



Design for Six Sigma in Product Development

Integration of Sustainability in the RG0-TT Mountain Bike Case Study

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The Methodology



**Metodologi DFSS
(IDOV)**

The IDOV Approach

Design For Six Sigma (DFSS) utilizes the IDOV framework to move beyond problem-solving into preventive, high-performance design.



Identify

Define business cases, collect Voice of the Customer (VOC), and translate needs into CTQs.



Design

Analyze CTQs, establish functional requirements, and select the optimal product concept.



Optimize

Refine detailed designs to ensure robustness and reduce variability in features.

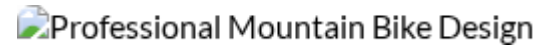


Validate

Final testing and verification against project objectives and customer expectations.

Focus: The RG0-TT Mountain Bike

Platform Strategy



RGBike aims for market leadership with a "Middle-Class" platform targeting 95% of users (Travel, Leisure, and Engagement segments).

- ✓ High-grade 7000 Series Aluminum frame.
- ✓ High-end braking system for enhanced safety.
- ✓ Modular customization for multiple terrains.
- ✓ Target Retail Cap: EUR 900.

Voice of the Customer (VOC) Collection

Reactive Collection

Focuses on historical data and current complaints.



Warranty Analysis & Claims.



Customer/Dealer Complaint Analysis.



Reliability testing over 10,000 km mileage.

Proactive Collection

Focuses on latent needs and competitive edge.



Field Tests & Customer Interaction.



Targeted Interviews (Kano Model).



Industry Journal & Literature Reviews.

Reliability Analysis: Failure Rate Trends

Testing 15 vehicles over 10,000 km identified three critical anomaly zones where failures deviate from standard linear wear.



Primary Anomaly Findings: Front brake disc wear (3,400km), Friction in front fork (6,000km), and Linear cracks in braking system (8,400km).

Prioritizing CTQ: AHP Pairwise Comparison

CTQ Code	Description of Technical Parameter	Importance (AHP %)	Difficulty (0-10)
C7.1	MTBF/MKBF Braking System	3.66%	5
C8.2	Seat Height Adjustment Time	3.52%	7
C8.5	Number of Available Customizations	2.67%	3
C7.3	Front Brake Disc Size (Increased to 180mm)	2.65%	1
C3.5	Cost of Frame Structure Group	3.40%	2

The Analytical Hierarchy Process (AHP) ensures that subjective customer voices are transformed into mathematically prioritized technical requirements.

Relationship Analysis: The HoQ

House of Quality (HoQ)

Evaluates 3,318 VOC-CTQ correlations and 6,162 CTQ-CTQ interactions (roof matrix).

Critical CTQs: Features with high active and passive relationships (e.g., Brake Reliability).

Reactive CTQs: Features strongly influenced by others (e.g., Comfort Parameters).

Enhancing Efficiency Through Lean Six Sigma Principles



Competitive Benchmarking Analysis

Comparison of RG0-TT performance against industry leaders to identify the "Quick Wins" and "Breakthrough Required" zones.



🚀 Quick Wins: Front Derailleur (Easy improvement, high impact).

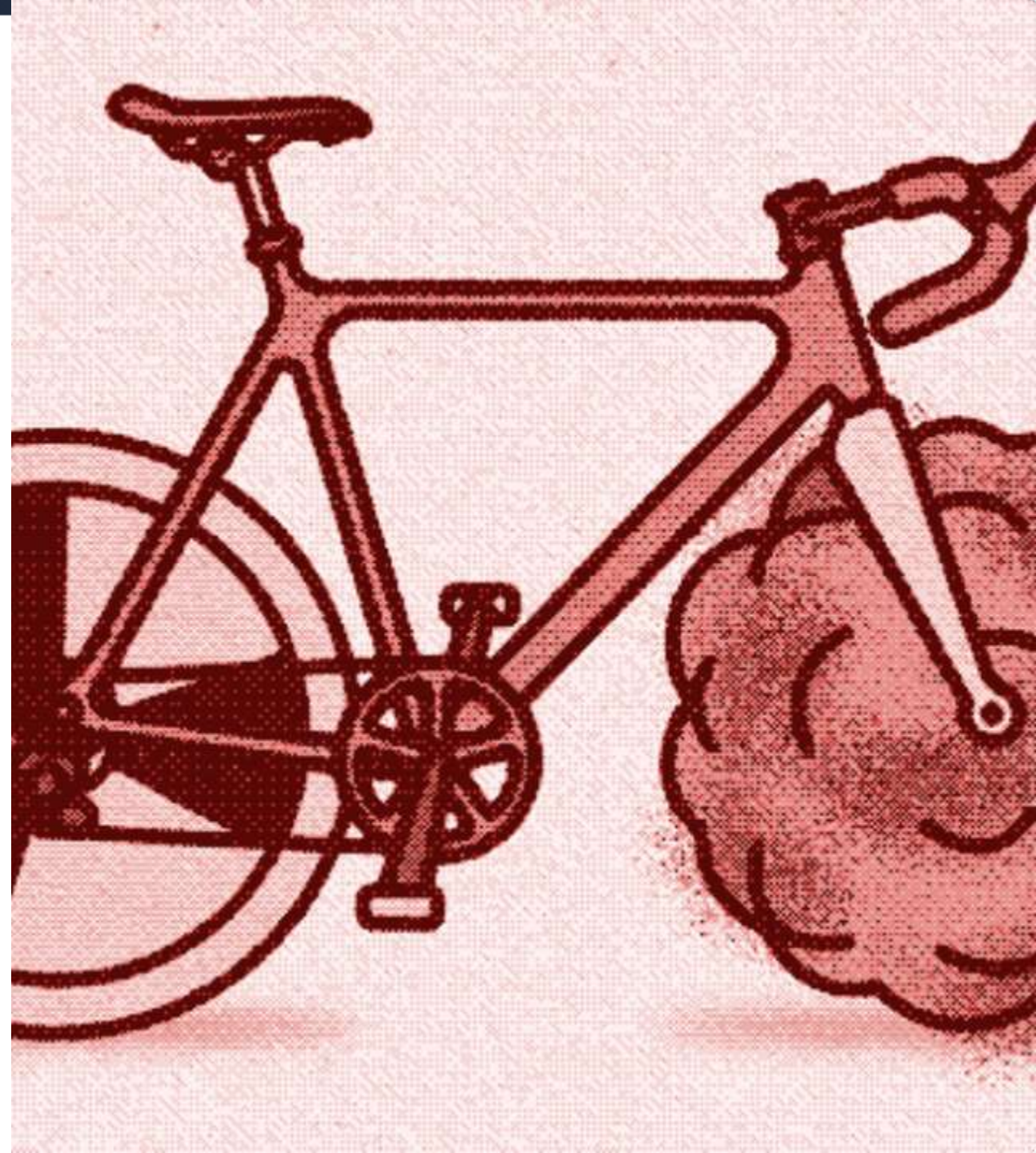
🚧 Bottlenecks: Seat Height Adjustment & Brake MTBF.

Sustainability & Design Excellence

Improving MTBF and MTTF directly reduces material and energy waste over the product's life cycle.

- 🌿 **Eco-Efficiency:** Design changes must balance GWP (Global Warming Potential) vs. Durability.
- ♻️ **Lifecycle Thinking:** Aluminum frame offers 40% substitution factor via recycling.
- 🔧 **Intelligence Driven:** Leveraging DFSS tools for precise, sustainable redesign.

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Improvement Result

KPI Utama	Before	After	Peningkatan
Reliability Brake System	3.500 km	8.000 km	+128,6%
Durability Komponen Utama	rata-rata 148 jam	rata-rata 300 jam	+102,7%
Safety Performance (Deceleration)	0,32 g	0,40 g	+25,0%
Customization Capability	4 opsi	8 opsi	+100,0%
Warranty Coverage	2 tahun	3 tahun	+50,0%
Ergonomic Adjustment Time	60 detik	3 detik	-95,0%

Reference

Arcidiacono, G., Risaliti, E., & Del Pero, F. (2024). Design for Six Sigma in the product development process under a sustainability point of view: A real-life case study. *Sustainability*, 16(23), 10387. <https://doi.org/10.3390/su162310387>