can sustain itself by generating revenue. For innovation, BM ensured value delivery of the technical core to the customer. It branched between the technical and economical domains, by selecting and configuring the technologies that could be offered to the target market (Chesbrough, 2002, p. 529,533, 550).

Chesbrough elaborated on his research (2002) and introduced the term “open innovation”. Open innovation (OI) is defined as an organization that can gather valuable ideas from both inside and outside the company and is able to go to market from both inside and outside the company as well. BM works here as a powerful framework for linking technical decisions to economic outcomes as shown in Figure 17, determining which internal elements are needed to connect with external technologies to create value, and which revenue mechanisms can generate profitable returns for commercializing the technologies.

The innovation of new technologies has three basic ways: incorporating the technology in a firm's current business, licensing technology, and launching new technology in new business areas. But sometimes, a new technology might have no obvious BM, and the managers need to find a suitable BM that captures the value of the technology. A BM specifically proposed for technology innovation was given: 1. Through the offering based on the technology, the value is created for users and led to articulate the value proposition. 2. The users to whom the technology was useful for whom, and the purpose for which it would be used to identify a market segment. 3. Creation and distribution of the

offering, and to determine the complementary assets required to support the firm's position in this chain, defining the structure of the firm's value chain. 4. Given the value proposition and value chain structure chosen by specifying the revenue generation mechanisms for the business and estimate the cost structure and target margins for producing the offering. 5. Describe the firm's position in the value network linking suppliers and customers, including the identification of potential complementary firms and competitors. 6. Formulate the competitive strategy by which the innovating firm would gain and maintain advantages over its competitors.

BM unleashes the potential value of innovation, but the firm may be trapped in its success in later years because the firm may be biased and miss a better BM because it conflicts with the current BM. Also, companies that have fewer resources might be able to gain greater success than those that have more resources, if comparatively their BM could create more value (Chesbrough, 2003, pp. 43, 63, 64, 65, 69,70,90).

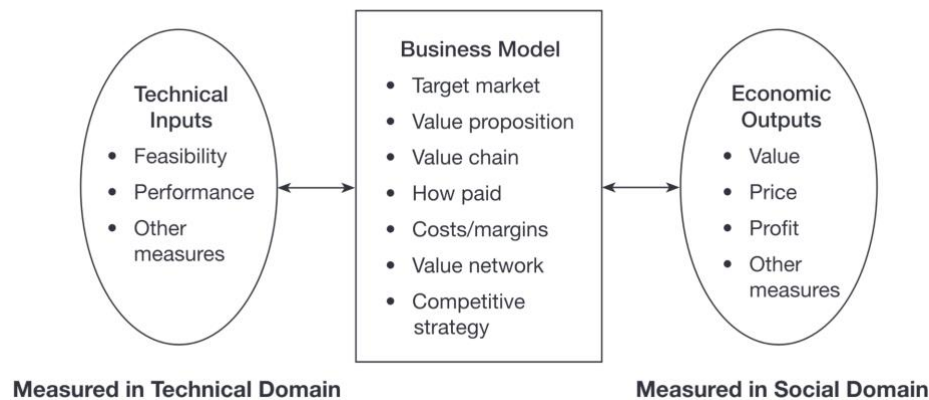


Figure 17 The Business Model as a cognitive map across the domains(Chesbrough, 2003, p. 69)

To identify the barriers and opportunities of BMI, Chesbrough conducted a literature review and case study. It was found that companies need to adopt an effective attitude towards BM experimentation to understand the barriers within an affordable cost. Internal leaders are needed for BMI to manage and deliver better BM for the organization.(Chesbrough, 2010, pp. 354, 362).

Tece explained the significance of BM and its connection with BS, innovation management and economic theories by literature research and case studies. He defined BM as the definition of the way enterprise created and delivered value to customers and generated profits. BMI has also been seen as a pathway to gain competitive advantages. BM naturally changed over time following the changes in the

market, technologies, and legal allowance. The matching of BMI and technological innovation was often required to capture value and the ignorance of this factor might lead to failure (D. J. Teece, 2010, pp. 173, 177,179, 186, 192).

In the view of international economics and emerging economics, Peng, Wang, and Jiang conducted an institution-based view on International business strategies focused on India and China (Peng et al., 2008, p. 920). Wu, Ma, and Shi researched the BMI on the aspect of descriptive technology in late-comer firms. By providing cheaper, simpler but good enough products or services, a secondary BMI could successfully be introduced to emerging economies that they could afford and access. Furthermore, an appropriate value proposition and utilized strategic partners to build a unique value network were the key elements for them to bypass large multinational businesses(Wu et al., 2010, p. 51,60).

For Osterwalder and Pigneur, BMI was nothing new, since fundamentally it was about creating value for companies, customers, and society and replacing outdated models. They defined: “A BM describes the relation of how an organization creates, delivers, and captures value.”(Osterwalder et al., 2010, p. 14). BM served as a blueprint for strategy implementation in organizational structures, processes, and systems. Evolved from their Nine Business Model Building Blocks (2005), Osterwalder and Pigneur developed the BMC. The BMC served as a tool for organizations or individuals to paint out a new or existing BM. BM was considered an important activity that enables the possibility for organizations to evaluate their market position health and adjust accordingly. By combining Business Canvas and SWOT analysis, which stood for strengths, weaknesses, opportunities, and threats, they could magnify the BM component to detail which reveals a new path to BMI.(Osterwalder et al., 2010, p. 5,14,15,212,216)

In this decade, researchers tried to summarize the previous theories since the 1990s and recomposed/redefined BM. The value and innovation of BMs in businesses and startups were emphasized. Many researchers (Chesbrough, 2002, p. 529,533, 550, 2003, pp. 43, 63, 64, 65, 69, 70,90, 2010, pp. 354, 362; Johnson et al., 2008, pp. 1, 5, 6, 8; D. J. Teece, 2010, pp. 173, 177,179, 186, 192; Wu et al., 2010, p. 51,60) focused on case studies that analyzed the success of companies, especially the cases of BMI through disruptive technologies or Technology innovation. According to Teece, the



## 2012-2021

Since late 1990s, scholars have been interested in internet-enabled marketplaces, yet it was not till the 2010s that technological advances enabled the development of innovative marketplaces based on digital platforms and the BM accordingly to address diverse consumer markets(Täuscher & Laudien, 2018, p. 319). Take social media as an example, in 2004 Facebook was invented, and after two decades nearly 68% of the adults in the US ever used Facebook(Schaeffer, 2024). Overall, 5.22 billion social media users were among the 5.52 billion Internet users worldwide(Petrosyan, 2024). The spending budget of marketing flipped in 2020 and the gap was constantly increasing, as can be seen in Figure 19(Jo Dixon, 2024). The way advertisement and marketing are done has been very different from the pre-social media and internet era.

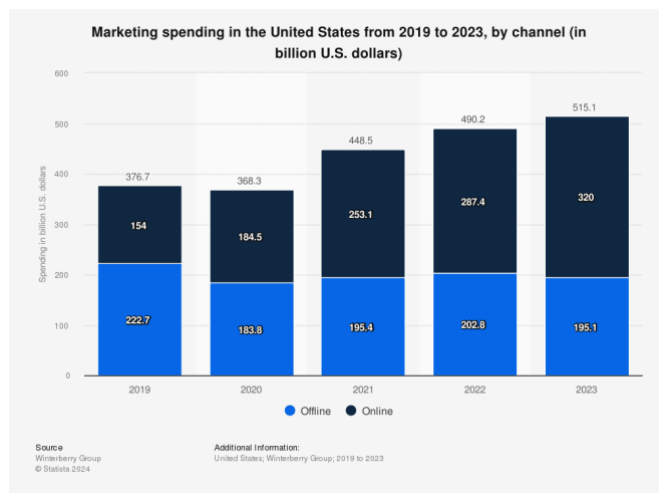


Figure 19 Marketing spending in the United States from 2019 to 2023, by channel(in billion U.S dollars) (Jo Dixon, 2024)

## BM definitions summaries and BMI

Various BM definitions, theories, and frameworks were published during the last decade, therefore, scholars gained a clearer structure toward the BM research. However, there was still no final agreement on the definition of BM and caused confusion in the literature(Massa et al., 2017, p. 1). In this decade, scholars were trying to clarify various definitions and categorize them.

Scholars conducted literature research on the BM theories and their development. Four essential research focuses were found, including innovation, change and evolution, performance and controlling, and design. Also, they identified that the BM concept and components had been comprehensively

defined and brought more visibility and transparency for scientists and practitioners to manage (Wirtz et al., 2016, p. 36,50). Massa, Tucci, and Afuah categorized three interpretations of BMs that emerged from the literature: as attributes of real firms, as cognitive schemas, and as conceptual representations of how firms function. The reasons for the disagreement over BM concepts were identified as BM concepts challenged traditional theories of value creation and capture. However, scholars were gradually aligned on BMs because BM concepts were loose on assumptions, multi-sided value creation, and role-playing as an evolution of traditional strategy and broadening previous perspectives. (Massa et al., 2017, pp. 1, 47,48,49, 50).

A literature review conducted by Foss and Saebi to examine BMI focused on BMI theories from 2000 to 2015. They defined BMI as "designed, novel, nontrivial changes to the key elements of a firm's BM and/or the architecture linking these elements" (Foss & Saebi, 2017, pp. 200, 201, 221). Four main streams of BMI research were categorized as the conceptualization of BMI, the process of BMI, the outcome of BMI, and the impact of BMI. However, they concluded that the BMI literature is characterized by conceptual ambiguity and that research efforts are uncoordinated. (Foss & Saebi, 2017, pp. 200, 201, 221).

Furthermore, the dynamic capabilities of a firm and its relationship to help BM design were discussed by Teece. It was found that the strength of dynamic capabilities enabled the effective creation and implementation of BM (D. J. Teece, 2018, p. 40,41,48).

#### **Industry 4.0(I4.0) and Digital Transformation (DT)**

The DBM and IT strategies were still under intense development, especially regarding its implication in firms and integration with technology strategies or DT.

Researchers rethought the role of digital business strategy in the aspects of its scope, its scale, its speed, and the value creation source and value capturing (Bharadwaj et al., 2013, p. 471).

I4.0 is a framework of a digital revolution in the industry under connectivity, data, computational power, analytics and intelligence, human-machine interaction, and advanced engineering (McKinsey&Company, 2022). Müller, Buliga, and Voigt conducted qualitative research with 68 sample Small and Medium-Sized Enterprises(SMEs) in German to understand their approach to BMI in Industry 4,0. The research suggested that Industry 4,0 generated the impact on SMEs' BM elements,

including value creation, value capture, and value offer (Müller et al., 2018, pp. 1, 7). As DT is an ongoing process of daily use of new technologies in an organization, Warner and Wäger revealed that DT recognizes agility as the core mechanism for the organization's BM, collaborative approach and culture renewal. As companies undergo DT, they are renewing their BMs by applying the logic of digitization to their established product-based BMs to derive value from a new relationship or multi-sided value proposition. (Warner & Wäger, 2019, p. 326,339).

### **Sustainable Innovation and Circular Economy**

Under the theme of sustainable Innovation and circular economy, researchers were still discovering the possibilities to integrate sustainability into different aspects of BM and BS for value creation.

Through the literature review, Boons and Lüdeke-Freund identified that the research in sustainable innovation tended to neglect the aspects of a firm's need of combining value proposition, up and downstreams value chain organization, and financial model for commercialization (Boons & Lüdeke-Freund, 2013, p. 9). Other scholars aimed to develop a framework guiding product developers and firm strategies towards circular economy and explore the possibilities of developing new product design and BM strategies while firms transfer to a circular economy (Bocken et al., 2016, p. 308.317).

Four clusters were in the text analysis result as shown in Figure 20. Technologies including cloud, cloud computing, Internet of Things (IoT), and blockchain were identified and belonged to the same cluster. Keywords DT, digitization, and digital technology were connected to technology, system, service, innovation, and strategy. BM did not appear in the analysis result, yet new BM (NBM) and BMI both appeared. NBM shared most keywords with BMI and BS, however, they belonged to different clusters. Besides value creation, BMI shared all the keywords with BS, including service, sustainability, China, Small and midsize enterprises (SMEs), competitive advantages, and implications. The keywords only connected to BM were integration, operation, efficiency, competition, Corporate Social Responsibility (CSR), and contribution.

SBM appeared yet only connected to sustainability. Circular economy was connected only to three other keywords, namely transition, system, and strategy. COVID occurred which refers to the Coronavirus disease pandemic that started in 2019 (World Health Organization, 2024).



technologies, and the role of consumers becomes central and active in the organization through co-creation collaboration enabled by I4.0 technologies. The establishment of a lean and connected organization has emerged as a trend (Strazzullo et al., 2024, p. 13827,13835,13836). Researchers also discovered that various digital capacities could indirectly help SMEs from emerging countries enter the international market via BMI (Anwar et al., 2022, pp. 4131, 4138,4139).

Manufacturing companies shift their business logic from up-front product sale to offer innovative services called “Digital Servitization” (DS). It generated a profound impact on the firm's BM and affected its cost structures, risk management, and revenue strings. Scholars found a customer-centric, iterative, and agile framework process that closely collaborated with key customers for firms to develop their revenue model for digital services in the early stage. It was highlighted that the solution and revenue model should be highly customized for the specific needs of each customer. The clarification between the revenue model and BM was done in the research, in which revenue models are often underemphasized in the DBMI of a firm and led to little revenue generated, although the firm might create considerable value for their customer (Linde et al., 2023, pp. 82, 94, 95, 96).

Researchers investigated how SMEs can utilize DS to escape from a disruptive market. Three streams of DS research were identified, including motivations and challenges, DS solutions, and its impact on the ecosystem. They argued that DS and BMI have a non-linear, complex and context-specific relationship, and that DS can help firms survive in disrupted markets. (Lamperti et al., 2024, p. 1,5,12).

### **Circular economy business models (CEBM)**

A circular economic action plan was proposed in March 2022 by the European Commission to be in line with the EU's 2050 climate neutrality goal (European Parliament, 2021). With the packages launched, many more researchers, mostly from European countries, were published to discover CEBM. However, the CEBM research that integrates sustainability and environmental conservation was still in its early stages (Awan & Sroufe, 2022, p. 1). Therefore, some scholars were exploring the opportunities and challenges of CEBM (Hina et al., 2022, p. 1), developing the framework for CEBM designing and delivering (Awan & Sroufe, 2022, p. 19) and its linkage to other fields such as digitalization (Chauhan et al., 2022, p. 1). Several frameworks (Awan & Sroufe, 2022, p. 19; Chauhan et al., 2022, p. 13; Hina



databases used in this research, Scopus provided most of the articles and journals that were used in the bibliography and text analysis.

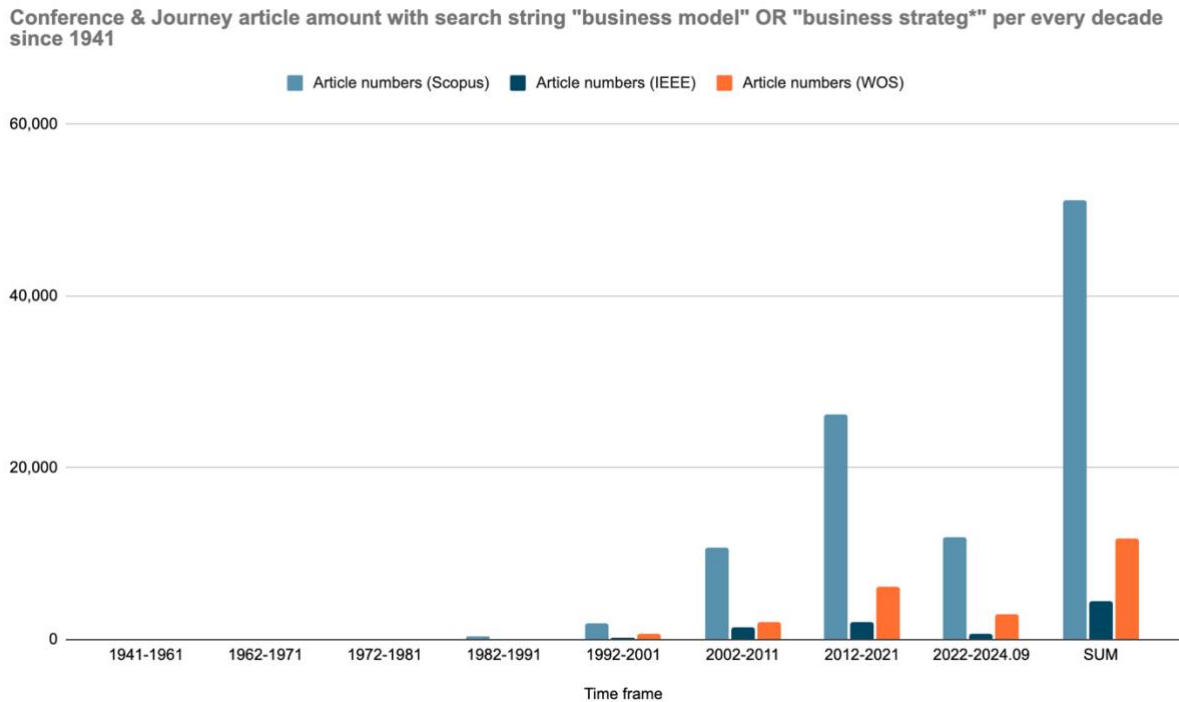


Figure 22 Conference & Journey article amount with search string "business model" OR "business strateg\*" per every decade since 1941

## Keywords

Keywords were identified using VOS viewer's bibliographic analysis with co-occurrence within each decade's publications. It was not possible to process the analysis with one publication from 1941 to 1961, therefore, the result starting from 1962. The top 10 keywords for each decade were selected after filtering out the noise.

The keywords from 1962 to 1971 were focused on business modeling, decision-making, and investments. Other keywords identified were: briquets, business activities, competitive environment, emerging patterns, investment decisions, logistic systems, and management tool.

From 1972 to 1981, only six keywords were identified, including management science, data processing, industrial management, management, marketing and sales, and materials. It can be seen that

the management-related fields were highlighted. From 1982 to 1991, the keywords were business strategies, strategic planning, management, industrial management, marketing, industrial economics, US, economics, organization and management, and technology. Business strategies became the most frequently used word amongst all the publications of the decade. Technology also emerged.

From 1992 to 2001, keywords were strategic planning, electronic commerce, internet, information technology, marketing, business strategy, costs, US, management, and competition. Various technologies were discussed, and competition seems frequently used in this context.

The usage of the BM emerged from 2002 to 2011 and appeared as the most frequently occurring keyword, followed by business strategies, electronic commerce, strategic planning, the internet, information systems, information technology, innovation, competition, and industry. The research direction of BM, which is linked with various technologies and competition, became obvious.

From 2012 to 2021, business models were developed with highly increasing keyword occurrences (2002-2011 occurrences: 2590 times, 2012-2021 occurrences: 5568 times), and various related keywords were identified. Including business modeling, BMI, new business models, Sustainable development, and sustainability. The following keywords are also included in the result: commerce, business strategies, information systems, and innovation.

Finally, from 2022 to 2024, the BM and its innovation were still strong keywords. Sustainability and its related field became the second largest group of keywords, including sustainability, circular economy, and sustainable development. Other keywords were innovation, DT, performance, business strategies, and commerce.

## Top cited

The top 10 most cited publications of all time from the SLR samples were selected and presented in Table 3. The publications from 2002 to 2011 were the most cited period among the top 10 cited publications (60%). Following from 1992 to 2001 (20%), 1972 to 1981 (10%) and 1982 to 1991 (10%).

*Table 3 Top 10 most cited publications of all time from the SLR samples*

Rank	Decade	Authors	Times Cited	Article Title
1	2002-2011	Henry W. Chesbrough	12,103	Open Innovation The New Imperative for Creating and Profiting from Technology
2	2002-2011	Osterwalder	10,003	Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers
3	1982-1991	Teece D.J.	6,283	Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy
4	1992-2001	PETERAF, MA	5,897	The cornerstones of competitive advantage: A resource-based view
5	2002-2011	Teece D.J.	4,925	Business models, business strategy and innovation
6	2002-2011	Alexander Osterwalder Yves Pigneur Yves Pigneur Christopher L. Tucci	3,700	Clarifying Business Models: Origins, Present, and Future of the Concept
7	1972-1981	Michael E. Porter	3,552	How Competitive Forces Shape Strategy
8	2002-2011	Magretta. J	3,478	Why business models matter
9	1992-2001	Amit, R; Zott, C	2,914	Value creation in e-business

## Countries

Figure 23 presents the distribution of SLR sample publications by country per decade. It can be observed that before 2011, most publications in the SLR sample came from the USA. After 2011, the majority shifted to European countries and multinational corporations.

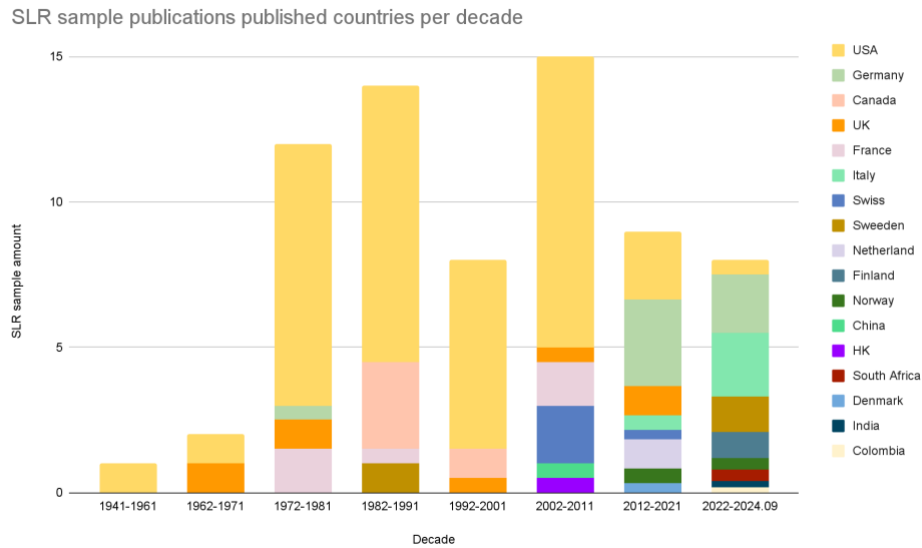


Figure 23 SLR sample publications published countries per decade

Figure 24 shows the percentage of publications by country. Most publications in this study originated from the USA (57.7%), followed by Germany (5.5%) and several European countries, including Switzerland, the UK, France, and Italy.

Publish countries of SLR sample publications

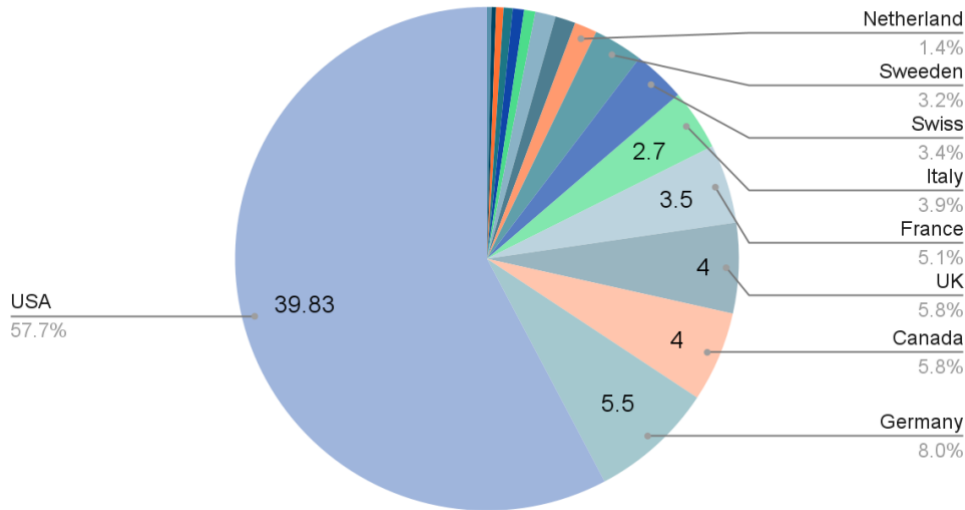


Figure 24 Publish countries of SLR sample publications

## Research Methodology

The research methods were categorized as quantitative, qualitative, conceptual, and mixed methods. The overall distribution of research methods is shown in Figure 25. Among the 69 SLR samples, 15 were identified as quantitative methods, including mathematical approaches, surveys, and statistical analysis of datasets. A total of 27 were qualitative methods, including case studies, interviews, and literature research. Additionally, 15 studies applied conceptual methods, in which conceptual frameworks were proposed. Finally, 12 publications used mixed methods combined elements of qualitative, quantitative, and conceptual approaches.

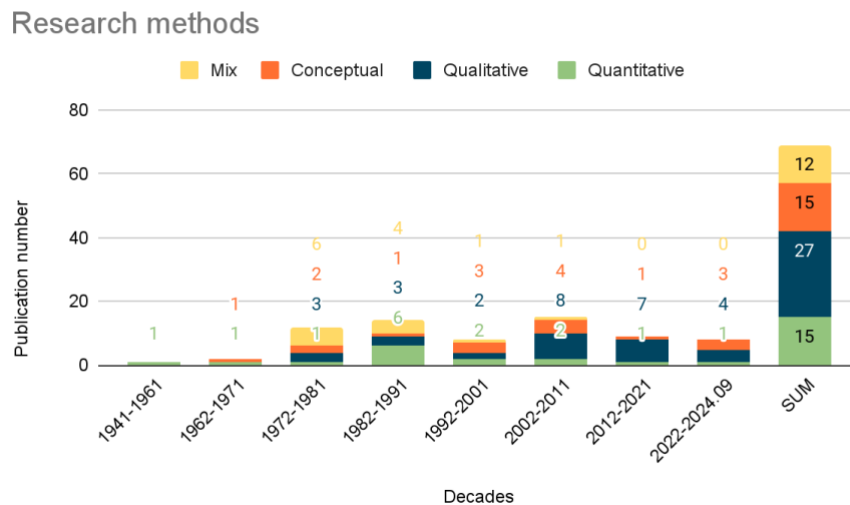


Figure 25 Research methods

To conclude, from 1941 to 1961, the business strategy was used as a military strategy in the business field, and the minor strategies were sometimes difficult to distinguish from the major tactics. In 1962-1971, decision-making and decision analysis in an uncertain economic environment was a strong research direction. Mathematical modeling approaches were majorly used to analyze the market mechanism. The decision-making process began to include constant evaluation to identify the threats and opportunities.

For 1972-1981, in the first half of the period, BM was used as a mathematical model as in the previous decade. In the second half of the 1970s, the conceptual framework, including the Growth-share matrix and Porter's 5 forces, fundamentally changed the concepts of BS by providing companies positioning strategies to best defend themselves against the competitors. The social science aspects of BS also

began to develop. In addition, the rise of the European market encouraged its economic research on BM and BS.

In 1982-1991, with the progress of technology and innovation, and the popularity of VC, the development of BMs and BSs was fostered. In terms of BS development, there was a strong interest in BS management, focusing on the environmental and structural areas. BS theories that evolved from past theories were also identified. Meanwhile, many researchers based their studies on Porter's 5 forces (1979). Porter's important concepts of value and value chain were introduced later in 1985 for firm examination.

The invention and publication of the World Wide Web, and technological evolution enabled an international unified marketplace in 1992-2001. BMs related to e-business and IT strategy was the main trend of the decade. Cheaply available information technologies enabled more business design choices and blurring industry boundaries, leading to the use of BM as the new industry analysis units in the beginning of 2000s. The social changes as immigration increased in the USA also led researchers to explore other aspects of BM in cultural diversity value creation. In 2002-2011, advanced technologies and personal devices entered the market for commercial purposes. To clearly define BMI, various BMI definitions were categorized then recomposed or redefined by researchers in the first half of the 2000s. In the second half of the 2000s, the concept of BMI was developed to create more value for companies, customers and society and to replace outdated models. Researchers have also focused on BMI in the context of technological innovation or emerging economies.

In 2012-2021, still no conclusion of the BM and BMI definition from the previous decade, researchers tended to categorize them once again. DBM and IT strategies have been intensively developed, especially in terms of their impact on companies and their integration with technology strategies or DT. For sustainable innovation and the circular economy, researchers have explored opportunities to integrate sustainability into various aspects of business models (BM) and business strategies (BS) for value creation.

The last period of 2022-16.09.2024, various aspects of DBMI and customer service options were explored. Achieving DT with new technologies and DS with customer centric focus was the trend for the last two years. On the other hand, circular economy business models were integrated into various fields, including digitalization. Publication trends related to BM and BS have grown tremendously since 1992 and continue to grow. Scopus had the highest number of publications of all three databases used. The co-occurrence analysis identified the top 10 keywords for each decade, which correspond to

the SLR results. The 10 most cited papers across all decades were selected and are shown in Table 3. More than half of the most cited papers were published in the period between 2002 and 2011. In the SLR samples, research published in the USA was the majority before 2011. European research and multinational collaborations then became the mainstream. Overall, more than half of the publications used in the SLR process came from the USA. The research methods of the publications were classified as quantitative, qualitative, conceptual and mixed. The most frequently used research methods were qualitative (39%), followed by conceptual (22%) and quantitative (22%), and the least frequently used was mixed (17%).

Building on the understanding of the development of general BMs, the following chapter identifies the shifts in terminology and keywords towards sustainability and digitalization

#### 4.2 Terminologies and keywords evolution of SBM and DBM

Starting with the same set of publications from the previous SLR protocol, 153 articles were filtered out due to duplication, irrelevance to the second research question, or lack of accessibility. A total of 25 articles were included in this analysis: 14 focused on DBM, with the earliest published in 1986, and 11 on SBM, with the earliest published in 1987. Based on the SLR results, the terminologies and keywords related to SBM and DBM are explained separately in the following sections.

## 4.2.1 SBM terminologies and keywords

### **Sustainable development**

In 1987, the World Commission on Environment and Development's report "Our Common Future" (also known as the Brundtland Report) introduced the concept of sustainable development, integrating environmental thinking with social, political and economic aspects of activity. (World Commission on Environment and Development, 1987, p. 11,13,33,37,).

### **Green evolution**

Inspired by Our Common Future, Elkington tried to develop sustainable strategies that created benefits for the company, customers, and the environment. From the early 1980s, a 'green evolution' began to emerge, leading to the rise of the ethical consumer in the early 1990s. One of the most significant trends identified was the "green" marketplace which was driven by the emergence of "green consumers". The new market growth in sustainability was expected to be profound, and successful companies would need to engage with this trend. However, challenges had emerged, including finding new ways to collaborate with suppliers, customers, stakeholders, and competitors.(Elkington, 1994, p. 90,91,92,93,94,97,99,).

### **Triple bottom line (TBL)**

In 1997, Elkington brought out the idea of the TBL which focused on the persuasion of economic prosperity, environmental quality, and social justice(Elkington, 1997, p. 70,72). It has been further elaborated into the 3Ps, profit, people and planet, as indicators for companies to demonstrate their commitment to sustainability.(Kenton Will, 2024).

## Green supply

In the early 2000s, scholars researched the impact of supply management capabilities on green supply by examining the development. It was argued that the green supply implementation could be more effectively understood by focusing on an organizations' internal specialized resources, rather than just looking at external environmental pressures. Supply management capabilities have been developed through a proactive corporate environmental approach, strategic purchasing and supply process (Bowen et al., 2001, p. 174,175,187).

## Sustainability

Within the same period, researchers pointed out that international sustainable development evolved economic, social, and environmental concerns, impacting all aspects of the firm's strategy and BM. A sustainable-value framework was established, shown in Figure 26. The framework considered environmental protection, a sustainability vision, technology integration, and stakeholders' perspectives. The scholar noted that the matrix for funding evaluation should avoid using short-term revenue and profitability as the standard, as it would almost never meet the target. (Hart & Milstein, 2003, p. 56,60,65).

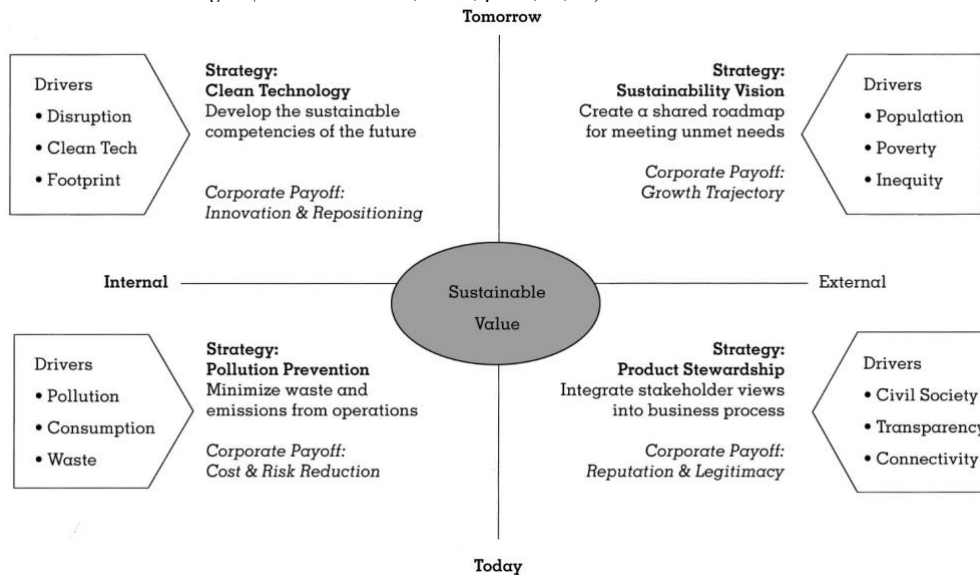


Figure 26 Sustainable Value Framework(Hart & Milstein, 2003, p. 60)

## Sustainability BM

In the late 2000s, a conceptualization and development of a Sustainability BM was done by Stubbs and Cocklin. Sustainability BM was defined as “a model where sustainability concepts shape the driving force of the firm and its decision-making.”(Stubbs & Cocklin, 2008, p. 103). To adapt to it, organizations required the development of internal structural and cultural capabilities, as well as collaboration with key stakeholders, to achieve both firm-level and system-level sustainability. Sustainability BM was based on an ecological modernization perspective, which reflected the cultural, structural, firm-level, and systems-level attributes. From the case study, structural and cultural characters were identified. Structural characteristics included processes, organizational forms and structures, and business practices. Cultural characteristics include norms, values, behaviors, and attitudes. Both domains required long-term focus.

The vision and mission of a sustainable organization were expressed in terms of social, environmental, and economic outcomes, which used profit as a tool to achieve the sustainable goals. The profit under this context means for the continuing existence of the organization, yet not the whole purpose to exist. Sustainable infrastructure was required from the system level of Sustainability BM, which demanded changes in legislation and regulation to promote its development at a local and global level. Its potential system-based Sustainability BM was illustrated in the research as Figure 27.

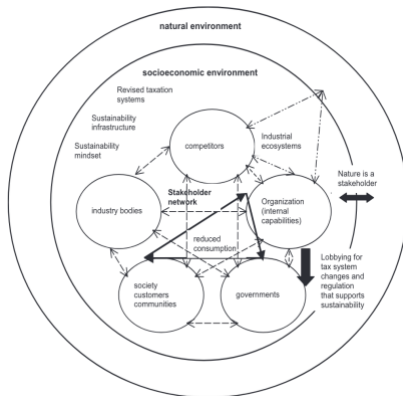


Figure 27 An Illustration of a System-Based SBM Graph(Stubbs & Cocklin, 2008, p. 124)

In addition, researchers argued that TBL report is not a good indicator of sustainability since the firms adopted the TBL were not necessarily sustainable in their overall business activities(Stubbs & Cocklin, 2008, p. 103,104,113,114,115,121,123,124).

## Sustainable innovation

Boons and Lüdeke-Freund reviewed the literature of BM under the domains of technology, organizational, and sustainable innovation. They revealed that sustainable innovation tends to disconnect with fundamental elements of BM, including value proposition, organization of supply chain and customer interface, and financial model. To bring the sustainable innovations to the market, the firms must not avoid combining their value proposition, up- and down-streams of the firm's value chain and a financial model. (Boons & Lüdeke-Freund, 2013, p. 9,16, 17).

## Circular economy

As mentioned in chapter 4.1. Circular economy has been a popular research topic. The options of product design and BM strategies for circular economy were elaborated into the strategy framework for firms transiting their business from linear to circular economy, as shown in Figure 28(Bocken et al., 2016, p. 308,316,317).

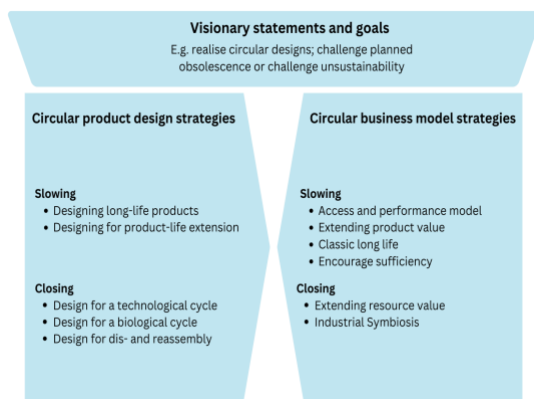


Figure 28 Circular economy product and business model strategy framework.(Bocken et al., 2016, p. 316)

However, the framework of the circular economy also received criticism for its unclarity and structural obstacles, with an ideological agenda, the scholars argued that the true impact of CE on sustainability remained uncertain(Corvellec et al., 2022, p. 1,9).

## Circular economy business model (CEBM)

A critical analysis was conducted to examine the literature and the current barriers and drivers of CEBMs. The barriers can be categorized as internal and external. Internal barriers included company policies and strategies, financial and technological limitations, lack of resources, collaboration

challenges, product design constraints, and internal stakeholders. External barriers were related to consumers, legislation, economics, supply chains, social and cultural factors, and the environment. Conversely, the drivers can also be divided into internal and external categories. The internal drivers included organizational factors, resource availability and optimization, financial aspects, and product and process development. The external drivers consisted of policy and regulation, supply chain factors, social and environmental influences, stakeholder pressure, and infrastructure. The importance of sufficient sustainable operations and manufacturing expertise was highlighted. Without these, even an effective and efficient CEBM could still fail due to unsuccessful waste reduction.(Hina et al., 2022, p. 1,7,13).

The usage of digitization technologies in support of the circulation economy was also explored. The scholars revealed that IoT and AI played a key role in CE transformation. The digitalization acted as both enabler and trigger for Circular BMs on its value creation, value delivery, and value capture dimensions. Additionally, Product-service systems BM which provided the combination of service and product has been acknowledged as a key BMI achieving digitally enabled CE (Chauhan et al., 2022, pp. 1, 10).

## 4.2.2 DBM terminologies and keywords

### **Innovation, technology transfer and IT**

As mentioned in Chapter 4.1, Teece discussed the factors leading to failure for firms that attempt to turn innovation into profit in the 1980s. Imitators may outperform innovators if they hold a stronger market position. However, when imitation is easy, the market may not function effectively. Innovative firms can face failure if they lack essential equipment and related capabilities. Therefore, public policy should not only focus on R&D but also on complementary assets and underlying infrastructure to promote innovation.(J. Teece, 1986, pp. 285, 304).

In the same decade, researchers identified factors that affected technology transfer in a multi-business firm based on a case study. They argued that technology transfer is the knowledge transfer and BS has a significant impact on its success, especially the reward system. Furthermore, the stability of the

management in the long run is essential for the innovative projects to be accomplished(Ounjian & Carne, 1987, p. 194,200).

The strategic alignment model was provided as an evaluation tool for IT in organizational transformation by Henderson and Venkatraman. There were two fundamental characteristic drivers of strategic management. First, strategic fit which indicates the relationship between internal and external components. Second, functional integration as the integration between business and functional domains. Four perspectives were designed to offer executives alternative frameworks for considering the role of IT in organizational transformation and preparing them for continuous adaptation to its potential impact, as shown in Figure 29.(Henderson & Venkatraman, 1999, p. 472,476,482)

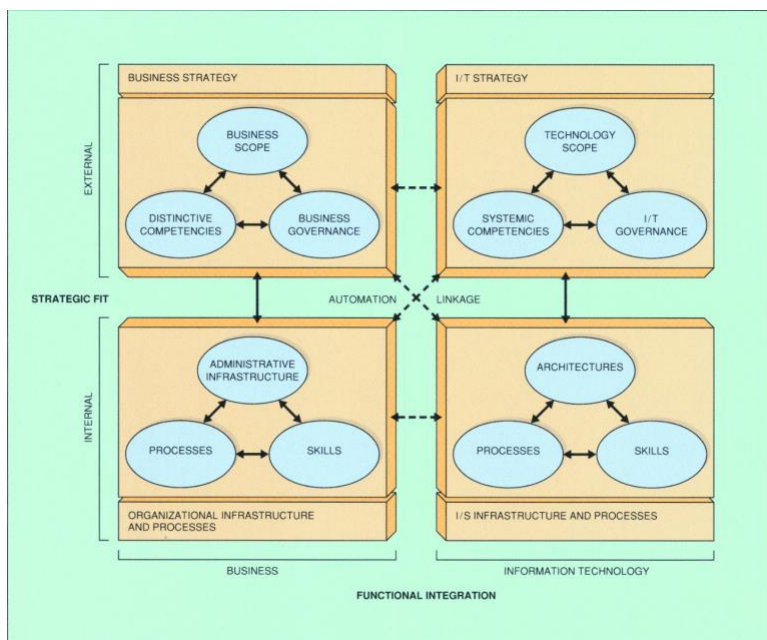


Figure 29 Strategic Alignment Model(Henderson & Venkatraman, 1999, p. 476).

## E-business

Through novel exchange mechanisms and translations that did not exist in traditional companies, e-business enabled new value creation. A model of e-business sources of value creation included four interdependent dimensions: efficiency, complementarities, lock-in, and novelty were proposed and shown in Figure 30. Faster and more informed decision-making has been enabled by e-business through leveraging the low-cost interconnectivity of the virtual market, and transaction efficiency can be further enhanced. By offering bundles of complementary products and services to customers, e-

business maximizes its value creation potential. Lock-in strategies prevent customers and strategic partners from migrating to competitors and create value in several ways, including loyalty programs and building customer trust, which encourage repeat transactions. Through its innovative operational approach, e-business realizes new sources of value creation by introducing novel ways of aligning commercial transactions and establishing entirely new markets. The authors note that subscription fees, advertising fees, and transaction revenues are the three major revenue sources for e-business firms. Also, innovation and BMI were crucial sources of value creation.

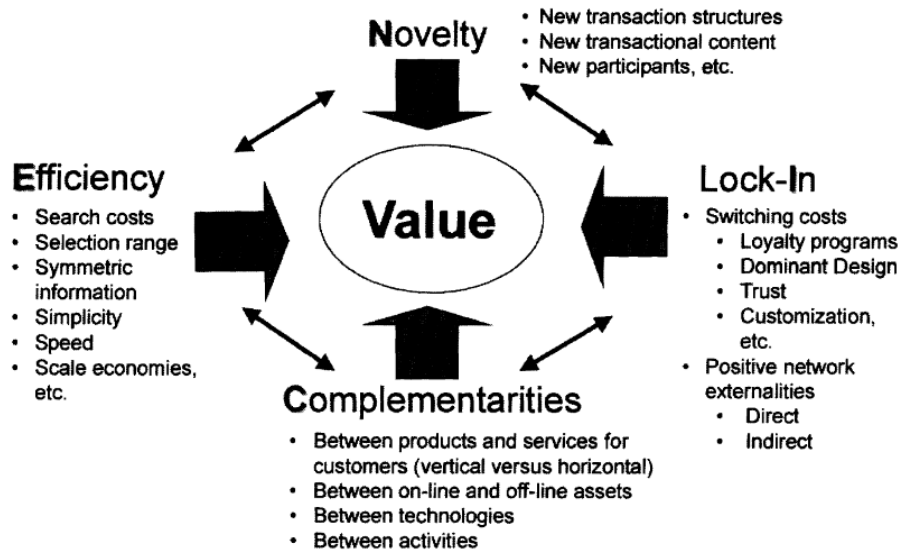


Figure 30 Source of value creation in e-business(Amit & Zott, 2001, p. 504)

The authors highlighted that the parallel shift in strategic thinking towards integrative dynamic, adaptive, and entrepreneurial strategies may be required for new sources of innovation that came with the emergence of virtual markets(Amit & Zott, 2001, pp. 503, 505, 506, 508, 515, 516).

The alternative service delivery mode enabled by Self-service technologies under the domain of e-commerce was studied and explored in its influencing key factors, and customer behaviors. Clear communication regarding the valued customer benefits was emphasized. The open innovative spirit including strengthening the co-producer role of customers and emphasizing co-creator value was employed to increase the role clarity, motivation, and ability of customers leading to a higher chance of product/service success, and customer satisfaction(Meuter et al., 2005, p. 61,78).

## **BM and technology innovations**

The role of BM in capturing value from early-stage technology was defined as the branch between technical innovation and economic profit since the technology inventions had no clear path from lab to market. The market and technical uncertainty led to difficulty in foreseeing suitable BMs, therefore, heuristic logic was required for finding an appropriate BM. In the successful cases, the emergence of BMs occurred from an interactive process of entrepreneurs' vision of new opportunities. In addition, VC also played a role in BMI of this decade. Since they needed to process technology commercialization under great uncertainty, many of them saw their decision as an investment to BM and pushed the evolution of BM once it was not working, therefore the BM seemed easier to establish in the independent venture than established firms(Chesbrough, 2002, p. 529,549,550,552).

## **Industry 4.0 and Digital Transformation**

The role of IT strategy as a fundamental driver of business value creation and capture has been redefined as digital technology has formed the new business infrastructures and brought the influence of new organizational logics to internal and external business coordination.

A detailed understanding of the impact of digital resources on the industry ecosystem was expected (Bharadwaj et al., 2013, pp. 471, 480,481). With the further development of technologies, researchers categorized that I4.0 had three-dimensional changes for firms, including high-grade digitized processes, smart manufacturing, and inter-company connectivity. The triggers of the BM change in German manufacturing SMEs in the value creation, value capture, and value offer aspects were researched. The researchers found that BMI in a certain direction could generate benefits for those SMEs to counteract the challenges and accelerate the implementation of I4.0(Müller et al., 2018, p. 2,11).

Research that focused on DT discovered the importance of the strategic renewal of business models in a firm's digital transforming process. Different types of dynamic capabilities were built and became the strategic imperatives for firms to ensure survival in the digital age. The ongoing BMI was pushed by strategic agility, which companies needed to accept the reality of sprinting failures, constant

redirection, and temporary advantages. (Warner & Wäger, 2019, p. 326,345,346).

DT was categorized into three stages including digitization, digitalization and digital transformation. Digitization describes the action of converting analog information into digital information and primarily digitized internal and external documentation processes but did not change value-creating activities. Digitalization was defined as how IT or digital technologies can be used to alter existing business processes, it was not only focused on the cost saving, but also process improvement that could potentially enhance customer experience. DT was the most profound phase, describing an overall company change that led to the development of a new business model. By implementing new business logic to create and capture value, DT introduced a new business model. The need for DT was concluded into three reasons, that were: 1. the rise of new technologies since the World Wide Web strengthened the development of e-commerce. 2. The shift of sales to digital firms due to digital technologies has changed the competitive landscape. 3. The change in customer behaviors under the digital revolution. The researchers identified that digital resources, digital agility, digital networking capability, and big data analytics capability were required for firms to transform digitally (Verhoef et al., 2021, p. 889,890,892,893).

### **DT achievement in practice and potential trends**

Industrial firms were under pressure from DT and the Industrial Internet of Things to enable the integration of real-time or near real-time information sharing between industrial machines. Through qualitative research on real-world cases, scholars revealed that BM transformation and a shift from traditional models toward outcome-centric DS were necessary for the digital reconfiguration of firms. Cultural change capability was especially crucial for DT. By leveraging Industrial Internet of Things and new technologies, the industry has been moving from an equipment-centric to a service-centric business model. Consequently, the development of a new service model became necessary, with service-based, pay-per-use models emerging as the new norm. (Ghosh et al., 2022, pp. 1, 9,10). For many SMEs, the usage of digital platforms for their BMI was a challenge, yet it brought a positive effect on both BMI and SEMs' capabilities reconfiguration. The capability reconfiguration could be identified as evolutionary and substitutional. The evolutionary capability reconfiguration involved SEMs updating their existing capabilities through adapting and selecting processes, which allowed

SMEs to use digital platforms in value creation activities. The substitutional capability reconfiguration refers to the replacement of outdated capabilities with new ones , which enables SMEs to adjust their BMI through cognitive processes of conceptual combination(Xie et al., 2022, p. 1,4,9,10). Furthermore, Scholars noted that to achieve the transformation to DBM in practical terms, the role of Chief Digital Officer could most effectively support the firms undergoing the process(Klos et al., 2023, p. 2017). The future development of 6G technology could shift the focus of innovation from individual technologies and products towards platforms and ecosystems innovation. It enables Everything-as-a-Service (XaaS) and Network-as-a-service (Naas) and could further change the value creation dynamics for current digital service providers and enable a variety of cloud-based services (Seppo Yrjölä et al., 2022, pp. 16299, 16306, 16307).

To summarize the terminologies occurring in the SLR analysis, definitions of the keywords related to SBMs and DBMs were identified and categorized into Table 4 and Table 5.

Table 4 Terminologies and keywords identified in SBM related articles

Concept/Term	Year	Article title	Definition	Original Citation
Sustainable development	1987	Our common future	Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. (World Commission on Environment and Development, 1987, p. 37)	-
Sustainable development	1994	Towards the Sustainable Corporation: Win-Win-Win Business Strategies for Sustainable Development	Involving the integration of environmental thinking into every aspect of social, political, and economic activity (Elkington, 1994, p. 90)	-
Sustainable development	2003	Creating sustainable value	"sustainable development "is a process of achieving human development...in an inclusive, connected, equitable, prudent, and secure manner. (Hart & Milstein, 2003, p. 56)	Gladwin, T., Kennelly, J., & Krause, T. 1995. Shifting paradigms for sustainable development: Implications for management theory and research. <i>Academy of Management Review</i> , 20(4): 878 –907.
Sustainability	1994	Towards the Sustainable Corporation: Win-Win-Win Business Strategies for Sustainable Development	"Sustainability," [...]requires that we pay attention to the entire life cycles of our products and to the specific and changing needs of our customers." (Elkington, 1994, p. 91)	Stephan Schmidheiny with the Business Council for Sustainable Development, <i>Changing Course: A Global Business Perspective on Development and the Environment</i> (Cambridge, MA: The MIT Press, 1992).
Sustainability	1997	Cannibals with forks: the triple bottom line of 21st century business	Sustainability is the principle of ensuring that our actions today do not limit the range of economic, social, and environmental options open to future generations.(Elkington, 1997, p. 20)	-

Concept/Term	Year	Article title	Definition	Original Citation
Green supply	2001	THE ROLE OF SUPPLY MANAGEMENT CAPABILITIES IN GREEN SUPPLY	We shall use the term “green supply” to indicate supply management activities that are attempts to improve the environmental performance of purchased inputs, or of the suppliers that provide them. They might include activities such as cooperative recycling and packaging waste reduction initiatives, environmental data gathering about products, processes or vendors, and joint development of new environmental products or processes. (Bowen et al., 2001, p. 175)	-
Sustainable enterprise	2003	Creating sustainable value	A sustainable enterprise is one that contributes to sustainable development by delivering simultaneously economic, social, and environmental benefits—the so-called triple bottom line. (Hart & Milstein, 2003, p. 56)	-
Global sustainability	2003	Creating sustainable value	Global sustainability has been defined as the ability to “meet the needs of the present without compromising the ability of future generations to meet their needs.” (Hart & Milstein, 2003, p. 56)	World Commission on Environment and Development. 1987. Our common future. Oxford: Oxford University Press, p. 8.
Sustainability business model	2008	Conceptualizing a “Sustainability Business Model”	“sustainability business model” (SBM)—a model where sustainability concepts shape the driving force of the firm and its decision making. (Stubbs & Cocklin, 2008, p. 103)	-
Sustainable business models	2013	Business models for sustainable innovation: state-of-the-art and steps towards a research agenda	sustainable business models enable social entrepreneurs to create social value and maximize social profit (Boons & Lüdeke-Freund, 2013, p. 16)	-
Sustainable innovation	2013	Business models for sustainable innovation: state-of-the-art and steps towards a research agenda	Many different definitions of the term “eco-innovation”, a label which is often used interchangeably with sustainable innovation. Related terms such as clean(er) technologies are also used in a way that overlaps with innovations that have a superior ecological performance. (Boons & Lüdeke-Freund, 2013, p. 11)	Carrillo-Hermosilla, J., del Río, P., Könnölä, T., 2010. Diversity of eco-innovations: reflections from selected case studies. Journal of Cleaner Production 18, 1073e1083.

Concept/Term	Year	Article title	Definition	Original Citation
Circular economy	2016	Product design and business model strategies for a circular economy	<p>The circular economy is viewed as a promising approach to help reduce our global sustainability pressures [...]</p> <p>The idea of a circular economy is not new and was given a theoretical foundation in the field of industrial ecology in the early 1990s [2]. Robert Ayres (in [2]) introduced the idea of industrial metabolisms: At the most abstract level of description, then, the metabolism of industry is the whole integrated collection of physical processes that convert raw materials and energy, plus labor, into finished products and wastes in a (more or less) steady-state condition. ([2], p. 23)(Bocken et al., 2016, p. 308)</p>	Ayres, R. U., "Industrial metabolism; theory and policy," in B. R. Allenby and D. J. Richards (eds), <i>The Greening of Industrial Ecosystems</i> , National Academy Press, Washington, DC, 23–37 (1994).
Circular Economy	2022	Drivers and barriers of circular economy business models: Where we are now, and where we are heading	<p>CEBM is characterised and defined as an organisational ecosystem to create, capture and deliver value by expanding products' useful lives through remanufacturing, repairing or designing long-life products[...]</p> <p>CE and CEBM have one fundamental difference. CE is an economic model, which emphasises the preservation and upgrading of materials to keep long-life products in use by remanufacturing, reusing, refurbishing, repairing, recycling and maintaining them . CEBM, meanwhile, is an approach through which organisations create value by adhering to CE principles (Hina et al., 2022, p. 1,2).</p>	<p>Nußholz, J.L., 2017. Circular business models: defining a concept and framing an emerging research field. <i>Sustainability</i> 9 (10), 1810. <a href="https://doi.org/10.3390/su9101810">https://doi.org/10.3390/su9101810</a>;</p> <p>Oghazi;Bocken, N.M., De Pauw, I., Bakker, C., Van Der Grinten, B., 2016. Product design and business model strategies for a circular economy. <i>J. Ind. Production Eng</i> 33 (5), 308–320. <a href="https://doi.org/10.1080/21681015.2016.1172124">https://doi.org/10.1080/21681015.2016.1172124</a>;</p> <p>Antikainen, M., Valkokari, K., 2016. A framework for sustainable circular business model innovation. <i>Technol. Innovation Manag. Rev</i> 6 (7). <a href="https://doi.org/10.22215/timreview/1000">https://doi.org/10.22215/timreview/1000</a>., Lewandowski, M., 2016. Designing the business models for circular economy—towards the conceptual framework. <i>Sustainability</i> 8 (1), 43.; Planing, P., 2015. Business model innovation in a circular economy reasons for nonacceptance of circular business models. <i>Open J. Bus. Model Innovation</i> 1 (11), 1–11.</p>

Concept/Term	Year	Article title	Definition	Original Citation
Circular Economy	2022	Linking circular economy and digitalisation technologies: A systematic literature review of past achievements and future promises	The concept of the CE, the green economy (GE) and the bioeconomy are understood to be interconnected as a result of economic, environmental and social goals. However, the CE is resource-focused, while the GE acknowledges the supporting role of all ecological processes (Chauhan et al., 2022, p. 2).	D'Amato, D., Droste, N., Allen, B., Kettunen, M., L`ahinen, K., Korhonen, J., Toppinen, A., 2017. Green, circular, bio economy: a comparative analysis of sustainability avenues. <i>J. Clean. Prod.</i> , 10.1016/j.jclepro.2017.09.053.
Circular Economy	2022	Critiques of the circular economy	The circular economy is to bring about perfect circles of slow material flows, to prompt a shift from consumer to user, and to enable a decoupling of resource use and environmental impact from economic growth (Corvellec et al., 2022, p. 1)	Lazarevic, D., & Valve, H. (2017). Narrating expectations for the circular economy: Towards a common and contested European transition. <i>Energy Research &amp; Social Science</i> , 31, 60–69. <a href="https://doi.org/10.1016/j.erss.2017.05.006">https://doi.org/10.1016/j.erss.2017.05.006</a>
Circular economy business model	2022	Drivers and barriers of circular economy business models: Where we are now, and where we are heading	CEBM is characterised and defined as an organisational ecosystem to create, capture and deliver value by expanding products' useful lives through remanufacturing, repairing or designing long-life products (Hina et al., 2022, p. 1)	Nußholz, J.L., 2017. Circular business models: defining a concept and framing an emerging research field. <i>Sustainability</i> 9 (10), 1810. <a href="https://doi.org/10.3390/su9101810">https://doi.org/10.3390/su9101810</a> ; Oghazi, P., Mostaghel, R., 2018. Circular business model challenges and lessons learned—an industrial perspective. <i>Sustainability</i> 10 (3), 739. <a href="https://doi.org/10.3390/su10030739">https://doi.org/10.3390/su10030739</a> ; Bocken, N.M., De Pauw, I., Bakker, C., Van Der Grinten, B., 2016. Product design and business model strategies for a circular economy. <i>J. Ind. Production Eng</i> 33 (5), 308–320. <a href="https://doi.org/10.1080/21681015.2016.1172124">https://doi.org/10.1080/21681015.2016.1172124</a> .
Circular business models	2022	Critiques of the circular economy	circular business models are to reduce costs, increase revenues, and manage risks, as well as provide possibilities for the finance sector to contribute to a transition to sustainability (Corvellec et al., 2022, p. 1)	Ellen MacArthur Foundation (2020). Financing the circular economy: Capturing the opportunity. <a href="https://www.ellenmacarthurfoundation.org/publications/financing-the-circular-economy-capturing-the-opportunity">https://www.ellenmacarthurfoundation.org/publications/financing-the-circular-economy-capturing-the-opportunity</a>

Table 5 Terminologies and keywords identified in DBM related articles

Concept/Term	Year	Article title	Definition	Original Citation
Technology transfer	1987	A study of the factors which affect technology transfer in a multilocation multibusiness unit corporation	The transfer of technology from research to products-producing or services-providing organizations can be defined as follows: Transfer of organized knowledge (resulting from GTE Laboratories' activities) to a business unit for the eventual purpose of producing new, or improved, products, processes or services. Transfer will occur through one, or more, of the following modes: occasional consulting; documentation (reports, assessments, programs or drawings); training (on the job, on-site or elsewhere); demonstrations (proof of principle or application to business unit problem); and collaborative technical work. Transfer is absolutely dependent on person-and-person communications, and is affected by all of those things which encourage or inhibit communication.(Ounjian & Carne, 1987, p. 194)	-
Information technology strategy	1999	Strategic alignment: Leveraging information technology for transforming organizations	We contend that IT strategy should be articulated in terms of an external domain-how the firm is positioned in the IT marketplace-and an internal domain how the IS (information systems) infrastructure should be configured and managed. (Henderson & Venkatraman, 1999, p. 474)	-
E-BUSINESS	2001	Value creation in E-business	business conducted over the Internet (which we refer to as 'e-business) (Amit & Zott, 2001, p. 493)	-
Virtual markets	2001	Value creation in E-business	virtual markets refer to settings in which business transactions are conducted via open networks based on the fixed and wireless Internet infrastructure (Amit & Zott, 2001, p. 495).	-
Digital transformation	2021	Digital transformation: A multidisciplinary reflection and research agenda	digital transformation, which we define as a change in how a firm employs digital technologies, to develop a new digital business model that helps to create and appropriate more value for the firm(Verhoef et al., 2021, p. 889).	-

Concept/Term	Year	Article title	Definition	Original Citation
Digital transformation	2019	Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal	Digital transformation has been defined as the use of new digital technologies, such as mobile, artificial intelligence, cloud, blockchain, and the Internet of things (IoT) technologies, to enable major business improvements to augment customer experience, streamline operations, or create new business models(Warner & Wäger, 2019, p. 326).	-
Digital Transformation	2023	Digital Transformation of Incumbent Firms: A Business Model Innovation Perspective	“Digital transformation describes a company-wide change that requires the development of new business models by implementing a new business logic to create and capture value.” (Klos et al., 2023, p. 2017)	J. Soluk and N. Kammerlander, “Digital transformation in family-owned mittelstand firms: A dynamic capabilities perspective,” <i>Eur. J. Inf. Syst.</i> , pp. 1–36, 2021. [Online]. Available: <a href="https://doi.org/10.1080/0960085X.2020.1857666">https://doi.org/10.1080/0960085X.2020.1857666</a> P. C. Verhoef et al., “Digital transformation: a multidisciplinary reflection and research agenda,” <i>J. Bus. Res.</i> , vol. 22, pp. 889–901, 2021.
Industry 4.0	2018	Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0	The concept of Industry 4.0 suggests an outlook from governmental institutions and corporate practice towards the fourth Industrial Revolution in manufacturing.(Müller et al., 2018, p. 4)	Kagermann, H., Wahlster, W., Helbig, J., 2013. Recommendations for implementing the strategic initiative INDUSTRIE 4.0. In: Final report of the Industrie 4.0 Working Group. Acatech, Frankfurt am Main, Germany.; Lasi et al., 2014; Liao et al., 2017)
Digital Business Strategy	2013	Digital business strategy: Toward a next generation of insights	Our working definition of digital business strategy is simply that of organizational strategy formulated and executed by leveraging digital resources to create differential value. (Bharadwaj et al., 2013, p. 472)	-

Concept/Term	Year	Article title	Definition	Original Citation
Business model innovations	2018	Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0	A business model innovation represents the “designed, novel, nontrivial changes to the key elements of a firm's business model and/or the architecture linking these elements”. (Müller et al., 2018, p. 3)	N. J. Foss and T. Saebi, “Fifteen years of research on business model innovation: How far have we come, and where should we go?,” J. Manage., vol. 43, pp. 200–227,2017.
Business Model Innovation	2023	Digital Transformation of Incumbent Firms: A Business Model Innovation Perspective	Business model innovation (BMI) is then defined as “designed, nontrivial changes to the key elements of a firm’s business model and/or the architecture linking these elements” . (Klos et al., 2023, p. 2017)	N. J. Foss and T. Saebi, “Fifteen years of research on business model innovation: How far have we come, and where should we go?,” J. Manage., vol. 43, pp. 200–227,2017.
Digital business model innovation	2023	Digital Transformation of Incumbent Firms: A Business Model Innovation Perspective	In the case of digital BMI, these changes are embodied in or driven by digital technologies. (Klos et al., 2023, p. 2017)	D. J. Teece, “Business models, business strategy and innovation,” Long Range Plan., vol. 43, pp. 172–194, 2010. R. G. Fichman, B. L. Dos Santos, and Z. Zheng, “Digital innovation as a fundamental and powerful concept in the information systems curriculum,” MIS Quart., vol. 38, pp. 329–A15, 2014. P. M. Bican and A. Brem, “Digital business model, digital transformation, digital entrepreneurship: Is there a sustainable ‘digital’?,” Sustainability, vol. 12, Jul 2020, Art. no. 5239.
Digital Transformation Capability	2022	Digital transformation of industrial businesses: A dynamic capability approach	We examine the development of Digital Transformative Capabilities’ (DTCs) as an unfolding process of sensing, seizing, and reconfiguring firm resources.(Ghosh et al., 2022, p. 3)	-

## Top cited paper

The top 5 cited articles of SBM and DBM within the SLR samples were listed in Table 6 and Table 7.

Table 6 Top 5 cited papers under SBM in SLR samples

Rank	Decade	Authors	Times Cited	Article Title
1	1992-2001	Elkington	21,668	Cannibals with forks: the triple bottom line of 21st century business
2	1992-2001	Elkington	6,430	Towards the Sustainable Corporation: Win-Win-Win Business Strategies for Sustainable Development
3	2012-2021	Bocken N.M.P.; de Pauw I.; Bakker C.; van der Grinten B.	2,085	Product design and business model strategies for a circular economy
4	2002-2011	Wendy Stubbs, Chris Cocklin	1,536	Conceptualizing a "Sustainability Business Model"

Table 7 Top 5 cited papers under DBM in SLR samples

Rank	Decade	Authors	Times Cited	Article Title
1	1982-1991	Teece D.J.	6,283	Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy
2	1992-2001	Amit, R; Zott, C	2,914	Value creation in e-business
3	2002-2011			The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies
		Chesbrough, H; Rosenbloom, RS	2,347	
4	2012-2021	Bharadwaj A.; El Sawy O.A.; Pavlou P.A.; Venkatraman N.	2,256	Digital business strategy: Toward a next generation of insights
5	2012-2021	Verhoef, PC; Broekhuizen, T; Bart, Y; Bhattacharya, A; Dong, JQ; Fabian, N; Haenlein, M	1,537	Digital transformation: A multidisciplinary reflection and research agenda

To conclude, the terminology and keyword changes in SBM started in 1987, and the concept of sustainable development was carried out to integrate environmental thinking into various aspects of human activities. To respond to the calling, the green evolution and green supply became the trend in the 1990s and early 2000s. The idea of sustainability emerged a few years later and became a majority

term. Built upon it, SBM, CE and sustainable innovations were developed in the late 2000s and 2010s. In particular, the concept of circular economy has developed, refined and eventually integrated as one of the long-term economic plans in the EU in 2022. Consequently, CEBM has become trendy in the past few years.

As for DBM, with the fast development of computing technology blooming from the 1980s to the 1990s, research on innovation, IT, and technology transformation became trendy. In the 2000s, with the World Wide Web, the keywords of E-business and technology innovation were very popular. In the early 2010s, with the maturity of IT technologies, it became a fundamental role for value creation and capture. Followingly, I4.0 and DT were the focus of the research in the 2010s to 2020s. In the past two years, the researchers concentrated on studies of the achievement of DT in practice and new BM trends including XaaS, DS which were enabled by the 6G, IoT, and other new technologies.

The top 5 cited papers included in the SLR for SBM and DBM were listed. For SBM, the top two cited papers were from 1992-2001 and much more cited than the rest of the papers. As for DBM, the distribution was more balanced. None of the publications from 2022 appeared on both ranks for top-cited papers, the reason might be that they are too new.

In the following chapter, the overview of shift factors was explained, and the shift of specific EIMI BMs was specifically monitored to understand how it changed according to the identified shift factors.

### 4.3 Shift factors and EIMI close look at BMs towards sustainability and digitalization

To understand better the shifting factor of general BMs towards sustainability and digitalization, a literature review was done.

#### 4.3.1 Shift factors of general BMs toward sustainability

In terms of society and policy, in the 18th century, the German forest industry first brought out sustainability as a principle for forest management. Essentially about the preservation of natural capital, sustainability was elaborated to other global environmental issues and became a fundamental principle in the overall economy and society. The term sustainability was not used merely regarding environmental protection but a responsibility towards future generations. In the 1960s environmental policies were engaged, in 1970 the USA first adopted the National Environmental Policy Act in 1969, subsequently, the concept was introduced in Germany and other European countries (Spindler, 2013, p. 11,12,13,14). Sustainable development became a concept of environmental policy which highlighted the harmonization of current and future economy via environmental protection. Later, the term sustainability became significantly popular and influenced global environmental policies due to the UN Environmental Conferences that started in 1972. The concept of sustainability further developed to include ethical and political aspects (United Nations, 2024c). As mentioned in Chapter 4.2, in 1987, the report “Our Common Future” edited by the World Commission on Environment and Development established the concept of sustainable development including social, political, and economic aspects (World Commission on Environment and Development, 1987, p. 33). In 1992, the UN Conference on Environment and Development called for urgent action on preserving natural resources on Earth and settled the fundamentals of “Earth Politics” globally (Spindler, 2013, p. 16; United Nations, 2024b). The Paris Agreement in 2015 was the first global climate agreement that enforced obligations on reducing emissions and adapting climate change on the participants. Agenda 2030 with 17 Sustainable Development Goals (SDGs) as in the Figure 31 was adopted by all United Nations Member States (Fischer et al., 2023, p. 23,24; United Nations, 2024a).



# SUSTAINABLE DEVELOPMENT GOALS



Figure 31 17 SDGs(United Nations, 2024a)

As for the society and economy aspect, after the first oil crisis in 1973, a world recession occurred in the mid-seventies that demonstrated the potential consequences of resource shortages. Not until the late 1980s, the economy of the northern hemisphere started to recover. People were starting to be aware of the limitations of economic growth. Later, the problems started to occur due to population explosion, pollution, and depletion of non-renewable resources. Particularly in developing countries, where there is overcrowding, uncontrolled urbanization, shortage of housing, and difficulty in offering proper medical and educational services from the government. It became obvious that the expectation of industrial development and unlimited economic growth was not feasible. Therefore, sustainable development was introduced as a solution to the growth problem, providing a compromise between development and conservation. As mentioned in Chapter 4.2 and the previous section, the report “Our Common Future” expressed the importance of balanced social equity, economic growth, and environmental maintenance which inspired researchers to develop economic theories along the sustainable concept (Du Pisani, 2006, p. 90,91,92,93). In the early 1990s, the concept of Corporate Social Responsibility (CSR), which evolved from 'business responsibility,' was explored by Carroll. He identified four key elements of CSR: economic responsibilities, legal responsibilities, ethical responsibilities, and philanthropic responsibilities, as shown in Figure 32.(Carroll, 1991, p. 39,42). When sustainability started trending in the 2000s, it naturally started integrating the concept of CSR

(Farcane & Bureana, 2015, p. 42). Later on, CSR represented the self-regulation of BMs by companies to operate in a society and environment-enhancing way (Fernando, 2024). In the early 2010s, the concept of a sustainable economy emerged, and three key trends were proposed: the quantification of priceless resources and their inclusion in economic systems, social responsibility, and the standardization of sustainability value chains.(Chouinard et al., 2011, p. 5). In 2011, the European Commission published a roadmap that transforms the EU to a competitive low-carbon economy in 2050 to respond to climate change by greenhouse gas. The goal was to reduce at least 40% of domestic greenhouse emissions compared to 1990 by 2030 and reach 80% less by 2050. According to the potential of technology and economics, all industries were required to contribute to the low-carbon goal (European Commission, 2016, p. 1,2,3). For emerging markets, concerns about climate change and CO2 emissions have become the primary drivers for the shift to sustainability (Halkos, 2023, p. 3220). To protect the environment, reduce raw material dependence, create jobs, and save consumers money, the EU also set up a goal to build a circular and climate-neutral economy by 2050 (European Parliament, 2023).

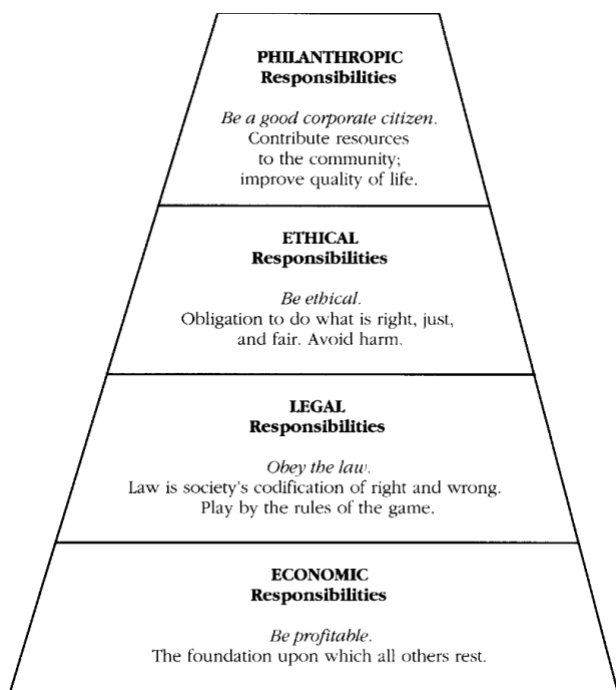


Figure 32 The pyramid of corporate social responsibility(Carroll, 1991, p. 42)

### 4.3.2 Shifts factors of general BMs toward digitalization

According to the Cambridge dictionary, digitalization is the noun of digitalize, which means “to change something such as a document to a digital form (= a form that can be stored and read by computers)” or “to start to use digital technology such as computers and the internet to do something” (Cambridge University Press & Assessment, 2024). Consequently, digitalization is inseparable from the development of computers. Since 1937, humans started to develop computing technologies (Computer History Museum, 2024), digital technologies have completely changed the way firms act in the business market. The innovative and improved way of using digital technologies in business was pushed by the speed of technology development. And the integration of digitalization in BM was crucial for a firm, otherwise, digitalization investment was rather an expense without a return (Ritter & Pedersen, 2020, p. 183,187).

Following the maturity of computer technology, different DBM theories were presented by researchers starting in the 1990s. As mentioned in Chapter 4.1, the concept of E-business was the origin of DBMs. The emergence of the virtual market drove a shift toward new forms of innovation in business strategic thinking (Amit & Zott, 2001, p. 516). In the following 15 years, with the rise of smart devices and social media, the communication methods had a drastic change between customers and businesses, which came along with the expiration of multiple communication channels offered by the business (Schallmo & Williams, 2018, p. 2). To create and capture the value of a business, IT strategy has become one of the fundamental drivers since the new business infrastructure was built (Bharadwaj et al., 2013, p. 480).

I4.0 was introduced by Germany in 2011, marking the beginning of the Fourth Industrial Revolution. Initially aimed at digitizing the manufacturing environment, I4.0 later expanded to include concepts of DT across various sectors. It also presented new opportunities for more efficient processes and enhanced value creation for customers. (Klingenberg et al., 2022, p. 1,4). BMI through I4.0 has been identified in three main approaches: service-oriented, networked ecosystem, and user-driven. (Ibarra et al., 2018, p. 4,7).

### 4.3.3 Impact on EIMI BMs

To better understand how the shifting factors of SBM and DBM have impacted EIMI BMs toward sustainability and digitalization over time, a literature review was conducted and cross-examined with the results of Chapter 4.2.

#### **Impact of SBM**

##### **1982-1991**

In the 1970s, the changes in the environment due to human activities became evident, resulting in the application of regulations affecting manufacturing.

During the 1980s, the shift to product-oriented manufacturing was linked to improving resource and energy efficiency, also increasing competitiveness. At the government level, environmental protection has risen higher on the political agenda. Regulations pressured industries to improve their sustainability (Schönsleben et al., 2010, p. 477,478).

With the world-wide industrial pollution of the environment, uneven human rights due to growing population, and the increasing wealth gap, the United Nations made a call for the integration of environmental thinking of social, political, and economic activities as crucial to enable sustainable development. Ensuring sustainable usage of resources for future needs was the main value proposition. On one hand, EIMI such as the chemical industry should find a replacement for environmentally harming compounds, and the governments should request the usage of environmentally friendly replacements, develop protocols, and take actions to monitor and report those implementations (World Commission on Environment and Development, 1987, pp. 11, 13,33,37, 124).

##### **1992-2001**

To respond to “Our Common Future”, BMs shifted to developing sustainable strategies which created benefits for the company, customers, and environment. Elkington reported in 1994 that environmentalists' attitudes had shifted from being anti-industry in the past to recognizing the crucial role that businesses play in achieving sustainable development goals. It again emphasized governmental stress on requiring industries to use environmentally friendly products and processes.

The mature green consumers and markets allowed industries to rely on "ethical" or "global" consumers. Social and environmental agendas and sustainable development strategies became the main value proposition. The industries in the 1990s responded by integrating sustainability in their BMs through environmental strategies and audits, product life-cycle analysis, supplier changes, corporate environmental reports and accounting, training programs, and ethical screening (Elkington, 1994, p. 90,91, 92, 93, 96).

Ho and Taylor found out that larger sizes, lower profitability, lower liquidity, and industries in manufacturing tended to have higher degrees of TBL disclosure practice, and the results of total TBL disclosure were mainly driven by non-economic disclosure (Jennifer Ho & Taylor, 2007, p. 144)). However, due to globalization and increasing competitiveness, the strength of industrial sustainable development has decreased. On the other hand, sustainable thinking had spread among customers and the demand for environmentally friendly, socially responsible products was increasing (Schönsleben et al., 2010, p. 478). Therefore, the impact of TBL on EIMI was partially high, but the results of it were partially dependent on the level of corporate ethics and preference.

## **2002-2011**

With the more mature term usage of 'sustainability', the BMs shifted to conceptualizing SBMs. Nature was considered a stakeholder, and the sustainable infrastructure including recycling facilities, renewable energy facilities, and ecological tax-reform systems made sure to promote and develop sustainability at a local and global level. Legalization and regulations with a sustainable mindset in society could become a supervision power for tracking the industry bodies (Stubbs & Cocklin, 2008, p. 116,123).

In the EU, the government cooperated with NGOs to push collaborative approaches in addressing business issues. The industries worked together with the government on legislation of recycling electronics. Resource efficiency, pollution prevention and demanding global stakeholders were the main drivers for EIMIs to turn to sustainability. The secondary drivers include CSRs and gaining a good reputation, were beneficial for EIMIs transiting and staying on SBMs. By using disruptive clean technologies, EIMIs could obtain sustainable competence, explore future markets and drive future economic growth (Hart & Milstein, 2003, p. 58,59,61,62, 68, 69).

## **2012-2021**

In the late 2010s, industries shifted towards sustainable manufacturing processes and adopted lean and green thinking for SBM implementation and achieving water reduction, enhancement of material efficiency, and minimization of subsequent costs (Caldera et al., 2017, p. 1546).

By focusing on inter-organizational networks and social systems aspects of sustainable innovation, SBMs research has found a mediator for innovation that is not only linked to production and consumption but also involves stakeholders and their expectations from other aspects. The process towards a balance of fulfilling customer needs and improving social and environmental effects could insecure the profit, especially in industries as EIMI, which are supply chain-dependent and lock-in technologies. The ecological pressure could be reduced once the product-service models are transformed and enable new profits by including recycling and close-up loop systems. Also, the producer-customer relationship could differ through the transformation of linear mass production to value co-creation or consumer co-production. Eventually, the finance model must shift from 'price-per unit' to 'job-to be done' to reach dematerialization (Boons & Lüdeke-Freund, 2013, p. 13,16).

Another promising approach to help global sustainable pressure was the circular economy. The process of converting raw materials, energy and labor, into finished products and wastes, should be seen as an integrated collection. An ideal state of an industrial ecology could be completely / almost completely internal cycling of materials in a way that resembles nature. The circular BMs enabled economic efficiency in reusing products and materials, and the usage of renewable resources (Bocken et al., 2016, p. 308).

## **2022-17.09.2024**

As required by the EU with its decarbonization targets by 2050, a combination of solutions was required for EIMI to reach the target (Mais & Bauernhansl, 2024, p. 1,2). Recent research discovered that the transition of circular economic BMs was enabled by digital technologies and revealed that IoT and AI played a crucial role. Manufacturing industries were taking active roles in big data usage. By integrating diverse datasets, including physical, cyber and stakeholders, the EIMI could create their special decision-making models. Through this integration, large-scale group decision-making could address diverse linear economic problems and promote circularity (Chauhan et al., 2022, pp. 1, 6). The

integration of green and SBM with I4.0 has also become a trend, which includes cloud-based BM for sustainable energy distribution networks and smart manufacturing (Najmaei & Sadeghinejad, 2023, p. 960). For the supply chain, I4.0 could enhance its sustainability and even create a new manufacturing business model (Esmaeilian et al., 2020, p. 7).

## **Impact of DBM**

### **1982-1991**

Following the development of computing technologies, innovation and technology transformation in firms became trendy topics for researchers. Teece made a fundamental approach to understanding how innovation could deliver value and its relationship to business strategy. For EIMI, including the chemical and petrochemical industry, strict copyright could protect their chemical formulas as trade secrets and effectively prevent the imitators from accessing them. Consequently, the market value translating from innovations could be ensured for the innovators for some time. The licensing of innovations as crucial BS could be sufficient for innovators to create value and special R&D was viable for this environment (J. Teece, 1986, pp. 285, 287,290). In the USA, industrial associations played an important role in providing technological subjects related to company productivity, profitability, and competitiveness. The infrastructure and manufacturing improvements led the EIMI to become a productivity-enhancing innovation market. Universities and federal laboratories have been given the role of assisting the adoption of innovations, however, their understanding of market priorities and positioning was important. From the point of view of cooperation, patterns shifted from one-to-one supplier-customer relationship to multi-companies cooperation via associations, furthermore, the fundamental technology transfer process also shifted from technological push to market pull (Maher, 1989, p. 73,79).

### **1992-2001**

In this period, BMs shift towards fields regarding IT and virtual markets. Through a new transaction structure, the potential new value could be enormous. However, this required a network of capabilities built by multiple stakeholders including customers, suppliers and complementors. Consequently, BMs could establish cross-industry and develop firm boundaries. The virtual markets required firms to shift

to integrative, dynamic, adaptive and entrepreneurial strategic thinking (Amit & Zott, 2001, pp. 515, 516). Western manufacturers faced strategic and organizational challenges in manufacturing facilities management in the 1980s and 1990s, which led to the firm's efficient, responsive and innovative strategies. With the competition becoming time-based and globalized, the usage of new tools including IT for decision-making, cooperation and collaboration became necessary to increase EIMI's flexibility and responsiveness. Deep knowledge and extended usage of IT became an important enabler for business improvement, and its role on next generation manufacturing is shown in Figure 33. To cut costs, reduce order processing time, and improve information flow, the implementation of Internet-based E-business in EIMI implementation was essential. By being particularly effective in connecting suppliers and customers on the supply chain, the role of e-business aimed to improve business processes, improve efficiency and increase competitiveness. By designing fundamental processes on knowledge-bases, EIMIs created value for both the organization and its customers. The time and cost reduction in the whole manufacturing chain from the usage of new technologies led to advantages in price, product innovation and service (Soliman & Youssef, 2001, pp. 538, 539,540,541,542,559).

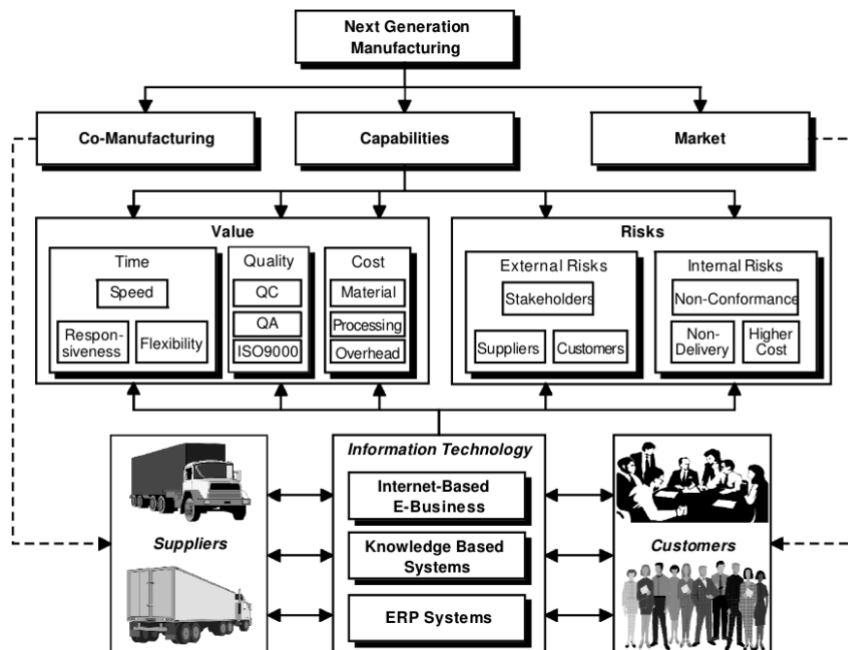


Figure 33 Role of IT in enhancing the capability of next generations' manufacturers (Soliman & Youssef, 2001, p. 540)

## 2002-2011

With the trend of e-business, the typologies of generic e-business models and components of e-business models were compiled by scholars. BM concepts have also been addressed in the domain of innovation and technology management. Either the innovative ideas in firms got commercialized through their BMs, or BMs complemented the traditional process, product and organization by being involved new forms of cooperation and collaboration. BMs have become the new unit of analysis (Zott et al., 2011, pp. 1025, 1032, 1038).

Forzi and Laing identified the need for “e-action” in the traditional EIMIs, and through a case study on the German metal industry, a BM and e-business solutions that transferred the paper-based test report system was developed accordingly as shown in Figure 34. By replacing the paper-based test report with electronic reports that used the internet as an information channel. A 24/7 system, multi-users available, and supporting independent testing from inspection organizations could be offered. This way, new solutions offering basic services including storage, remote access, and archive report files were created and fulfilled as well as value-added services including evaluation of the suppliers, value comparison of test reports and detailed offering of material-related information. By integrating web-based databases and trust-worthy information content management for value-added services, platforms could be established. The scholars emphasized that enterprises must deeply transform their organizational philosophy including structure, used methods and interaction with external organizations to successfully adapt in the networked economy. In addition, the phenomena of constant blurring of company borders due to the reduction of physical and information barriers of firms through evolution of economic systems has occurred. And the EIMI trend towards a tight interconnected economy and dynamic economy was undoubtable (Forzi & Laing, 2003, p. 126,127,128,129,130,131,132,133).

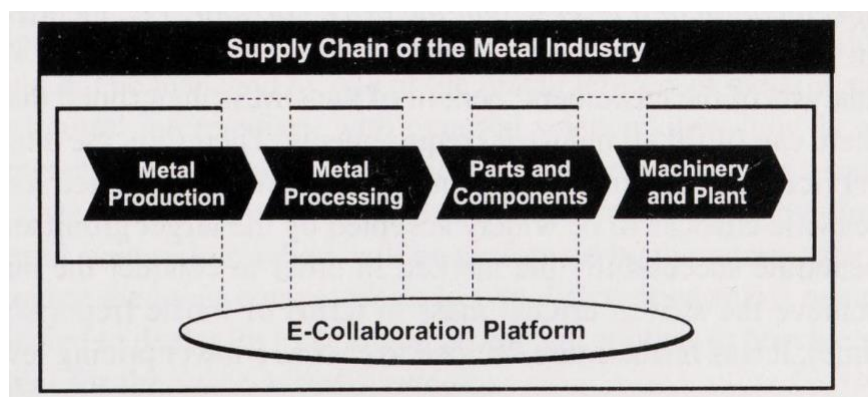


Figure 34 Business collaboration infrastructure for the metal industry(Forzi & Laing, 2003, p. 127)

## **2012-2021**

BM shifted towards implementation and/or integration of technology strategies or digital transformation. Meanwhile, IT has been seen as a fundamental driver for value creation instead of a mere tool. Digital technologies were fundamentally transforming many industries from their business strategies, business processes, firm capabilities, products and services, as well as key inter-organizational relationships in extended business networks. Cross-industry disruption has been enabled by the emergence of digital platforms, which then provoked new forms of business strategy (Bharadwaj et al., 2013, p. 471,480). DT in manufacturing represented the merging of the operational production process with the innovation process and brought operational technology and IT together. Both internal and external aspects required the firm's attention. Internally, all the participants involved in operational processes must also participate in the innovation process to ensure organizational support for decision-making. Innovation management based on the internal roles could guide the successful innovation implementation in the manufacturing environment. External shift including transformation of business products into customer-specific services. The alignment of business objects, metrics and processes of firms was required for the development of new BMs and market perception (Holzhauser & Schalla, 2017, p. 287).

With high-level digitization process, smart manufacturing, and intercompany connectivity, I4.0 affected the value creation, value capture and value offer of manufacturing enterprises.(Müller et al., 2018, p. 2) Research on the steel industry in Brazil figured that I4.0 tends to gradually improve the firm's operations efficiency and productivity instead of causing a revolutionary change (Martins et al., 2021, p. 1). In terms of value offering, I4.0 has significantly impacted manufacturing enterprises' BMs, leading to a broader product spectrum, greater flexibility, higher product quality and better customization to meet customer demands. Value capture aspects, cost transparency, co-design and joint decision-making became the main shifts (Martins et al., 2021, p. 7).

## **2022-17.09.2024**

To understand the DBM transformation in firms, researchers conducted empirical studies regarding the BM changes during DT. The recent rapid development of digital technologies including IoT, 3D printing and AI created new business opportunities but also disrupted the established industry (Klos et

al., 2023, p. 2017) . In Brazil, researchers found that the steel factories with a higher technological content tend to have a greater impact on their innovation projects and therefore greater technological opportunities. A company that set up a product development research center enabled enhanced agility, productivity and competitiveness by focusing on problem elimination, process simplification and cost reduction (Scopel et al., 2023, p. 240). A new digital service from manufacturing companies became a new value-offering product from its DT. This represented the business logic that shifted from up-front product sales towards advanced service contracts. Since digital services could change the structure of the manufacturing industry, it was essential to collaborate with selected customers and benefit from in-depth understanding of customer needs for value creation. Furthermore, an appropriate revenue model to capture the added value was required (Linde et al., 2023, p. 82,96).

To conclude, the shift factors of general BMs towards sustainability were mostly related to society and policy. Disasters due to human activities occurred and forced people to rethink the cost of a highly developed society. Starting from the 1960s, different environmental policies from different world organizations, including the UN and EU. The idea of considering environmental protection in economic development was developed in the 1980s. In recent years, decarbonization and the development of a circular economy became two major directions to focus on EU economic development. On the other hand, the shift factors of general BMs toward digitalization were closely developed along with the development of digital technologies. Some technologies including the Internet and IT brought disruptive changes to the way firms do business. Therefore, there was constant stress for firms to continue updating. The governmental push of I4.0 also led to the further development of DBMs.

For EIMIs, both SBM and DBM aspects were important. In the SBM aspect, most changes were following the regulation and environmental agendas. For DBM aspects, increasing productivity and creating new values through technology transformation, technology strategies and DT were the main drivers.

## 4.4 Aligning SBM and DBM trends with EIMI case study

According to Chapter 4.1, the SLR result from 2022 to 10.09.2024 revealed that research in the past two years covering SBMs focused on CEBM. Within DBMs, DBMI, OI, customer-centric orientation and servitization were trending topics. The top 10 keywords identified by VOS Viewer were: business models, sustainability, innovation, circular economy, sustainable development, business model, innovation, DT, performance, business strategies and commerce. In Chapter 4.3, it was found from the literature research that EIMI's BM develops towards decarbonization, DT implementation, and I4.0. In this Chapter, a co-occurrence analysis of publications on Scopus with keywords SBM and DBM were done to identify current academic research trends. Scopus was selected as the VOS analysis database since it provided the highest number of publications in the previous VOS analysis.

### 4.4.1 VOS bibliometric analysis

From the VOS analysis result of SBM four main clusters were identified as shown in Figure 35. The cluster "sustainable development" contains climate change, CE, supply chains, life cycle, commerce, e-commerce, waste management, environmental impact, sustainable business and competition. I4.0, manufacturing, environmental economics, BMC and sustainable development goals (SDGs) belonged to the cluster of SBMs. The "sustainability" cluster contained keywords including innovation, supply chain management, BMI, stakeholders, digitalization, SBM innovation, business development, CSRs, numerical models, strategic approach, DT, dynamic approach, corporate sustainability, COVID-19, and entrepreneurship. The last cluster "BM" included business modeling and value creation.

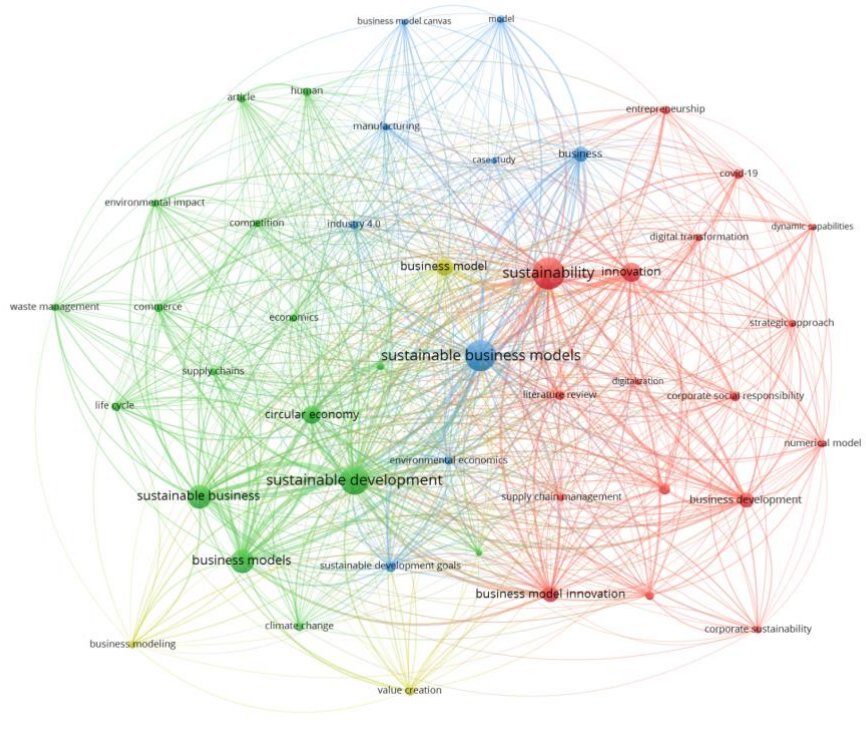


Figure 35 Keywords identified with search string SBM

Five clusters appeared for the VOS analysis result of DBM as shown in Figure 36. BMs cluster includes DBMs, digital business, AI, data analytics, blockchain, digital technologies, value creation and competition. The cluster “digital transformation” contains as keywords: BMI, commerce, DBMI and dynamic capabilities. Digitalization clusters have keywords digital innovation, ecosystems, digital platforms and information use. Keywords I4.0, sustainable development, sustainability, entrepreneurship and business belong to the digital economy cluster. Finally, in the innovation cluster, keywords such as COVID-19, business development, digitalization and sales appeared.



## 4.4.2 Case Study: BASF

A case study was done to check the alignment of identified trends with real deployment in the industry. Chemical company BASF was examined as a case study example in EIMI, and the BMs of BASF were studied in detail using BMC and SWOT analysis.

Headquartered in Ludwigshafen, Germany (BASF, 2025b), BASF operates their business across multiple continents (BASF, 2025a) and is currently the biggest chemical company in the world as shown in Figure 37 (Financial Times, 2024).

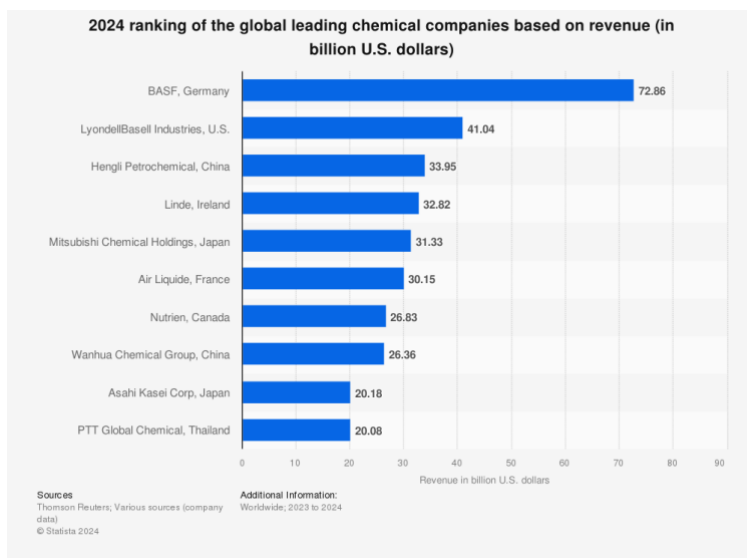


Figure 37 2024 ranking of the global leading chemical companies based on revenue (in billion U.S. dollars)(Financial Times, 2024)

### BASF's BMC

As mentioned in the theoretical background, the business canvas includes nine elements: Key Partnerships, Key Activities, Key Resources, Value Proposition, Customer relationship, Channels, Customer Segments, Cost Structure and Revenue Streams.

BASF has various key partners in both internal and external activities. For innovation, BASF engage with industrial associations and partners as part of their global network for Know-How (BASF, 2024a, p. 16) as well as cooperation with top universities, innovation hubs and research institutes for product research and development (BASF, n.d.-l, 2024a) and OI (BASF, n.d.-d). For product manufacturing,

BASF needs to rely on raw material and energy providers as key partners (BASF, 2024a, p. 9,10). Furthermore, a supply chain sustainability company offering software as a service, partnered with BASF to integrate a blockchain platform with supply chains that lower the energy use (BASF, 2022). While building the Verbunds and operating other business activities, BASF works with government agencies (BASF, 2024a) and maintains a continuous exchange between residents and site management through community advisory panels to ensure the residents' rights (BASF, 2024a). On the sales end, the cooperation with online and offline distribution partners can increase sales of BASF's products (BASF, 2024a, p. 40).

For the external activities, BASF engages in human rights responsibilities with industrial associations (BASF, 2024a, p. 22), NGOs (BASF, 2024a) and stakeholders (BASF, 2024a). To promote sustainability topics, BASF works with its network of partners, lobbying groups and associations (BASF, 2024a) to cooperate with the Taskforce on Nature related Financial Disclosures (TNFD) and Nature Advisory Council to work on Biodiversity (BASF, 2024a).

To conclude, BASF cooperates with industry alliances, NGOs, government, renewable energy, and raw material suppliers to reach their sustainable goals and transition to CE. Collaboration with top universities, innovation hubs, research centers and their stakeholders is crucial for BASF to develop innovative solutions for both their DBMI and SBMI.

Key activities of BASF that focus on manufacturing are building more Verbund to increase productivity (BASF, 2024a, p. 24) and customer-focused research activities to help BASF to understand the essential customer needs (BASF, 2024a, p. 10). BASF initiated many different activities to reach their sustainable goals including reducing the carbon foot-print of existing products (BASF, 2024a, p. 16), optimizing Verbund system for Carbon-optimized supply energy and avoiding CO2 emission by converting to renewable energy (BASF, 2024a, p. 19) in chemical processes and products (BASF, 2024a, p. 9,16). The efficient usage of raw materials, waste reduction, increasing renewable and recycled raw materials, developing climate smart technologies (BASF, 2024a, p. 10,19,20), accelerating and implementing projects related to low-emission production technologies and developing recycling technologies allowed BASF further transform toward circular economy (BASF,

2024a, p. 16,19). Water management has also been BASF's goal for many years to reduce exploitation of water resources in their Verbunds (BASF, 2024a, p. 21). Sustainability-oriented supply chain management was realized to increase sustainability globally and create transparency (BASF, 2024b, p. 158). It is also integrated by BASF to evaluate their products and processes using methods sustainable value measuring methods including SEEbalance® Socio-Eco-Efficiency Analysis, and TripleS (Sustainable Solution Steering) portfolio analysis (BASF, 2024a, p. 17). To demonstrate BASF's commitment to climate protection, a new advisory council was founded in 2023 to protect biodiversity and ecosystems (BASF, 2024a, p. 21) while realizing SDGs to contribute to Agenda 2030 (BASF, 2024a, p. 15,18).

On the other hand, BASF adopts digitalization through promoting digital skills among employees, cooperations and partners to strengthen the competitiveness (BASF, 2024a, p. 11) and integration of digital technologies in business to achieve better efficiency (BASF, 2024a, p. 11). These efforts include digitizing the plants and systematically analyzing production data to reach further automation in processes (BASF, 2024a, p. 11).

To summarize, projects related to low-emission production technologies and developing recycling technologies, efficient usage of raw materials, reducing waste, increasing renewable and recycled raw materials, and developing climate-smart technologies for sustainability enhancement are pillars of BASF's strategy towards CE. To reach BASF's decarbonization goal, the optimization of supply chain and adoption of carbon-optimized production processes need to be implemented. Moreover, their products and processes are evaluated with many sustainable metrics. By realizing SDGs, BASF demonstrates its commitment to Agenda 2030.

While implementing digital tools, digital skills are promoted to BASF's employees, cooperators, and partners to strengthen the competitiveness in digitalization.

Key resources of BASF are strong R&D that keeps them in a leading position (BASF, 2024a, p. 10) through patents and Know-How as their foundation resources for business operations (BASF, n.d.-n, 2024a, p. 65). For the manufacturing, BASF's Verbund production facilities are one of the important key resources (BASF, 2024a, p. 9) with the support of their well-established global supply chains (BASF, n.d.-q). In addition, positive brand reputation (BASF, 2024a, p. 26) and societal acceptance of

their business activities (BASF, 2024a, p. 18) allows BASF to gain customer's trust and doing daily operation. BASF finds financial support through its investors (BASF, 2024a, p. 70).

To summarize, strong R&D supports BASF in developing innovative, sustainable and digital solutions, while its optimized global supply chain enables increasingly sustainable production process.

BASF's value proposition is to help improve quality of life and protect the environment, while strengthening their position as pioneers for sustainable solutions and realizing climate-neutral production (BASF, 2024a, p. 10). Other correlated values, include the resource-efficient principle, which is the foundation of the Verbunds, as well as carbon-optimized and reliable production (BASF, 2024a, p. 5), offering solutions for customers to reduce their carbon footprint and achieve their sustainable goals (BASF, 2024a, p. 16) to adding value for customers, environment and society (BASF, 2024a, p. 17). BASF also commits to the Paris Climate Agreement to further elaborate their impact on global climate protection (BASF, 2024a, p. 18). BASF's broad portfolio (BASF, 2024a, p. 5) ensures that individual customer requirements are met (BASF, 2024a, p. 30).

In brief, BASF commits to the Paris Climate Agreement for global climate protection, through various sustainable solutions, BASF supports their customers to reduce their carbon footprint and create value while building production sites based on resource-efficient, carbon-optimized, and reliable production concepts.

For customer relationships, BASF cooperates with their customers to create innovative products (BASF, 2024a, p. 16). For certain products, the tailor made and co-creation solutions are offered (BASF, 2024a, p. 30,32) enforcing BASF's intention to support the needs of customers (BASF, 2024a, p. 61). The details of business activities are also reviewed by stakeholders and their questions are then seriously considered to adjust the company's strategy (BASF, 2024a, p. 18). Establishing a learning center with events, podcasts, news features and videos enabled BASF to train and share their knowledge with their customers (BASF, n.d.-m).

BASF's OI approach co-creates innovative products with its customers and shares information regarding their sustainable and digital innovations via various channels to gain customers' trust and promote transparency.

The channels BASF uses to reach the customer segments are digital systems (BASF, 2024a, p. 11), BASF's global product network (BASF, 2024a, p. 30), direct sales to the customers, online portals (BASF, n.d.-o), personal contacts (BASF, n.d.-g), official website (BASF, n.d.-p), partnerships (BASF, n.d.-f), events and fairs (BASF, n.d.-k), social media (Linkedin, n.d.), E-commerce platforms (Amazon.de, n.d.) , and Podcast (BASF, n.d.-j). By adopting this diversified communication strategy, BASF enabled new value-adding sources.

Customer segments of BASF include chemicals and plastics industries, transportation industries and its related industries, agriculture, consumer goods and related, construction, electronics, energy and resources, health and nutrition related industries (BASF, 2024a, p. 5). The adoption of sustainable innovations is also helping BASF's customers achieve sustainable goals, since many of them are businesses with similar sustainability goals and requirements.

The cost structure of BASF includes raw material, production and energy cost (BASF, 2024a, p. 10), investments in property, plant and equipment and Verbund for production (BASF, 2024a, pp. 23, 24), R&D cost for product innovation (BASF, 2024a, p. 16,17), plant digitalization and adapting data analysis system for further automation process (BASF, 2024a, p. 11), employee training (BASF, 2024a, pp. 11, 26), logistics and distribution cost (BASF, 2024a, p. 10). Towards the sustainable transition, investment on renewable power assets and purchasing green power on the market through long-term supply agreements can make sure BASF gets sufficient shares of renewable energy sources (BASF, 2024, p.19).

In conclusion, Investment and cost on green energy recycling technology implementation cost in Verbund are delicate to BASF's SBM. The cost for R&D to reach product innovation, digitalizing plants and adapting data analysis systems for further automation processes contribute to their DBMI.

Finally, the revenue streams of BASF are revenue from product sales (BASF, 2024a, p. 5), licensing and services fee of their intellectual properties (BASF, 2024a, p. 18), sustainable solutions and recycling services offered to customers (BASF, n.d.-e, 2024a, p. 17), software and digital solutions (BASF, n.d.-h). The sustainable solutions and recycling services show the effort BASF adopted to SBM, while software and digital solutions provided by BASF are new revenue streams from their DBMI.

To summarize, a BMC of BASF was visualized and presented in Figure 38.

The Business Model Canvas of BASF

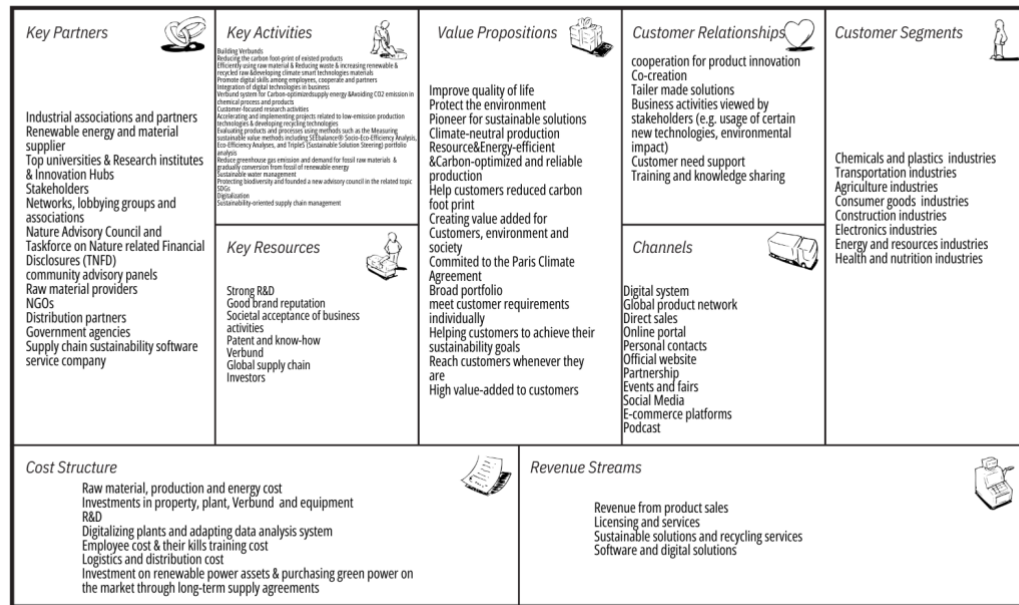


Figure 38 The Business Model Canvas of BASF

## SWOT Analysis

As mentioned in Chapter 4.1, SWOT analysis includes four main categories of analysis aspects of a firm, namely strengths, weakness, opportunities, and threads. According to the BASF Factbook 2024, a SWOT analysis of BASF was done and listed.

### Strength

1. International operation and leading position.

As the biggest chemistry company in the world, BASF offers services in 93 countries and owns six Verbund sites located in EU, North America and Asia for production (BASF, 2024a, p. 5,9).

2. Broad portfolio

A broad portfolio including 6 segments, 11 operating divisions and 70 strategic business units make sure to cover a wide customer range (BASF, 2024a, p. 5).

### 3. Strong R&D

With around 10,000 employees and a huge investment of 2.1 Billion Euro in 2023, the innovation strength is one of the foundations of BASF's success (BASF, 2024a, p. 10).

### 4. BASF Verbund concept

By integrating production plants, energy and material flows, logistics and site infrastructure, Verbund system creates efficient value chains for basic chemicals, industrial and final consumer products.

Energy and raw materials have been used efficiently by integrating new digital technologies, while production output has increased and CO2 emissions have been reduced (BASF, 2018, 2024a, p. 9,11).

### 5. Pioneer position for sustainable solutions

Highly integrated sustainability into the decision-making process and strong commitment to sustainability. The early adoption of sustainable strategy, steering process and BMs makes BASF stand at the leading position (BASF, 2024a, p. 10,17,18).

## **Weakness**

#### 1. Products covered specific regulation and customer concerns

10% of product BASF sales are regulated with specific or strong regulations partially with the usage of high-concern substances which could lead to customer concern in mid-short-term and it could eventually posing strong global reputation risk (BASF, 2024a, p. 17).

#### 2. Energy intensive manufacturing process

Transformation toward climate neutrality is challenging for energy-intensive companies (BASF, 2024a, p. 18). In addition, the large amount of used electricity also generates huge costs, especially for the Verbunds located in Germany, where the energy crisis occurred, led to high energy costs for the past few years (BASF, 2024b, p. 209)

#### 3. Strong dependence on raw material

Some divisions in BASF have a strong dependence on raw materials, consequently causing a high fluctuation in raw material prices. Therefore, any negative change in raw material prices on the market could cause a huge loss for BASF (BASF, 2024b, p. 179).

#### 4. High complexity of company transformation

BASF is facing the challenge of transforming itself to increase profitability while being socially responsible, considering long-term political decisions, environmental agreements, and overcoming geopolitical difficulties (BASF, 2024a, p. 10).

#### 5. High development cost to maintain competitiveness

Strong R&D has been mentioned before as a strength, yet to stay in a leading position, high investment in R&D expenses is required in every segment (BASF, 2024a, p. 29).

### **Opportunities**

#### 1. Digitalization and adaptation of DBMs

The growing potential of digitalization made BASF promote digital skills among their employees and corporate partners and integrate them as part of the business (BASF, 2024a, p. 11). Several DBMs, including virtual lab assistance for architectural coating, virtual pharma assistants, gas treatment connecting systems, and digital platforms to assist farmers (BASF, n.d.-h).

#### 2. Potential digital disruption of AI

The potential digital disruption of established processes using AI could increase overall efficiency and effectiveness. By taking the leading role in DT in the chemical industry, BASF could potentially enhance its whole value chain (BASF, 2024b, p. 181).

#### 3. Strong demand for sustainable products

The demand of BASF's customers for sustainable products is rapidly increasing due to sustainable consciousness. On top of that, the strict EU regulation on decarbonization and reducing greenhouse emissions are a strong push for the overall industry to choose more sustainable products and production (BASF, 2024a, p. 17,18).

#### 4. Growing population for higher demand of nutrition and care products

The growth of the population is positively related to the growing need for food, as well as the pharmaceutical industry. It could benefit BASF's sales in their agricultural, nutrition, and health divisions. Additionally, cosmetics detergents and the cleaning industry are also in growing demand (BASF, n.d.-c, 2024a, p. 56).

#### 5. New circular economy BMs

In the transition process of BASF towards a circular economy, new BMs emerge as opportunities. By incorporating the concept into their Verbund site, renewable energy and recycled new materials were used to reach decarbonization (BASF, 2024a, p. 19,25). Circular services, including Infrared Spectroscopy (trinamiX) to determine the plastic composition and the smart farming system xarvio, are also provided as new BMs of BASF (BASF, 2021).

### **Threats**

#### 1. Geopolitics challenge

With a global footprint and a massive logistic network, geopolitical challenges could affect the business activities of BASF in certain countries (BASF, 2024a, p. 5,6,10).

#### 2. Product Safety

As a chemical company that produces physicochemical, toxicological, and ecotoxicological products that may have negative effects on people and the environment if handled incorrectly, product safety management is important to be secured (BASF, 2024b, p. 146).

#### 3. Intense competitiveness

Competitors from Asia, North America, and the Middle East have increased significantly due to advantageous raw material and energy prices. The producers located in raw materials-rich regions could expand their value chains in consumer-oriented sectors. This can impact BASF fundamentally in production since their two largest Verbund are both located in the EU. Furthermore, the expansion of digital marketplaces for chemicals could change the current existing customers and suppliers relationship of BASF (BASF, 2024b, p. 181).

#### 4. Continuous pressure from EU environmental regulations

High-level detailed measures and regulations are expected to continue generating pressures on chemical and industry-related firms that could generate significant impacts on BASF and their customers in decreasing competitiveness on the operation and reducing product portfolios (BASF, 2024b, p. 181).

#### 5. Climate changing

The carbon prices, taxes and legislation burden could increase drastically for an EIMI as BASF due to the governmental response to climate change. On the other hand, as EIMI, the high energy, raw material dependent and strong regulation on some of their products require their constant improvement of their SBM and DBM. The tightening of EU regulations and climate change are initial threats for BASF and force them to further evolve new solutions.

Nevertheless, the emerging opportunities of high demands on digitalization and CE solutions can be a strong driver for BASF to acquire SBM and DBMs to create more value (BASF, 2024b, p. 182).

To further understand the impact of SBM and DBM academic trends on BASF's BM, an analysis of BASF BMC and SWOT alignment with current research trends were conducted.

#### **SBM trend: Circular economy**

Circular economy, a key terminology mentioned in Chapter 4.2, affects seven segments on BASF's business canvas and shows as opportunities and weakness for BASF's SWOT analysis. In the key partner segment, BASF's partners include renewable energy and material suppliers for product manufacturing. Among the key activities it is important to mention, developing recycling technologies, increasing renewable and recycled raw materials, accelerating and implementing projects related to low-emission production technologies. A strong R&D to support BASF's sustainable innovations is therefore a key resource of the company. The value proposition of Verbunds is built around the concept of resource-efficient, carbon-optimized and reliable production. For customer segments, the industries' demands on BASF's recycling technologies and circular solutions have increased (BASF, 2024c, p. 4). The cost structure mainly consists of the investment on green energy and R&D costs. Revenue streams

include sustainable solutions, recycling services, and software. New circular economy BMs act as an opportunity for BASF to enter new markets. By “closing the loop” and “extending the loop”, BASF aims to reach €10 billion in sales by 2030 (BASF, 2024c, p. 5). BASF's weakness of strong dependence on raw materials could be reduced by recycling the raw materials.

### **SBM trend: Climate change**

Climate change is a long-term shift in temperature and weather patterns. Since the 1800s, human activities have been the main driver of climate change, mainly due to the greenhouse gas emissions from burning fossil fuels, which affect human health, food production and safety. To avoid a worsening change in the climate, greener economies are required (United Nations, n.d.). The key activities of BASF dedicated to decreasing climate change consist in reducing the carbon footprint by optimizing their Verbund system for Carbon-optimized supply energy and switching to renewable energy gradually (BASF, 2023a, p. 114). By 2023, BASF has reduced 22.8% of their total greenhouse gas emission compared to 2018 (BASF, 2024a, p. 19). The key resource is their R&D on the development of climate-smart technologies, for example, the Carbon Capture and Storage (CCS) technologies, which could potentially capture and storage 95% of production process generated CO<sub>2</sub> (BASF, 2024a, p. 20). Value proposition of helping their customers to reduce their carbon footprint and committed to the Paris Climate Agreement for global climate protection. Eventually, cost structure implied in recycling technology implementation fee in Verbund and investment in renewable power are the major costs. On the other hand, climate change can act as a threat to BASF, since the EU targets EIMI to lower the overall carbon emission, implementing higher carbon taxes to pressure the industry.

### **SBM trend: Supply chain management**

The EIMI supply chain has been put under pressure to increase its resource efficiency and adopt CE, and the digitalization of the supply chain could enhance its collaboration on resource usage, waste management, and recycling of material by increasing information exchange and tracking (Tolettini & Di Maria, 2023, p. 2,3). BASF integrated CE into their supply chain management by having renewable energy and material suppliers for product manufacturing production as their key partners. For key activities, sustainability-oriented supply chain management is adopted to increase sustainability

globally and create transparency. For example, the Supplier CO2 Management Program has launched since 2021 that supported 70% of BASF's suppliers to evaluate and reveal their product carbon footprint (BASF, 2024a, p. 20). In key resources, BASF's global supply chains are crucial for their business operations. Within the channel of BASF's global product network, a standard global guideline is established to ensure that their structure and processes adapt in response to the changing conditions including the environmental, social and ethical aspects (BASF, 2023a, p. 114). For cost structure, the integration of digital technologies on the supply chain for horizontal integration and logistic visibility are the major expenses (BASF, n.d.-r).

Supply chain management acts as a strength and thread for BASF since BASF has well-implemented logistics. However, the present geopolitical threats could drastically affect their well-established global network. BASF counts their sustainability-oriented supply chain management as part of risk management and monitoring the condition regularly (BASF, 2023a, p. 114).

### **SBM trend: Waste management**

It has become increasingly important to re-utilize waste for EIMI sustainable development due to regulation and scarcity of materials. For example, very high temperature required during the production processes has been identified as a common condition for EIMI. Consequently, the waste heat and unused waste streams have represented an important potential for sustainable improvement. The collaboration of manufacturers with waste users and producers might lower the risk and increase the opportunities, but the cost of implementing waste management is still debatable on its economic viability. The main drivers for the implementation of waste management rely mainly on regulatory impact and other pressures in business conditions (Schönsleben et al., 2010, pp. 478, 480).

For BASF, reducing waste and using recycled raw materials are key activities while having recycling technology implementation costs as part of its cost structure. Meanwhile, providing safe waste management and recycling services to other firms has become one of their revenue streams. Through integrating CE, BASF found new usage for 46.3% of their waste in 2023 (2024b, p. 111). It could be a big opportunity thanks to stricter EU regulations and push firms to adopt more sustainable production processes. On the other hand, continuous pressure from EU environmental regulations is still a threat to EIMI.

### **SBM trend: Environmental impact**

As mentioned in the section on climate change, the impact of business activities on the environment is vital. In BASF's key activities, they realized their commitment to climate protection and founded a new advisory council in 2023 to protect biodiversity and ecosystems. From the point of view of value propositions, BASF aims at creating value-added for customers, the environment and society. For example, BASF controlled 90% of their water abstraction through sustainable water management and engaging responsible usage of water in their value chain (BASF, 2024b, p. 113). The trend of researching environmental impact can emphasize the strength of BASF since they are in pioneer positions for sustainable solutions.

### **SBM trend: Environmental economics**

Environmental economics is the study of the efficient distribution, use and protection of the world's natural resources, focusing on how to use and manage limited resources to provide for the population while balancing concerns about environmental impacts (Chen, 2024). Therefore, the efficient usage of sources, SBM and balance between economic and environmental aspects of business activities lies in this trend. BASF's key partnership with renewable energy and material suppliers for product manufacturing as well as promoting sustainability topics with networks, lobbying groups and associations fit the concept of developing environmental economics. Resource-efficient production, waste reduction, decreasing carbon footprint, water management and accelerating development of sustainable technologies are key activities. For cost structure, the investment in green energy and implementation cost of sustainable technologies are spent. Environmental economics acts both as an opportunity and a threat since there is a strong demand for sustainable products triggered by governmental regulations, but the initial high carbon prices and taxes can be a threat, especially for EIMI.

### **SBM trend: SDGs**

As mentioned in Chapter 4.3, 17 SDGs are adopted by UN members, BASF emphasized that their contributions to SDG 2 (Zero hunger), SDG 5 (Gender equality) , SDG 6 (Clean water and sanitation),

SDG 7 (Affordable and clean energy), SDG 8 (Decent work and economic growth), SDG 12 (Responsible consumption and production) and SDG 13 (Climate action) (BASF, 2024a, p. 18). For example, BASF aims to increase the portion of women in leadership to 30% by 2030 (SDG5), covering 90% relevant spend with sustainable evaluation by 2025 (SDG8,12) and reducing absolute CO2 emission by 2030 by 25% compared to 2018 (BASF, 2024a, p. 15). BASF's business activities are viewed in detail to identify the connection with SDGs, including BASF's key partners cooperating with TNFD and NAC to work on biodiversity, key activity on implementing SDGs to contribute to Agenda 2030 and value propositions to help to improve quality of life. Within the SWOT analysis, SDGs lie as their strengths, weaknesses and opportunities for BASF. On the one hand, strong R&D allows BASF to create innovative solutions to contribute to SDGs and provide opportunities for satisfying the strong demand for sustainable products. On the other hand, the transformation toward climate neutrality is challenging for energy-intensive companies.

### **SBM trend: CSR**

The concept of CSR was mentioned in Chapter 4.3, which focuses on economic responsibilities, legal responsibilities, ethical responsibilities and philanthropic responsibilities.

BASF's key partnership with NGOs, stakeholders and industrial associations to gain a better understanding of different perspectives on addressing conflicting goals for human rights addressed their CSRs. For example, since 2010, BASF delivered 81 chemistry labs in 81 cities with the Turkish Ministry of National Education (BASF, n.d.-a). However, CSR represents a weakness for BASF in that it is facing the challenge of transforming itself to increase profitability while being socially responsible.

### **DBM trend: Digital economy/ digital business**

Since the 1990s, the evolution of new technological trends leads to changes in the definition of digital economy. Recent definitions of digital economy emphasized the main areas of DT (Bukht & Heeks, 2018, p. 4,10). For example:

The digital economy is the economic activity that results from billions of everyday online connections among people, businesses, devices, data and processes. The backbone of the digital economy is hyperconnectivity which means growing interconnectedness of people,

organizations and machines that results from the Internet, mobile technology and the internet of things (IoT) (Deloitte, 2021).

The BASF's adaptation of the digital economy into their BM is identifiable within the BMC segments key partners, key activities, cost structure and revenue streams. The online distribution partners are their key partners and digitizing the plants and systematically analyzing data to reach further automation processes in BASF are the key activities. Cost structure including costs of digitalizing plants and adapting data analysis system for further automation process, and new revenue streams through providing software and digital solutions. The high R&D cost to maintain competitiveness in the digital economy can occur as a weakness for BASF, but it provides great opportunities for BASF to explore new markets, including new DBMs such as virtual lab assistance for architectural coating, virtual pharma assistants, gas treatment connecting system and digital platform to assist farmers.

### **DBM trend: AI**

The shift of production industries from a product-centric perspective towards a customer-centric perspective triggered the adaptation of current market characteristics, including extreme product customization, short lead times, low volumes and high mix in a more cost-effective approach to stay competitive. Consequently, to find tools that predict energy consumption, optimize the production process and customize product pricing are required. AI has the potential to support decision-making that improves production planning accuracy and calculates price efficiently (Aikenov et al., 2024, p. 1184,1191).

The adaptation of AI is in all areas of BASF's daily business activities including production, engineering, R&D and management (BASF, n.d.-b). This integration requires key partners in universities and research centers to support their technology innovation (BASF, 2019), key resources of strong R&D teams that add cost structure for R&D cost for product innovation, and revenue streams of AI-powered software and digital solutions provided by BASF. AI's potential can be both a weakness and an opportunity for BASF, on one hand, it requires high R&D costs to maintain competitiveness, on the other hand, the potential digital disruption of AI can bring the overall enhancement of BASF's value chain.

## **DBM trend: Data analysis**

Big data analysis has become essential for the manufacturing industry in forecasting, predictive maintenance and automation. It can support industries in managing the challenge of improving production efficiency and product quality while reducing energy consumption and cost, especially relevant to decision-making, predictive manufacturing and service innovation (Wang et al., 2018, p. 11). BASF's key partnerships were established with universities and research centers to support technology innovation through big data analytics. Key activities include integrating digital technologies in business to achieve better efficiency, evaluating their products and processes using sustainable methods and metrics, and systematically analyzing data to reach further automation processes. For key resources, strong R&D teams with a skilled workforce in data science support BASF in big data management and analysis. The cost structure is the investment and implementation cost for acquiring new technologies.

Data analysis lies as a strength for BASF since their strong R&D teams have used data for different business activities, including digital laboratory and AI training (BASF, n.d.-i). However, high R&D and implementation costs along with the complexity of integrating and transforming the firm's structure across entire systems can be the weakness of BASF, it can also provide opportunities for BASF to use big data in their DBM development.

## **DBM trend: Blockchain**

Blockchain technology is a transparent, immutable, and tamper-resistant digital ledger that stores records across networks (Hayes, 2024). The benefits of integrating blockchain technologies include discovering real-time problems and performing SDGs-related actions, enhancement of transparency of the supply chain through information sharing, improvement of coordination efficiency in transactions and reinforcement of reliability of data transmission in the e-commerce supply chain (Zhang, 2021, pp. 964, 967).

BASF's key partners with supply chain sustainability software service companies to digitalize the cotton supply chain using blockchain platforms to provide end users data traceability and transparency have shown their commitment to sustainability and digital advancement in customer segments. Value propositions aspect: through advanced digital tools, BASF aims to help its customers reach their sustainable goals. The blockchain platform is offered to the farmers in the agricultural industries in the

customer segment (BASF, 2022). The cost structure focuses on the development and implementation costs. Finally, the revenue stream is the service fee of the digital solutions. The implementation of blockchain has both weaknesses and opportunities for BASF; the cost of development and implementation can be high, but the DBMI provides new revenue streams and further automation of production.

### **DBM trend: Digital platforms**

Digital platforms are BMs that host interactions amongst groups by using online infrastructures, including various social media, online marketplaces, and crowdsourcing websites. By connecting buyers and sellers, setting prices and establishing trust, digital platforms can create value (Gibson, 2024).

Online distribution partners of BASF are their key partners in integrating digital platforms in BASF's BM. The usage of various platforms to communicate with BASF's customers has become an important channel for marketing, gaining customers' trust and promoting transparency.

The opportunities that BASF can gain from digital platforms are to adapt to digitalization and develop DBMs, but the intense competitiveness in digital marketplaces from all over the world could potentially expose BASF to the threat of losing existing customers.

### **DBM trend: Customer-centric orientation**

In Chapters 4.1 and 4.3, it was mentioned the revenue models for digital services engaged with a highly customer-centric, iterative and agile process required close collaboration with key customers. An in-depth understanding of customer needs is necessary for value creation. 83% of BASF R&D budgets were spent on application and customer-related (BASF, 2024a, p. 16).

Through key activities of customer-focused research for their need, offering value propositions that meet individual requirements of customers, building cooperation with their customers to create innovative products for customer relationships and using multiple channels including personal contacts for product selling, BASF integrated a customer-centric orientation into their business activities. BASF owns strength in this trend since they have a broad portfolio covering a wide customer range with tailored solutions to satisfy specific customer needs.

### **SBM & DBM trend: I4.0**

As the concept and integration with BMs of I4.0 were discussed in detail in Chapters 4.1 and 4.2, the adaptation of I4.0 in various business activities to stay competitive is essential. BASF's key partners with universities and research centers to support technology innovation can further drive the key activities of integrating digital technologies in business to achieve better efficiency. Their strong R&D is a key resource for adopting I4.0, but the cost of digitalizing plants and adapting data analysis systems for further automation processes can be added to the cost structure. Integrating I4.0 into their Verbund concept provides BASF strength in a more efficient production process. However, BASF's weakness of high complexity for business transformation could slow its evolution with I4.0.

### **SBM & DBM trend: DT**

As discussed in the previous chapters 4.1, 4.2, and 4.3, DT plays an important role in firms' development of DBMs and DBMI. Universities and research centers to support technology innovation are key partners of BASF for their DT, the key activities of developing sustainable technologies and promoting digital skills among employees, cooperating entities and partners to strengthen the competitiveness in digitalization, accelerating and implementing projects related to low-emission production technologies, digitalizing the plants and systematically analyzing data to reach further automation processes. Key resources of strong R&D support their DT and cost structure, including investments in property, plant, equipment and Verbund for production with digitalizing plants and adapting data analysis systems for further automation process. Revenue streams of service fees of their intellectual properties can be one of the benefits of DT integration.

It can expose BASF's weakness of the high complexity of company transformation along the process. Meanwhile, the opportunities for digitalization and adaptation of DBMs can occur.

### **SBM & DBM trend: Dynamic approach/ dynamic capabilities**

As discussed in Chapters 4.1, 4.2, and 4.3, dynamic capabilities have been identified as a key factor in the effective creation and implementation of BM. In the digital age, firms have developed diverse types

of dynamic capabilities to ensure their survival and thrive in an increasingly competitive environment. The EIMI towards a dynamic economy is a clear indication of this trend (Albalooshi, 2003, p. 126,127,128,129,130,131,132,133; D. J. Teece, 2018, p. 40,41,45,46,48; Warner & Wäger, 2019, p. 326,327,339,341,346).

Through promoting digital skills among employees, cooperate and partners to strengthen competitiveness in digitalization, integration of digital technologies in business to achieve better efficiency and accelerating sustainable technologies development, BASF continuously evolves and responds to the market needs. The strong R&D department that innovates products and provides potential new BMs based on data collection and analysis is a key resource, and the cost structure related to R&D and data analysis systems implementation is needed for dynamic capabilities development. The revenue stream of licensing, services fees, software, and digital solutions is the result of creation.

BASF's strong R&D has become their strength in building their dynamic abilities, while the high development cost to maintain competitiveness can be a weakness.

### **SBM & DBM trend: BMI**

For BMI, BASF's key partners include industrial partners for OI, top universities, innovation hubs, and research institutes for product research and development, stakeholders on viewing particle business activities and specialized digital service companies for edge-cutting technological integration. Key activities are developing sustainable technologies and digitalizing the plants to enhance production efficiency. Key resources of powerful R&D can support BMI in their product and process innovation. Through SBMI, BASF's value proposition focuses on strengthening BASF's position as a pioneer for sustainable solutions and realizing climate-neutral production. The cooperation with their customers for tailor-made and co-creation solutions shows that BMI has shifted to a customer-centric approach. The channels of BASF widely adopt various digital platforms to expand their market. In customer segments, BASF's BMI attracts customers from diverse industries who are looking for technologically advanced and/or sustainable innovative solutions. However, their strong commitment to innovation can result in increased cost structures due to the high investment cost. However, the generation of new revenue streams through innovative products, sustainable solutions, software and digital products, licensing and service fees for intellectual properties can offer considerable benefits.

Strong R&D capabilities allowed BASF to keep high innovative energy, while its pioneer position for sustainable solutions gives it a competitive advantage in BMI. On the other hand, the high complexity of company transformation, including long-term political decisions, environmental agreements and overcoming geopolitical boundaries, might slow their BMI, while high development cost is required to maintain competitiveness. Potential digital disruption of AI and strong demand for sustainable products can create opportunities for BASF to further expand their market on new DBM and SBM value capturing. Lastly, the threat of intense competitiveness challenges BASF in terms of innovation and market share.

The business canvas and SWOT analysis presented the current BM transformation of BASF and matched them with the current academic trends. The strong orientation toward CE and BMI matches the result from both SLR results and VOS bibliometric analysis from the past five years' publications. Many of the identified trends are integrated by large EIMI corporations such as BASF. From the point of view of SBM, BASF's focus on CEBM includes using recycled material, increasing the usage of renewable energy, improving waste management, corporate sustainability and SDGs are included in the company's core values. On the aspect of DBM, the continuous adaptation of digitalization and DBMI, including the usage of AI (BASF, n.d.-b), blockchain technologies (BASF, 2023b), big data, IoT (BASF, 2024b, p. 178) and digital platforms encouraged the innovation of their DBMs. The BASF R&D department plays a fundamental role in many adaptations of SBM and DBM innovation, functioning as their primary support for continuous evolution to survive and maintain competitive advantage despite the significant investment required.

## 5. Discussion

The purpose of this chapter is to discuss the key findings of the research questions. This study aimed to explore the evolution of business models over time, with a focus on digital and sustainable business models and their impact on EIMI. Four main questions were used to guide the research:

- RQ1: How have the research streams and areas of focus shifted in studies of general BM over time?
- RQ2: How have the keywords and terminology related to SBM and DBM evolved?
- RQ3: Shifting factors towards SBM and DBM and how does it affect the overall EIMI industry?
- RQ4: To what extent do identified trends in Sustainable Business Models (SBM) and Digital Business Models (DBM) align with the BM of an Energy-Intensive Manufacturing Industry (EIMI) case study?

The following sections analyze how the findings contribute to answering these research questions, their practical implications, a discussion of the study's limitations and future research agendas.

### 5.1 Theoretical contributions and potential implications

For RQ1, the results suggest that the concept of BM was initially developed as mathematical approaches from the 1960s to the 1970s. In the 1980s, they began transforming due to the development of innovative technologies. Following the publication of World Wide Web in the 1990s, BMs were rapidly used under the content of e-business and IT strategies. With the commercialization of personal devices in the 2000s, the outdated models were replaced with BMI. DBM, IT strategies, sustainable innovation, and CE came to the focus of BMs in the 2010s and lately, DT, DBMI and customer-centric focus were highlighted in the research from 2022. The continuous growth of BM and BS research has continued growing since the 1990s, and the most cited publications were mostly published between 2002 to 2011. The USA published most of the publications used in the SLR process before 2011, then the European research and multinational collaborations publications became the majority. In the SLR samples, the publications were the most qualitative research.

The terminologies and keywords evolution in SBM and DBM were then identified to answer the RQ2. For SBM, to integrate environmental thinking into various aspects of human activities, sustainable development was carried out in 1987. Following the trend of green revolution and green supply in the 1990s and early 2000s, sustainability became the major term. Terminologies including SBM, sustainable innovations, and CE were developed in the 2000s to 2010s. With the integration of CE into the EU long-term economic plan in 2022, CEBM has become a trendy topic in academic research. The development of computing technologies in the 1980s and 1990s fostered the research of BMs in innovation, IT and technology fields. Further on, the fast development of E-business in the 2000s led to the maturity of IT technologies as a fundamental role for value creation and capture. I4.0 and DT became the most prominent research keywords in the 2010s to 2020s followed in the past two years by a focus on the achievement of DT and the BMs of new technologies including 6G and AI. The publications between 1992 to 2001 were the most cited for SBM, on the other hand, DBM publications were almost equally cited in each decade.

A literature review was conducted to answer RQ3. The shifting factors toward SBM are closely related to societal and policy influences, particularly due to evolving environmental regulations from major global organizations. In recent years, decarbonization and the circular economy (CE) have become key priorities for the EU economy, with a clear roadmap and concrete goals. For DBM, the advancement of digital technologies has been a major driving force. Additionally, in the 2000s, investors began viewing BMs as a new evaluation tool for examining the commercialization potential of technologies under high uncertainty. Disruptive technologies, including the internet and IT, continuously pressured firms to adapt and upgrade their BMs. In recent years, the emergence of I4.0 continues to drive further DBM development.

To answer RQ4, a VOS analysis of current research trends was conducted using publications related to SBM and DBM from the past five years, along with a case study of BASF, which examined its BMC and SWOT analysis. The cross-analysis confirmed BASF's transition toward a CEBM, aligning with current trends. By integrating the SDGs into its core company values and optimizing its supply chain, BASF is taking a pioneering role among EIMIs that have adopted SBM. Additionally, BASF is undergoing continuous DT and developing new DBMs by leveraging cutting-edge technologies,

including AI, big data, and IoT. Furthermore, BASF has been developing and integrating various digital tools to achieve their sustainability goals and creating further value for the customers.

To conclude, this thesis provides a comprehensive overview of BM evolution and its shifts toward SBM and DBM. Through SLR and text-based analysis, the development path of BM across decades was closely examined. The shifts and driving factors behind SBM and DBM were presented within their historical context. Finally, their connection to EIMI was identified through a detailed case study. The findings of this research could provide other researchers insights into how SBM and DBM have been developed and what are the important factors that guide the direction of development.

Furthermore, how the current trends of sustainability and digitalization can be related to BMs has been clarified. Most importantly, the explorations of EIMI SBMs and DBMs. EIMI is an important target for decarbonization and sustainable development, but there is very little academic research focusing on this industrial sector.

Surprisingly, all the results of the current trend indicate the sign of the crossing path of SBM and DBM. Especially dedicate the importance of transformation towards CE and the use of advanced technologies to help companies achieve their goals.

Highlighting the development of EIMI BMs and a case study could provide a practical view of how to support EIMI in developing its SBM and DBM. The BASF case study emphasized the efforts and ambitions of a pioneer in the chemical industry to develop sustainability while continuously generating new value. The trends identified can also serve as inspiration for EIMI to update their current BMs.

## 5.2 Limitations and further research

Several limitations have been identified. First, the keyword "business planning" appears to be an alternative term for early BM and BS research. Including it in the search string might have broadened the scope of earlier academic insights in this field. Another limitation is the restriction to journal and conference papers in the database search filters. Many influential publications have been published as books or magazine articles by peer publishers. Despite backward search tracking, some relevant works that could have addressed the research questions may have been neglected. Finally, literature on SBM in energy-intensive manufacturing prior to 2020 was limited, making it difficult to track overall shifts in EIMI SBMs. Examining company reports from key EIMI companies could provide valuable insights. Future research could focus on tailored BM designs for EIMI's transition toward SBM and

DBM. Additionally, exploring evaluation metrics for SBM implementation through DT or investigating how BMI can be achieved by integrating SBM and DBM presents promising research directions.

## 6. Conclusion

This thesis aims to answer the questions of how general BM evolves, how it shifts towards sustainability and digitalization, what are the shifting factors and to what extent do identified trends in SBM and DBM align with the BM of EIMI case study. While the text-based and bibliometric analysis indicated a broad and complete research direction of publications, the SLR results provided a detailed look at the most cited publications of each decade and represented the focus of academic research at that time. Finally, a case study gave a practical view of how one EIMI acquired the SBM and DBM to remain competitive. Based on these conclusions, further research focused on EIMI's BM evolution, especially its SBM and DBM development, can be considered. It can be concluded that the evolution of BM is closely related to the evolution of government regulations and technological innovation. From the literature review of current trends and the case study, it was found that the adaptation of new technologies to realize SBMI and DBMI is crucial for companies to remain competitive. Currently, few publications focus on the EIMI industry. By providing a general understanding of BM evolution, updating the current trend and case study, this thesis aims to bridge the impact of SBM and DBM on EIMI and draw the attention of scholars to elaborate further research in this field. The interaction between SBM and DBM and how it can contribute to further BMI development is another promising area for future research.

## Appendix

<b>Usage purpose</b>	<b>Tool</b>	<b>Reference</b>
processing bibliographic datasets, conceptual inspiration, assisting in understanding partial publications and grammar correction for text writing	ChatGPT	OpenAI. (2025, March 17). <i>ChatGPT (Version 4)</i> [Large language model]. Retrieved from <a href="https://openai.com">https://openai.com</a>
Processing bibliographic datasets	Zotero	Corporation for Digital Scholarship. (2025). Zotero (6.0.37)[Software]. Retrieved from <a href="https://www.zotero.org/">https://www.zotero.org/</a> (Original work published 2006)
Grammar correction for text writing	Grammarly	Grammarly. (2025). Grammarly (Version 14.1227.1) [Large language model]. Retrieved from <a href="https://www.grammarly.com/">https://www.grammarly.com/</a>
Grammar correction for text writing	DeepL	DeepL. (2025). DeepL Translator (Version 1.42.0) [Large language model]. Retrieved from <a href="https://www.deepl.com">https://www.deepl.com</a>
Plagiarism checking	Turnitin	Turnitin. (2025). <i>Turnitin</i> (Version 3.5) [Software]. Retrieved from <a href="https://www.turnitin.com">https://www.turnitin.com</a>
Assisting in understanding partial publications	docAnalyzer.ai	docAnalyzer.ai. (2025). docAnalyzer.ai (Version 3.7) [Software]. Retrieved from <a href="https://docanalyzer.ai/">https://docanalyzer.ai/</a>
Assisting in understanding partial publications	SciSpace	SciSpace. (2025). SciSpace (Version 3.0) [Software]. Retrieved from <a href="https://typeset.io/">https://typeset.io/</a>

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