

TEACHING

SUSTAINABLE SOFTWARE ENGINEERING

The SusA Framework

Slides adapted from material by Birgit Penzenstadler,
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Why do we develop new IT Systems?



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AirBnB – why?

- To help people find private accomodation on holidays?
- To simplify and lower the costs of traveling, and help people make money on renting apartments?
- To stimulate traveling?
- To help people find stimulating experiences in life?
- Because!?



What if our assumptions about the effects do not hold true? How can we learn?



AirBnB problems

Airbnb problems in Barcelona, Spain

Almost half of holiday rentals in Spain's second-largest city are unlicensed according to the council, which makes them illegal.

Last year Barcelona fined Airbnb €600,000 for refusing to adhere to local laws by continuing to advertise unlicensed properties. As a result, Catalonia's capital has a [team of inspectors](#) who wander the streets sniffing out illegal rentals using designated apps that cross-reference licences with advertised properties. This helps to identify illegal properties and gives authorities the power close down the premises, boot out occupants and fine the owner €60,000.

“Barcelona exists for its people. The priority is it’s a place to live” ~Janet Sanz, Barcelona Housing Councillor.

2. Airbnb can have negative impacts on locals' quality of life

Hiring a place on Airbnb so you can enjoy a “cheaper” holiday actually pushes rent prices up for locals who **need to live in the city**. You’re a visitor competing with locals for accommodation. The only difference is locals need it long-term, but hosts can charge tourists more for short-term stays so this is way more appealing to some.

<https://www.theinvisibletourist.com/why-you-shouldnt-use-airbnb-issues-you-didnt-know/>

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The Bitcoin Network Now Consumes 7 Nuclear Plants Worth of Power



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Facebook and political influence



Goal	Implementation	Unintended effects
Helping people find private, cheap accomodation during vacations	AirBnB	Depopulated city centres, black market for hotels
Democratize currency	Bitcoin	Boon for criminal transactions, stimulating fraud, enormous energy consumption
Improve social networks in a world where people move away from each other	Facebook	Loss of trust, skewed worldview as Facebook harvests information and uses it to alter our perception of reality



**These effects are the direct consequences
of design choices in development**

Why do developers make these choices?
Who is affected?
Does it matter?



**What goals could or should you
have when changing something?**





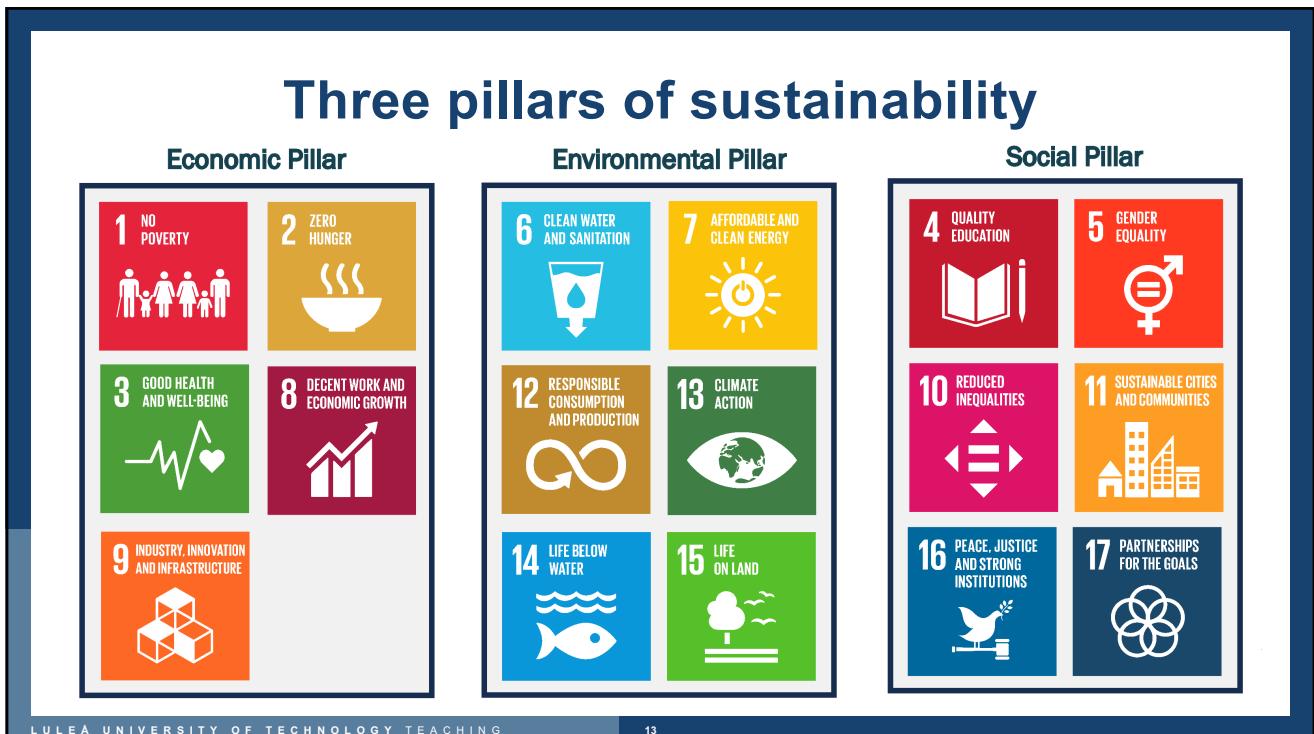
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Definition of Sustainability

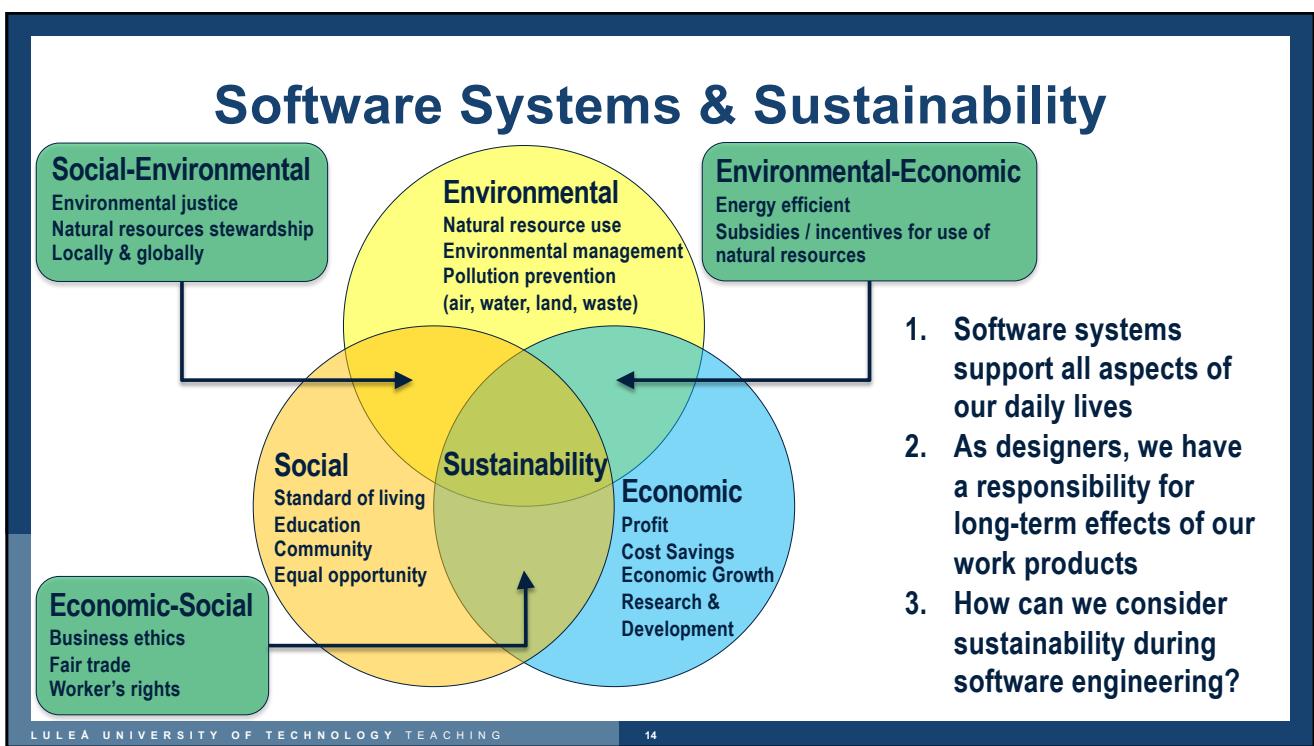
- Sustainability is the capacity to endure
 - For humans, as opposed to ecology, sustainability is the potential for long-term maintenance of well-being, which has environmental, economic, and social dimensions.
- To analyse sustainability for a specific context or system it is necessary to define:
 - What to sustain? For whom? For how long? At what cost?
[Joseph Tainter 2006]

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Sustainability & Software Systems

- Two main understandings for software systems
 - Green *in* IT:
energy, hardware, efficiency
e.g. green data centers
 - Green *by* IT:
system purpose
e.g. car sharing system
- Again: How can we consider sustainability during software engineering?



Sustainability in software engineering

- Business only focus vs advancing multiple dimensions simultaneously
- Focus on internal stakeholders vs include external stakeholders
- Focus on stakeholder want vs helping the stakeholder understand system's enabling effects
- Identify risks to timely project completion vs include enabling and structural effects and risks that can develop over time



Designing Future Software for Sustainability: The Karlskrona Manifesto

- What is going wrong?
 - Misperceptions
 - Framing sustainability as only protecting the environment
 - Dismissing unstainability as a distinct research discipline
 - Thinking that taking small steps in sustainability is sufficient, appropriate, and acceptable

www.sustainabilitydesign.org



Designing Future Software for Sustainability: The Karlskrona Manifesto

- How to get it right?
 - Sustainability is systemic
 - ... is multidimensional
 - ... is interdisciplinary
 - ... transcends the system's purpose
 - ... applies to both a system and its wider contexts
 - ... requires action on multiple levels
 - ... requires multiple timescales
 - Changing design to take long-term effects into account doesn't automatically imply sacrifices
 - System viability is a precondition for and enabler of sustainability design

Designing Future Software for Sustainability: The Karlskrona Manifesto

**As designers of software technology, we are responsible
for the long-term consequences of our designs**

www.sustainabilitydesign.org



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SUSTAINABILITY IN SOFTWARE ENGINEERING

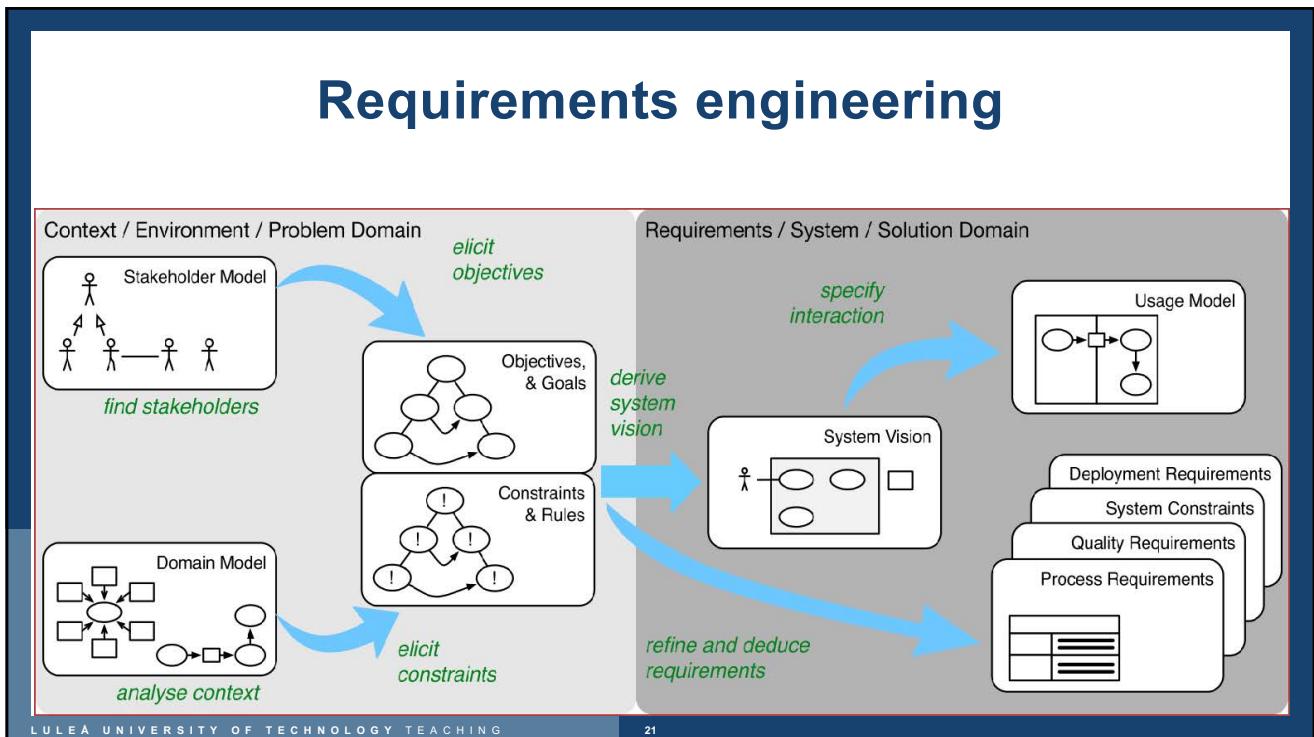
Starts with requirements engineering



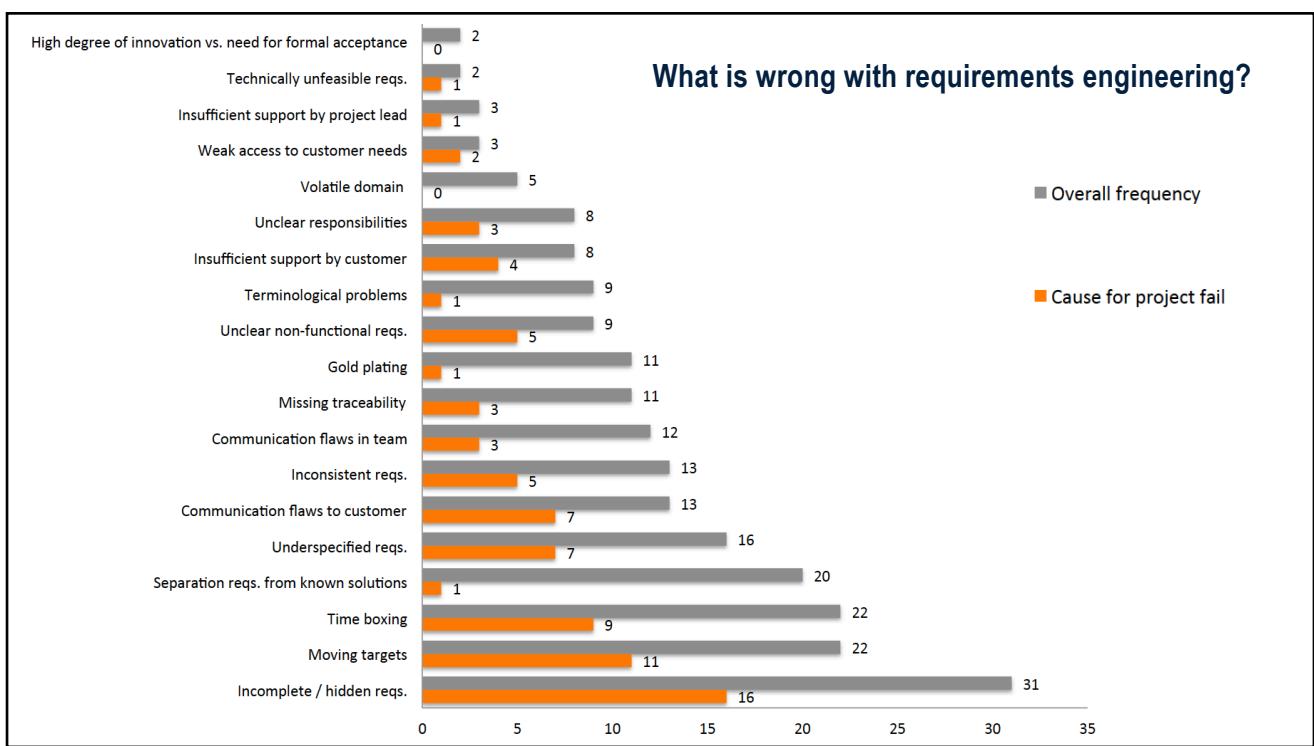
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Requirements engineering



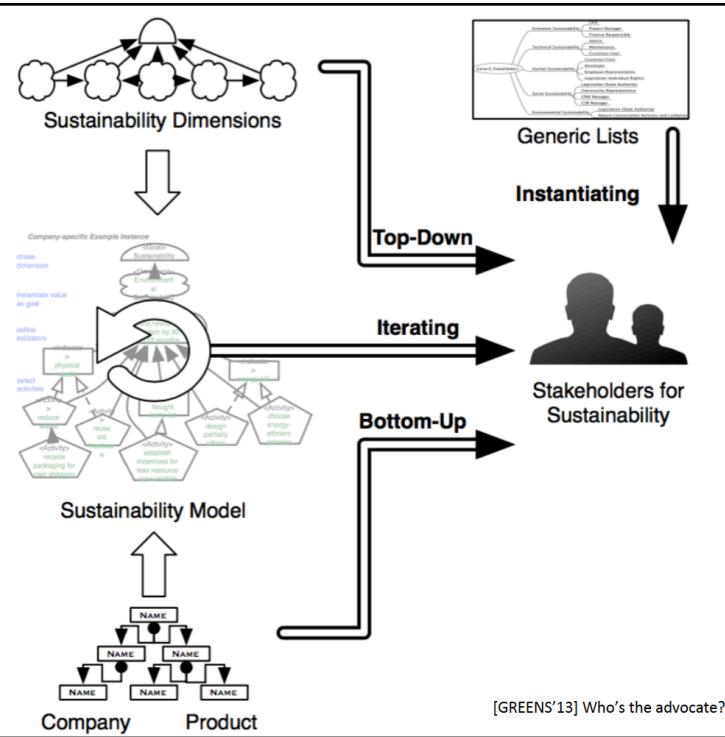
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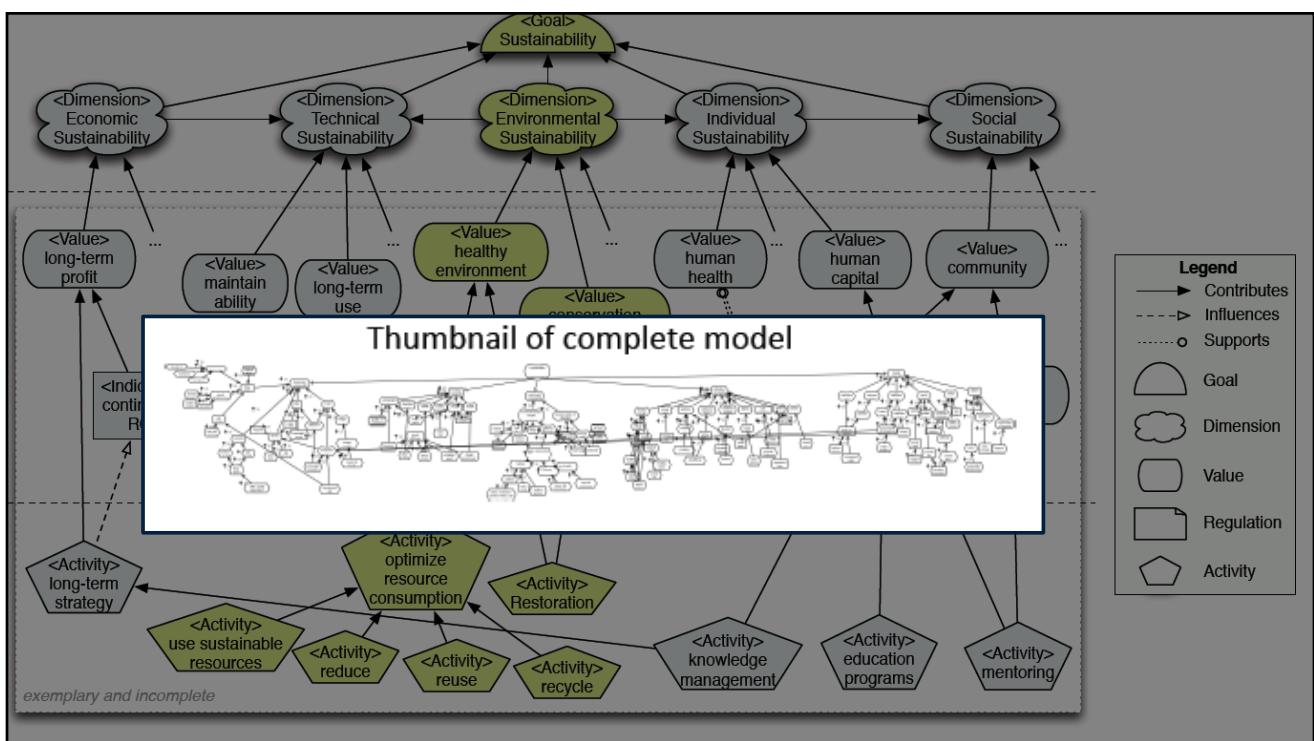
Questions for green requirements engineering

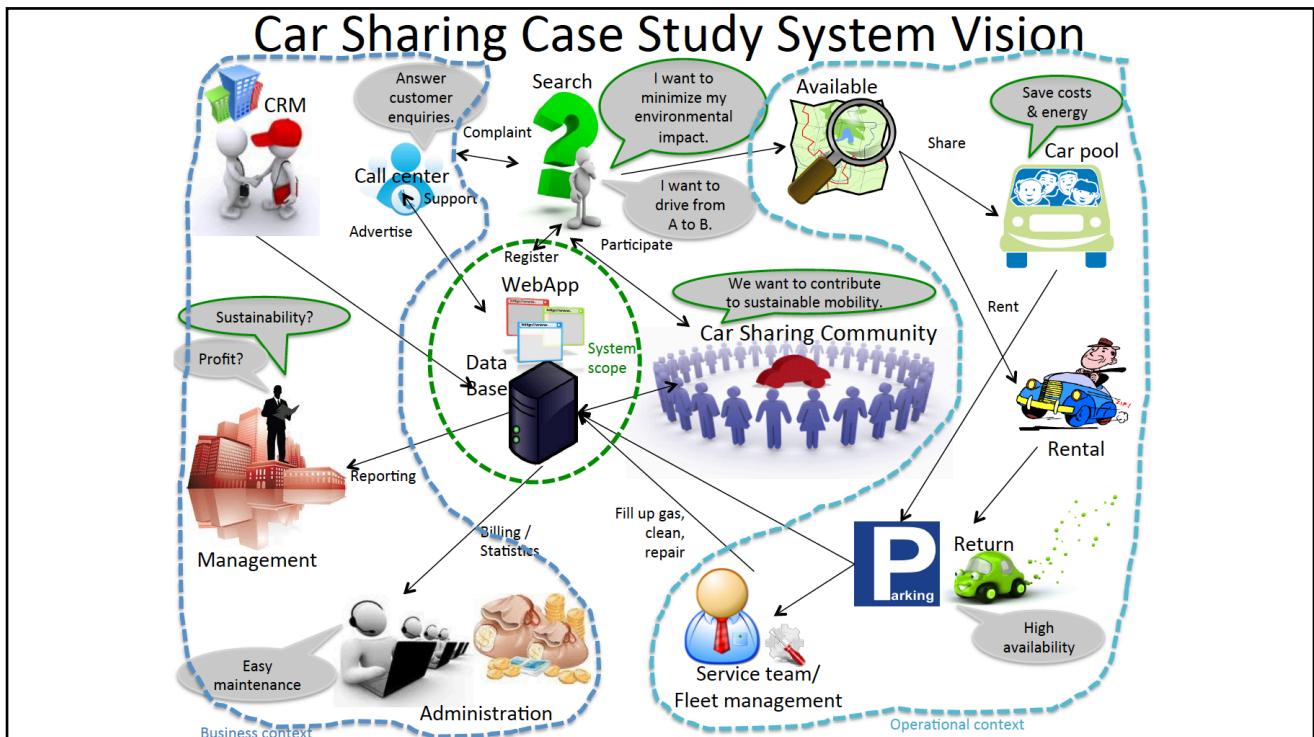
- Does the system have an explicit sustainability purpose?
- Which impact does the system have on the environment?
- Is there a stakeholder for environmental sustainability?
- What are the sustainability goals and constraints for the system?



A generic list of sustainability stakeholders

Dimension	Stakeholder Description/Rationale
Individual	User The user is affected by the system in various ways. For example, users of online learning courses educate themselves through software.
	Developer The developer is heavily involved in creating the system. Aspects like sustainable pace and growth of the developer must be considered.
	Employee represent. The mental and physical safety of individuals needs to be maintained. Employee representatives watch rights of employees involved.
	Legislation (indiv. rights) Systems must respect the rights of their users. A legislation representative is a proxy for privacy and data protection laws.
Social	Legislation (state authority) The state has a strong interest in understanding a system's influence on the society. In contrary to the individual rights legislation representative, the state authority representative speaks from the perspective of the state as a whole.
	Community represent. In addition to the state authority, other communities such as the local government (e.g. the mayor) or non-government clubs might be affected by a software system. A complete analysis must take their views into account.
	CRM The Customer Relationship Manager (CRM) is in charge of establishing long-term relationships with their customers and creating a positive image of the company.
CSR manager	Some companies created the dedicated position of the Corporate Social Responsibility (CSR) manager, who develops a company-specific vision of social responsibility.
Economic	CEO The chief executive officer integrates sustainability goals into a company's vision.
Project manager	It is very important to have the project manager agree in what ways the project should support sustainable aspects as he decides on prioritization with conflicting interests.
Finance responsible	As sustainable software engineering often also affects the budget, many financial decisions have to be made to implement a sustainable software engineering model in a company.
Environm.	Legislation (state authority) Environment protection laws are in place to ensure sustainability goals. These laws must be reflected in the model.
	CSR manager The CSR manager is often also responsible for environmental aspects.
	Activists /Lobbyists Nature conservation activists and lobbyists (e.g., WWF, Greenpeace, BUND)
Technical	Admin The administrator of a software system has a strong motivation for long-running, low-maintenance systems, making his work easier.
	Maintenance The hardware maintenance is interested in a stable, long-term strategy for installation of hardware items.
Customer	Users are interested in certain longevity of the systems they are using. This refers to user interface and required soft- and hardware.





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Sustainability analysis

- “What does X mean for my/our system?”
- Sustainability dimensions
 - Environmental, individual, social, economic, technical
- Orders of impact
 - Immediate
 - Enabling
 - Structural

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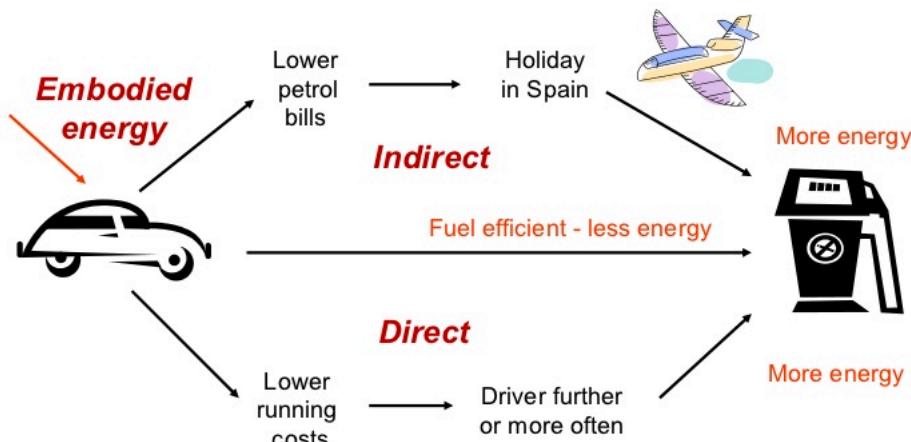
Orders of effect

1. **Immediate effects** are the direct effects of the production, use, and disposal of software systems. This includes the immediate benefit of system features and the full life-cycle impacts, such as a life-cycle assessment (LCA) would include. A LCA evaluates the environmental impact of a product's life from the extraction of raw material to its disposal or recycling.
2. **Enabling effects** arise from a system's application over time. This includes not only opportunities to consume more (or fewer) resources but also other changes induced by the system use.
3. **Structural effects** represent “persistent changes observable at the macro level. Structures emerge from the entirety of actions at the micro level and, in turn, influence these actions.” Ongoing use of a new software system can lead to shifts in capital accumulation; drive changes in social norms, polices, and laws; and alter our relationship with the natural world

Rebound effect

- In conservation and energy economics, the rebound effect (or take-back effect, RE) is the reduction in expected gains from new technologies that increase the efficiency of resource use, because of behavioural or other systemic responses. These responses usually tend to offset the beneficial effects of the new technology or other measures taken.
- Example: People turn up the graphics settings when getting a newer and more efficient GPU; resulting in more power draw than the less efficient GPU.

Illustration of rebound effects



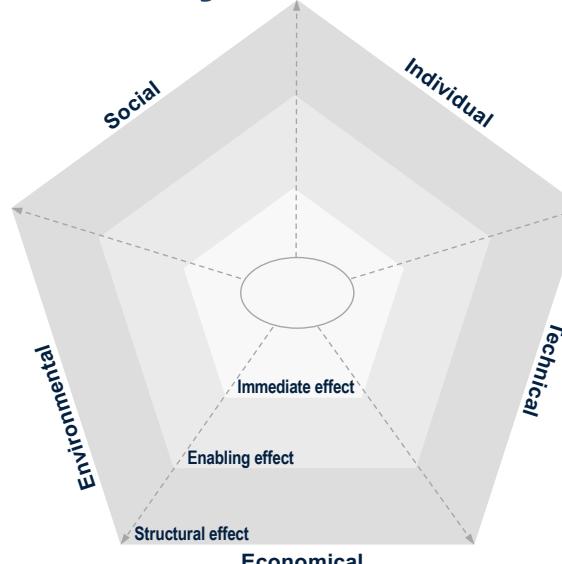
5 dimensions of sustainable design

A software engineering perspective

- Individual
 - maintaining human capital (e.g., health, education, skills, knowledge, leadership, and access to services)
- Social
 - preserving the societal communities in their solidarity and services
- Economic
 - maintaining capital and added value.
- Environmental
 - improving human welfare by protecting the natural resources: water, land, air, minerals and ecosystem services.
- Technical
 - longevity of information, systems, and infrastructure and their adequate evolution with changing surrounding conditions

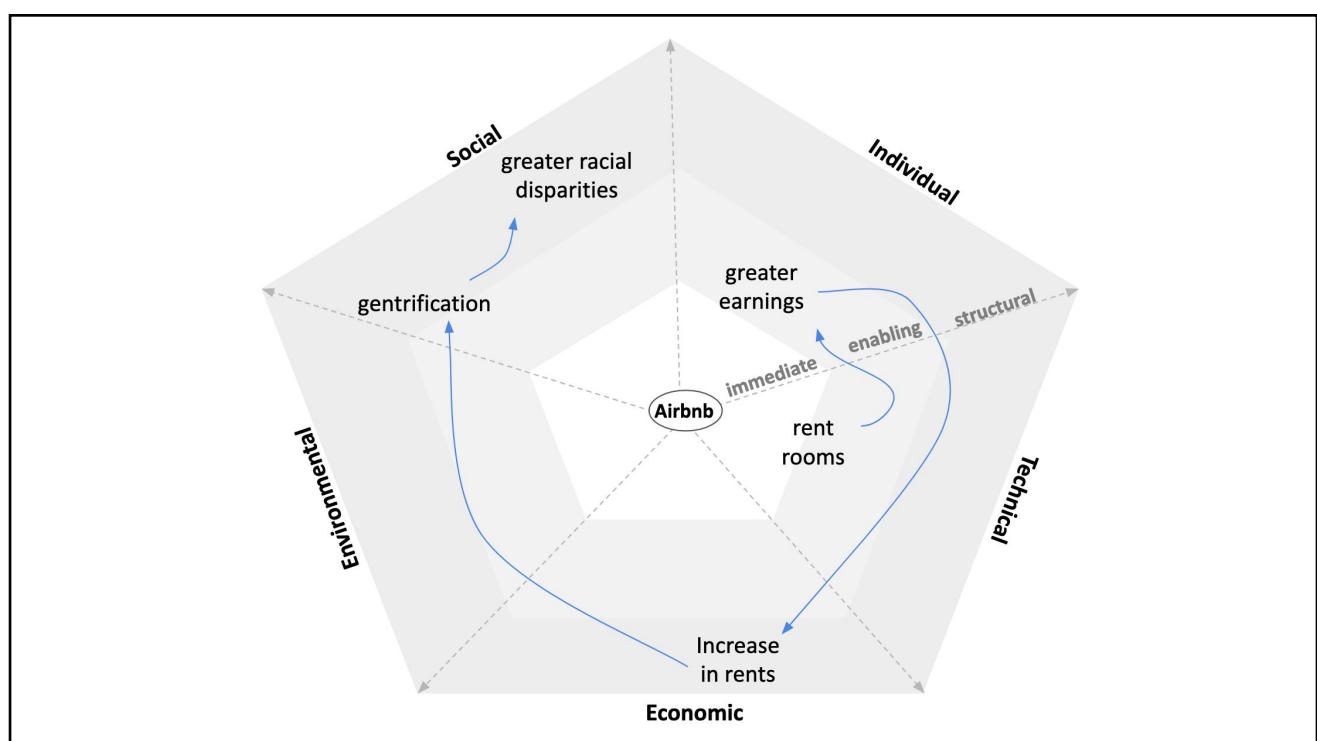


The Sustainability Awareness Framework

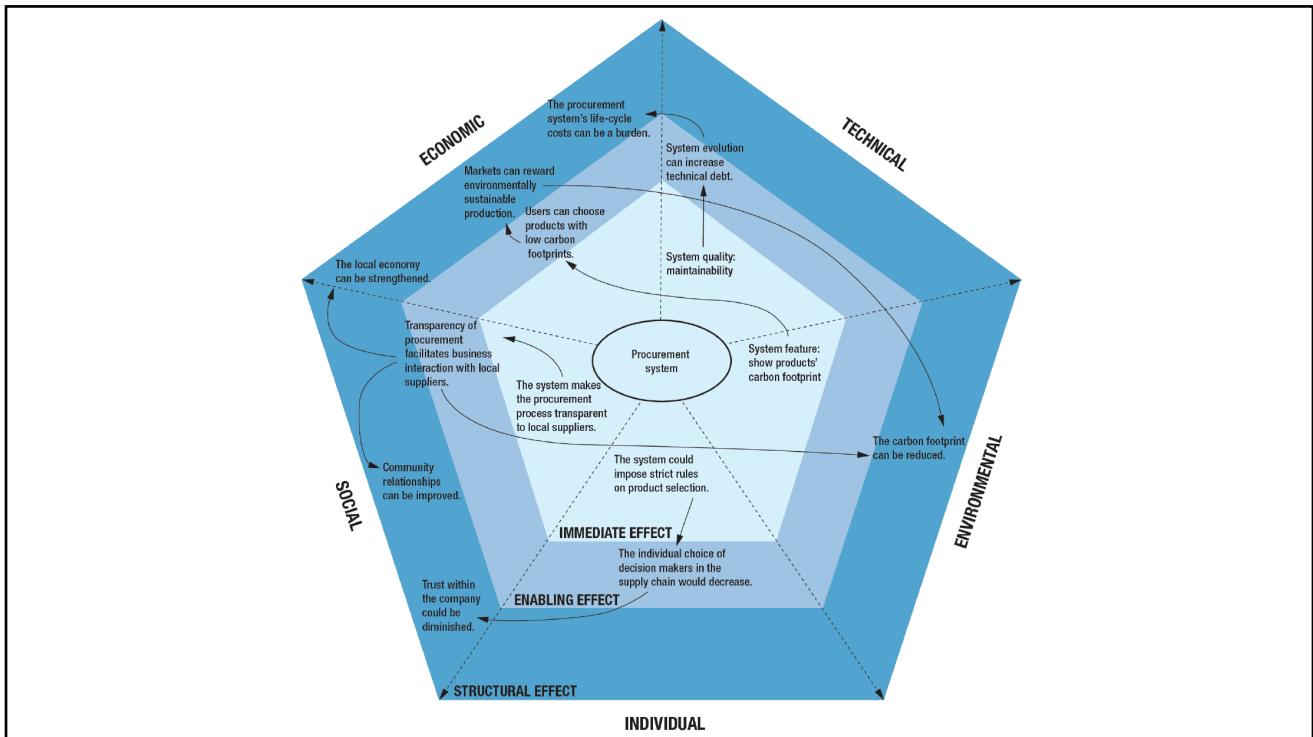


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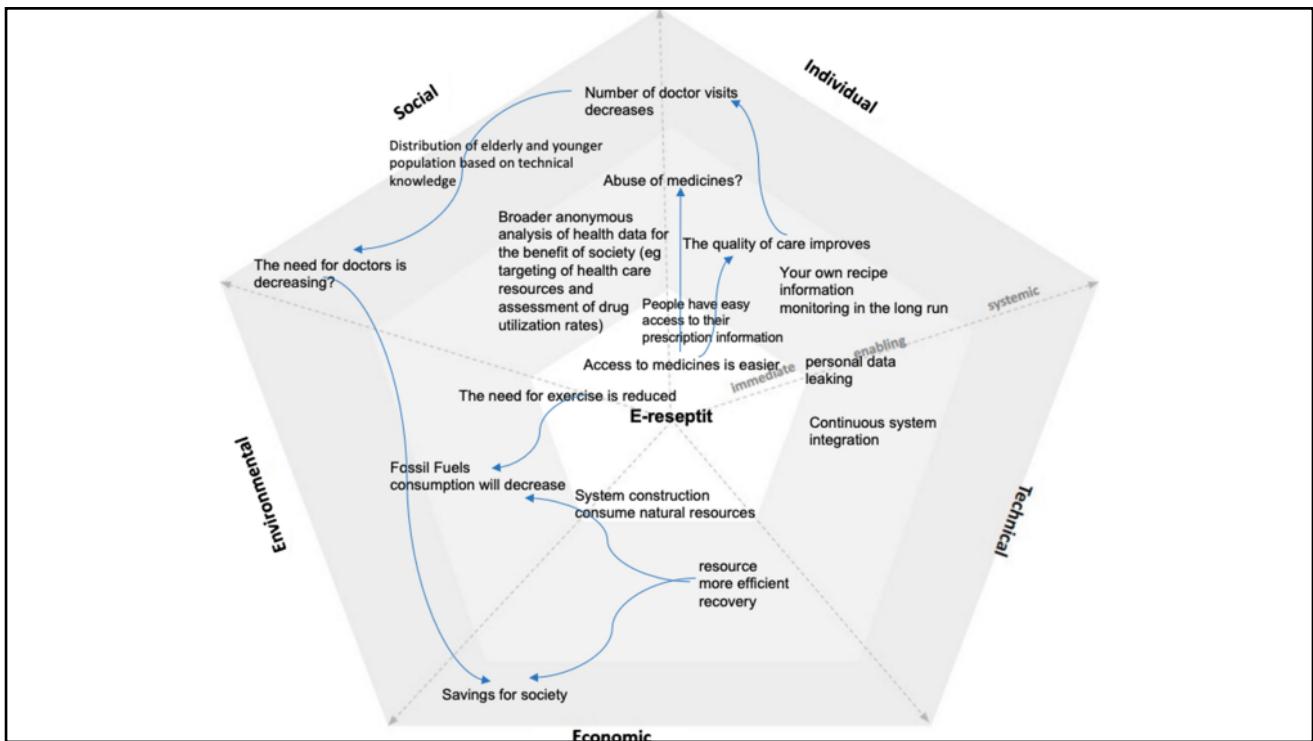
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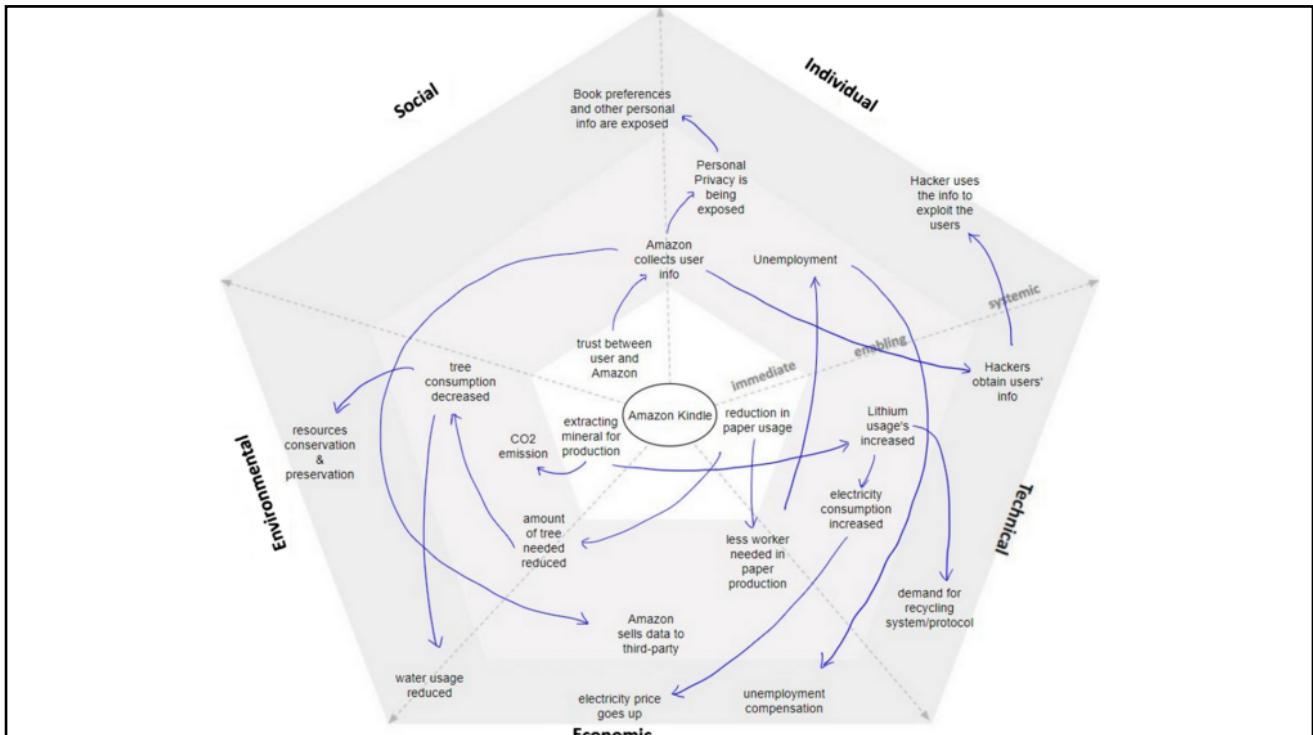
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The SusA Framework workshop

- Discuss the 5 dimensions of sustainable design in Hemtjänst 3.0
 - Guided by several questions per dimension
- Identify immediate, enabling and structural effects
- Identify relations between effects
- Create the SusA radar diagram
- Present your radar diagram for another group

- You have received short documents to read before the workshop
 - The Karlskrona manifesto
 - The SusAF Workbook with questions

