

# *Consumer and Marketing Research Using the Monte Carlo Simulation*

Xiangyuan Huang<sup>1,a,\*</sup>

<sup>1</sup>Guanghua Cambridge International School, Shanghai, 200135, China  
a. 31240015@caa.edu.cn

\*corresponding author

**Abstract:** In order to conduct consumer-related research and develop marketing strategies to outperform rival businesses, Monte Carlo simulation, a technique that was first employed in nuclear weapons and has subsequently been used in other physics-related domains, is described in this study. The literature on using Monte Carlo simulation for market and customer-related research and suggestions is summarized in two parts in this paper. The first section discusses the role of Monte Carlo simulations in customer research, outlining the various factors that affect consumers' decisions to purchase goods and services, and the second section discusses the specific help that Monte Carlo simulations can offer businesses, particularly in terms of measuring markets and creating effective marketing strategies. The paper also offers several applicable examples to describe certain elements in the middle of the text. Eventually, it is argued that Monte Carlo simulation, when used in conjunction with other techniques, can assist businesses in comprehending the market's costs and unpredictability and in developing effective marketing strategies.

**Keywords:** Monte Carlo simulation, marketing, customer research, marketing strategies

## 1. Introduction

### 1.1. Background

Every business must have a thorough understanding of the market or consumer in order to compete successfully. To achieve efficient and successful customer relationship management, more and more businesses are implementing customer-focused strategies, procedures, tools, and technologies. They are aware that developing tight relationships and partnerships with their clients requires comprehensive and integrated customer knowledge [1]. Monte Carlo modelling is a computing methodology that designs and analyzes complicated systems or phenomena using random sampling techniques. To assess the probability distribution of the system or to address issues that are challenging or impossible to address using analytical techniques, this method generates a huge number of random samples, and be utilized in a variety of areas. In the beginning, John von Neumann and Stanislaw Ueland named the method after the Monte Carlo Casino in Monaco and established the majority of the fundamental techniques of Monte Carlo simulation. They proposed using it to study the properties of neutrons passing through radiation shielding and, together with others, carried out simulations of many other nuclear weapons challenges. With the development of the times, the field of biology also makes use of the simulation method of Monte Carlo to mimic the behaviour of bio-

logical systems, such as cells and proteins, and to have a deeper understanding of molecules of biological substances as well as to develop new medications and treatments. In addition to assisting in scientific research, Monte Carlo simulation mimics financial instruments like stocks or bonds, it can be utilized in the financial industry to estimate financial values and calculate the risks involved with various investment plans such as marketing, so the Monte Carlo simulation can also assist businesses in conducting consumer research and using that information for marketing.

## 1.2. Objective

This paper will overview the current body of research and go into greater detail about how Monte Carlo simulations might aid businesses in their marketing decisions. The paper is divided into two main sections: the first examines the role of Monte Carlo simulation in customer research, which simulates a variety of factors that affect customers' consumption of goods and services; the second examines the specific assistance that Monte Carlo simulation offers businesses in measuring their markets and developing effective marketing strategies. Additionally, the thesis will offer a number of instances to further clarify each of the elements that have been hypothesised to be helpful. The summary review concludes with a more succinct summary that is offered at the end.

## 2. Consumer Research

About the role of Monte Carlo simulation in the field of customer research, Furness mentioned that by simulating the process of contingency and uncertainty, which includes Client behaviour model integrity, customer life cycle value measurement, customer service procedure modelling, and market share measurement, Monte Carlo simulation—which was created for designing nuclear weapons—is used in marketing and customer relationship management [2]. The verification, validation, and computational load are aspects of using MNS analysis that must be taken into account [2]. Monte Carlo simulations can be used to simulate the behaviour of a sizable population of consumers and forecast their responses to changes in the market like price, advertising, and other variables. This can be quite beneficial for businesses seeking the best marketing plan to maintain their revenue. By performing simulations of various pricing scenarios, businesses may predict how consumers will respond to various price points and ascertain the best price for their products by using Monte Carlo simulations to model consumer behaviour in response to price changes.

First, Monte Carlo simulations can help businesses determine customer satisfaction. Customer feedback and ratings can be analyzed using Monte Carlo simulations to find patterns and trends in consumer satisfaction. Businesses can pinpoint the key elements and problems affecting customer happiness and make improvements by analyzing a sizable data set of consumer feedback. Customer satisfaction is one of the criteria used to evaluate a product in marketing decisions and refers to how much a consumer appreciates using a product after consuming it. In order to determine the probability of customer actions in response to retail business strategies, Taylor et al. simulate consumer happiness using game theory, revenue matrix modelling, and the Monte Carlo method of modelling [3]. The result is that if the retail organization chooses a certain strategy and a group of customers chooses one of the provided methods, a Nash equilibrium is attained [3]. Customer satisfaction will be affected by a series of factors. For instance, in the hospitality industry, numerous factors, including feelings, corporate social responsibility, employee satisfaction, and a sense of fairness and equity, might affect customer satisfaction [4]. Another example is food. Consumer views of food safety had a favourable impact on customer satisfaction, which can be used to demonstrate the strong correlation between consumer perceptions of food safety and customer pleasure in the restaurant experience [5]. Furthermore, customer relationship management (CRM) is a comprehensive key necessity for a company's marketing, selling, and support functions that boost client satisfaction.

[6]. Besides, price and service quality are two of the factors that have a negligible impact on client satisfaction, whereby price has a detrimental effect and quality of the service has a favourable impact [7]. Customer satisfaction can increase consumers' deliberate efforts to repurchase products or services. The projected increase in value occurs as the degree of customer happiness rises, and the company's sales and profits reach their maximum potential. It can be said that satisfaction has positive effects on consumer behaviour, brand recognition, and cost advantages [4].

Several researchers also investigate how customers react to firm changes. Many factors that makeup variables in the study of customers can affect consumer reactions. Examples include market trends in the context of shifting customer preferences or consumer purchasing behaviours. Businesses can use a Monte Carlo simulation to add various variables, run it multiple times, and observe the results that might happen in different scenarios. Chun discovered that, in direct marketing, consumer reaction to requests for a particular action decreases geometrically over time via a number of response models [8]. The maximum likelihood estimation method, among the methods that the author investigates, has been shown to be the approach that performs Monte Carlo simulations most efficiently. The maximum likelihood estimation method can rapidly reveal the real parameter values when there is adequate sample data [8]. This data can assist marketers in making more informed choices regarding product price, promotion, and other factors. For instance, Gao et al. examined how the persistence of misleading impressions impacted how willing guests were to promote positive terms in the hospitality sector. According to research findings, when data breaches happen, customers may actively spread the news about businesses that are generally regarded as capable if they believe that error stability is low rather than high. Customers who have a common relationship with a company respond similarly to that company [9]. Because corporate social responsibility practices have a favourable effect on customer response in the online retail sector. Customers will respond positively to online retailers who actively engage in social responsibility activities because they have a high level of support and confidence in the company [10]. According to this research, hotels should allocate strategic resources based on how to target consumers perceive their brands and how they relate to the target market [9].

Customers can be divided into groups based on a variety of criteria using Monte Carlo simulation, including their sensitivity to price, their product preferences, and their location's culture. Businesses use it to model and select the most effective segmentation strategy by anticipating how customers will respond. This approach may also be employed to assess the effectiveness of consumer segmentation models. Purwaningsih et al. explained how a commercial organization conducting data analysis generates difficult-to-obtain customer revenue data using Monte Carlo simulation, ensuring that the approximation conditions are satisfied and enabling the organization to build customer segmentation models and obtain the typical revenue and consumption patterns of customers for use in decision-making [11]. The drawback of this approach is that Monte Carlo simulations can occasionally require the use of outside knowledge [11]. The economic, demographic, and psychological aspects of the business are examined, including internet usage, online experience, psychographics, and user experience [12]. Online marketers must segment and analyze online consumers to comprehend their distinctive traits, cater to their continuously changing wants, and efficiently budget marketing spending [12]. In addition, the MCS can also assess the reliability aspects of the system, For the Essential Services Council to assess the level of service and conduct cost estimation using the Monte Carlo modelling (MCS) method, Goel et al. propose an MCS-based finding as a supported index to compute the dependability of distinct customer kinds [13]. According to the findings, there is not much of a difference between the simulation and analytic outcomes under specific circumstances [13].

### 3. Marketing

In order to model and analyze the outcomes of complex systems and simulate the effects of various marketing tactics and scenarios, a statistical methodology known as Monte Carlo simulation is used. This method enables firms to make data-driven decisions.

After a detailed study of the customer by Monte Carlo simulation, it can continue to be of great help in marketing. Establishing strong bonds between your company with future or existing customers is the main objective of marketing so that they come to appreciate your goods, services, or knowledge and help you dominate the market [14]. Responding to the market is at the core of marketing strategy [6]. Companies are set up so that they can respond quickly, constantly looking for market opportunities. As a result, they invest a lot of time and energy into addressing the pressures of globalisation by increasing their sales operations, which enables them to gain a competitive edge [6].

The majority of small and medium-sized enterprises (SMEs) lack the skills necessary to do appropriate market research and develop a targeted marketing strategy. There is a critical need for improvement in this field. Monte Carlo simulation can benefit SMEs by simulating, examining, and providing recommendations for the future growth of the business. Financial projections, production schedules, and marketing strategies are a few examples. SMEs can better understand the market's current situation, the risks involved with their plans for various market and marketing strategies, and the chances of success by simulating a variety of potential situations and results. The market uncertainty of SMEs can also be represented by Monte Carlo simulations. Using Colombian export frozen beef as an example, Cano et al. combine the IMS method of fuzzy logic and Monte Carlo simulation to show that there is a probabilistic resolution of uncertainty in terms of market evaluation variables, which enables the development of an international market selection method. This is a useful market evaluation model for SMEs that can raise export performance [15].

Businesses can use Monte Carlo simulations to examine how different risk factors will affect a project or process. The probability of various events can be calculated via the Monte Carlo method, such as product flaws, production delays, or cost overruns when a business is developing a new product. This allows the organization to recognize these possible risks at an early stage and take action to lessen their influence on the project. In terms of risk reduction, Zhu et al. suggest a method for calculating and analyzing the market cost of chemical construction projects by combining parallel Monte Carlo modelling, Likert scale methodologies, and competitive landscape [16]. The findings demonstrate that the approach can raise the likelihood of winning a tender while lowering the risk associated with project bidding [16]. The validity and applicability of the method are tested by the authors using a Saudi petrochemical project procurement and construction contracting project as an example [16].

Li et al. created scenarios using Monte Carlo simulation methods and employ a number of methods to demonstrate, for instance, that the financial risks connected to uncertainty and market prices are represented using projected negative risk [17]. This set of techniques explains how generation companies (GENCO) can lower financial risk by managing projected returns and offers a closed-loop solution for risk-based bidding by GENCO in the energy and ancillary services market [17].

In order to make money for the firm, a company's strategy heavily relies on its consumers first and foremost, followed by the advertising and distribution of its products. The response to the market is at the core of marketing strategy. By responding to the challenges of globalization by increasing its sales operations, a firm can strengthen its competitive advantage because of its positioning, which makes it responsive and always on the lookout for market prospects [6].

The categorization of tourist motivations for visitors from mainland China to Macau is consistent with the economic diversification of the "Monte Carlo of the East," according to Shi et al., who classify the city's visitors into three distinct customer groups. In the context of a transformative environment that requires economic sustainability amidst the anti-corruption storms from mainland China, these findings offer a valuable and successful marketing strategy for Macau [18].

The entrepreneur's performance with regard to sales outcomes and prior market research in building a successful marketing strategy is referred to as a marketing strategy. Entrepreneurs can utilize the marketing mix's indicators, such as market research and development, products, prices, site or location of the business, and promotions, to their fullest potential in order to draw in customers [19].

Market segmentation is another tool that marketers can utilize, as demonstrated by the Macau example. For instance, there are two segmentation methods used in the tourism industry: the first uses general consumer characteristics, such as psychological, geographic, and expression factors; The second method makes use of a set of circumstances and traits such as consumer perceptions, interests, and views toward products and services, product use patterns, advantages desired, frequency of purchase, and actual spending [20].

Marketing strategies are the concepts and techniques that firms use to offer their products and services to their target audience. Korpioja demonstrates how Monte Carlo simulation can be very helpful for marketing managers who lack programming and statistics by using it to solve marketing-related problems and simulate them from an operational perspective [21]. They model these problems in a spreadsheet environment and create probability distributions in a sales simulation model [21]. Depending on the types of customers, firms' objectives, budget for advertising, and other factors, marketing techniques are modified and vary from one to another. Most companies mainly use advertising as a marketing decision.

The typical consumer only selects brands they are already acquainted with [14]. A brand will perform better in the marketplace if customers associate it with more than just its name. To capture the market, marketers should be able to elicit an emotional response [14]. The primary advertising means utilized by businesses is social networking site marketing, which advertises and promote goods and services on well-known sites like Facebook or Twitter. In greater detail, firms might collaborate with active influencers who have a sizable social media following to recommend their brands and goods in the form of videos. Furthermore, Businesses might cooperate with search engine companies or online shopping sites to raise their product's position on search engine results in pages and attract more people to buy it.

The strategy process is described by Morgan et al. as involving both the organizational mechanisms that influence these strategic marketing decisions, such as the assessment process, setting targets, contrasting top-down and bottom-up strategic planning techniques, the extent of planning, and other factors are discussed [22]. as well as the mechanisms used to make and achieve those decisions, such as marketing mix planning, financial planning, corporate communication, organizational remodel, performance tracking and management structures [22]. Besides, some companies may also choose to encourage current customers to suggest the brand or product to people around them like forwarding the link in exchange for a discount or a free item. For instance, the well-known Chinese online shopping app Pinduoduo invites users to share their links to WeChat groups in return for discounts.

#### 4. Conclusion

This paper explores the history of Monte Carlo simulation, its subsequent applications in several disciplines, and the effects of marketing on consumers and enterprises. For the purpose of giving marketing advice to businesses, the Monte Carlo simulation is combined with various techniques

for customer research and marketing simulation. Monte Carlo simulation significantly contributes to consumer satisfaction, consumer response, and customer segmentation in terms of market research. Monte Carlo simulations can aid businesses in understanding the market through market costs and help them to decide on market strategy. Businesses can then employ this understanding to manage higher risk and other market-related challenges, resulting in the development of efficient marketing approaches and techniques. Given the literature and summaries above, I believe that Monte Carlo simulation can be very helpful in user research and market research because it is a quick way to give businesses recommendations and the best marketing tactics. It is a tool that may be employed and is very beneficial for businesses, but it also needs to be used in conjunction with other techniques like revenue matrix modelling and game theory.

## References

- [1] Parvatiyar, A., & Sheth, J. N. (2001). *Customer relationship management: Emerging practice, process, and discipline*. *Journal of Economic and Social Research*, 1–34.
- [2] Furness P. *Applications of Monte Carlo Simulation in marketing analytics[J]*. *Journal of Direct, Data and Digital Marketing Practice*, 2011, 13: 132-147.
- [3] Taylor, M., Kwasnica, V., Reilly, D. and Ravindran, S. (2019), "Game theory modelling of retail marketing discount strategies", *Marketing Intelligence & Planning*, Vol. 37 No. 5, pp. 555-566.
- [4] Prayag, Hassibi, & Nunkoo. (2019). A systematic review of consumer satisfaction studies in hospitality journals: conceptual development, research approaches and future prospects. *Journal of Hospitality Marketing & 38 Management*.
- [5] Jaemin, C. , & Borchgrevink, C. P. . (2018). *Customers' perceptions in value and food safety on customer satisfaction and loyalty in restaurant environments: moderating roles of gender and restaurant types*. *Journal of Quality Assurance in Hospitality & Tourism*, 1-19.
- [6] Daulay, R., & Saputra, R. (2019). *Analysis of Customer Relationship Management and Marketing Strategies Against Competitive Advantage on the company's distributor in Medan City*. *Proceedings of the Proceedings of the 1st International Conference on Economics, Management, Accounting and Business, ICEMAB 2018*, 8-9 October 2018, Medan, North Sumatra, Indonesia.
- [7] Lie, D. , Sudirman, A. , Butarbutar, M. , & Efendi, E. . (2019). *Analysis of mediation effect of consumer satisfaction on the effect of service quality, price and consumer trust on consumer loyalty*. *International Journal of Scientific & Technology Research*.
- [8] Chun Y H. *Monte Carlo analysis of estimation methods for the prediction of customer response patterns in direct marketing[J]*. *European Journal of Operational Research*, 2012, 217(3): 673-678.
- [9] Gao, Y. L. , Zhang, L. , & Wei, W. . (2021). *The effect of perceived error stability, brand perception, and relationship norms on consumer reaction to data breaches*. *International Journal of Hospitality Management*, 94(1), 102802.
- [10] Pengyi, S., & Xiucheng, F. (2016). *Online Retail Enterprises' Social Responsibility Behavior and Consumer Response: A Moderating Model in the Chinese Context*. *China Soft Science*(3), 11.
- [11] Alamsyah, A. , & Nurris, B. . (2017). *Monte carlo simulation and clustering for customer segmentation in business organization*. *IEEE*, 104-109.
- [12] Akar, E. . *Customers' online purchase intentions and customer segmentation during the period of covid-19 pandemic*. *Journal of Internet Commerce*.
- [13] Goel, L. , Liang, X. , & Ou, Y. . (1999). *Monte carlo simulation-based customer service reliability assessment*. *Electric Power Systems Research*, 49(3), 185–194.
- [14] Savchenko, A. Y. . (2017). *THE GREAT IMPORTANCE OF HUMAN REACTION IN MARKETING*.
- [15] Cano J, Campo E, Gómez-Montoya R. *International market selection using fuzzy weighing and Monte Carlo simulation[J]*. *Polish Journal of Management Studies*, 2017, 16(2): 40-50.
- [16] Zhu B, Yu L A, Geng Z Q. *Cost estimation method based on parallel Monte Carlo simulation and market investigation for engineering construction project[J]*. *Cluster Computing*, 2016, 19: 1293-1308.
- [17] Li, T., Shahidehpour, M., & Li, Z. (2007). *Risk-constrained bidding strategy with Stochastic Unit Commitment*. *IEEE Transactions on Power Systems*, 22(1), 449–458.
- [18] Shi T, Liu X, Li J. *Market segmentation by travel motivations under a transforming economy: Evidence from the Monte Carlo of the Orient[J]*. *Sustainability*, 2018, 10(10): 3395.
- [19] Echdar, S. (2013). *Entrepreneurship Management: Tips for Being an Entrepreneur*. Yogyakarta: ANDI Publisher

- [20] *Legoherel, P. (1998). Toward a market segmentation of the tourism trade: Journal of Travel & Tourism Marketing, 7(3), 19–39.*
- [21] *Korpioja , E.-M. (2022). From Data to Insight: Monte Carlo Simulation as a Marketing Intelligence Tool . From Data to Insight: Monte Carlo Simulation as a Marketing Intelligence Tool.*
- [22] *Morgan, N. A., Whitley, K. A., Feng, H., & Chari, S. (2018). Research in marketing strategy. Journal of the Academy of Marketing Science, 47(1), 4–29.*