Hardnut Report – Egholm A/S

Introduction

Egholm A/S is a Danish, family-owned company located in Lemvig, founded in 1992. The company specializes in developing robust utility machines that maintain urban environments, parks, and public spaces. Their machines are used globally by schools, hospitals, and municipalities and are known for reliability, flexibility, and innovative design.

In recent years, Egholm has faced a new challenge arising from the electrification of their product line. Electric drivetrains are quieter and cleaner, but they also expose the limitations of battery capacity and energy management. One of the main barriers to broader market adoption is the short operational time of current models: while the combustion-engine tractors can operate all day, the electric versions typically last only 2–3 hours, whereas the goal is 8 hours of continuous operation.

This challenge is not purely technical. It also concerns how the machines are used and how operators' habits, comfort preferences, and task planning influence real-world energy consumption.

Hence, our defined Hardnut problem became:

"Hvordan kan vi påvirke og støtte brugerens adfærd, så E-Traktoren bruges mere energieffektivt i daglig drift – uden at det opleves som en begrænsning – og dermed bidrage til lavere driftsomkostninger og øget markedsværdi?"

Understanding the Problem

Egholm's electric tractors represent a critical step toward sustainable municipal maintenance. However, maximizing their efficiency requires both technological optimization and human-centered innovation.

From our company visit and dialogue with Egholm's engineers, we learned that:

- Approximately ¼ of the tractor's total cost comes from the battery pack.
- Operators often run machines at unnecessarily high power levels, draining energy faster.
- Tasks such as mowing wet grass or vacuuming dust in high humidity can drastically increase power consumption.
- Comfort-related energy uses, such as cabin heating or cooling, further shorten runtime.

It became evident that improving efficiency is not simply about installing bigger batteries or redesigning motors it’s about helping users operate smarter, supported by technology that assists without restricting.

This insight led us to focus on behavioral optimization through feedback and guidance rather than full automation. The solution must support, not replace, the user’s expertise.

Exploration and Methods

We followed the Double Diamond framework to structure our innovation process.

1. **Discover:**
   We began by understanding Egholm’s mission, technical setup, and operational context. The visit to Lemvig and the presentation by company representatives gave valuable insights into user scenarios and product constraints.
2. **Define:**
   We analyzed where the greatest energy inefficiencies originate and found that user behavior, environmental conditions, and comfort settings were key factors. From here, we defined our Hardnut around user behavior and energy optimization.
3. **Develop:**
   We brainstormed several solution categories:
   - Gamified user interfaces providing feedback on driving style or power use.
   - Automatic power regulation based on humidity and workload.
   - Modular cabin concepts with season-specific insulation to reduce HVAC loads.
   - Predictive energy estimation tools that help operators plan work schedules around weather and charging cycles.
4. **Deliver:**
   Through discussion and evaluation, we converged on a human-centered, data-driven concept: a system that measures environmental and operational parameters, provides actionable feedback to the operator, and uses AI to learn optimal usage patterns over time.

The Proposed Concept – Supporting Efficient Behavior

Our proposed concept, the Energy-Aware Assistance System (EAAS), aims to support users in operating the E-Tractor efficiently without reducing performance or flexibility.

The system combines sensor-based data, user feedback, and AI-based learning to guide behavior subtly:

- Environmental sensors measure humidity, surface resistance, and temperature.
- Operational sensors monitor speed, torque, and energy flow.
- The system processes this data to assess the tractor's real-time energy profile.
- A simple interface (dash display or app) provides feedback for example, a green smiley when driving efficiently or a gentle warning when unnecessary power is used.

The design principle is "nudge, not limit":
instead of forcing restrictions, the system nudges the operator toward energy-efficient choices through intuitive feedback.

This approach is technically feasible because the sensors required already exist in modern electric drivetrains. Strategically, it strengthens Egholm's brand as a smart, sustainable, and user-friendly equipment manufacturer. From a user perspective, it enhances satisfaction because efficiency improvements are achieved with the operator, not against them.

Strategic and Technical Reflections

Implementing behavior-based optimization aligns directly with Egholm's ESG ambitions and sustainability goals. Lower energy consumption per task contributes to reduced operational costs and improved product lifetime.

From a strategic perspective, this approach:

- Increases customer satisfaction by extending runtime without expensive hardware changes.
- Enhances market competitiveness, especially in municipal sectors focusing on green transitions.
- Generates valuable operational data that can inform product development and future AI models.

From a technical perspective, the main challenges include:

- Integrating additional sensor inputs without complicating maintenance.

- Designing user interfaces that communicate effectively without distracting the operator.
- Developing algorithms that adapt across varying tasks mowing, sweeping, or snow removal each with distinct power patterns.

Long term, these systems could evolve into predictive energy management, where machine learning continuously optimizes power usage based on accumulated data from multiple users and conditions.

Human Factors and Behavioral Insights

The human side of this Hardnut is equally important. Many operators develop habitual behaviors based on experience with combustion-engine machines. Electric drivetrains, however, behave differently they deliver torque instantly, and small changes in throttle or hydraulic pressure can drastically affect consumption.

Therefore, supporting behavioral change requires transparent and non-intrusive feedback. Our interviews and reflections suggested that:

- Operators dislike systems that feel restrictive or judgmental.
- Positive reinforcement (“You saved 10% energy today!”) works better than penalizing feedback.
- Gamified elements such as weekly efficiency scores or comparison between operators could motivate sustainable habits over time.

This behavioral perspective ensures that the technology is adopted willingly and integrated into daily practice, rather than ignored or bypassed.

Group Dynamics and Learning Process

Throughout the project, our group experienced both challenges and growth. Early on, one member failed to submit part of the analysis on time, causing frustration and misalignment. We addressed this by revisiting our group contract, setting clearer expectations for task division and progress reporting.

Later, two members participated in the company visit while others couldn’t attend due to schedule conflicts. This temporarily caused disconnection, but we held a follow-up session where those who traveled shared detailed insights and photos, re-aligning the team. This reflection strengthened our collaboration and mutual understanding.

Our group has since learned to use conflict and miscommunication constructively recognizing them as natural parts of innovation teamwork.

Reflections from Previous Project

In a previous project, we developed an app concept to assess solar potential for residential rooftops. That experience taught us the importance of scope management our inclusion of too many variables made the product overly complex and hard to use.

Applying that lesson here, we intentionally narrowed our scope. Initially, we considered many energy-saving aspects from route optimization to driver gamification but we realized that too many features would dilute usability. By focusing on environmental awareness and feedback, we achieved a balance between technological sophistication and user simplicity.

This represents a clear learning curve in our engineering mindset: prioritizing impact and feasibility over theoretical completeness.

Conclusion

Our conclusion is that behavioral support systems represent a powerful yet underexplored lever for improving energy efficiency in Egholm's electric tractors.

Instead of increasing battery size or redesigning motors, efficiency can be achieved through smart guidance, adaptive feedback, and user empowerment. The goal is to make efficient driving a natural, rewarding behavior not a restriction.

Strategically, this approach enhances product competitiveness, reduces operational costs for clients, and strengthens Egholm's ESG profile. Technically, it lays the groundwork for AI-based predictive optimization. Humanly, it respects the operator's expertise while fostering more sustainable habits.

The Hardnut challenge thus embodies the intersection of technology, strategy, and human behavior exactly where meaningful innovation happens.