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Chemical Industry Case Study: Difference and Shifts in R&D Strategies

Hyunbin Kim[1] and Jason Park[1#]

[1] Bergen County Technical High School, Teterboro, NJ, USA
[#] Advisor

ABSTRACT

This paper aims to examine the role of research and development (R&D) in the growth of three main companies in different nations: DSM (Dutch State Mines), LG Chem, and Exxon Mobil. These three companies have demonstrated distinct strategies for R&D that have shaped their evolution and contributions to their respective industries. This paper will also dive into the history of these three companies and how major events have influenced their R&D spending, along with the trends found in their spending. This case study highlights the pivotal role of R&D spending in shaping the companies' strategies, innovation culture, and contribution to their industries and nations.

Introduction

Significant historical events have profoundly impacted the most prominent companies and nations throughout the world. While some companies have struggled in the midst of those events, others in the chemical industry created excellent opportunities for growth and innovation. One example of such a company would be DSM (Dutch State Mines). Founded in 1902, DSM specialized in the development of coal and coke before shifting to fertilizers and intermediates near the mid-1900s and again to fine chemicals near the late-1900s. During the period of WWII, DSM gained momentum in the chemical scene and began to establish itself in the industry. After adding fine chemicals to its business portfolio, DSM started to prioritize a significant portion of its research and development (R&D) in the chemical industry, which proved to be highly beneficial for the company. In fact, DSM's ability to flexibly cope with the fickle state of the economy and make the necessary transition allowed the company to thrive even when one of its business industries (such as the coal industry) was in decline. (Long history (n.d.))

Another example would be South Korea. Under the Park Regime (1961-1979), led by Park Chung-hee, South Korea underwent a significant economic transformation. Park's economic policies led South Korea to move from an agricultural-based economy to an industrialized one, rapidly growing the economy of South Korea; South Korea's GNP grew at an average rate of 9.3% per year between 1962 and 1979. R&D played a huge role in this era, as Park's government placed a strong emphasis on the innovation of technology and provided incentives to the companies not sparing R&D expenses, which worked as a catalyst in boosting the economy and LG Chem being one of its beneficiaries. (Kim, 1995)

A third and last example would be Exxon Mobil. Exxon Mobil is a multinational oil and gas corporation that is widely recognized as one of the largest and most profitable companies in the world. With a history that spans more than a century, Exxon Mobil has long been at the forefront of innovation in the oil and gas industry. Over the years, Exxon Mobil has spent billions in R&D to achieve numerous milestones, such as discovering new oil reserves, developing more efficient drilling techniques, and creating new products and materials that are used throughout the industry. (Our history. (n.d.)) By consistently allocating a large portion of firm expenses on R&D, Exxon Mobil has been able to maintain its position as a leader in the oil and gas sector and remain competitive in a rapidly changing global market.

This study will focus on how R&D is incorporated into past historical effects of various chemical companies and nations, along with the impact it has made in advancing those companies.* Furthermore,

we'll delve into their R&D spending in various economic conditions and observe the relative prioritization companies place on R&D expense as compared to the companies in other industries. Lastly, we'll dissect how these companies have carefully chosen their main businesses and analyze the correlation between the focused business and the nature/culture of the company and its respective country.

Background

Case Study #1

Dutch State Mines (DSM)

Since the shift to fine chemicals in the mid-1900s, DSM has invested heavily in R&D. During this time period, DSM became a major producer of caprolactam, a key ingredient in the production of nylon, which was used in the manufacturing of various different forms of military equipment. DSM's research in the caprolactam process led to further diversification within the chemical field, helping the company stay afloat in a rapidly changing market during the series of world wars. (Linsten et al., 2017) DSM's successful transition from coal to petrochemicals and ultimately to its current state as a global science-based company in health, nutrition, and sustainable life is underpinned by its strategic decisions, adaptability, and significant investments in research and development. The transition from coal to petrochemical was initially prompted by the Dutch government's decision to close the coal mine in 1973 and the discovery of a large natural gas field in the Netherlands. Recognizing the need to make changes, DSM ventured into the petrochemical and bulk chemicals industry.

In the late 1900s, DSM made a strategic move to focus on performance materials, including plastics and synthetic fibers such as nylon. This shift allowed them to leverage their existing foundation and expertise to develop innovative products. Notably, DSM's acquisition of Polymer Corporation in 1992 played a crucial role in their successful transition. The acquired company provided DSM with advanced engineering perspectives and technology, enabling them to prioritize innovation and R&D like never before. As the petrochemical business faced challenges and intensified competition, DSM made a final transition into the life science and nutrition sector, its current primary focused business. They recognized the potential for growth in these areas and sought to address sustainability concerns. (DSM N.V. - company profile, information, business description, history, background information on DSM N.V.(n.d).)

Case Study #2

LG Chem

South Korea is a country that has experienced rapid economic growth in recent decades, due in part to its emphasis on research and development. The South Korean government has played a significant role in promoting R&D spending through its policies and incentives. One of the most notable policies implemented by the South Korean government to promote R&D spending was during the Park Regime. This policy was introduced in the 1960s by President Park Chung-Hee and focused on promoting industrial development and technological innovation. The Park regime provided tax incentives, subsidies, and other forms of support to companies that committed to advancing their technology and innovating products.

The Park regime had a significant impact on R&D spending in South Korea. In the 1970s and 1980s, the South Korean government actively encouraged companies to invest in R&D, with the goal of developing new technologies and industries that would drive economic growth. (Branstetter & Kwon, 2018) This period of revolution was so impactful in a way that innovation has become a large part of South Korea and its companies' culture.

With such effort, South Korea became one of the world's leading countries in terms of R&D spending, with companies such as Samsung, LG, and Hyundai sparing no expense in R&D. During the Park Regime in South Korea, which pursued a strategy of economic growth through industrialization, LG Chem, previously known as "Lucky Goldstar," strategically expanded its business into the chemical industry. While

initially focused on cosmetic creams and other chemicals, LG Chem recognized the potential in the growing demand for plastics and synthetic materials, which were integral to industries such as construction, automotive, and electronics. (Chaudhuri, 1996) This expansion played a crucial role in supporting the country's industrialization efforts and driving exports, becoming the foundation and momentum behind LG Chem's growth. South Korea's unique political status and emphasis on research and development (R&D) have provided opportunities for companies like LG Chem to thrive. Although LG Chem did not go through all the transition processes that chemical companies like DSM have gone through, the company has cleverly leveraged its expertise in IT and electronic materials, which align with its strengths and the country's technological capabilities. This strategic focus allows LG Chem to support other subsidiaries within the LG Group, such as LG Electronics, further strengthening its position in the market. (*Technology & innovation: LG Electronics Strategy Report* 2023) By leveraging the government's support for R&D and capitalizing on the talents of its people, LG Chem can continue to contribute to South Korea's economic growth and strengthen its position as a leader in the chemical industry.

Case Study #3

Exxon Mobil

ExxonMobil is a leader in the oil and gas industry and has a strong reputation for innovation and R&D. Like the two previously mentioned companies, ExxonMobil has consistently invested in creating new technologies, improving its products and processing, and exploring new business opportunities. In the past, ExxonMobil continued to invest heavily in R&D, particularly in petrochemicals. The company developed new processes and technologies for producing chemicals and plastics from petroleum, which led to new business lines and helped the company diversify its revenue streams. ExxonMobil's R&D efforts are coordinated through its Corporate Strategic Research function, which is responsible for identifying and developing new technologies that can drive business growth. (Our history. (n.d.))

Over the years, ExxonMobil has made significant investments in R&D to enhance its exploration and production capabilities, improve operational efficiency, develop cleaner and more sustainable energy solutions, and mitigate environmental impacts. The company has established several research centers and laboratories worldwide, which are currently staffed with highly skilled scientists, engineers, and technicians. (*Energy Technology Centers (n.d.)*) ExxonMobil's R&D activities encompass a wide range of disciplines, including geoscience, chemistry, engineering, and materials science. Through extensive research, the company has made notable contributions in various areas, such as seismic imaging, reservoir modeling, drilling technologies, and enhanced oil recovery techniques. These advancements have enabled ExxonMobil to locate and extract hydrocarbon resources more efficiently, even in challenging environments. In recent years, ExxonMobil has also focused on developing cleaner energy alternatives and reducing greenhouse gas emissions. The company has invested in R&D for advanced biofuels breakthroughs in energy efficiency. ExxonMobil aims to leverage its R&D capabilities to address the dual challenge of meeting the world's growing energy demand while simultaneously reducing environmental impacts. Collaboration has been a key aspect of ExxonMobil's R&D strategy. (Greg, 2022)

Graph Analysis

Despite hardships such as the global financial crisis in 2008 and the unprecedented challenges brought on by the COVID-19 pandemic, R&D has remained paramount for LG chem, Exxon Mobile, and DSM. Three companies have shown R&D spending habits where, regardless of economic status, they allocated a significant portion of total expense onto R&D. In fact, according to the figures below, Exxon Mobil's R&D spending spiked from 2008 to 2009 despite the financial crisis (Annual reports (n.d)). In addition, DSM continued to spend large amounts of money on R&D during the years Covid-19 took place, spending around 400 million euros in 2020 (Financial Results & Presentations: DSM). LG Chem appears to have gradually spent

increasing amounts of money on R&D without any significant drop in the past decade (Audit report: Ir Archive: Investor Relations: Company: LG Chem (n.d)).

From the Early 2000s to 2021, ExxonMobil has consistently been spending over $500 million on R&D. With the exception of the COVID-19 pandemic where the company's R&D spending has decreased by roughly 30% (2019-2021), the company has increased its involvement in R&D almost every year for the past two decades, R&D expense rising during the 2008 housing crisis. Even during the pandemic, they managed to allocate over $800 million for the continuous evolvement of the company's technology and related endeavors (*Annual reports* (n.d)).

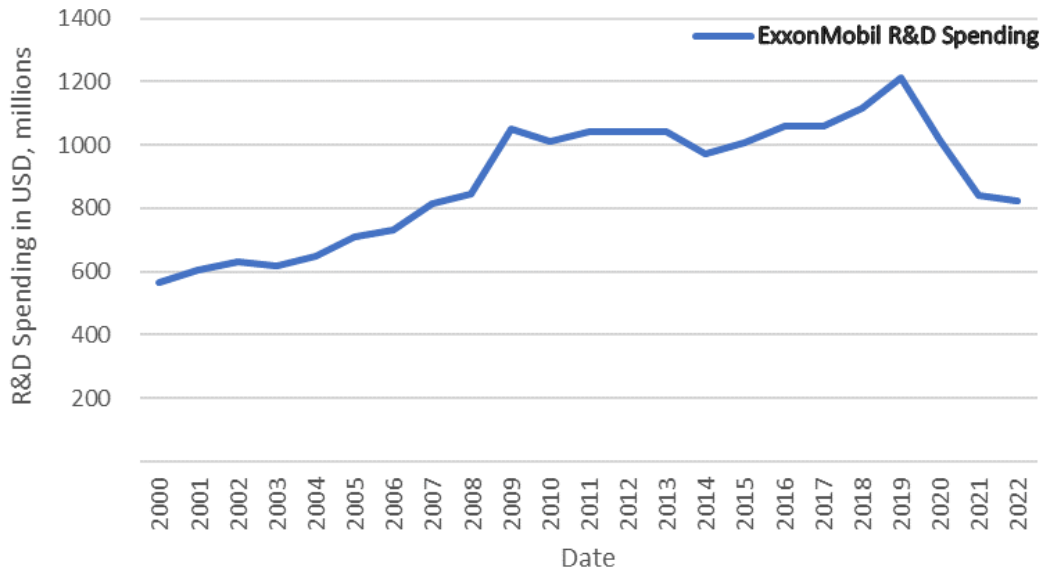

Figure 1. ExxonMobil R&D Spending in USD, millions vs. Date

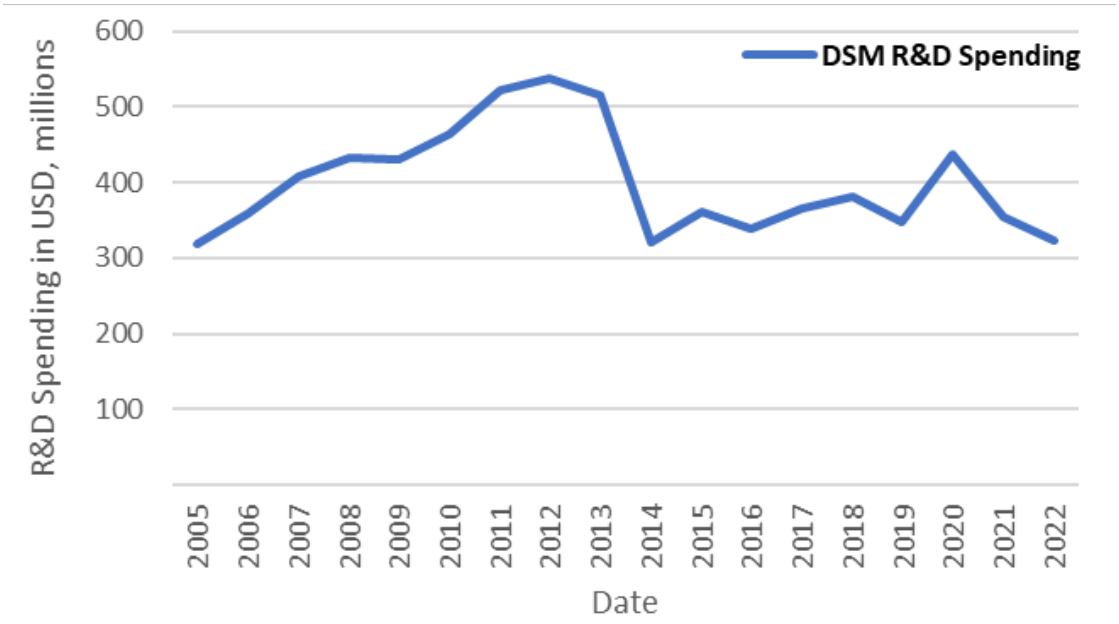

Figure 2. DSM R&D Spending in USD, millions vs. Date

A similar trend appears in DSM's R&D spending. For the past 20 years or so, DSM has spent no less than $300 million on R&D. During the epic economic crises in 2008 and 2020, the company continued

to show that innovation and research are the cores of its company policies, and they have no intention whatsoever to reduce its spending as they spent roughly $400 million in each respective years (*Financial Results & Presentations: DSM*).

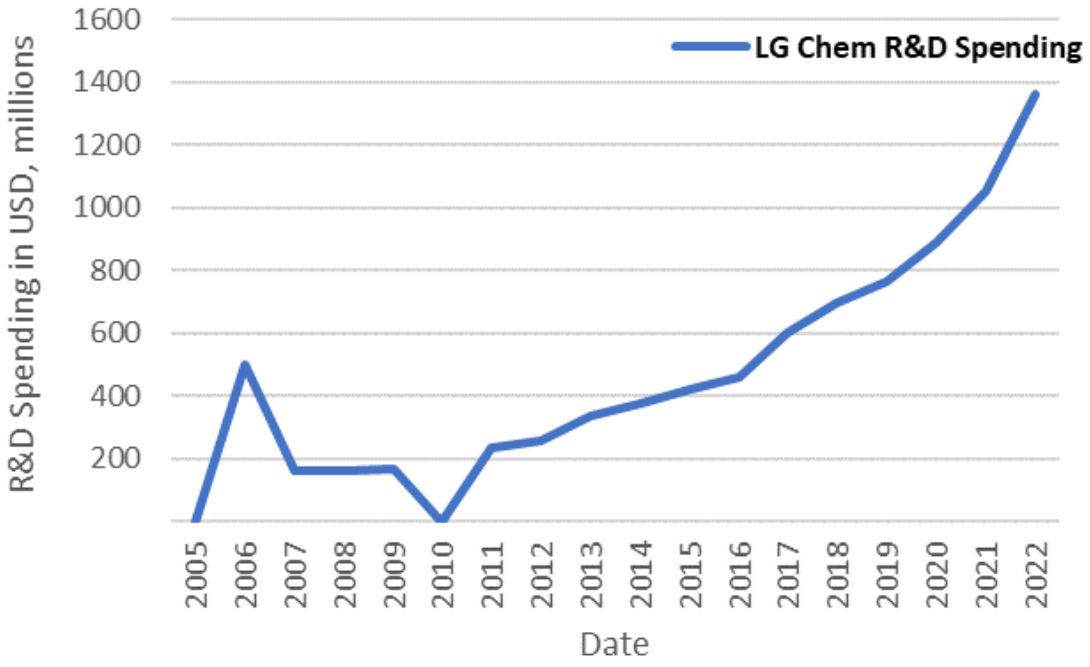

Figure 3. LG Chem R&D Spending in USD, millions vs. Date

Likewise, we can observe that LG Chem is not different from the other two companies. In the early 2000s, the company had shown a somewhat conservative approach to R&D expenses. However, from 2010 on, they started to aggressively invest in R&D as their spending from 2011 to 2022 rose exponentially, by about 600%. Most recently, they have been spending roughly a billion dollars each year to ensure competitiveness for their recent business, which we will delve into in the next section (Audit report: Ir Archive: Investor Relations: Company: LG Chem (n.d)).

Individual R&D Strategies

DSM, Exxon, and LG Chem exhibit distinct disparities both in terms of their industry focus and R&D spending. DSM concentrates on its own internal facilities (The Innovation Center) to accelerate the innovation power and speed of its core businesses. LG Chem mostly focuses on the production and innovation of lithium batteries, which are prominent in the creation of EVs. Lastly, Exxon focuses much of its R&D on improving the sustainability of its business activities, turning it more environmentally friendly; Exxon works tirelessly to reduce pollution.

DSM is known for its high level of technological innovation, especially in the development of advanced materials and biotechnological solutions. The company encourages a culture of innovation by providing employees with the resources, support, and freedom to explore new ideas and develop innovative solutions. Moreover, as DSM, an "ideal" chemical company," has seamlessly transitioned through numerous phases that epitomize the evolutionary trajectory of an industry leader, the company has expertise in various fields, allowing the company to internally develop products with confidence (*Innovation and technologies* (n.d)). Thus in 2006, they established the DSM Innovation Center (DSM- All out Innovation Key Features of DSM's Approach to Innovation (n.d)).

Consequently, as of 2020, DSM has experienced great success on different fronts. In aligning its transformation with industry shifts and futuristic pursuits, DSM embodied the core attributes of resilience, agility, and visionary leadership that characterize an industry trailblazer and accomplished the following four components: generating innovation-driven revenue, extending the technological base of DSM, establishing an improved innovation logistics, and establishing an innovation-oriented culture (DSM- All out innovation Key Features of DSM's approach to Innovation (n.d)) In the annual report of the DSM in 2020, the company reported 184 million euros in net sales of continuing operations. The Innovation Center played a major role in it as it's shown through the company's collaboration with Svelete Medical on the Drug-Eluting Coronary Stent Study and improvement in the innovation process by the seamless delivery of clinic material for regulatory approvals (such as the Bridge Enhanced ACL repair product) (*Innovation Center Performance 2020*).

LG Chem, too, fosters a culture of innovation and thereby attracts top talent as the company creates a dynamic and challenging environment in which researchers and engineers can prosper. LG Chem focuses on recruiting individuals with expertise in battery technology, materials science, and renewable energy which all signal their primary target market: electric cars (*[Bloomberg] LG's new take on Future Mobility* 2023).

Ironically, the company was forced to experience rapid growth during one of the most turbulent times in the country's history. Although some major companies like Samsung, Hyundai, and LG were able to take advantage of the situation to rise as global giants, they inevitably ended up lacking the foundation that most global giants have (history and data to which companies can rely their decisions and research on) to compete with them. Therefore, we can observe unique traits for all three companies in that they chose to bring their battles to the fields that haven't been fully explored yet: mobile phones and modern cars. LG Chem's commitment to lithium batteries for electric vehicles (EV) cannot be understated. In 2019 and 2020 alone, they have spent over a billion dollars in R&D and production of EV batteries, thereby improving battery performance and battery longevity, and reducing cost. (Ahn, 2020) The company's effort positioned the company as a leading global supplier with various automakers relying on their battery technology, which substantially grew LG Chem's revenue and profitability. As the quality of the company's product is globally recognized with the support of "government [...], technological advancements, and robust automotive industry", LG Chem has greatly contributed to helping South Korea to "become a pioneer in the EV business" (Ly, 2023).

ExxonMobil, the company that has established itself fairly adequately as the largest oil and gas company with expertise and resources, now invests greatly in the sustainability of the environment, spending billions on R&D to fight pollution and decrease emissions (Published by Statista Research Department & 25, 2023). The company's top talents have been offered challenging and innovative projects in energy research and technological development. Exxon's R&D department has been actively working on advanced biofuels, exploring renewable alternatives to traditional fossil fuels. Their effort is aimed at reducing greenhouse gas emissions and addressing growing concerns of climate change. As already the leader of the oil and gas industry, ExxonMobil could position itself as a leader in the energy industry as it continuously invests in sustainable solutions with a reduced carbon economy (*Advanced Biofuels and Algae Research* 2018).

ExxonMobil plans to reduce greenhouse gas emissions through 2030 compared to 2016 levels supporting its net-zero goal. The plan is expected to result in a 20-30% reduction in corporatewide greenhouse gas intensity, including reductions of 40-50% in upstream intensity, 70-80% in the methane industry, and 60-70% in flaring intensity. Such plans include actions that are expected to reduce absolute corporate-wide greenhouse gas emissions by roughly 20% with an estimated 70% reduction in methane emissions, a 60% reduction in flaring emissions, and a 30% reduction in upstream emissions. Currently, the company has deployed new technology to expand the measurement and mitigation of methane emissions and reduced methane emission intensity from operated assets by more than 40% as of year-end 2021 versus 2016 levels in line with greenhouse gas emission reduction plans. Moreover, the company has reduced Scope 1 and 2 emission intensity by 9% with absolute emissions falling by approximately 13%. The company's consistent

willingness to improve the current environmental issues shows as it recently announced increased investment in lower-emission initiatives to about 17 billion dollars until 2027, a 15% rise from the previously announced amount (*Advancing Climate Solutions Progress Report* 2023).

Conclusion

In conclusion, the case study showcases how R&D has been integral to the growth of these three diverse companies. DSM's ability to adapt to changing market dynamics through strategic innovation, LG Chem's strategic expansion into cutting-edge technologies like lithium-ion batteries, and ExxonMobil's commitment to sustainability exemplify the pivotal role R&D plays in shaping companies' trajectories. These case studies underscore the fact that R&D is not merely a means to maintain competitiveness but a driving force behind industry leadership. These companies' dedication to R&D amid economic challenges such as the financial crisis and the COVID-19 pandemic emphasizes the enduring importance of adaptability. Ultimately, R&D serves as a catalyst for growth, differentiation, and sustainability.

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References

Advanced Biofuels and Algae Research. ExxonMobil. (n.d.-a). https://corporate.exxonmobil.com/what-we-do/lower-emission-transportation/advanced-biofuels/advanced-biofuels-and-algae-research#Algaeforbiofuelsproduction

Advancing Climate Solutions Progress Report. ExxonMobil. (n.d.-b). https://corporate.exxonmobil.com/news/reporting-and-publications/advancing-climate-solutions-progress-report#:~:text=Our%202030%20GHG%20emission%2Dreduction,in%20corporate%2Dwide%20methane%20intensity.

Ahn, J.-K. (2020, October 19). Korea's leading EV Battery Makers' R&D spending hits record $1 bn in H1. KED Global. https://www.kedglobal.com/battery/newsView/ked202008180002

Annual reports. Exxon Mobil Corporation. (n.d.). https://investor.exxonmobil.com/sec-filings/annual-reports

Audit report: Ir Archive: Investor Relations: Company: LG Chem. Audit Report | IR Archive | Investor Relations | Company | LG Chem. (n.d.). https://www.lgchem.com/company/investment-information/ir-report/audit-report/consolidated-financial-statements

Branstetter, L. G., & Kwon, N. (2018). South Korea's transition from imitator to innovator: The role of external demand shocks. Journal of the Japanese and International Economies, 49, 28–42. https://doi.org/10.1016/j.jjie.2018.01.004

[Bloomberg] LG's new take on Future Mobility. LG Global. (n.d.). https://www.lg.com/global/mobility/press-release/lgs-new-take-on-future-mobility#:~:text=The%20mobility%20business%20powered%20by,a%20partner%20to%20its%20customers.

Chaudhuri, S. (1996). Government and economic development in South Korea, 1961-79. Social Scientist, 24(11/12), 18. https://doi.org/10.2307/3520100

DSM-All out Innovation. Corporate Innovation online. (n.d.). https://corporateinnovationonline.com/wordpress/wp-content/uploads/2010/06/DSM-Profile-Final1.pdf

Energy Technology Centers. ExxonMobil. (n.d.-a). https://corporate.exxonmobil.com/who-we-are/technology-and-collaborations/energy-technology-centers

Financial Results & Presentations: DSM. @corporate. (2023, May 2). https://www.dsm.com/corporate/investors/results-center/results-presentations.html

Gregg, A. (2022, January 26). ExxonMobil aims for net zero greenhouse gas emissions from operations by 2050. The Washington Post. https://www.washingtonpost.com/business/2022/01/18/exxon-greenhouse-gas-net-zero/ r/results-presentations.html
Innovation and technologies. @personal-care. (n.d.). https://www.dsm.com/personal-care/en_US/about/innovation.html
Innovation Center Performance 2020. DSM Integrated Annual Report 2020. (n.d.). https://annualreport.dsm.com/ar2020/review-of-business/innovation/innovation-center-performance-2020.html
Kim, K. S. (1995). The Korean Miracle (1962–80) revisited: Myths and realities in strategies and development. Asian Industrialization and Africa, 87–143. https://doi.org/10.1007/978-1-349-13178-5_4
Lintsen, H. W., Hollestelle, M. J., & Hölsgens, H. N. M. (2018, October 24). The Plastics Revolution: How the Netherlands became a global player in plastics. Eindhoven University of Technology research portal. https://research.tue.nl/en/publications/the-plastics-revolution-how-the-netherlands-became-a-global-playe
Long history. @engineering-materials. (n.d.). https://www.dsm.com/engineering-materials/en_US/connect/long-history.html
Ly, F. (2023, March 31). Why South Korea is dominating the EV sector in Asia. Storm4. https://storm4.com/resources/intel-bites/south-korea-ev-sector-asia/#:~:text=Electric%20cars%20(EVs)%20are%20gaining,pioneer%20in%20the%20EV%20business
Our history. ExxonMobil. (n.d.). https://corporate.exxonmobil.com/who-we-are/our-global-organization/our-history
Published by Statista Research Department, & 25, A. (2023, August 25). ExxonMobil: R&D spending 2022. Statista. https://www.statista.com/statistics/281239/research-and-development-costs-of-exxon-mobil/#:~:text=ExxonMobil%27s%20R%26D%20costs%202001%2D2022&text=ExxonMobil%20spent%20824%20million%20U.S.%20dollars%20on%20research%20and%20development%20in%202022
Technology & innovation: LG Electronics strategy: Report example. IvyPanda. (n.d.). https://ivypanda.com/essays/how-lg-electronics-manages-technology-and-innovation/