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Engineering Sustainability Requirements

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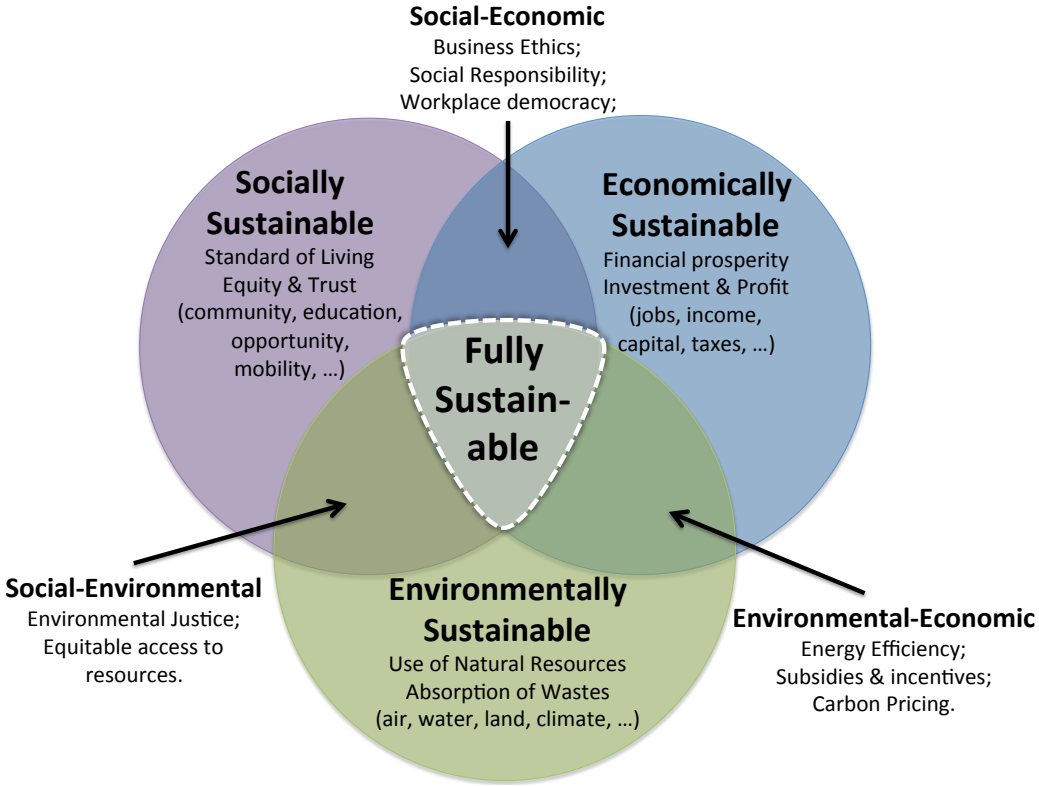
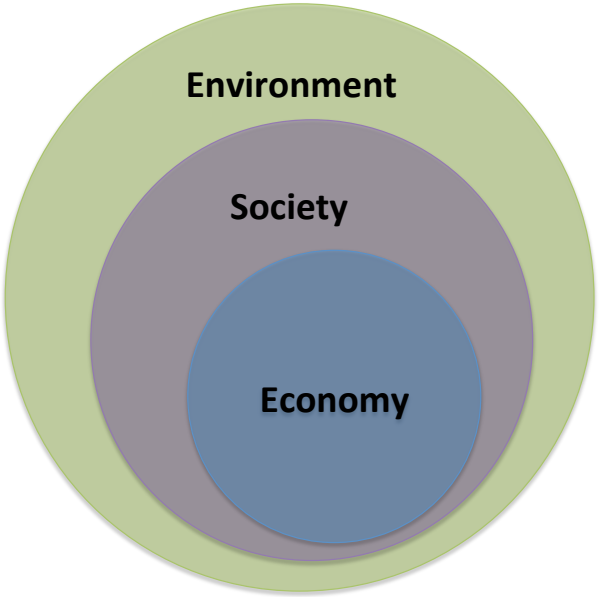
Lexington, May 3 2017

What is Sustainability?



(a) Weak Sustainability (adapted from [18])



(b) Strong Sustainability

Ref: *Sustainability Design and Software: Karlskrona Manifesto*, Becker, Chitchyan, Duboc, Easterbrook, Penzenstadler, Seyff, Venters, ICSE SEIS 2015

Manifesto: http://sustainabilitydesign.org/karlskrona-manifesto/

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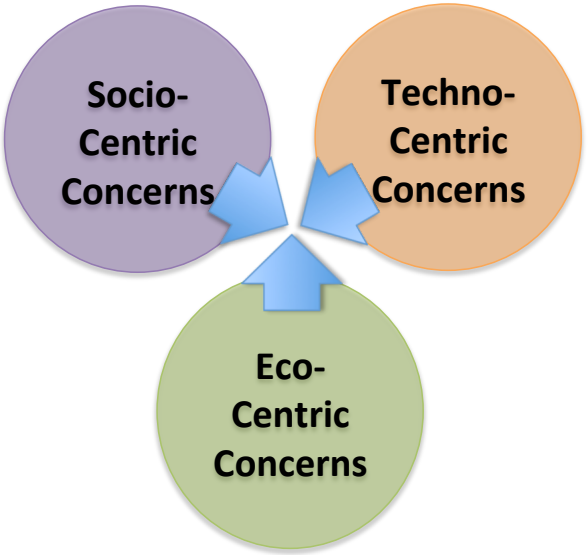
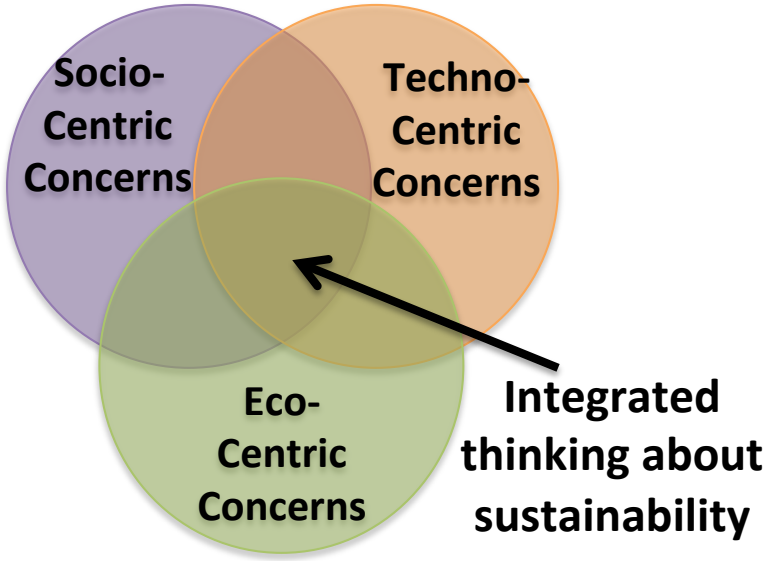
Pragmatic View: Software Design Agenda





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Manifesto: http://sustainabilitydesign.org/karlskrona-manifesto/

How Do Software Professionals Perceive It?

Category	Finding
Individual findings	Sustainability as environmental or financial
	Sustainability as separate from SE
	Sustainability as a nice-to-have quality
The professional environment	Lack of methodological support
	Need for mentality change
	Assumed costs as barrier
	Concerns of small companies
	The role of the customer
	Companies lack time
	Engineers lack management support for it
	Doubts about benefits for business
	Perception of trade-offs and risks
Norms in SE practice	Project success assessed at delivery only
	Poor communication of sustainability values
	Regulations are drivers for sustainability

Ref: *Sustainability Design in Requirements Engineering: State of Practice?*, Chitchyan, Becker, Betz, Duboc, Penzestadler, Venters, ICSE SEIS 2016

How Do Software Researchers Perceive It?

Corpus- assisted discourse analysis:

- Defined in terms of 5 Dimensions
  - Environmental, Social, Personal, Technical, Economic
- Interpreted in terms of Orders of Effects
  - Direct, Indirect, Systemic
- Focused on “more sustainable”, so remaining unsustainable

Ref: *Characterising Sustainability Requirements: A New Species, Red Herring, or Just an Odd Fish?*, Venters, Seyff, Becker, Betz, Chitchyan, Duboc, McIntyre, Penzestadler, ICSE SEIS 2017

Differences per Software Research Area

Area	Key concepts	Motivation	Main actors	Sustainability requirement context
IS	Cost effectiveness Process improvement Process structuring	Improve cost effectiveness of process, aiming for cost reduction.	Business, Regulators, Customers	Metrics and controls context, "such as operating and capital cost, safety, energy cons., waste gen., efficiency"
ICT	Optimisation of IT infrastructure, Green computing, Environmental sustainability, Sustainability of IT services, Longevity of energy systems	Improved resource and energy efficiency of ICT	Customers, employees, business partners, NGOs	Environmental sustainability related to energy consumption and performance
SW Eng	Software development process models	Environmental impacts of ICT	Software developers, administrators, users	Implicit non-functional qualities
Sys Eng	Optimize systems considering sustainability issues	Economic expectations and environmental consciousness	All stakeholders in context, noting they have varying background	Sustainability requirements have to be communicated
Ergonomics	Multi-dimensional understanding with economic, social, and environmental	Economic and business-strategic aspects, human factors	Wide range of stakeholders, including all designers	Environmental context and long life cycles
RE	Multi-dimensionality of sustainability, Interdependence of dimensions, Trade-offs, General models of sustainability	Make sustainability more tangible, Make related goals explicit, Assess sustainability	Decision making households and/or software professionals, regulators	Multiple dimensions and trade-offs: 'Achieve acceptable level of service (...), have min. impact on natural env., be socially and economically acceptable'

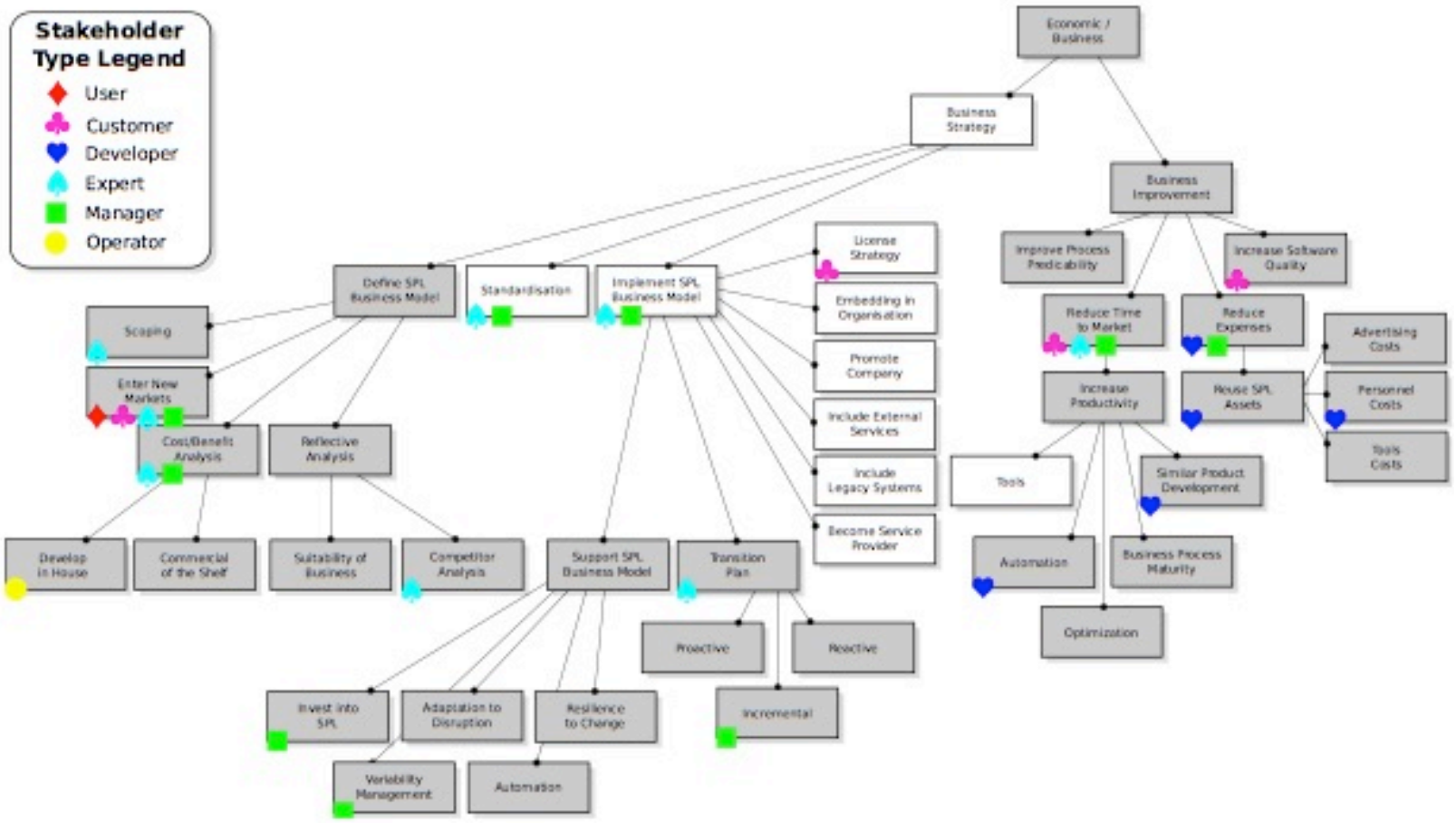
Ref: *Characterising Sustainability Requirements: A New Species, Red Herring, or Just an Odd Fish?*, Venters, Seyff, Becker, Betz, Chitchyan, Duboc, McIntyre, Penzestadler, ICSE SEIS 2017

Social Sustainability: Case of Equality

Variability	Solutions for equal access to services	Requirements
Technology used (HW, AV, TA, CP, AGM, PIM.)	Make the system available in different devices (desktop, tablets, mobile, smart TVs, kiosks), different operating systems (Android, iOS, Mac, Windows)	Users with different devices and different operating systems must have access to the system by providing compatible versions of the system running on desktops, tablets, mobiles (AV,TA, PIM), kiosks (HW), smart TVs (AV, AGM), and suitable for android, iOS, Mac and Windows.
Visual Disability (HW, AV, TA)	Different format of information (audio, video, text)	Users with blindness and visual impairment must be allowed to view information in the system by providing the information in different formats such as audio, video, larger text, and text in alternative colours.
Language (HW, AV, AGM,TA)	Multilingual interface	Users speaking in different languages must be supported in accessing the information in the system by providing multilingual website (languages included can be based on the most used language in the world).
Information media (HW, TA)	Speech synthesizer	Users can record or query info through voice note that will be analyses through Speech synthesizer.
Technical literacy level (PIM)	Keyboard shortcuts	Users with good computer expertise should be able to use the system using keyboard shortcuts functions.
Age (HW)	Suitable information details for all ages	Users from different age ranges should be provided with suitable information details for all ages.
Gender (HW)	Suitable information without offending any gender	Users from different genders should be provided with suitable information without offending any gender.
Religion (HW)	Acceptable information aligned with religious considerations	Users from different religions should be provided with acceptable supportive information (religious food certificate, health and religious observances (e.g., healthy diet while fasting or lent), advice on medical procedures of religious significance (e.g., circumcision or blood transfusion).

Ref: *Engineering Requirements for Social Sustainability*, Hinai & Chitchyan, ICT4S, 2016

Software Product Lines: Economic Sust.



Ref: *Uncovering Sustainability Concerns in Software Product Lines*, Chitchyan, Groher, & Noppen, Journal of Software: Evolution and Process, 2017

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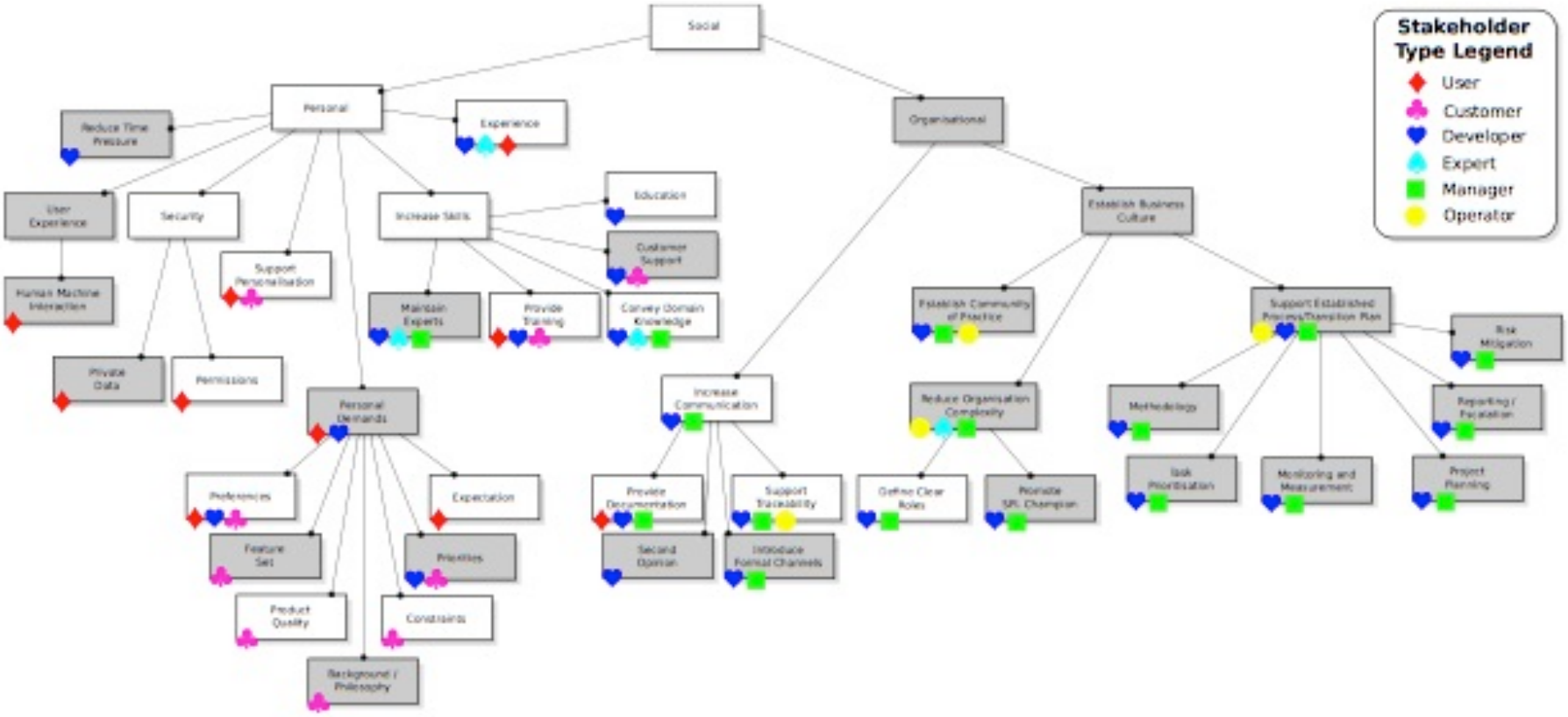
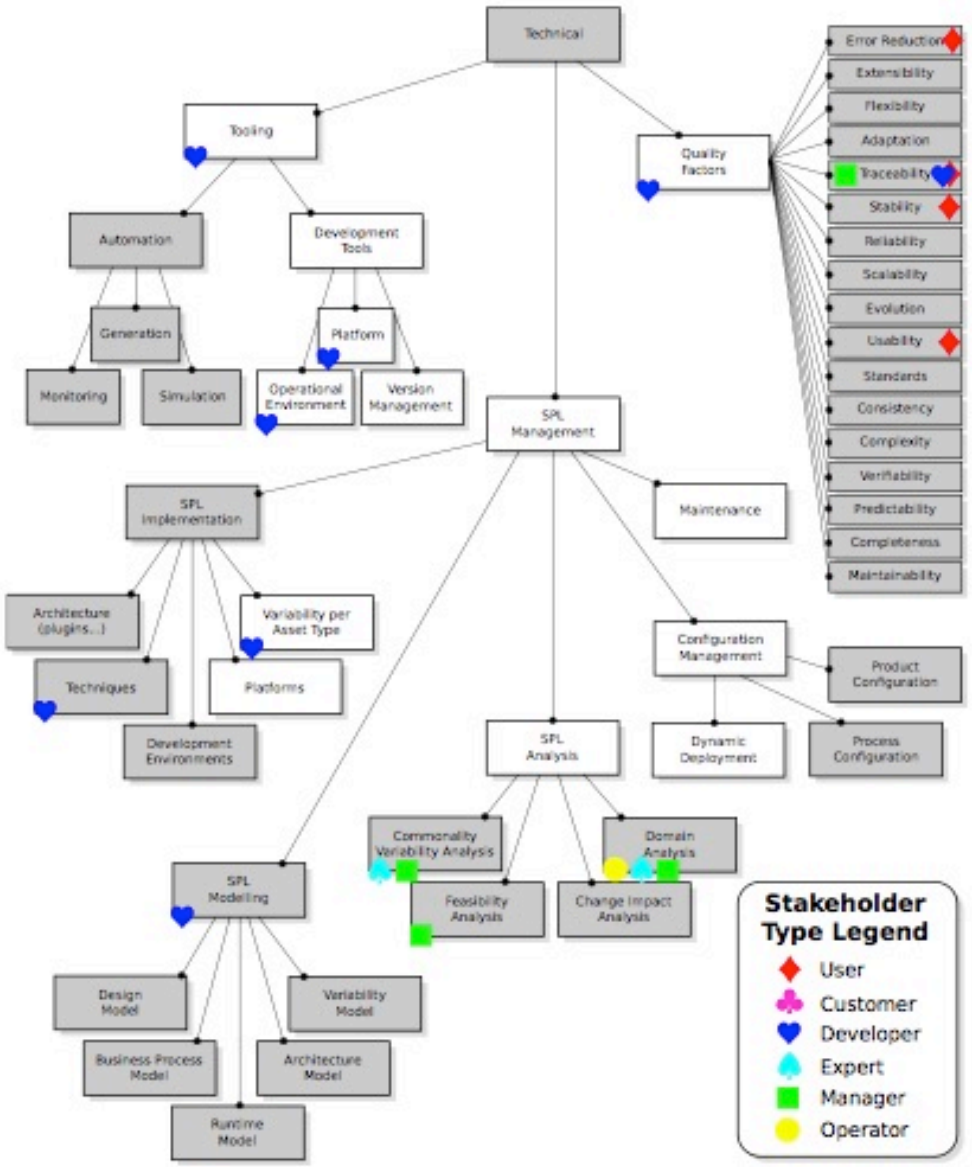
Software Product Lines: Social and Personal



Ref: *Uncovering Sustainability Concerns in Software Product Lines*, Chitchyan, Groher, & Noppen, Journal of Software: Evolution and Process, 2017

Software Product Lines: Technical Sust.



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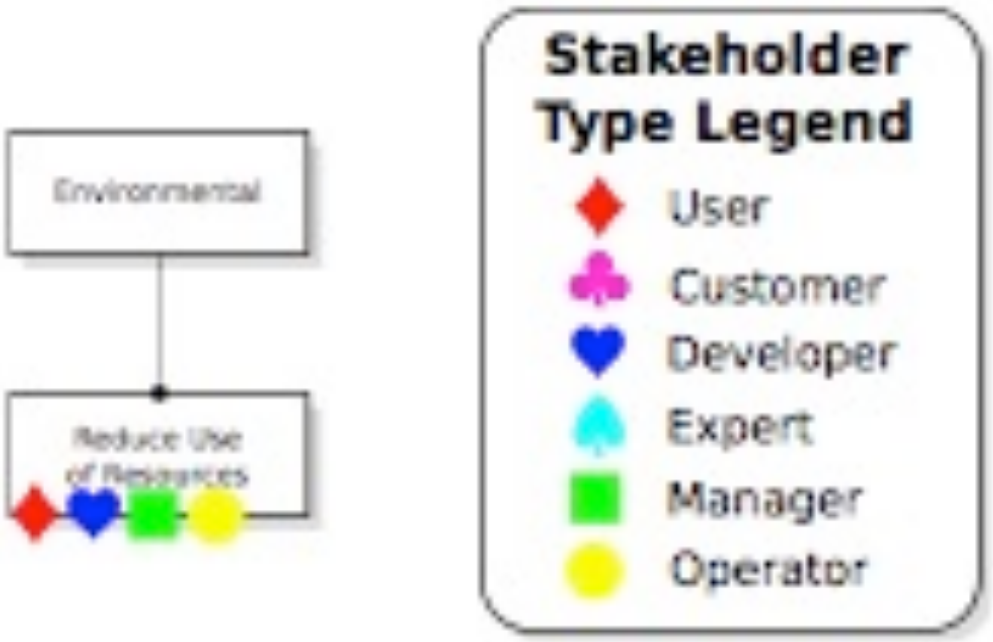
Software Product Lines: Environmental Sust.



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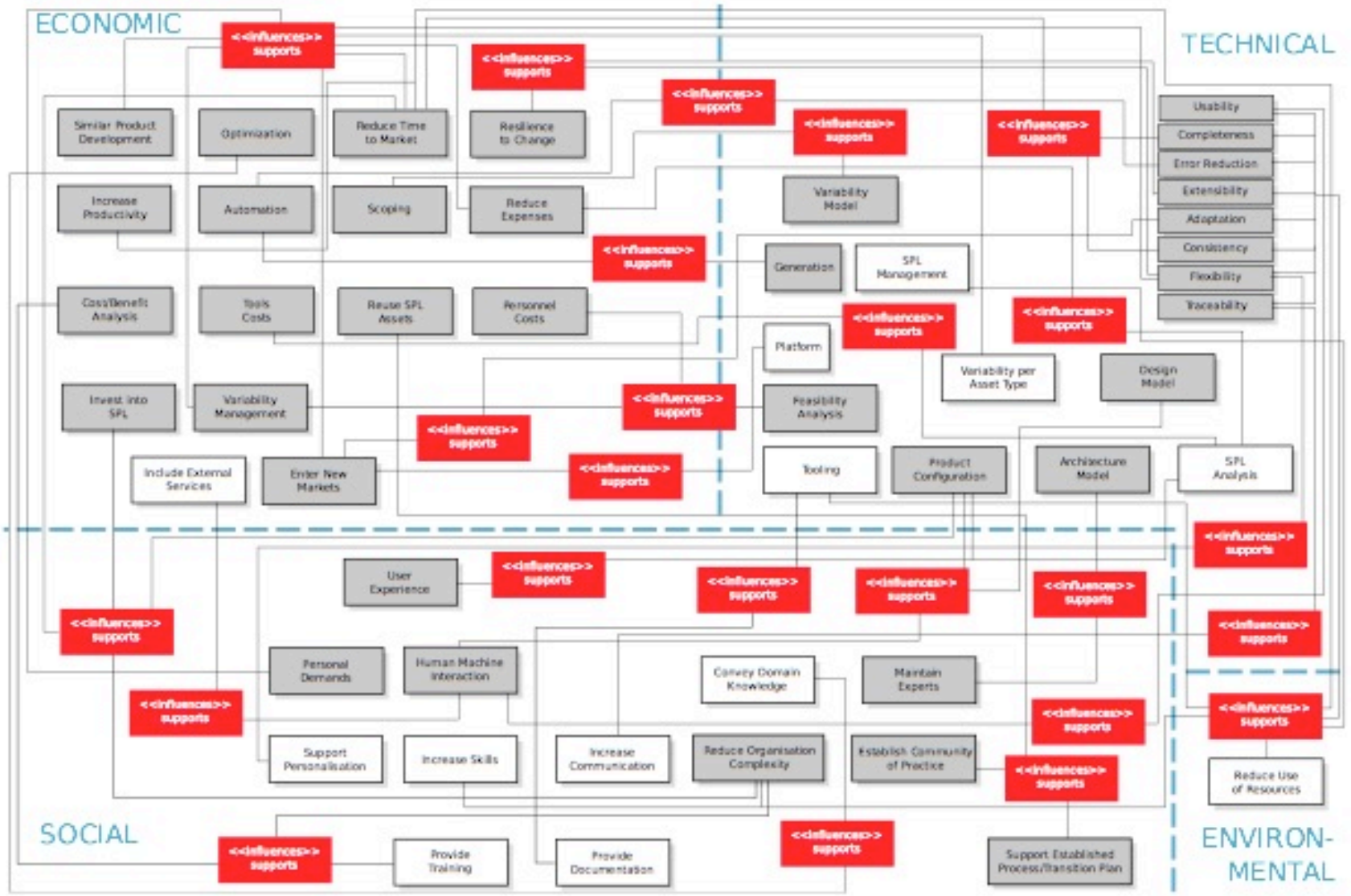
Software Product Lines: Interdependencies



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Ongoing Work

- Sustainability requirements in Energy Systems
  - Peer-to-Peer Energy Trading (EPSRC HoSEM project)
  - Re-factoring Energy System for Sustainability (EPSRC Living with Environmental Change fellowship)
- Sustainability Requirements Interactions
  - Sustainability Debt (with Christoph Becker and Steffi Betz)
  - Requirements Interdependencies (with Ben Secretan)
  - Interdependencies in SPL (with Iris Gropher & Joost Noppen)
- Common Foundations for Sustainability Requirements (with KM Group)
  - Workshop on RE4SuSy at RE 2017 (with Karlskrona Group)