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Rethinking Customer Satisfaction Towards More Sustainable Products – Sufficiency Within the Extended Kano Model

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Abstract: A variety of development tasks rely on value engineering, aiming to achieve maximized functionality and requirement fulfillment with reduced efforts, thereby enhancing product value for improved customer satisfaction. Historically, augmenting system performance, for example, through novel technologies and a higher proportion of mechatronic systems has been regarded as a common method to meet customer requirements more passionately. In this context, the sufficiency strategy of sustainable product development is often perceived as restricting, implying that products embracing sufficiency provide fewer functionalities to reduce the environmental impacts. Consequently, they are supposed to be less enticing, and, as a result, society has to reduce expectations on customer satisfaction. The present work introduces a paradigm shift by portraying sufficiency positively within an extended Kano Model, proposing the 'reverse sufficiency-multifunctionality function' to enhance customer satisfaction through sufficient and sustainable design. The concept is illustrated using common functional requirements for vehicles ensuring its validity.

Keywords: Sufficiency, Customer Satisfaction, Kano Model, Requirements Engineering, Design for Sustainability

1 Introduction

In the landscape of contemporary business, the significance of customer satisfaction cannot be overstated; it stands as a linchpin for ensuring sustained success, particularly in the context of a fiercely competitive and globalized market. Thus, the focal point of product development has increasingly shifted towards customer-centric strategies in recent years, with a dedicated emphasis on understanding, meeting, and exceeding customer needs and expectations. In this pursuit, requirements engineering is gaining substantial traction for its role in operationalizing and optimizing stakeholder- and customer-oriented approaches for deriving product needs. In this context, the Kano Model (Kano, 1984), developed in the 1980s by Noriaki Kano, emerges as a vital tool for categorizing requirements and understanding their impact on customer satisfaction. By leveraging the insights provided by the Kano Model, businesses can prioritize their efforts towards addressing the most critical customer needs and delivering products that not only meet but exceed customer expectations, thus enhancing overall satisfaction and competitive advantage.

Besides customer-oriented activities in product development, an increasing emphasis relies on 'design for sustainability', reflecting an evolving consciousness towards environmental responsibility and ethical consumption (Brenner and Pflitsch, 2017). While the conventional emphasis on 'efficiency' (e.g., same quality with less effort) has historically dominated discussions around sustainability, the rising prominence of the circular economy (Kirchherr et al., 2017) has pushed the concept of 'consistency' (also 'eco-effectiveness', e.g., same quality with different effort) into the forefront. Within this paradigm shift, also the principle of 'sufficiency' (e.g., acceptable quality with reduced effort) has garnered attention as a nuanced approach, offering a novel perspective on balancing customer satisfaction with the triple bottom line of sustainability (Elkington and Rowlands, 1999).

Considering the satisfaction of customer needs as a driver for business success, it is evident that sufficiency, due to its paradoxical nature of seeking to mitigate consumption in a consumption-driven economy, has not yet found widespread application in product development (Bocken and Short, 2016). Therefore, the present work aims to address a pivotal research question:

'How can the sufficiency strategy of design for sustainability not only be integrated but inspiringly represented within the Kano Model for enhancing customer satisfaction?'

The exploration of this question is guided by a literature review in Section 2, delving into the foundational principles of the Kano Model, engaging in a thorough examination and discussion. This section encompasses an analysis of existing literature regarding perspectives on sufficiency in design and customer satisfaction. These efforts reveal weaknesses in current practices and yield to the identification of research gaps in Section 3. By navigating the intricate interplay of customer satisfaction and sustainability within the Kano Model, our aim is to contribute nuanced insights that extend the discourse on sufficiency for design for sustainability by presenting a novel concept for mapping such aspects within an extended Kano Model in Section 4. The proposed concept is validated in Section 5 by presenting a practical use case

example out of the automotive industry referring to the realization of functional requirements. The present work concludes with a discussion, conclusion, and an outlook in Section 6.

2 Literature Review

2.1 Customer Satisfaction and the Kano Model

Product development is a multifaceted process that lies at the heart of every successful business endeavor (Ehrlenspiel and Meerkamm, 2013). It encompasses the conception, design, and realization of products that meet the needs and desires of consumers while aligning with the strategic objectives (e.g., costs) of the organization. Thereby, it is aimed at the cultivation of long-term customer relationships including repeat purchase options through loyalty in accordance with Lewin (2009). Satisfied customers are more likely to become repeat purchasers, brand ambassadors, and advocates, thereby driving revenue growth and market expansion (Miltenović et al., 2014). In an era where customer retention and loyalty are essential for business sustainability and growth, the cultivation of positive customer experiences and relationships is paramount (Lam et al., 2004).

In today's fiercely competitive marketplace, where consumer preferences are constantly evolving and product life cycles are becoming increasingly shorter, the ability to deliver products that not only meet but exceed customer expectations is crucial for sustained success. However, difficulties along product development arise from the various boundary conditions such as intense cost and time pressure, and responsibility regarding sustainability (König et al., 2023b). Therefore, the fundamentals of product development must prioritize the alignment of product features, functionalities, and attributes with the evolving needs and preferences of customers. By adopting a customer-centric approach to product development, organizations can gain deeper insights into customer needs, preferences, and pain points, allowing them to design and deliver products that resonate with their target audience and engender lasting satisfaction and loyalty. The Kano Model is a method for classifying customer requirements based on their impact on customer satisfaction. It represents a methodology to describe an exponential relationship between customer excitement and need fulfillment. The model distinguishes between basic requirements (essential quality attributes), performance requirements (performance quality attributes, also known as one-dimensionals in accordance with Sauerwein (2000)), and exciting requirements (excitement quality attributes). This classification enables companies to strategically align their product development efforts and address the needs of their customers more effectively, particularly through the integration of the Kano Model with 'quality-function-deployment' (QFD) (Matzler and Hinterhuber, 1998) or other methods for acquiring the 'voice-of-customer'. The typical classification of requirements in the Kano Model includes the following categories of quality-attributes:

- **Basic requirements** are fundamental functions or features that customers consider to be taken for granted. Their non-fulfillment leads to dissatisfaction, while their fulfillment does not generate significant satisfaction.
- **Performance requirements** are functions or features where there is a direct correlation between their fulfillment and customer satisfaction. The better these requirements are met, the more satisfied the customer.
- **Exciting requirements** are those that exceed customer expectations and positively surprise them. Their fulfillment leads to a significant increase in customer satisfaction, while their non-fulfillment does not cause significant dissatisfaction.

Products that only meet basic and performance requirements are considered average and interchangeable (Sauerwein, 2000). Thus, the Kano Model provides insights into potential purchasing decisions of customers by illustrating the hierarchy of customer requirements. While must-haves contribute minimally to customer satisfaction, reflected in their curve often only barely reaching the upper half of the diagram, attractive quality attributes predominantly drive purchase decisions (Sauerwein, 2000). One-dimensionals can support purchase decisions if they locate on the top right side within the diagram.

Fundamentally, customer perceptions of attributes change over time. Excitement requirements become one-dimensionals (Sauerwein, 2000), meaning they shift towards customer dissatisfaction while maintaining the same level of requirement fulfillment. Ultimately, they become basic requirements, thus, they generally move from top to bottom of the satisfaction hierarchy.

This classification represents the classical categorization by Noriaki Kano, with the intention that functional improvements evoke excitement. However, this classification is viewed critically and as insufficient (Mikulić and Prebežac, 2011). For instance, studies indicate that usability is more important than performance for customer satisfaction (Kekre et al., 1995), suggesting the need for additional categories of quality attributes in the Kano Model. An important extension of the traditional Kano Model relates to **inverse quality attributes** (Chen and Chuang, 2008), which represent functions or features whose reduction or limitation leads to increased customer satisfaction. While the traditional Kano Model focuses on improving functions to increase satisfaction, the consideration of inverse attribute requirements addresses the possibility of increasing customer satisfaction through targeted reduction of certain features. Furthermore, **indifferent quality**

attributes (Chen and Chuang, 2008) within the Kano Model refer to features or functionalities that exert minimal influence on customer satisfaction. These attributes neither evoke delight nor dissatisfaction when present or absent. Recognizing these attributes is imperative for efficient resource allocation in product development endeavors. However, their relevance may fluctuate across diverse customer segments, underscoring the necessity for comprehensive market research.

2.2 Strategies for Environmental Sustainability

Design for sustainability is rooted in the principles of environmental responsibility and social stewardship, aiming to minimize negative impacts on the environment and society while delivering value to customers. Within a holistic framework, three core sustainability strategies play pivotal roles in guiding product design and development processes (König et al., 2023a) towards environmental sustainability:

- ***Efficiency*** focuses on optimizing resource utilization while enabling the same or even a better product quality. This strategy involves enhancing energy efficiency, reducing material consumption, and streamlining production processes to minimize environmental footprints. For instance, implementing lightweight structures, improving manufacturing processes, and optimizing logistics can contribute to overall efficiency gains. They are limited to physical restrictions of technologies and processes.
- ***Consistency*** or (eco-)effectiveness emphasizes aligning product design and production practices with the principles of the circular economy, realizing the same product quality by consuming other efforts. This strategy aims to create closed-loop systems where materials circulate. Designing products for disassembly, implementing reverse logistics systems, and fostering partnerships with suppliers for material recovery are key initiatives under the consistency strategy.
- ***Sufficiency*** represents a paradigm shift towards reevaluating consumption patterns and prioritizing the fulfillment of essential needs over excessive consumption. This strategy advocates designing products that meet functional requirements with minimal material and energy inputs, thereby reducing overall resource consumption and environmental impact. Implementing minimalistic functionalities (Kaspar et al., 2022) and a long product durability, promoting product longevity through modular design, and encouraging product sharing or leasing models are examples of sufficiency-oriented approaches offering benefits on the environment.

Linking these sustainability strategies with the triple bottom line concept of sustainability (Elkington and Rowlands, 1999) (environmental, social, and economic aspects) poses challenges as the strategies operate at a higher level (Brinken et al., 2022). An initial approach by Metzner-Szigeth (2019) attributes efficiency measures to a technological dimension and, consequently, to focusing on the reduction of resource consumption (mainly environmental aspects). Furthermore, consistency is primarily linked to environmental sustainability, and sufficiency matches socio-economic aspects operating on an even broader societal scale. However, as a clear differentiation is not feasible, we mainly focus on environmental sustainability and, additionally, consider the influences of business model variations for the sake of simplification.

2.3 Perspectives on Sufficiency

Sufficiency is often met with the preconceived notion that it inherently involves enabling less, thereby reducing customer expectations and requirements. Therefore, it lacks the allure associated with more performance-oriented offerings. However, this perception overlooks the nuanced potential of sufficiency as a strategy for promoting sustainability, and customer satisfaction. Despite the challenges posed by conventional attitudes towards sufficiency, there are various ways it can be implemented in products (Brinken et al., 2022; Princen, 2003; Sandberg, 2021):

- **Modular and upgradable designs**. The adoption of modular design principles allow for easy disassembly, repair, and upgradability of products. By designing products with interchangeable components and standardized interfaces, companies can extend product lifetimes, reduce electronic waste, and provide customers with the flexibility to customize and upgrade their products over time.
- **Product longevity and durability.** Prioritizing durability and longevity in product design using high-quality materials and robust construction techniques can ensure that products withstand the test of time. By designing products that are built to last, companies can reduce the frequency of replacements and repairs.
- **Shared economy models.** Shared economy models, such as product leasing, rental, or subscription services, typically prioritize access to goods and services over ownership. By shifting towards shared ownership models, companies can maximize the utilization of products and minimize idle capacity.
- **User-centric design.** Adopting a user-centric approach to product development, involving customers in the design process supports a better understanding of their needs, preferences, and usage patterns. By co-creating products with customers, companies can ensure that products are tailored to meet specific user needs, resulting in higher levels of satisfaction and engagement.
- **Education and awareness.** Invest in educating consumers about the benefits of sufficiency-oriented products and the importance of sustainable consumption practices. By raising awareness about the environmental and

social impacts of overconsumption, companies can empower consumers to make more informed purchasing decisions and embrace sufficiency as a desirable and responsible lifestyle choice.

- **Streamlined and minimalistic design.** Emphasizing the essentials, minimalistic design for sufficiency aims to maximize functionality while eliminating excess, thereby efficiently utilizing resources. This design philosophy prioritizes simplicity, focusing on essential features to enhance user experience and minimize environmental impact.

2.4 Minimalistic Design as Enabler of Sufficiency

Minimalism is recognized as a means to prioritize meaningful pursuits associated with happiness, fulfillment, and freedom (Hook et al., 2023). It finds application in various fields such as arts, music, and architecture (Obendorf, 2009), including, for instance, minimalistic graphic design and logo creation (Gumber, 2023). In software engineering, minimalism is reflected in feature-driven development and feature-based negotiation. Technical examples cover single-speed bicycles, remarkable notepads or no-frills flying. The consumerist culture's abundance of goods often leads to environmental degradation and dissatisfaction (Kasser and Kanner, 2004), making minimalism a compelling alternative. It significantly contributes to a product's usability (Nguyen, 2019) and serves as a paradigm shift and enabler for sustainability as part of the sufficiency strategy (Kang et al., 2021). It gained in popularity in highly consumerist countries like the USA, Japan, and European nations (Uggla, 2019).

3 Sustainability Strategies and Customer Satisfaction Within the Kano Model

3.1 Classical Understanding

The impact of integrating the strategies of design for sustainability (efficiency, consistency, and (classical) sufficiency) within the Kano Model is illustrated in Figure 1. Thereby, the varying impacts of these sustainability strategies on customer satisfaction and product performance is considered. We draw upon the theoretical aspects explained in Section 2 regarding the understanding of the sustainability strategies and conclude the following concept as state-of-the-art and classical understanding.

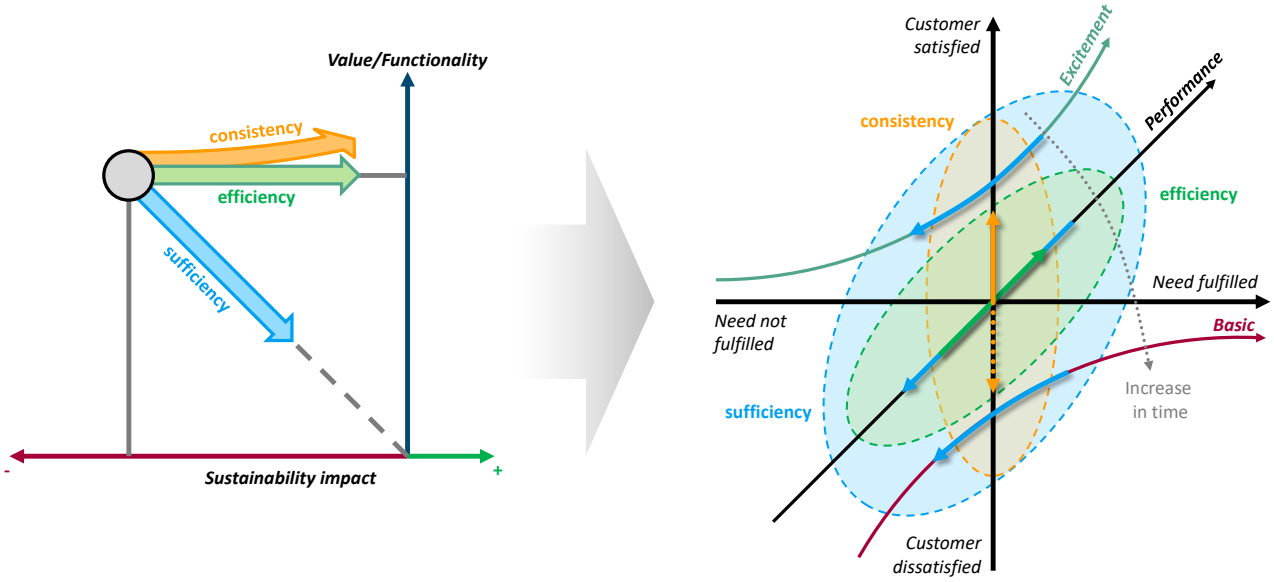

Figure 1. Classical understanding regarding effects of the sustainability strategies (efficiency, consistency and sufficiency) on the product's value/functionality, its sustainability impact, and the customer satisfaction within the Kano Model

Efficiency. In the context of the Kano Model, efficiency corresponds to optimizing performance requirements to achieve maximum value with minimal resource consumption or, in general, effort. This optimization typically results in improvements or a streamlining of existing features without sacrificing quality. In terms of the Kano Model's classification, efficiency-related improvements would manifest as upward shifts along the diagonal axis, indicating enhancements in performance that contribute positively to customer satisfaction or realizing the same performance with reduced environmental impact. For example, reducing energy consumption of a vehicle while maintaining the same level of functionality or improving manufacturing processes to minimize waste generation would be considered efficiency-driven improvements and shift quality attributes on the performance-axis to the top right corner.

Consistency or (eco-)effectiveness in the Kano Model refers to maintaining a consistent level of requirement fulfillment across different product features or attributes. While consistency does not necessarily involve enhancements in performance, it ensures that customer expectations are met reliably and predictably. In the Kano Model framework, consistency-related adjustments would result in vertical shifts of attributes (can have a positive or negative effect on customer satisfaction), indicating changes in how requirements are fulfilled or how the way of fulfillment is accepted (e.g., enthusiasm for a rejection of electric vehicles) rather than the (objective) level of satisfaction they provide.

(Classical) ***sufficiency*** represents a departure from the traditional focus on maximizing customer satisfaction towards a more balanced approach that combine essential functionality with resource efficiency and effectiveness. In the Kano Model, sufficiency-driven changes – in the classical understanding – would typically manifest as shifts towards the lower-left quadrant, indicating a reduction in need fulfillment and potentially lower levels of customer satisfaction. For example, offering simplified product versions with essential features (e.g., omitting the air condition in a car) or promoting usage scenarios that emphasize functionality over extravagance would align with sufficiency-oriented strategies and cause a shift to a lower degree of need fulfillment as well as customer satisfaction.

3.2 Weaknesses of the Classical Understanding

Efficiency measures consistently yield positive effects when improved in the Kano Model and are, as a consequence, relatively easy to justify to the customer and to promote in decision-making within product development. Supporting this understanding, existing literature presents methodologies (e.g., the contributions of Mishimar (2023) as well as Tandiono and Rau (2022)) for transparently translating classical efficiency enhancements, identified as customer desires, into technical requirements using (environmental) QFD. This process results in their positive representation within the Kano Model. However, while consistency measures can have effects in both directions (positive and negative representation in the Kano Model), sufficiency measures only result in a shift of quality attributes towards customer dissatisfaction and a lower degree of need fulfillment in the classical understanding. Thus, implementing sufficiency tends to decrease product excitement, making sustainably designed products appear less attractive due to reduced functionality and requirement fulfillment, advocating society to reduce expectations. Having this restricting undertone in mind, the issue of holistically implementing sustainability by each of the presented strategies while promoting customer satisfaction requires a novel methodology presenting classical sufficiency-oriented measures in a way that portrays sustainably designed products inspiringly from the customer's perspective.

Thus, we build upon the idea of Bocken and Short (2016), who noticed, that there is an upcoming tendency to focus more on 'promoting wants' rather than 'satisfying essential needs' in product development. This shift in focus emphasizes the importance of aligning product features and attributes with genuine customer needs and preferences, rather than simply catering to superficial desires. This shift towards a needs-based approach to product development reflects a growing recognition of the importance of sufficiency in today's competitive marketplace. Therefore, recent studies have highlighted the positive effects of minimalism on consumer happiness, as minimalism fosters increased self-awareness, enhanced retrospection, positive emotions, and sustainability benefits (Bryant and Veroff, 2017; Ivtzan and Lomas, 2016; Kang et al., 2021). Furthermore, minimalism supports the personal well-being (Kasser, 2009) and enhances quality-of-life, as evidenced by a recent study from China (Fu et al., 2023). Consequently, the rise of minimalism-driven lifestyles has been identified as a potential game-changer for industries, particularly concerning environmental sustainability (Amritesh and Kaur, 2023). Additionally, from an economic perspective, sufficiency may represent the most promising strategy for sustainable market growth, as revenues can be generated independently of material consumption through altering business models (e.g., shared economy models). In this regard, the implementation of efficiency measures may be the least economical (involving high levels of investment in technologies and process optimization with only marginal reductions in negative environmental impacts), while consistency measures may be economically indifferent (due to shifted environmental impacts and the resulting unclear relationship between costs and environmental benefits). We aim to transparently illustrate these positive aspects of sufficiency on decision-making in product development. Therefore, the subsequent section introduces the concept of the extended Kano Model resolving the negative impact of (classical) sufficiency, thereby addressing the initial formulated research question**.**

4 The Concept of an Extended Kano Model

4.1 Rethinking Customer Satisfaction Through Inspiring Sufficiency and Unattractive Multifunctionality

The fundamental concept of the proposed extended Kano Model is based on the operationalization of describing inverse quality attributes, incorporating the sufficiency concept in terms of its positive effects on customer satisfaction through minimalism and customer dissatisfaction through overconsumption. The basic mechanism is depicted in a directed morphological box in Figure 2, illustrating the idea that functional requirements can be addressed at different levels of functionality.

Sufficient design (solution principle A) relies on elegance and conscious simplicity in addressing functional requirements. By adopting a less-is-more philosophy, a manageable, easily repairable, and simple-to-disassemble product architecture results, which can increase the emotional value, particularly for lightweight products (König and Vielhaber, in press), through streamlined interactions and eliminated distractions. Historically, products guided by such design principles only fulfill basic quality attributes, meaning they do not directly evoke customer delight according to the classical understanding of the Kano Model. However, they offer benefits to usability and sustainability inherent in the inspiring sufficiency concept, resulting in **reverse sufficiency quality attributes**.

Multifunctional design (solution principle C) is situated on the right side of the directed morphological box and driven by the pursuit of greater performance and improved functionality to delight and retain customers. Nevertheless, as indicated by Hallowell (1996), this holds true only as long as technical and environmental conditions remain stable, which are evolving due to global warming and the growing awareness about overconsumption of goods. Consequently, significant drawbacks arise in customer satisfaction regarding **reverse multifunctionality quality attributes**, as products become difficult for end-users to repair and to handle at the end of their life cycle, inherently exhibiting a higher level of emotional or psychological obsolescence (Palafox, 2020), potentially leading to customer dissatisfaction.

Comfortable design (solution principle B) lies between these design strategies, offering potential for customer delight by facilitating processes and slightly enhancing the fulfillment of functional requirements without significant increases in product architecture complexity. Moreover, comfortable design does not impose significant environmental impacts and can also enhance customer delight through ease of repairability.

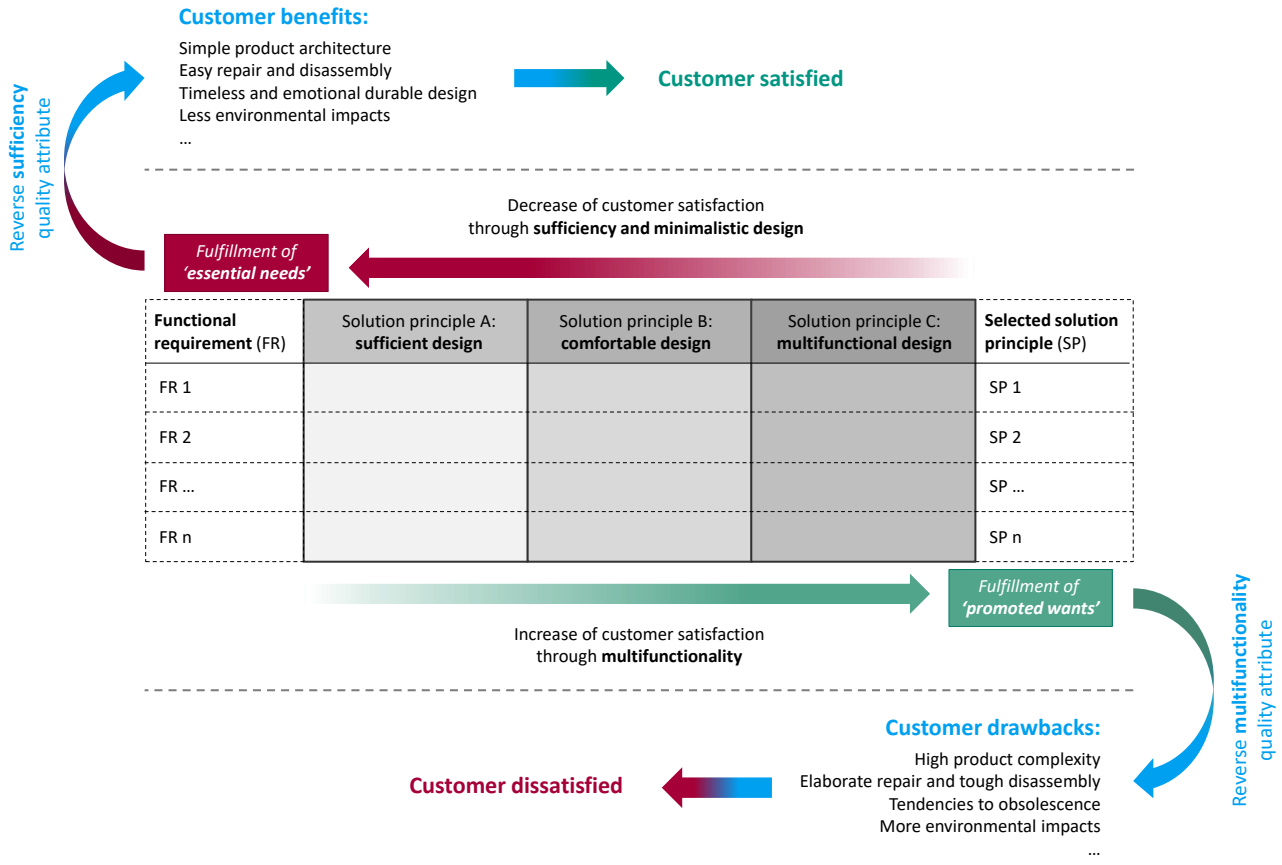

Figure 2. Concept of reverse customer satisfaction through an inspiring sufficient design within a directed morphological box

4.2 The Reverse Sufficiency-Multifunctionality Function Within the Extended Kano Model

Building upon the concept of shifting requirements, as illustrated in blue in Figure 3, the **reverse sufficiency-multifunctionality function** is defined, moving inversely between need fulfillment and customer satisfaction. It is based on the implied inspiring customer benefits of sufficient designs through reduction, and the potential customer drawbacks of multifunctionalities in complex product architectures outlined in the preceding subsection. As a result, unmet 'promoted wants' are classified as delight-inducing and categorized as **reverse sufficiency quality attributes** in the upper left quadrant of the extended Kano Model, when focusing on the high-quality implementation of 'essential needs'. In contrast,

traditionally delight-inducing performance and multifunctionality-driven requirements are situated in the lower right quadrant. They address non-essential promoted wants and lead to customer dissatisfaction due to their drawbacks on customer excitement as well as embracing more environmental impacts and are indicated as **reverse multifunctionality quality attributes**. In the center of the extended Kano Model, one-dimensional performance attributes shift minimally (**indifferent quality attributes**), as design changes only slightly alter customer delight and functionality (e.g., by implementing comfortable design principles). Only radical changes shift them inversely between customer satisfaction and need fulfillment along the sufficiency-multifunctionality function. At that point, they are no longer classified as performance attributes but rather as excitement or basic requirements in the classical Kano Model.

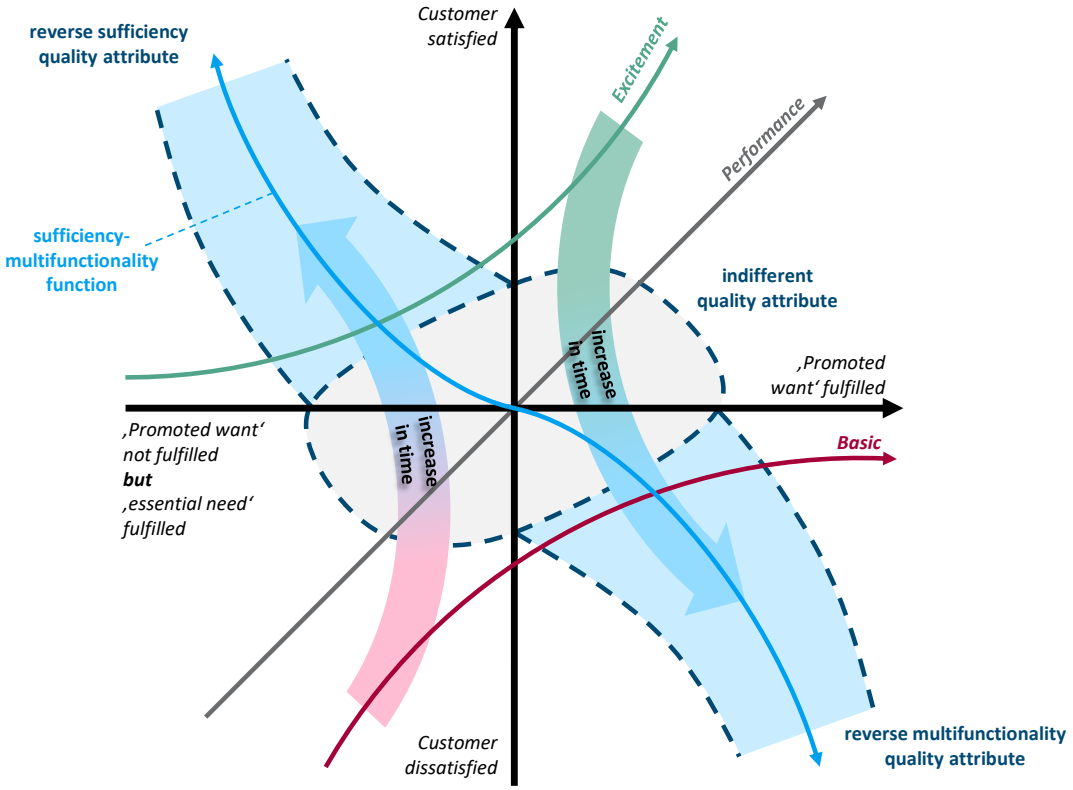

Figure 3. The extended Kano Model proposing the reverse sufficiency-multifunctionality function for quality attributes

4.3 Re-Interpreting the Temporal Dimension

In the traditional Kano Model, the temporal aspect is considered as excitement requirements gradually transition over time into performance, and finally into basic requirements. Consequently, quality attributes in the classical Kano Model migrate from top to bottom. However, the extended Kano Model, with the inclusion of the sufficiency-multifunctionality function, presents a different perspective. Essential need requirements, which have long been regarded as implicit basic requirements, can evolve over time from bottom to top, progressing from performance to excitement requirements in terms of reverse sufficiency quality attributes. Here, a simple design with high-quality fulfillment of essential needs without the addition of features and functionalities becomes customer exciting. Conversely, the implementation of promoted wants may overwhelm customers with product complexity, challenging repair processes, and other aspects, thus dissuading them from making a purchase decision. Consequently, attributes typically considered excitement requirements increasingly transform into reverse multifunctionality quality attributes and migrate along the customer satisfaction axis in the extended Kano Model from top to bottom. This underlying notion is supported by the correlation between age and minimalistic design. A study by Malik and Ishaq (2023) indicates that as product users' age increases, a pure yet high-quality fulfillment of essentially needed functionalities becomes increasingly exciting. If this correlation is generalized to inspiring sufficiency measures in general, it may result in the inverse temporal shifting of requirements in the extended Kano Model based on the sufficiency-multifunctionality function.

4.4 Limitations of the Extended Kano Model

In essence, the proposed categorization and potential classification of requirements along the sufficiency-multifunctionality function aim to introduce a new mindset for positively portraying the concept of inspiring sufficiency within the Kano Model. Nevertheless, this representation and interpretation of requirements merely present another means by which customers can become either delighted or dissatisfied. Due to the diversity of customers with various subjective

perceptions of products and functionality, this model certainly cannot be universally applied in place of the classical Kano Model. Nonetheless, when evaluating functional requirements and solution principles, it remains imperative to accurately solicit customer expectations. Mapping such requirements on the inverse sufficiency-multifunctionality function is another approach to positively represent minimalism, thereby promoting environmental friendliness through reduction and making the added value tangible.

Thus, it's important to recognize the limitations of the extended Kano Model. Firstly, it may – as the classical Kano Model – not adequately capture the nuances of cultural differences in customer preferences, as what constitutes excitement or satisfaction may vary across different cultural contexts. Secondly, the model may struggle to account for rapidly changing technological advancements, which can significantly impact customer perceptions and expectations. Thirdly, there is a risk of oversimplification, as the model may overlook complex interactions between different attributes and fail to capture the multidimensional nature of customer satisfaction. Finally, the extended Kano Model may face challenges in accurately predicting future trends and shifts in customer preferences, particularly in dynamic and unpredictable markets. Therefore, while the extended Kano Model offers valuable insights into customer satisfaction dynamics, it should be used judiciously and complemented with other methodologies to ensure a comprehensive understanding of customer needs and preferences.

5 Application Example: Functional Requirements for Vehicles

In Figure 4, the concept of the extended Kano Model is illustrated on the application example of functional requirements for vehicles, that can be addressed in various ways regarding the degree of functionality. The extended Kano Model operates primarily at a higher meta-level, serving to foster a paradigm shift in product development for engineers and management in their decision-making regarding design alternatives. Additionally, it can be utilized for communication purposes with customers, aiming to render sufficiency-related decisions more transparent. For this purpose, the directed morphological box (explained in Figure 2, visualized on the left side in Figure 4) serves as a tool for gathering ideas pertaining to various solution concepts, ranging from sufficient to comfortable, and up to multifunctional design, each differing in the degree of delivering performance required to fulfill respective functional requirements.

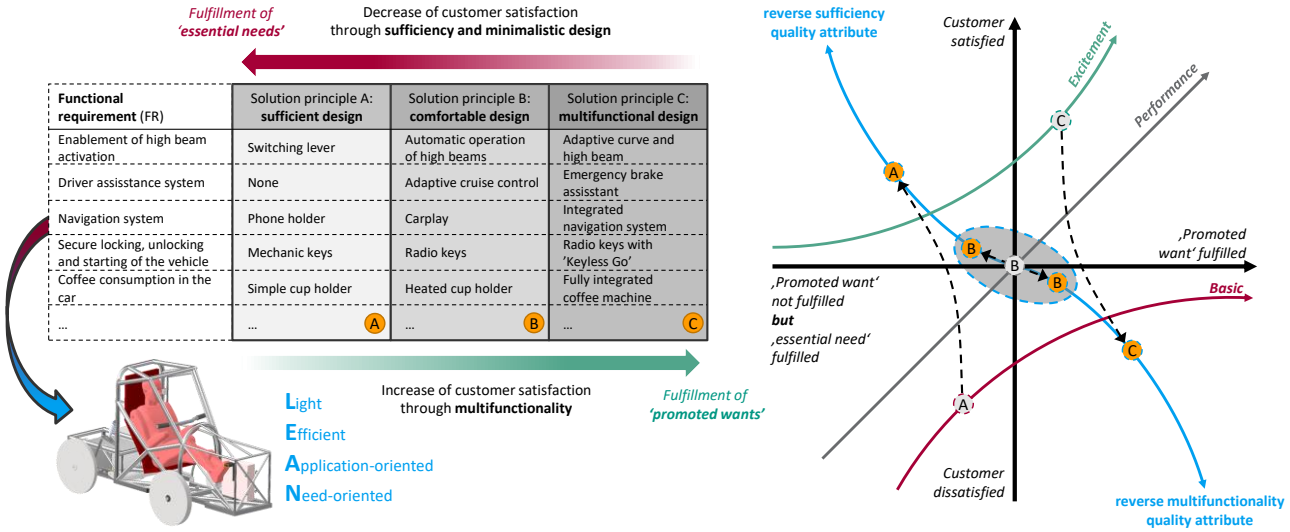

Figure 4. Exemplary implementation of the extended Kano Model on three functional requirements for vehicles and the shifting of reverse quality attributes on the reverse sufficiency-multifunctionality function

They can be allocated within the extended Kano Model (presented in Figure 3, illustrated on the right side of Figure 4), quality attributes shift inversely on the sufficiency-multifunctionality function (from grey to orange). This means that the sufficient realization of a functional requirement can become exciting to customers over time, even though it originally represents an uncommunicated basic requirement. Consequently, there is a shift of the quality attributes towards the top left to reverse sufficiency quality attributes. This can be exemplified for high beams, for instance, in the concept of a classic high beam that is switched on and off via a lever aside of the steering wheel.

The multifunctional solution concept by realizing the functional requirement of high beams through an adaptive and automatically regulated curve and high beam brings higher environmental impacts (manufacturing of sensors, microcontrollers, and wiring, as well as a higher energy consumption during usage and an additional vehicle weight causing a higher impact on the environment, while providing a complex handling and disassembly of components at end-of-use). This can significantly increase product complexity for customers, potentially overwhelming them and dissatisfying them as a result. At the same time, implementing the functional requirement through this initially intended

as customer-exciting multifunctional realization poses an increased risk of malfunction during operation, ultimately reducing usability and consequently customer satisfaction. Thus, a solution concept historically interpreted as an excitement requirement shifts towards reverse multifunctionality quality attributes, towards customer dissatisfaction within the extended Kano Model on the sufficiency-multifunctionality function towards the bottom right.

Realizing functional requirements through a comfortable solution in balance between sufficient and multifunctional design experiences only minimal impacts in the realm of performance attributes due to the design change, as the customer is not overloaded by non-pragmatic functions and yet does not have to forgo important functionalities. This design paradigm can also bring advantages from a sustainability perspective and despite increased functionality, bring valuable secondary effects. As a consequence, there will be only a low up to no shift of the requirements solution principle on the sufficiency-multifunctionality function over time.

Such design considerations regarding the degree of functional requirement realization can influence future mobility concepts. As a possible example, lightweight electric vehicles, explicitly tailored to customer needs and realized in an application-oriented manner, may gain importance. In this context, König et al. (2024) conclude that technically outstanding lightweight products, which achieve an increased lightweight degree through reduced functionality, can enhance the emotional value of products for customers and thereby contribute to products being used as long and as carefully as possible promoting a circular economy.

6 Discussion, Conclusion & Outlook

Customer-centric product development stands as a cornerstone of market success, fostering consumer loyalty and satisfaction (Lewin, 2009). However, a common pitfall lies in the tendency to over-engineer products, prioritizing novelty and performance-oriented multifunctionality over essential needs. This approach can lead to dissatisfaction and pose challenges in long-term customer retention. Moreover, amid the backdrop of increasing environmental consciousness, concerns arise regarding the sustainability of this prevailing trend.

Traditional sustainability strategies, such as efficiency and consistency, may fall short in fully addressing the multifaceted challenges of sustainable product development. Therefore, we entered the concept of inspiring sufficiency: a paradigm shift towards balanced, sufficient design that meets core needs without excess. Aligned with the minimalist movement's emphasis on well-being and enhanced quality-of-life, inspiring sufficiency advocates for products that prioritize essential functionality and durability while minimizing resource consumption and environmental impacts. This approach offers a more measured and balanced alternative to incessant innovation and consumption, contributing to personal well-being and enhanced quality-of-life on a global scale.

By embracing inspiring sufficiency-oriented approaches, companies can not only enhance the sustainability of their product offerings but also foster deeper connections with customers by aligning with their core values and aspirations for a more sustainable future. To visually reconcile this aspect of sufficiency with business success and long-term customer retention through loyalty, the quality attributes of the Kano Model were discussed and re-evaluated as a representation of customer satisfaction compared to need fulfillment. In this regard, an inverse relationship between requirement fulfillment and customer excitement was proposed. This approach allows sufficiency to be portrayed positively through the fulfillment of only essential needs, detached from previous considerations, while also mitigating the promotion of unnecessary wants that may detract from customer excitement. The resulting extended Kano Model was validated using the example of a lightweight electric vehicle and its features. As a consequence, new mobility concepts such as LEAN-Mobility (Kaspar et al., 2020; Vielhaber et al., 2017), focusing on essential user needs with reduced comfort but also reduced environmental impacts, may gain in significance in the future in contrast to overengineered car concepts. Furthermore, as we focused on environmental sustainability, the influence of socio-economic aspects of the sustainability strategies on customer satisfaction can be analyzed in more detail in future work.

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