International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 12 Issue: 08 | Aug 2025 www.irjet.net p-ISSN: 2395-0072

Harmonizing Innovation and Efficiency: Unveiling the Strategic Confluence of Mass Customization and Frugal Engineering with Design Principles

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Abstract - *A significant paradigm change in product manufacture and customer involvement has been brought about by mass customization. Two notable examples are Nike's innovative NikeiD platform and Dell Technologies' success in letting users customize their own PCs. According to recent polls, there is a high level of customer desire in personalization, which could lead to substantial market expansion. The study explores how cost efficiency and design flexibility can work together, emphasizing how common design concepts like modularity, scalability, simplicity, and user participation can support these objectives. Customization increases brand loyalty, helps businesses stand out in a crowded market, and can save money. In a time when customers value customized more and more, embracing mass customization can boost sales, customer loyalty, and business success. In the end, the study presents the combination of economical engineering with mass customisation as a game-changing approach to the design and development of next-generation products.*

Key Words: Mass Customization, Frugal Engineering, Design Thinking, Innovation Engineering, Sustainability

1.INTRODUCTION

Mass customization is one paradigm shift that has permanently changed how businesses interact with their clients and produce goods in the always changing business and consumer preferences landscape. Redefining client loyalty and revolutionizing industries, this game-changing idea sprang to prominence in the 1990s. Businesses that have cleared the path and demonstrated the amazing potential of personalization include Nike and Dell Technologies (2). This article explores the revolutionary paradigm change that mass customization has brought about, providing insights into how it affects customer loyalty, profitability, and differentiation in an age of increasing price transparency. Businesses that embrace mass customization are well-positioned to prosper in an increasingly individualized world as the digital age continues to change consumer expectations (3,4).

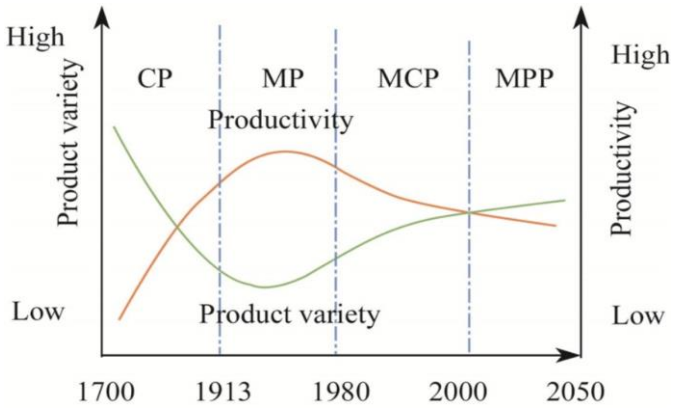

Fig -1: Evolution of production paradigm

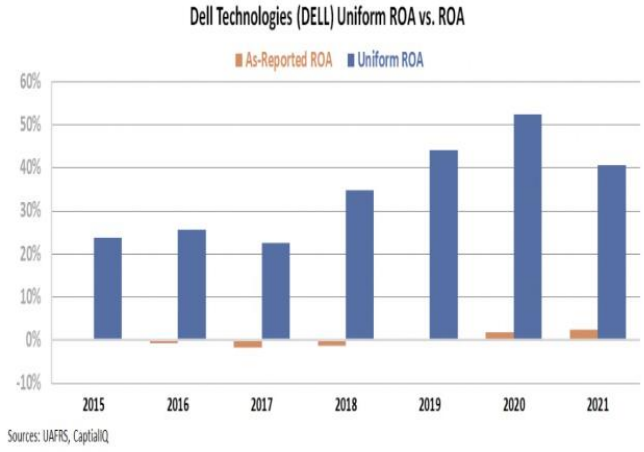

Fig -2: As-reported ROA vs Uniform ROA

The concept's creator, Dell Technologies (DELL), provides the best case study on mass customization. Dell started giving PC consumers the option to "build their own" devices in the 1990s, which basically allowed them to customize their PCs to the precise specifications they wanted (5,6). Dell used this tactic with great success. The company was able to attain great size and produce strong profitability levels because it was able to sell enormous quantities of PCs and source its suppliers wisely. Dell's mass customisation technique helped

them become one of the most well-known PC manufacturers in the world (7). These levels of profitability give the impression that Dell's mass customization strategy may be hurting rather than helping returns. The issue, though, is that Dell's true profitability is distorted by the as-reported measures (8). According to uniform metrics, the company has produced steady and increasing profits since 2015. In particular, Dell was able to increase its return on assets (ROA) from 24% in 2015 to even higher levels of 41% in 2021.

1.1. Tearsheet for Dell Technologies Inc.

According to Dell Technologies Inc.'s (DELL:USA) Uniform Accounting tearsheet (1), the company's Uniform P/E trades at 11.1x, below the global corporate average of 25.2x but near its own historical average of 9.5x. Low EPS growth is necessary to maintain low P/Es. Having stated that, Dell Technologies recently demonstrated a 14% Uniform EPS increase (9). Generally speaking, the stock and valuation recommendations made by Wall Street analysts offer very little direction or insight. Nonetheless, Wall Street analysts typically include pertinent information in their short-term earnings projections.

We translate Wall Street's GAAP earnings projections into Uniform earnings projections. When we do this, the Wall Street analyst-driven projection for Dell Technologies is a 3% EPS decline in 2023 after an insignificant EPS rise in 2022 (10). We may utilize earnings growth valuation criteria to back into the necessary growth rate to support Dell Technologies' $89 stock price based on the current stock market valuations. The term "market embedded expectations" is frequently used to describe this. Utilizing mass customisation and an economical engineering approach to commercialize these items, this technique expands the use of Dell technologies. The brand improves worker opportunities and user service (11).

At the moment, the company's valuation is based on the assumption that Uniform earnings will decline by 10% a year over the next three years. Through 2023, Wall Street analysts anticipate that Dell Technologies' earnings growth will surpass the current stock market valuation (12). Additionally, the company's earnings power is seven times higher than the corporate average over the long term. Additionally, cash flows and cash on hand exceed all of its commitments, including capital expenditures and debt maturities. When combined, they indicate a low credit risk (13). In summary, Dell Technologies is trading below its average peer valuations despite having uniform profit growth that is much above peer averages. For skilled workers who possess a precise understanding of the fundamentals of technology, Dell technology improves the opportunity (14).

2. METHODOLOGY

2.1 Success in product customization

2.1.1 Scope

Less than 10% of online buyers have attempted customisation options, while 25% to 30% are interested in doing so, according to a Bain survey of over 1,000 shoppers. Although the whole potential of personalization is difficult to estimate, a 25% personalized footwear market might generate $2 billion annually (15).

2.1.1 Illustration

consumers who developed their own shoes, for example, gave businesses a 50% higher Net Promoter ScoreSM (NPS®), a common metric for gauging customer loyalty, than consumers who regularly purchased items from the same manufacturer, according to our research. Generally speaking, higher NPS corresponds to increased lifetime customer value, sales, and referrals.

2.1.3 Requirement

More than 1,200 global executives from a variety of industries participated in a recent Bain poll, and 67% of them said they thought their customers were growing less brand loyal. At a time when the Internet is quickly generating high pricing transparency and making it simpler for customers to compare items with standard characteristics, customization also aids businesses in setting their products apart from those of their rivals (16). 49% of mobile phone owners use their device to compare costs, and there are more and more price comparison apps available, according to Google.

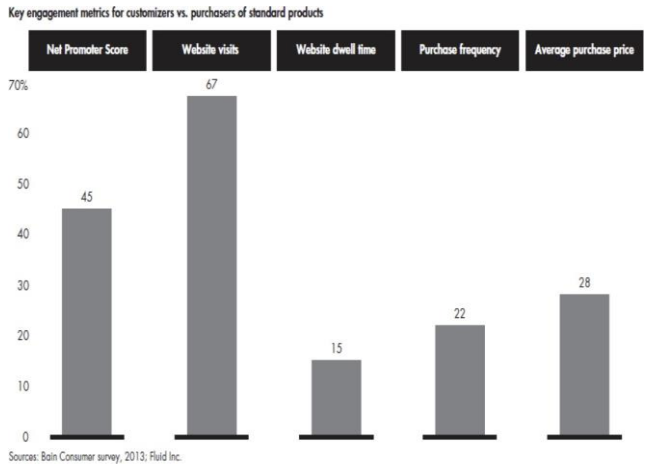

Fig -3: Customers who customize a product are more engaged and spend more than consumers who buy standard products

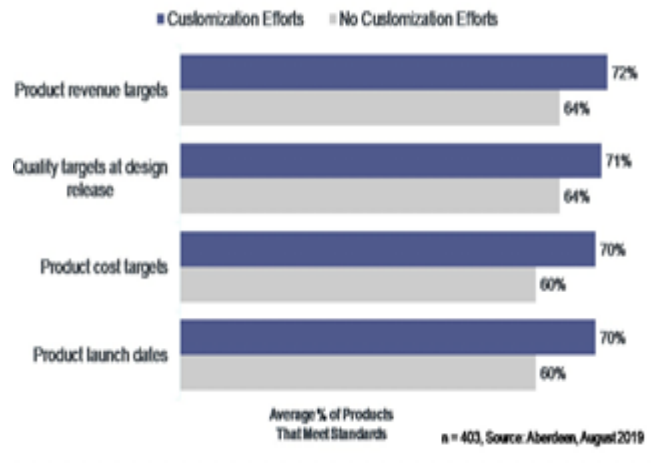

Fig -4: Business Impact of Investing in Innovative Customization

2.2 Business Impact of Investing in Innovative Customization

Companies that are best in their class recognize the benefits of optimizing production capacity. They have a particular interest in two types of customisation that entail altering the actual product: transparent customization and collaborative customization. The ability to modify items as they are being manufactured is a crucial component of emerging smart manufacturing technologies. This change decreases downtime and makes businesses more agile. In actuality, businesses that have already adopted some kind of customization report a 62% reduction in savings due to the decrease in production downtime. The reduction for other companies is only 49% (17, 18).

3. RESULTS & DISCUSSIONS

3.1. Pioneers in Mass Customisation

3.1.1 Nike

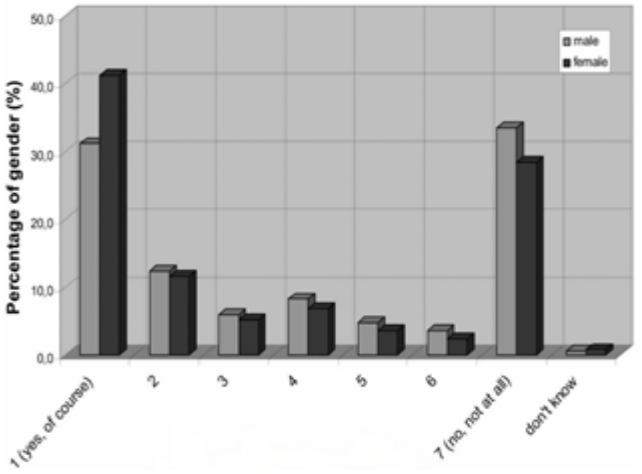

Fig -5: Interest in customised shoes

The idea of mass customization was initially presented by Nike in 1999 (Team, 2011). With NikeiD, the firm introduced the first successful platform in the industry, allowing its potential customers to buy shoes by personalizing their comfort, color, and style. Also see this report from the Consumer Barometer, which was conducted by KPMG and IFH Cologne (Muehlbauer, 2017) and included a sample of about 500 customers who were interested in tailored products. Three customers out of ten have already created a design for the product they require based on their personal preferences. Of those interviewed, 55% of seasoned consumers are willing and significantly able to pay a greater price for certain things, and 43% of them anticipate seeing more customization offerings. Businesses who used customization had a 62% boost in performance in the last two years alone, while those that did not saw a 51% increase (Gaffney, 2019).

3.1.2 Harley-Davidson

The well-known motorcycle manufacturer Harley-Davidson (H-D) responded to issues like an aging customer base and the need for customized bikes. Mass customization gave way to mass personalized production (MPP). This required significant automation, space reduction, and manufacturing restructuring, which led to a 50% worker decrease. Versatile, smart production is now feasible because to Industry 4.0 ideas like IoT, CPS, smart sensors, and M2M communication. As a result, many motorbike models with mass customization may now be produced on a single production line (19).

3.1.3 My Virtual Model Inc.

The Montreal-based company My Virtual Model Inc. is revolutionizing the purchasing process itself. Customers may use the software to create virtual versions of themselves, or "avatars," which they can use to test out things from stores like Sears, Best Buy, Levi's, and adidas. The service has already attracted over 10 million users, and the initial outcomes are remarkable: According to Land's End Inc., the average order value increased by 15%, and the conversion rate increased by 45% (20).

About 30% of the men and 40% of the women surveyed indicated a great interest in buying customized shoes and were willing to pay a premium price for them, according to a study done by EUROShoE.

4. CONCLUSION

Mass customisation has become a transformative force in the dynamic world of business and consumer preferences. In order to highlight its potential to increase profitability and set businesses apart in a world of price transparency, this article has examined its historical influence and highlighted success stories such as Dell Technologies and Nike. With polls

indicating potential billion-dollar industries driving consumer interest in customization, it is evident that personalization increases customer lifetime value, sales, and loyalty. As evidenced by Harley-Davidson's shift, advancements in smart manufacturing and technologies like IoT and CPS are essential. Businesses such as My Virtual Model Inc. are using virtual avatars to redefine shopping, and EUROShoE's research highlights the need for personalized goods. Adopting mass customization is now strategically necessary rather than optional, setting up companies to prosper in a personalized future where goods are tailored to each individual customer.

ACKNOWLEDGEMENT

The authors acknowledge the PAM Lab of IIT Kharagpur, where the ideation of this research article happened, and the facility provided by the PAM Lab was great for exploring more about this research article.

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BIOGRAPHIES

The author (Tushar Tiwari) is a Research Scholar pursuing a Ph.D. in the Research domain of Product Design and Development with an area of interest in Assistive device design and technology development with Frugal Innovation since the 2nd of August 2021 at IIT Kharagpur, West Bengal, India. The author completed his M.Tech (Postgraduate) degree from the Industrial Design department at NIT Rourkela, Odisha, India. Before that, he had 2 years of Teaching Experience at Aarya Academy Pvt. Ltd., Bilaspur.