

Impact of Data Analysis on Product Development

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Abstract: *Data analysis is becoming a popular term nowadays, being used by almost everyone who wishes to extract useful insights from already available data, but very few studies have investigated how this process of data analysis can impact product development in a firm. The aim of this study is to investigate and examine the impact of data analysis on product development. Through a comprehensive literature review, this paper sheds lights on how data mining, visualization and lastly data analysis can improve product development including product conceptualization and design. This paper also sheds light on the power of big data analysis, that is increasingly gaining popularity as vast amounts of data is getting generated in real time. Moreover, this paper highlights how various data mining techniques, data visualization and text mining can be used in the process of new product development. Ultimately this paper concludes by proposing whether data analysis proves to be beneficial for an organization and whether it drives a business to success with products that have been developed with the help of data analysis.*

Keywords: *Data, Analysis Big data, Product development, Product design, Data mining, Visualization.*

INTRODUCTION

Firstly, in today's interconnected digital world, 'Data' has become one of the most important facet, transforming the way we live, manage organizations and interact with each other. It has emerged as one of the most important asset for any organization, be it on an individual level or company level. Data as in itself refers to measurements and observations that are collected as a source of information, but the true meaning of data lies in its capacity to serve as a catalyst for innovative insights and further help in decision making.

One of the most mesmerizing aspects of data is its role in facilitating informed decision making processes. By analyzing and interpreting the data that is collected by either primary or secondary sources, individuals and organizations can gain insights relating to patterns, trends and correlations that occur in the data overtime, in order to make decisions that could help them to mitigate risks, optimize outcomes and lead to the success of the business. When it comes to collection, analysis, interpretation and decision making of data, this is where Data Analysis comes into picture. Data analysis plays a crucial role in extracting useful value from the data in order to transform these values into insights that can be proved useful in making data driven decisions, thus enabling an organization to gain a competitive advantage.

Data analysis is the process of checking, cleaning, changing data into specific formats aimed towards the goal of exploiting data in order to gain useful insights from the information, informing conclusions and to support data driven business decisions. It includes a broad range of techniques, tools and methodologies aimed towards discovering meaningful insights from raw data, which can be structured or unstructured and of varying sizes and formats. The primary objective of data analysis is to uncover trends, patterns, relationships and anomalies within the datasets, enabling organizations to derive actionable insights. The data analysis process includes 7 steps:

1. Data collection,
2. Data cleaning and preprocessing,
3. Exploratory data analysis,
4. Statistical analysis,
5. Machine learning and predictive modelling,
6. Data visualization and
7. Interpretation and decision making.

Overall, by leveraging advanced data analysis techniques and tools, businesses, policymakers, researchers and decision makers can exploit the power of data to address complex challenges, identify opportunities and drive sustainable growth and innovation.

Secondly, every business has a product or service that they offer to their customers in order to increase their sales and gain revenue, increase their reputation by enhancing customer experience and for this they need to offer products that can satisfy customer needs.

Development of a product requires a systematic process of creating, designing and bringing new products or services to the market. Product development, at its core aims to fulfill the unmet needs, solve problems or capitalize on emerging opportunities in the marketplace.

The journey of product development typically begins with identifying opportunities or gaps in the market, conducting market research and understanding customer needs and pain points. Once this phase is fulfilled, the process moves forward to design of the product that includes the definition of features, specifications and functionalities of the product. Following the design process, the actual development of the product starts that involves engineering, prototyping and iterative testing. Once the product has been thoroughly assessed, the process moves to commercialization and product launch which involves developing market campaigns and strategies. (Wickham, 2016), (Krishnan, 2001), (Brown, 1995)

REVIEW OF LITERATURE (ROL)

1. This is an original study based on primary data from UAE which gives us an insight about the success of the new product based on the traditional marketing analytics and big data analytics. The primary data were collected through online questionnaires. The three significant determinants of new product development (NPD) success were the big data analysis (BDA), traditional marketing analysis (TMA) and big data system quality (BDSQ). The study helps the business managers and policy makers in understanding and increasing the organization's performance in the role of big data analytics. The significant role of findings in this study is that how organization's performance had a positive impact and derive information. (Aljumah, 2021)
2. This study examines how big data is incorporated into international companies' new product development (NPD) initiatives. It focuses on how big data can accelerate time to market, improve product uptake, and cut costs. It emphasizes how crucial it is to use big data to better understand consumers, create better goods, and offer personalized services. Autonomy, Connection, and Ecosystem (ACE) are the three guiding concepts for utilizing big data in NPD, according to the report. These guidelines are intended to spur innovation and unleash big data's potential in NPD procedures. The article offers helpful advice on how businesses may use big data to their advantage, including how to prioritize client demands, discover vulnerabilities in goods early on, launch products swiftly, and add needed features. (Tan, 2017)
3. This article discusses the difficulties that the product development process (PDP) faces due to shorter development times, evolving client requirements, and more complicated products. The increasing amount of unexpected occurrences in the PDP is thought to be too much for traditional tools to handle, which has led to a quest for supplementary tools. Here, the application of textual data mining to enhance PDP quality and dependability prediction is the main focus. This paper highlights the value of researching textual databases, in contrast to earlier research that focused mostly on numerical databases. It exhibits successful implementations within two large multinational businesses and indicates prospective PDP areas where textual data mining could be employed. The importance of using textual data mining to improve quality and dependability in product development is emphasized in the study. (Menon, 2004)
4. In order to improve competitiveness, loyalty, and profitability, this article discusses the significance of new product development (NPD) for businesses. It emphasizes the necessity of matching products with consumer wants. In order to develop a product map, the study examines the connections between client wants, product attributes, and transaction records using data mining techniques, notably the Apriori algorithm.

This map shows a variety of knowledge patterns and guidelines that can direct the creation of novel cosmetics and advertising campaigns. According to the study, the cosmetics industry can effectively drive NPD initiatives and influence its supply chain by utilizing client insights from the demand side. (Liao, 2008)

5. This study investigates how big data helps the customers to communicate all the requirements that they may not have realized they had. Managers will be able to create products that mainly focus on the needs of the customers with the help of the gathered data and information. Big data is the outcome of mass communication and is also low-cost, interactive, multimedia-rich information. Customers can gain a better grasp of new items from it, and it enables new, streamlined ways for large-scale customer and company involvement. The situation is changing, with more big data analytics applications being used for supply chain management, operations, and product creation. This study ultimately finds three phases of how big data can be used in new product development- concept and idea generation, engineering and design and testing and launching of the product using the data that is collected and analyzed. (Zhan, 2018)
6. This paper studies about the issues relating to the development of a new digital camera product and in order to investigate these research issues, they have used data mining techniques including decision trees and association rule. They implement these techniques in order to understand customer's preferences and accordingly make new products for customers. All the knowledge that is extracted from the data mining and illustrated on product maps which in-turn propose solutions and suggestions for new product development. It concludes stating that data mining techniques can make dramatic changes in business practices and provides an engine to understand and analyze customer requirements. Knowledge extraction from data mining can prove useful in finding solutions and giving suggestions for new product development and could suggest possible marketing solutions. (Bae, 2011)
7. This study explores how big data is being utilized in the context of new product development among

various industries. This study focuses on the discussions on the benefits of data analytics in identifying customer preferences, insights and market trends to inform product development strategies. By focusing on the challenges faced by companies in product development process such as high failure rates, uncertainties etc. it discusses how data analytics can help then overcome these challenges, citing examples with relevant case studies and examples of companies that have leveraged big data in NPD efforts. By giving specific focus on a food company in the case study, the literature review may delve into applications of data analytics in food industry, including discussions on consumer behavior analysis, food safety monitoring and quality control. The review may touch upon the technological and organizational implications of implementing data analytics in the new product development process including discussion on data collection, storage, privacy and security. (Jagtap, 2019)

8. The introduction of big data and big data analytics is highlighted as transformative for the business in this article. The literature emphasis on the role of new product development for the food industries to maintain competitiveness in a fast paced market. It acknowledges the complexities involved in product development due to factors raw material prices, operational costs and customer demands. Despite complexities, accelerating new product development is vital for profitability and market share. Big data analytics' significance in streamlining processes and decision-making across business functions is emphasized. Data Analytics also presents opportunities for exploring new product development. In B2B context, big data analytics facilitates the exploration and extraction of data to uncover patterns and correlations, aiding informed decision making in new product development and efficiency. There is a research gap in understanding how data analytics, customer agility and environmental dynamics influence new product success. Hence this study aims to empirically examine these aspects and ultimately concludes by stating that a firm's customer agility is enhanced by the

implementation of big data aggregation and analytical tools. (Shirazi, 2022)

9. This study explores the impact of various information technology (IT) tools on new product development (NPD) effectiveness, focusing on their influence in the discovery, development, and launch stages. Data from NPD managers in the US and Canada indicate that specific IT tools, such as decision support systems and concept testing software, significantly enhance NPD effectiveness across all stages. The research paper addresses gaps in existing research by examining the role of IT tools in NPD performance and underscores the importance of understanding their impact across different stages. The findings have both theoretical and managerial implications, emphasizing the necessity for further exploration in this area. (Durmuşoğlu, 2011)
10. The paper presents a design framework utilizing advanced data analytics to analyse online product reviews (OPRs) and identify customer needs. The framework aims to refine qualitative OPR data into useful quantitative insights on product features to inform design decisions. It combines OPRs, design theory, and data analytics and is validated through a case study on Amazon product reviews. The paper emphasizes the challenge of analysing unstructured OPR data and introduces a sentiment analysis framework integrating natural language processing and machine learning algorithms. The effectiveness of the framework is demonstrated through a case study on the "Coleman Oversized Quad Chair with Cooler," showing its potential for data-driven design decision-making and generating accurate customer needs. The paper concludes by highlighting the probable principle shift towards data-driven decision making in design. (Ireland, 2018)
11. This paper discusses the challenges faced by high-tech companies in product development, emphasizing the need for high-quality information accessible at the right time and place. It highlights the growing importance of textual databases due to their ability to handle unforeseen information effectively. Data mining is proposed as a tool to extract valuable insights from textual databases swiftly. The research identifies trends such as increasing product complexity, changing customer expectations, and shorter development times as key challenges. The study investigates various textual databases within the product development process to understand their uses, structure, content, and potential for data mining. Overall, leveraging textual databases and data mining can enhance decision-making and competitiveness by providing timely access to valuable information. (Menon R. T., 2005)
12. This research study introduces a data management and visualization tool designed alongside a Multidisciplinary Design Optimization (MDO) framework to enhance the utilization of results in the Product Development Process (PDP). Addressing a common issue of MDO studies offering limited optimal configurations, the tool enables effective post-processing of large datasets, facilitating non-technical team engagement. Illustrated with a UAV configurator built using MATLAB's GUI, the tool exemplifies its potential for integrating MDO into manufacturing. It aims to complement existing optimization frameworks and explores its efficacy in enhancing MDO for complex product development like UAVs within the PDP. (Papageorgiou, 2018)
13. The paper discusses the significance of achieving "zero fault" in industries to avoid unnecessary expenses. It introduces data mining as a method to improve production quality, focusing on its role in assemble-to-order (ATO) environments. The methodology proposed is validated through a pilot study. Product diversity increases to meet customer needs, but its costs must be managed efficiently. Assemble-to-order strategy, combining modular design and delayed product differentiation, helps achieve product diversity. Evaluating the cost of product diversity is complex due to indirect costs. Product quality and complexity are interdependent, impacting productivity and quality. Postponement and modularity strategies are employed to manage product diversity effectively. Modularity involves designing interchangeable modules to increase flexibility in product assembly. The paper underscores the importance of managing product diversity efficiently to minimize costs while ensuring quality. It explores methodologies and strategies to achieve this goal, highlighting the

complexities involved in evaluating costs and managing diverse product portfolios effectively. (Da Cunha, 2006)

14. The paper explores the significance of effective product conceptualization in new product development (NPD) and emphasizes the role of information technology (IT), particularly data mining, in enhancing this process. It highlights the challenges faced in product conceptualization and proposes an axiomatic product conceptualization system (APCS) to address these challenges. The APCS integrates customer requirements with design knowledge management and employs data mining techniques to support the product conceptualization process efficiently. The paper presents a unified framework for product conceptualization and discusses the application of a web-based data-mining system in this context. A case study on wood golf club design validates the proposed system. The section on data-mining technology for axiomatic design explains how data mining can be employed to elicit customer requirements and facilitate the product conceptualization process. It describes the role of various stakeholders in the APCS and the use of data mining tools for knowledge elicitation. The application of a web-based data-mining system section elaborates on the establishment of a web-enabled APCS to facilitate collaboration among geographically distributed designers and customers. It outlines the components required for setting up the web environment and discusses the data-mining applications of the system. In concluding remarks, the paper highlights the potential of the proposed approach to improve conventional axiomatic design theory and emphasizes the benefits of integrating customer knowledge into the product conceptualization process. (Yan, 2009)
15. The article aims to first illustrate the benefits that organizations receive from applying big data analysis (BDA), and then it conceptualizes the main sources of general competitive advantage that BDA offers. The study not only outlines the specific advantages of utilizing BDA, but it also conceptualizes and suggests three primary sources of overall competitive advantage that BDA provides. These include a benefit from customer relationships, risk mitigation, and product quality. From the analysis of uses of BDA, the advantages of product quality, risk reduction, and client relationships have been suggested as the three primary general sources of advantage stemming from business-to-business acquisitions. (Bartosik-Purgat, 2018)
16. This study that shows how consumer goods companies can invent and test new items before putting them on the market with the assistance of digital BDA firms. By using sophisticated machine learning (ML) techniques and controlled ad hoc online experiments, a new breed of big data analytics (BDA) companies is crowdsourcing massive amounts of optical character recognition (OCR) data in order to predict demand and assess the viability of new product launches across many industries. BDA firms use carefully thought-out digital experiments to crowdsource ad hoc OCRs, enabling them to produce and deliver strategic and transformative value to client CGCs. Prescriptive and predictive data analytics, when paired with machine learning techniques, can help close a number of knowledge gaps. Two examples of these gaps are predicting the demand for new products and assessing their potential for the online market. (Mariani, 2020)
17. This paper presents a thorough analysis of information mining from massive consumer opinion data to support product design, drawing on more than 10 years of research on this particular research topic. Through this study, researchers and practitioners will gain a better understanding of recent advancements in pertinent studies and applications that focus on the processing, analysis, and exploitation of massive consumer opinion data to support product creation. New developments use AI and big data to analyse customer opinions and help with product development. NLP, sentiment analysis, and deep learning are some of the techniques used to hone insights gleaned from user-generated material, reviews, and social media. Understanding is improved by tailored recommendations and predictive analytics, and ethical issues guarantee appropriate data use. (Jin, 2019)
18. In order to identify hidden needs, the study suggests a novel method that combines text mining research of consumer complaints with

Outcome-Driven Innovation (ODI). It stresses understanding client jobs to discover demands throughout different stages of product consumption, in contrast to earlier approaches. This approach discloses client requirements that were not previously known, as demonstrated by a case study on air conditioners. Among its benefits are the instruments it offers for efficiently analysing massive amounts of complaints and the decreased need on managerial knowledge for understanding. Some drawbacks, though, are that only a portion of the task phases are examined and end-user concerns are the exclusive emphasis. Subsequent investigations seek to expand the range of examination, create all-inclusive client databases, and improve automation for instantaneous findings. All things considered, the study presents a viable approach to comprehending and meeting consumer expectations during the product development process. (Joung, 2018)

19. Knowledge is considered an asset in the modern digital economy, and knowledge management helps a business create new products and make important strategic management decisions. In order for a product to satisfy the needs of the client, technological proficiency such as engineering and process know-how must be linked with customer knowledge to ensure market acceptance. The potential of knowledge management for customer knowledge management has not received much attention, despite the fact that its significance in a product's technological advancement has long been acknowledged. In order to address the significance of the necessity for customer information in innovative product creation, this study proposes an E-CKM model with a methodology for precisely detailing the process of customer knowledge management for innovative product development. Transforming implicit knowledge into explicit knowledge is a crucial activity in the knowledge management domain since it allows information to technologies to gather customer insights from many market areas, including data mining and web-based surveys. An empirical study using the E-CKM model has been conducted, and it satisfies the requirements for a multiple-assessment scheme's evaluation criteria.

To lower project risk and ensure commercial success, the outcome is taken into consideration while making decisions on the development of novel products. (Su, 2006)

20. This research demonstrates a direct link between analytics' competitive value and performance. In this study they asked participants to evaluate the competitive standing of their company. Top performers were those who chose to "substantially outperform industry peers" performers, but individuals who indicated that they "somewhat or substantially underperform industry peers" were placed in the lower performance category. It was discovered that top performers were twice as likely to be businesses that firmly agreed that their use of business information and analytics sets them apart from competitors in their sector. Different from their counterparts, top achievers take a different approach to corporate operations. To be more precise, they apply analytics to as many big and minor decisions as they can. Their chances of doing so were doubled. Employ insights to direct daily operations twice as frequently as using analytics to direct future strategy. They make decisions that are supported by thorough analysis at a rate that is more than twice that of lesser achievers. For companies looking to develop, become more efficient, or stand out from the competition, the relationship between performance and analytics-driven management is significant. (LaValle, 2010)

RESULT

By transforming unstructured data into valuable insights, data analysis enables businesses to recognize opportunities, reduce risks, and improve overall performance. It expedites the time-to-market by offering insights into consumer preferences, industry trends, and production efficiencies to enhance the productivity. By using data analytics to support decision-making across the product development lifecycle, it results in enhanced decision-making, better resource allocation, risk mitigation, and feature prioritisation.

It enables products to be tailored and customized according to the unique tastes and behaviour patterns of each customer, increasing customer happiness and loyalty. Organisations can also easily detect and

resolve possible problems early in the product development cycle, leading to higher-quality goods, by evaluating data from numerous sources, including production processes, customer feedback, and quality assurance testing. By using data analytics, businesses may anticipate changes in consumer demands, market trends, and product performance resulting into predictive insights. This gives them the ability to proactively modify their product development plans and outperform rivals. Without sacrificing performance or quality, firms can lower the costs of product creation by optimizing supply chains, production processes, and resources using data analytics. Iterative improvement is made possible by continuous data analysis throughout the product lifecycle. This allows firms to quickly adapt to shifting market conditions and customer feedback, improving current goods or creating new ones. In an increasingly dynamic market, companies that successfully apply data analytics to product creation get a competitive edge by remaining adaptable, customer-focused, and nimble. This gives them a competitive advantage. These findings demonstrate the significant impact of data analytics on various aspects of product development, ultimately contributing to organisational success and innovation.

DISCUSSION

Processes and results in every aspect of company have undoubtedly been shaped by data analysis. Given the influence of data analysis on product development, the process of making decisions in product development has undergone a complete transformation. We no longer have to rely on scant input; instead, we have enormous amounts of data at our disposal to help guide decisions. Data analysis is being used by organizations as a kind of compass to help them with their product creation process. Businesses can gain a deeper understanding of their customers through data analysis. Not only should you try to infer what features they would like, but you should also try to figure out how they are using the company's goods and adjust your offerings accordingly. It all comes down to efficiently attending to their demands and assisting in the prediction of future trends. Businesses can spot new opportunities and adjust their strategies by analysing market data and customer behaviour trends. Additionally, it aids in locating specialized markets

and underserved clients. Businesses may create goods that connect with consumers and gain new market share by using the correct data insights. Furthermore, using data analysis makes it possible to identify problems early. It facilitates risk mitigation and obstacle navigation.

Additionally, data analysis may spur innovation. Through ongoing analysis of feedback and performance metrics, businesses may quickly iterate new products. It all comes down to encouraging an environment of experimenting and learning from both mistakes and successes. Data analysis stimulates innovation and propels the development of novel solutions in addition to improving already-existing ones. It gives companies the ability to push the envelope and provide their customers with genuinely revolutionary items. It provides hard data to assess a product's effectiveness.

While there are many advantages to data analysis for product creation, there may also be drawbacks. The danger of relying too much on statistics at the price of creativity and intuition is one possible disadvantage. It could overlook opportunities since it doesn't fully capture the complexities of market dynamics or human behaviour. Depending on variables like data sources, gathering techniques, and data integrity, there may be problems with data quality, accuracy, and dependability. Inaccurate analysis and conclusions might arise from biased or low-quality data sets. Large-scale client data collection may give rise to privacy issues. Businesses need to keep their customers' trust while adhering to data protection requirements. Failing to do so may have legal repercussions and harm a brand's reputation. Furthermore, an abundance of data can cause analysis paralysis, a condition in which decision-makers find it difficult to make timely judgments because they are overwhelmed by the volume and variety of data accessible. This could impede product development's flexibility and inventiveness. But thanks to data analysis, we are no longer flying in the dark. Companies are guided towards product excellence and customer delight by a well-defined roadmap that is founded on actionable insights. Despite its difficulties, data analysis is unquestionably a game-changer in the realm of product creation, helping companies to reduce risks, foster innovation, make more informed decisions, and provide customers with extraordinary value.

IMPLICATION

The implication of data analysis in product development could thus prove to be beneficial for a business if appropriately implemented. Data analysis provides valuable insights about the recent market trends, customer behaviour and product performance. Using these insights, informed choices throughout the product development lifecycle can be made by the decision makers. By analysing the customer related data, businesses can identify the customer behaviour and what they actually need and desire from the product that is being offered, thus helping them to develop products that better align with the market demands and customer preferences. This targeted approach can increase the likelihood of product success. Data analysis facilitates iterative product development by providing feedback loops. By constant analysis of this data, companies will be able to find areas of improvement and refine their products according to the insights that are received.

Once data analysis is implemented in any business, it helps in mitigating risks that are associated with product development by identifying potential issues that might arise initially in the process. By analysing the customer feedback, they can anticipate various challenges and can create and adapt strategies, reducing the risk of failure. Businesses with the help of data analysis in product development can tailor products to meet specific needs of the customer leading to a more satisfying customer experience. This could in turn result in increased customer loyalty and positive word-of-mouth recommendations.

Data analysis in product development could also allow businesses to allocate resources efficiently by focusing on areas that need improvement and that offer highest return on investment. This could help in preventing wastage of resources on unprofitable or less profitable products and features. With the help of the insights and knowledge that you gather from the data, your business will be able to gain advantage against your competitors in terms of either market trends, fulfilling customer needs or in terms of efficient delivery of products to your customers more quickly than the competitors. Data analysis in product development can inform marketing strategies by identifying target customers, optimizing messaging and determining the most effective channels for reaching potential customers, which could lead to more successful

product launches and increased sales. Moreover, with the help of data analysis, a business can personalize products and services based on individual customer preferences and behaviour, thus enhancing customer satisfaction and loyalty. Overall, incorporating data analysis into product development can have a positive impact on the business, both its products and success.

REFERENCE

- [1] Aljumah, A. I., Nuseir, M. T., & Alam, M. M. (2021). Traditional marketing analytics, big data analytics and big data system quality and the success of new product development. *Business Process Management Journal*, 27(4), 1108-1125. <https://www.emerald.com/insight/content/doi/10.1108/BPMJ-11-2020-0527/full/html>
- [2] Durmuşoğlu, S. S., & Barczak, G. (2011). The use of information technology tools in new product development phases: Analysis of effects on new product innovativeness, quality, and market performance. *Industrial Marketing Management*, 40(2), 321-330. <https://www.sciencedirect.com/science/article/pii/S0019850110001446>
- [3] Zhan, Y., Tan, K. H., Li, Y., & Tse, Y. K. (2018). Unlocking the power of big data in new product development. *Annals of Operations Research*, 270(1), 577-595. <https://link.springer.com/article/10.1007/s10479-016-2379-x>
- [4] Tan, K. H., & Zhan, Y. (2017). Improving new product development using big data: a case study of an electronics company. *R&D Management*, 47(4), 570-582. <https://onlinelibrary.wiley.com/doi/abs/10.1111/radm.12242>
- [5] Menon, R., Tong, L. H., Sathiyakeerthi, S., Brombacher, A., & Leong, C. (2004). The needs and benefits of applying textual data mining within the product development process. *Quality and reliability engineering international*, 20(1), 1-15. <https://onlinelibrary.wiley.com/doi/abs/10.1002/qre.536>
- [6] Liao, S. H., Hsieh, C. L., & Huang, S. P. (2008). Mining product maps for new product development. *Expert Systems with Applications*, 34(1), 50-

- 62.<https://www.sciencedirect.com/science/article/pii/S0957417406002545>
- [7] Ireland, R., & Liu, A. (2018). Application of data analytics for product design: Sentiment analysis of online product reviews. *CIRP Journal of Manufacturing Science and Technology*, 23, 128-144.<https://www.sciencedirect.com/science/article/pii/S1755581718300336>
- [8] Bae, J. K., & Kim, J. (2011). Product development with data mining techniques: A case on design of digital camera. *Expert Systems with Applications*, 38(8), 9274-9280.<https://www.sciencedirect.com/science/article/pii/S0957417411000509>
- [9] Su, C. T., Chen, Y. H., & Sha, D. Y. (2006). Linking innovative product development with customer knowledge: a data-mining approach. *Technovation*, 26(7), 784-795.<https://www.sciencedirect.com/science/article/pii/S0166497205000799>
- [10] Menon, R., Tong, L. H., & Sathiyakeerthi, S. (2005). Analyzing textual databases using data mining to enable fast product development processes. *Reliability Engineering & System Safety*, 88(2), 171-180.<https://www.sciencedirect.com/science/article/pii/S0951832004001371>
- [11] LaValle, S., Lesser, E., Shockley, R., Hopkins, M. S., & Kruschwitz, N. (2010). Big data, analytics and the path from insights to value. *MIT sloan management review*.<https://sloanreview.mit.edu/article/big-data-analytics-and-the-path-from-insights-to-value/>
- [12] Bartosik-Purgat, M., & Ratajczak-Mrozek, M. (2018). Big data analysis as a source of companies' competitive advantage: A review. *Entrepreneurial Business and Economics Review*, 6(4), 197-215.<https://pdfs.semanticscholar.org/34b3/d1453900d80449bcbfd5597d2bb9c56fd66e.pdf>
- [13] Mariani, M. M., & Wamba, S. F. (2020). Exploring how consumer goods companies innovate in the digital age: The role of big data analytics companies. *Journal of Business Research*, 121, 338-352.https://centaur.reading.ac.uk/93071/1/24Sep2020Anonymous_manuscript_revised_Centaur.pdf
- [14] Mariani, M. M., & Wamba, S. F. (2020). Exploring how consumer goods companies innovate in the digital age: The role of big data analytics companies. *Journal of Business Research*, 121, 338-352.<https://www.designsociety.org/download-publication/40940/A+Data+Management+and+Visualization+Tool+for+Integrating+Optimization+Results+in+Product+Development>
- [15] Jin, J., Liu, Y., Ji, P., & Kwong, C. K. (2019). Review on recent advances in information mining from big consumer opinion data for product design. *Journal of Computing and Information Science in Engineering*, 19(1), 010801.https://orca.cardiff.ac.uk/id/eprint/113766/1/Literature%20review_V10.pdf
- [16] Joung, J., Jung, K., Ko, S., & Kim, K. (2018). Customer complaints analysis using text mining and outcome-driven innovation method for market-oriented product development. *Sustainability*, 11(1), 40.<https://www.mdpi.com/2071-1050/11/1/40>
- [17] Yan, W., Chen, C. H., Huang, Y., & Mi, W. (2009). A data-mining approach for product conceptualization in a web-based architecture. *Computers in Industry*, 60(1), 21-34.<https://www.sciencedirect.com/science/article/pii/S0166361508000973>
- [18] Da Cunha, C., Agard, B., & Kusiak, A. (2006). Data mining for improvement of product quality. *International journal of production research*, 44(18-19), 4027-4041.<https://hal.science/hal-00512901/document>
- [19] Jagtap, S., & Duong, L. N. K. (2019). Improving the new product development using big data: A case study of a food company. *British Food Journal*, 121(11), 2835-2848.https://repository.lboro.ac.uk/articles/journal_contribution/Improving_the_new_product_development_using_big_data_a_case_study_of_a_food_company/9735998/1/files/17436116.pdf
- [20] Shirazi, F., Tseng, H. T., Adegbite, O., Hajli, N., & Rouhani, S. (2022). New product success through big data analytics: an empirical evidence from Iran. *Information Technology & People*, 35(5), 1513-1539.https://www.researchgate.net/profile/Hsiao-Ting-Tseng/publication/354007478_New_product_success_through_big_data_analytics_an_empirical_evidence_from_Iran/links/61f607aa4393577abef

c607b/New-product-success-through-big-data-analytics-an-empirical-evidence-from-Iran.pdf

- [21] Wickham, H., & Wickham, H. (2016). *Data analysis* (pp. 189-201). Springer International Publishing. https://link.springer.com/chapter/10.1007/978-3-319-24277-4_9
- [22] Krishnan, V., & Ulrich, K. T. (2001). Product development decisions: A review of the literature. *Management science*, 47(1), 1-21. <https://pubsonline.informs.org/doi/abs/10.1287/mnsc.47.1.1.10668>
- [23] Brown, S. L., & Eisenhardt, K. M. (1995). Product development: Past research, present findings, and future directions. *Academy of management review*, 20(2), 343-378. <https://journals.aom.org/doi/abs/10.5465/A-MR.1995.9507312922>