Designing a business model to reduce CO2-emissions from construction machinery: aligning business and environmental objectives

Summary report from the project ZECA – Towards Zero carbon footprint in construction work through circular business models

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We outline a concept of business models for using construction machinery that supports the reduction of CO_2 emissions while also being profitable. We suggest an integrated concept with a business model where the provision of low-emissions machinery is linked with technical driver support, production life cycle data and contractual incentives. Construction companies would purchase a specified construction effort rather than construction machines. To support the implementation and diffusion of this concept, buyers and sellers need relevant and easy to use data to compare different machinery for the same kind of work, containing relevant environmental costs as well as standardized and accepted measures of work.

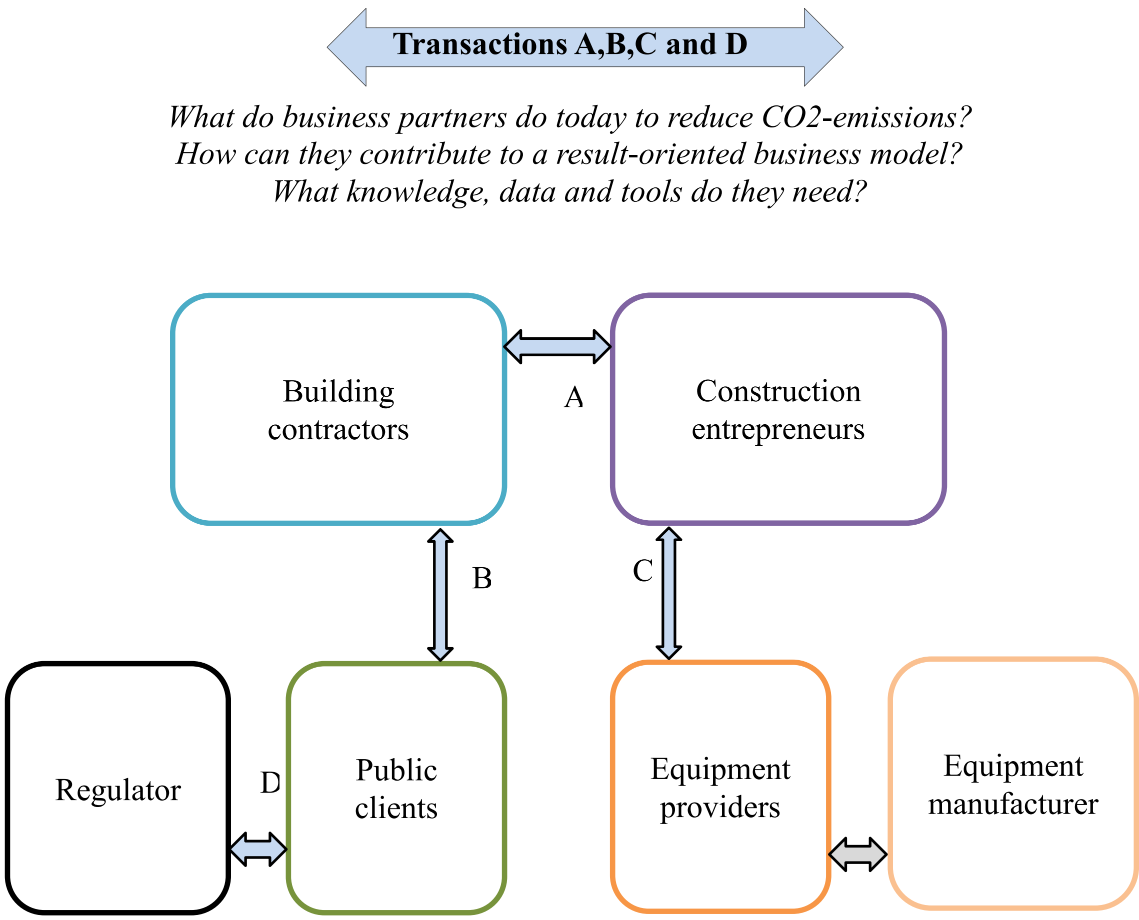
Table of Contents

Executive summary

Emissions from the use of construction equipment represent a large proportion of the carbon footprint. They can be reduced significantly in different ways: changing fuel, using fuel-efficient machinery, optimizing the use of existing machinery or the whole work process. The largest potential lies in construction work, such as roads and railroads. But technical potentials need to be supported by organizational measures.

We outlined a concept of business models for using construction machinery that supports the reduction of CO_2 emissions in different ways while also being profitable. Modern machines with comparable functions only differ marginally in respect to fuel consumption. However, different drivers vary very much more in efficiency.

We suggest an integrated concept where the provision of low-emissions machinery is linked with technical driver support, production life cycle data and contractual incentives. Constructors would purchase a specified construction effort rather than construction machines. To support the implementation and diffusion of this concept, buyers and sellers need relevant and easy to use data to compare different machinery for the same kind of work, containing relevant environmental costs as well as standardized and accepted measures of construction work.



Background

Customers and suppliers alike need to reduce their carbon footprint in order to contribute to international agreements on climate change. Most business partners can use this objective as an opportunity to reach business goals through designing new kinds of sustainable business models, or sustainable product-service systems.

Emissions from the use of construction equipment represent a large proportion of the carbon footprint. They can be reduced significantly in different ways: changing fuel, using fuel-efficient machinery, optimizing the use of existing machinery or the whole work process. The largest potential lies in construction work, such as roads and railroads. But these means need to be supported by organizational measures.

However, to reach both business and environmental objectives these systems need to be explicitly and carefully designed. Moreover, their successful implementation and diffusion depends on how they are supported by explicit innovation efforts to change the 'industry regime' in which they are embedded. Currently, sustainable business models are very popular and they are being developed for a large number of consumer products (sport clothes, cars, bikes etc.). However, their application to more complex value-chains, involving business to business relations, is evolving much slower, with a few notable exceptions such as jet engines or trains.

Objective

Based on a literature review and a pilot study of current practices in the building industry in Sweden, we aimed to outline a concept of a sustainable business model for the sale, procurement, maintenance and use of construction equipment that aims to reach both business and climate goals.

The literature review suggest that the necessary changes need support from trustworthy and easy to use life-cycle data, contractual incentives, standardized emission measures and work achieved as well as driver visualization. To this end, we structured our data collection and analysis according to three research questions:

1. What do business partners do today to reduce CO2-emissions? What shapes their practice and how does it impact on the possibilities for a result-oriented business model that is both profitable and reduces emissions for the use of construction machinery?
2. How can they contribute to design such a business model? For example, what resources are there that could be put to use?
3. What additional knowledge, data and tools (including procurement demands and contractual terms) would they need to that end?

Project realization

We focused our work to the construction industry which offers the largest potential for CO2-reduction from construction equipment, compared to e.g. building houses where the largest potential lies in reducing climate impact through the choice of building materials. We focused on the major public clients, such as the Swedish Transport Administration

(Trafikverket) and the major Swedish cities (Stockholm, Göteborg, Malmö) as they are best equipped with resources to change procurement practices. Moreover, we focused on larger and more complex machinery that require more skilled drivers and more advanced technical support, as these are currently often not hired alone, instead drivers are hired with accompanying machines. We interviewed people in the following organizations and roles:

1. *Regulator:* Experts at the Swedish Competition Agency, charged with oversight as well as knowledge support for public procurement.
2. *Clients:* Technical experts and procurers at Swedish Transport Administration and Malmö city.
3. *Building contractors:* Environmental coordinators and buyers of construction work from the three major building contractors (Skanska, NCC and PEAB).
4. *Construction entrepreneurs:* a driver and the CEO for their interest group (Maskinentreprenörerna).
5. *Construction equipment providers/manufacturers:* Technical and environmental experts from two of the major providers (Swecon for Volvo and Delvator for Hitachi), an eco-driver trainer, sales and technical experts at Volvo Construction Equipment as well as the CEO for a rental agency (Cramo).

We visited a construction worksite in Malmö where we interviewed the client (the city), the building contractor and a driver. We also organized a workshop which most of our interviewees attended in addition to a number of other experts. The workshop provided a precious opportunity for feedback on preliminary findings from the interviews, field visit and document analysis as well as a precious opportunity for interaction among the different partners.

We decided to structure our analysis in terms of the different transactions between the partners as these provides the ground for new business model design and implementation. This means:

1. *Building contractors vs Construction entrepreneur*s: This is the locus for the result-oriented business model.
2. *Public clients vs Building contractors:* The building contract regulates business and environmental directives and incentives.
3. *Construction entrepreneurs vs Providers.* The manufacturers' role is addressed in relation to the providers.
4. *Regulator vs Public clients:* Public procurement regulations structure what is possible but the regulator also provides expert support.

Results and deliverables

Literature review

A result-oriented business model is most effective

The various ways to reduce CO2-emissions can be seen as an issue of resource efficiency. Sustainable business models could be a salient means to achieve a sustainable economy. However, new kinds of business models do not necessarily provide radical environmental benefits. They have to be designed and implemented so that the business case and the environmental case converge. The environmental effects are (only) materialized if business models realise technical potentials for recycling, remanufacturing, reuse, maintenance and holistic planning and operation. These effects could be characterized through dividing business models into three different categories.

a) Product-oriented such as product-related and advice and consultancy.
b) Use-oriented e.g. product-lease, product-renting/sharing and product pooling.
c) Result-oriented e.g. activity management, pay-per-service unit and functional result.

Substantial positive environmental benefits, especially for complex value-chains, can only be expected when business models are designed so that both user and provider have incentives to increase the life-time of the existing stock through careful and optimal use as well as design.

Designing and implementing a result-oriented business model

A business model structures and is structured by e.g. both product technology and by buyer-supplier transactions as well as various regulations. An effective implementation of a result-oriented business models requires specific "tactics" such as freedom on means for provision of results, agreement focusing on results, comprehensive data collection, frequent interaction, long-term relationships between fewer partners as well as alliance partnering to co-create value across the value-chain.

Moreover, an effective implementation of result-oriented business models also requires institutional reform of the current 'industrial regime'. For suppliers, important barriers to implementation and diffusion of result-oriented business models include e.g. the difficulty to quantify savings arising from in economic and environmental terms. For customers, important barriers include the cultural shift necessary to value an ownerless way of having a satisfaction fulfilled or the lack of knowledge about life-cycle costs. For suppliers, performance-based business models also entails new kinds of business risks when e.g. manufacturers or providers own the machines and cannot be sure how much to charge customers to cover their costs, especially when the market fluctuates. Regulators often do not reward companies' environmental innovation, for example, they do not reward them for internalizing external costs. External costs are the costs for environmental impacts from business operations that are not part of business calculations. If building contractors pay the full price for climate impacts, they need to be able to pass them on to or share them with clients.

An effective implementation of a result-oriented business models requires setting up collaborative schemes along the whole value-chain that enables new ways to make business. This can be achieved e.g. through communication materials that speak to all parties.

Need for life-cycle data and visualization

The buyers and sellers of construction equipment need easy to use life-cycle data to compare different equipment for the same kind of work, containing relevant externalities as well as standardized and accepted measures of work.

Drivers also need visualization support so that they can relate their driving behavior to the outcome. Visualization needs to support reduction of CO_2 in different ways. Visualization should preferably also be linked to driver support and learning systems. The data supplied should be made available in a standardized format so that different users can make use of software systems that are decoupled from specific machinery brands.

Pilot study results

What do partners do today to reduce emissions?

There are current schemes in use among all the business partners that can support the design of a business model that is both profitable and reduces carbon emissions. These include climate calculations among both clients and building companies, eco-driving training, technical support that guides and visualizes drivers as well as turnkey or build and maintain contracts.

What resources could be used for a result-oriented business model?

Moreover, there are schemes that could be put to use such as e.g. functional procurement and contractual incentives to reduce emissions, advanced support technologies such as DynaRoad and existing data exchange systems for fuel consumption, vehicle use etc. that are currently not used.

Need for knowledge, data and tools

To enable the design of such business models, there is a need for re-arranged relations among the different partners such that their respective contributions to carbon emissions are aligned, technically and with respect to risk-sharing and remuneration. There is also a need for more detailed data around how machines are used, life-cycle data for their use and what they achieve.

Conclusions and future research

Conclusions

In sum, we suggest that a business model that is both profitable and reduces carbon emissions is best designed as result-oriented integrated concept, where the provision of low-emissions machinery is linked with technical driver support, production life cycle data and contractual incentives.

Future research and development

We suggest that designing and implementing sustainable business models requires:

1. More knowledge about the efficient use of construction machinery and how technology could be better used to that end.
2. Support systems within the construction machines for learning from using them.
3. Verified measurements of emissions relative to work achieved. This enables computing the carbon footprint from actual work.
4. Inbuilt technology in construction equipment for comparing work achieved and carbon emissions.
5. The design of a common interface for exchanging data across brands.

6. Packaging such data for business calculations. This makes it possible to compare different integrated concepts between different construction entrepreneurs
7. Tools for improved planning and logistics at the workplace, enabling a more efficient use of construction machinery.
8. Standards for different uses (such as excavating, loading and shuffling) that could be used to create baseline data for work and emissions, as a ground for contractual incentives.
9. Contracts that include the carbon footprint and incentives to reduce it.
10. Contractual schemes where clients contribute to share risks for experiments in carbon reduction.

Appendix: Summarizing the findings

Transaction	Current practice	Possibilities to enhance a result-oriented business model	Need for knowledge, data and tools
A. Building contractors vs Construction entrepreneurs	Most construction work procured from small entrepreneurs The driver is hired, not the machine Machine efficiency only varies 4 percent Drivers' efficiencies varies up to 40 percent	Technical support for more efficient work and for measuring work Training for eco-efficient drivers Contracting for work rather than hours Integrated concept: "right machine"+technical support+trained driver	Measuring work and emissions/fuel consumption LCC-data including external costs Standardizing work Access to data across brands Contractual incentives for entrepreneurs to reduce emissions
B. Public clients vs Building contractors	Different kinds of contracts Different measures for reducing CO_2 – scorecards, energy plans, environmental zones, low emissions machines, eco-driving demands environmental bonuses, energy mapping	Turnkey contracts provide freedom Build and maintain contracts provide incentives CO_2 upper limit, contractual incentives CO_2-emissions costs into contracts	Baseline data – what is usually needed in terms of fuel consumption Contract models that create incentives to reduce emissions LCC-data including external costs
C. Construction entrepreneurs vs Provider	Providers sell machines Individual machinery solutions Individual solutions offered: data package, maintenance, eco-driving, design modification Data often not used	Providers may provide eco-driving training, streamlining work practices Providers may provide technical support for efficient driving and for following up Providers may rent machines, not sell	Support for measuring work and emissions/fuel consumption Standardizing work – ISO? Different categories? Access to data across brands Design for interoperability
D. Regulator vs public clients	Principles for public procurement Technical knowledge and aesthetics	Regulator can provide expert support Swedish Transport Authority can use own expertise and existing schemes for climate impact reduction	A verified baseline for emissions Procurement demands that support innovation but not exclude small entrepreneurs Contractual demands that are followed up