



Customer Genetic Data for Sustainability and Innovation Management

Ivelina Ivanova-Kadiri¹ 

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Abstract: *The availability of affordable genetic testing has enabled the collection of vast amounts of genetic data, creating new opportunities for marketing management. The use of genetic data empowers companies to develop personalized products and services and enhance customer relationship management. This, in turn, creates a competitive advantage for boosting companies' strategic market positioning by enhancing their sustainability and innovation policies. This review paper aims to explore how businesses can leverage genetic data for sustainability and innovation management. The framework presented outlines the integration of genetic data into different stages of sustainable product development thus allowing for precision targeting through responsible innovation management. The paper also examines the potential ethical and legal implications of using genetic data in marketing management.*

1. INTRODUCTION

The integration of genetic insights with business strategy is transforming marketing landscapes (Hoffman et al., 2022), leading to personalized engagement (Kotler et al., 2021) and sustainable innovation (Sachs, 2015; Schaltegger & Wagner, 2011). In an era marked by heightened environmental consciousness and rapid technological progress, businesses must adopt innovative strategies aligned with sustainability goals (SDGs). Simultaneously, the field of genomics has revolutionized, democratizing access to genetic data. This paper investigates the convergence of these trends, exploring how customer genetic data can fuel sustainability and innovation in product development. The intricate interplay between genetic insights, sustainable practices, and innovation lays the foundation for this exploration. By leveraging technology to propel sustainability-driven innovation, marketing based on DNA data - genetic marketing - enables precision targeting (Daviet et al., 2022) and gene-based segmentation to promote sustainable development through smart consumption (Ivanova-Kadiri, 2023), and facilitate innovation management. This paper aims to provide a comprehensive synthesis of the current state of knowledge on leveraging genetic data for business, identifying research gaps, and proposing future directions. The methodology includes analyzing existing business models in implementing genetic data for business purposes. The study's implications provide a basis for further research and practical implementation in leveraging genetic data for sustainable business practices and innovation management.

2. PRECISION MEDICINE: MARKETING KPIS

The integration of genetic insights into innovation management is reshaping traditional business models. Genetic data once limited to healthcare applications, now fuels innovation across sectors as diverse as consumer goods, entertainment, interior design and tourism. This paradigm

¹ Faculty of Management, Marketing Department, University of Economics - Varna, Kniaz Boris I Blvd. No 77, 9000, Varna, Bulgaria

shift is exemplified by the rise of direct-to-consumer genetic testing (DTC-GT), which empowers individuals to uncover their genetic makeup. Beyond satisfying curiosity, DTC-GT enables businesses to tailor products and services to individual genetic profiles, fostering hyper-personalization. Direct-to-consumer genetic testing has emerged, providing individuals with ancestry and health risk identification. The traditional biotechnology business model has expanded to include direct-to-consumer supply. While businesses recognize the transformative potential of genomics, the accumulation of genetic databases expands the scope of genomic products and services.

Vanhala et al. (2013) have identified five DTC genetic testing business models based on consumers' motivations for purchase, such as curiosity, medical needs, or lifestyle factors. These models include comprehensive genomic tests, genomics as part of individual health planning, services based on comprehensive genomic tests, medical precision tests, and restricted trait tests. Table 1 outlines the marketing KPIs for each business model.

Table 1. Marketing KPIs of DTC genetic testing

	Genome as data bank material	Genome as a tool for health planning	Genome-as-a-service	Medical precision tests	Restricted trait tests
Value proposition	Comprehending health risks and genomics through entertainment and familiarity.	Genome-informed health plan with lifestyle support.	Outsourced genetic testing for an easy and fast individualised lifestyle service.	Trusted and precise response to customer's medical inquiry.	Entertaining and informative details about a person's unique characteristics.
Target groups	Early adopters, genomics enthusiasts, and specific niche groups based on service.	Individuals pursuing lifestyle change, tech-savvy individuals, and those with lifestyle-related health issues.	Lifestyle and fitness enthusiasts, quantified self-followers.	Affluent persons interested in their own risk of disease.	Early adopters, genomics enthusiasts, and specific niche groups based on service.
Key resources	Genome data is a valuable revenue source due to its critical nature and significant value.	Genome data contributes to service offering alongside professionals and software, as key resources.	Genome data and software expertise are essential for service offerings.	Genome data crucial for product development.	Genome data crucial for product development, but the resale value of customer data is low.
Assessment of business model	Strong market position is essential. Some players evolved into healthcare testing providers.	Incomplete understanding of genome data interpretation makes this model risky to use.	Great potential once genetic data interpretation improves. Quick launch for software-based service.	Growing demand for functional models. Whole genome sequencing may revolutionize the business model.	A challenging model with price competition difficulties against genome-wide tests.

Source: Vanhala et al., 2013

Another emerging paradigm capitalizes on the individual's genetic code as a foundational element to create personalized physical products and services. Panasonic's Genome House initiative makes genetic composition central to product innovation and leverages the human genome as an essential and irreplaceable asset within its business model (Ivanova-Kadiri, 2023).

3. BUILDING CUSTOMER GENOMIC PERSONA THROUGH BEHAVIOURAL GENETICS

In the fascinating world of behavior genetics, the idea of individuals having unique genomic personas is uncovered (Carey, 2013; Kuechle, 2019), shaped by a combination of their genetic makeup and external influences, which impact their consumer behavior (Conway & Slavich, 2017; Daviet et al., 2022). This concept sheds light on how specific genes can influence behaviors like risk-taking, seeking novelty (Kuechle, 2019; Li et al., 2017), and embracing sustainability. Understanding these genomic personas opens new avenues for businesses to customize their products and services to match customers' genetic inclinations and external influences.

The concept of genomic personas has significant implications, especially in the realm of sustainability and eco-design. As businesses increasingly focus on eco-friendly product development (Schäfer & Löwer, 2021) valuable insights into consumers' inherent tendencies toward sustainable choices are provided by behavior genetics. Armed with this knowledge, products that align with customers' genetic predispositions for eco-consciousness can be created (Ivanova-Kadiri, 2023), leading to more appealing and sustainable offerings. Moreover, the idea of genomic personas also connects with the notion of smart consumption, emphasizing informed and responsible choices. Tailoring product recommendations based on customers' genomic profiles can facilitate the development of personalized and relevant suggestions, enabling consumers to make smarter, more sustainable decisions that align with their preferences and values. Ultimately, the application of customer genomic personas can build a more environmentally responsible consumer culture.

4. DATA PRIVACY AND ETHICAL CONSIDERATIONS

The utilization of customer genetic data poses substantial ethical and legal quandaries, demanding businesses to navigate these complexities with heightened responsibility. The intricate nature of personalized genetic insights underscores the need for unwavering commitment to data protection, informed consent, and transparency. This dual focus ensures that genetic data is employed for constructive purposes while zealously safeguarding the autonomy and rights of individuals. The integration of customer DNA data into business strategies remains a contentious subject, largely due to apprehensions concerning data privacy and ethical ramifications.

The DNA testing surge has enriched databases of key players like 23andMe, Ancestry, and others. A 2018 poll revealed that 50.5% of Americans would share DNA for \$95, 11.7% altruistically, while 37.8% hesitated. Erasing DNA (72.2%), non-disclosure (69.8%), and consent (67.9%) were key considerations (Briscoe et al., 2020). Concerns included insurance exploitation, job discrimination, identity theft, cloning, and data misuse. Ethical issues of genetic marketing intertwine with secure data sharing. Notably, 23andMe shared data from five million customers with GlaxoSmithKline (GSK), raising ethics debates (The New York Times, 2019). Likewise, FamilyTreeDNA shared data with the FBI for crime-solving, questioning privacy ethics in genealogy (TIME, 2018). Amidst precision medicine's growth, genetic data's role in drug development and investigations is critical.

Globally, legal frameworks treat genetic data diversely, with the EU's GDPR notably safeguarding genetic data under personal data regulations (Ivanova-Kadiri, 2022). Correspondingly, the European Genomic Data Infrastructure (EGDI, n.d.) initiative facilitates secure genomic data

sharing within Europe. Recognizing genetic data's rising importance, EGDI establishes a cohesive ethical and privacy framework. This domain poses significant challenges, recognized within big data realms (Reali et al., 2018). Secure storage necessitates regulatory and software tools. Robust ethical guidelines are pivotal in governing genetic data's business use, ensuring privacy and enabling sustainable product development. Adherence to GDPR assures data security and consent. EGDI not only propels genetic research but also preserves privacy and builds public trust.

The integration of emerging technologies not only amplifies the potential for success (Muriithi, 2020) but also aligns with the demonstrated positive correlation between innovation, customer engagement, and marketing outcomes (Fidel et al., 2015). As consumers increasingly embrace circular consumption practices with a distinct sustainability focus, persistent barriers such as cost implications, limited sustainability interest, and information gaps (Deloitte-UK, 2022) underscore the necessity for businesses to seamlessly incorporate sustainability into product development strategies. Moreover, the imperative to address gaps in scientific evidence within the realm of direct-to-consumer genetic testing remains. This imperative not only upholds consumer trust within the broader healthcare context but also ensures the reliability and consistency of genetic insights (Delfanti, 2011). A holistic consideration of ethical, legal, and scientific facets serves as the foundation for an ethically responsible and comprehensive framework for the sustainable management of DNA-based products and services, further elucidating the intricate interplay between innovation, sustainability, and responsible genetic data utilization.

5. FRAMEWORK FOR SUSTAINABILITY AND INNOVATION MANAGEMENT OF DNA-BASED PRODUCTS AND SERVICES

Understanding customer genetic data for sustainability and innovation involves exploring the fusion of sustainable entrepreneurship and innovation (Schaltegger & Wagner, 2011). This synergy integrates environmental and social aspects into entrepreneurial ventures, aligning with sustainable consumption tailored to unique genetic personas. Sustainability innovation propels eco-friendly product and process development, aligning with economic success and broader sustainability goals (Schäfer & Löwer, 2021). By embracing customer genetic data, businesses customize offerings to individual genetic inclinations, ensuring alignment with sustainable preferences. Considering the "triple bottom line" of social, environmental, and economic factors (Elkington, 1998) reinforces businesses' commitment to practices harmonizing with customer genetic data. Categorizing sustainability practices and interactions (Schaltegger & Wagner, 2011) offers insights into catering to unique genetic personas. Integrating sustainability principles into daily operations (Hopkins, 2016) aligns businesses with customer preferences for sustainable choices. A long-term perspective (World Commission on Environment and Development, 1987) is vital for precise sustainable consumption. "Natural capitalism" (Hawken et al., 2013) aids businesses catering to sustainability-minded customers. Strategic sustainability management (Stead & Stead, 2014) guides precision in consumption. Successful sustainability integration examples (Elkington, 1998) inspire embracing customer genetic data.

The proposed framework for sustainability and innovation management of DNA-based products and services (figure 1) seamlessly integrates genetic data into sustainable innovation, emphasizing ethics and engagement. It aligns with environmental and social goals, creating personalized offerings that resonate with values. This approach drives value, advantage, and societal betterment, ensuring DNA-based products contribute to a sustainable and ethical future.

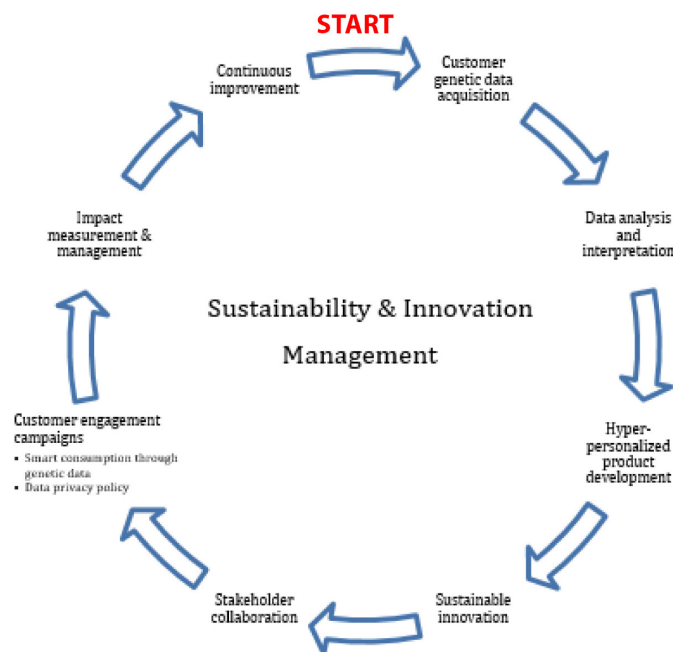


Figure 1. Framework for sustainability and innovation management of DNA-based products and services

Source: Own processing

The framework consists of eight steps, which integrate customer genetic data into the key principles of innovation management:

- Step 1. Customer genetic data acquisition.** Obtaining genetic information from customers through consented means, employing state-of-the-art genetic testing technologies. Upholding data security, privacy, and strict adherence to ethical and legal standards.
- Step 2. Data analysis and interpretation.** Utilization of bioinformatics and data analytics to delve into the genetic data. Identify patterns, variations, and potential health indicators, gaining valuable insights into each customer's unique genetic profile.
- Step 3. Personalized product development.** Harnessing genetic insights to tailor DNA-based products and services to individual preferences, health needs, and sustainable consumption practices. Pioneering innovations in areas such as personalized nutrition, skincare, and fitness.
- Step 4. Sustainable innovation.** Integration of genetic data into the product design process, facilitating the creation of environmentally friendly and socially responsible offerings. Embracing a life cycle perspective, considering the product's entire journey from sourcing to disposal.
- Step 5. Stakeholder collaboration.** Cultivating collaboration with genetic researchers, healthcare professionals, and regulatory bodies to ensure the accuracy, safety, and compliance of DNA-based products.
- Step 6. Customer engagement campaigns.** Developing targeted marketing campaigns that resonate with customers' genetic predispositions and values. Educate customers about the benefits of DNA-based products in promoting sustainable lifestyles.
- Step 7. Impact measurement and management.** Monitoring and assessing the broader effects of DNA-based products and services on consumers, the environment, and the overarching landscape of sustainability.
- Step 8. Continuous improvement.** Continuously refining product offerings and engagement strategies based on evolving genetic insights.

While precision in sustainable consumption remains paramount, it's equally crucial to comprehend the ripple effects that DNA-based products can generate. This entails carefully observing how these offerings resonate within the fabric of society and whether they genuinely contribute to the culture of sustainable consumption and responsible innovation. In this vein, businesses venture beyond the confines of product design and marketing to embrace their role as contributors to a more sustainable and ethically sound future.

6. FUTURE RESEARCH DIRECTIONS

The realm of genetic data business holds intriguing avenues for future scholars to explore. This involves refining the ethical aspects of using genetic information, especially concerning personalized product offerings while safeguarding data privacy. The convergence of technologies like AI and blockchain presents opportunities to balance these concerns. The study of decentralized data sharing's potential impact is another important direction. Investigating data ownership in relation to genetic information is crucial. Additionally, understanding how DNA-based products affect consumer behavior and contribute to sustainability goals on a societal level is a key focus.

Future research could delve into integrating genetic data into healthcare systems and promoting genetic literacy. Thus, scholars can significantly shape the ethical and innovative landscape of the genetic data business. Their insights can navigate complexities and establish responsible practices that balance innovation with ethics.

7. CONCLUSION

Utilization of genetic data for sustainable innovation management enables ecologically friendly and socially responsible product creation. Employing a comprehensive life cycle approach, businesses can ensure positive environmental impacts from sourcing to disposal. Yet, integrating customer genetic data into strategies necessitates addressing ethical concerns around data privacy and consent. Robust data protection and transparent communication are vital to uphold customer confidentiality. Moreover, the potential biases and stigmatization tied to genetic data must be carefully managed to ensure inclusivity. Despite challenges, this integration has the potential to build strong customer engagement and trust.

Behavior genetics and genomic personas offer a potent tool for businesses to enhance sustainability efforts. Understanding the link between genetics and consumer behavior aids in crafting precise strategies for eco-design and sustainable product development. This innovative approach can reshape customer interactions, promoting eco-conscious choices in the market. The framework introduced in this paper plays a pivotal role in bridging the realms of genetics, sustainability, and business innovation. Its primary objective is to guide businesses in effectively incorporating customer genetic data into their sustainable product development strategies. Through the framework's systematic approach, businesses can navigate the challenges of data privacy, ethical use, and potential biases associated with genetic information. The framework's emphasis on societal impact measurement ensures that DNA-based products contribute to a culture of sustainable consumption and responsible innovation, advancing both environmental preservation and economic prosperity.

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