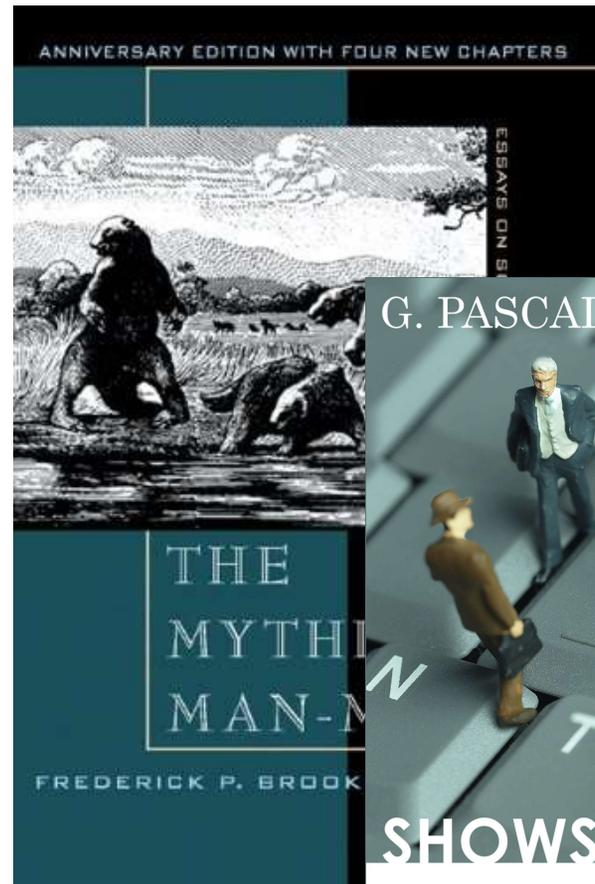


What do software *practitioners* think about sustainability?

Tiffany Babey, Catherine Happer and Tim Storer

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Software efficiency hasn't been a dominant concern in the software industry since at least the 1990s.



Modern conceptions of software sustainability focus on maintainability, readability and re-use.



Software Sustainability Institute

About the Software Sustainability Institute

Cultivating research software to support world-class research

Software is fundamental to research: **7 out of 10 researchers report** their work would be impossible without it. From short, thrown-together temporary scripts to solving a specific problem, through an abundance of complex spreadsheets analysing collected data, to the hundreds of software engineers and millions of lines of code behind international efforts such as the Large Hadron Collider and the Square Kilometre Array, there are few areas of research where software does not have a fundamental role.

Since 2010, the Software Sustainability Institute has facilitated the advancement of software in research by cultivating better, more sustainable, research software to enable world-class research ("Better software, better research"). In 2018, we were awarded funding from all seven research councils. Our mission is to become the world-leading hub for research software practice.



The Software Sustainability Institute motto.

Wider conceptions of sustainability in software practice as a growing concern in the literature.

Journal Articles

- Duboc, Leticia, Birgit Penzenstadler, Jari Porras, Sedef Akinli Kocak, Stefanie Betz, Ruzanna Chitchyan, Ola Leifler, Norbert Seyff, and Colin C. Venters. "Requirements engineering for sustainability: an awareness framework for designing software systems for a better tomorrow." *Requirements Engineering* 25, no. 4 (2020): 469-492.
- Penzenstadler, B., Duboc, L., Venters, C., Seyff, N., Wnuk, K., Chitchyan, R., Easterbrook, S., & Becker, C. **Software engineering for sustainability: Find the leverage points!** *IEEE Software*. [preprint]
- Christoph Becker, Stefanie Betz, Ruzanna Chitchyan, Leticia Duboc, Steve M. Easterbrook, Birgit Penzenstadler, Norbert Seyff, and Colin C. Venters. **Requirements: The Key to Sustainability**. *IEEE Software Special Issue on the Future of Software Engineering*, Volume 33, Issue 1, pages 56-65, January 2016. [preprint][link]

Conference Publications

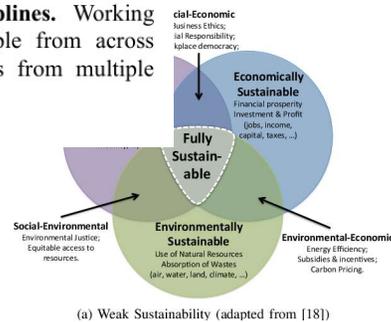
- Porras, Jari, Colin C. Venters, Birgit Penzenstadler, Leticia Duboc, Stefanie Betz, Norbert Seyff, Saeid Heshmatisafa, and Shola Oyedeji. "How Could We Have Known? Anticipating Sustainability Effects of a Software Product." In *International Conference on Software Business*, pp. 10-17. Springer, Cham, 2021.
- Colin C. Venters, Sedef Akinli Kocak, Stefanie Betz, Ian Brooks, Rafa Capilla Sevilla, Ruzanna Chitchyan, Leticia Duboc, Rogardt Haldal, Ana Moreira, Shola Oyedeji, Birgit Penzenstadler, Jari Porras and Norbert Seyff (2021). **Software Sustainability: Beyond the Tower of Babel**. 1st International Workshop on the Body of Knowledge for Software Sustainability (BoKSS'21), Co-located with ICSE 2021, June 1-2, 2021 [preprint]
- Norbert Seyff, Birgit Penzenstadler, Stefanie Betz, Ian Brooks, Shola Oyedeji, Jari Porras, Leticia Duboc, Sedef Akinli Kocak and Colin C. Venters (2021). **The Elephant in the Room – Educating Practitioners on Software Development for Sustainability**. 1st International Workshop on the Body of Knowledge for Software Sustainability (BoKSS'21), Co-located with ICSE 2021, June 1-2, 2021 [preprint]
- Birgit Penzenstadler, Stefanie Betz, Leticia Duboc, Norbert Seyff, Ian Brooks, Jari Porras, Shola Oyedeji and Colin C. Venters (2021). **Iterative Sustainability Impact Assessment: When to propose?** 1st International Workshop on the Body of Knowledge for Software Sustainability (BoKSS'21), Co-located with ICSE 2021, June 1-2, 2021 [preprint]
- Leticia Duboc, Stefanie Betz, Birgit Penzenstadler, Akinli Kocak, Ruzanna Chitchyan, Ola Leifler, Jari Porras, Norbert Seyff, & Colin C. Venters, C. C., (Accepted/In press). **Do we really know what we are building? Raising awareness of potential Sustainability Effects of Software Systems in Requirements Engineering**. 27th IEEE International Requirements Engineering Conference. [SuSAD Forms]
- Norbert Seyff, Stefanie Betz, Iris Groher, Melanie Stade, Ruzanna Chitchyan, Leticia Duboc, Birgit Penzenstadler, Colin Venters and Christoph Becker. **Crowd Focused Semi-Automated Requirements Engineering for Evolution Towards Sustainability**. *Proceedings of the 26th International Requirements Engineering Conference (RE'18), RE@Next! Track*. (accepted for publication). IEEE Press [Preprint to follow]

Thus, we propose the following initial set of **principles and commitments**:

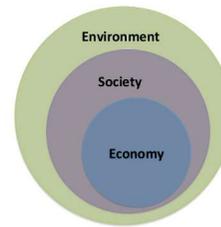
Sustainability is systemic. Sustainability is never an isolated property. Systems thinking has to be the starting point for the transdisciplinary common ground of sustainability.

Sustainability has multiple dimensions. We have to include those dimensions into our analysis if we are to understand the nature of sustainability in any given situation.

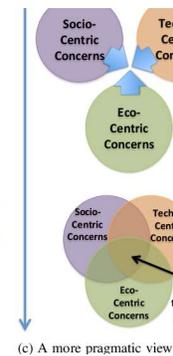
Sustainability transcends multiple disciplines. Working in sustainability means working with people from across many disciplines, addressing the challenges from multiple perspectives.



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



(b) Strong Sustainability



(c) A more pragmatic view of sustainability

Sustainability applies to both a system and its wider contexts. There are at least two spheres to consider in system design: the sustainability of the system itself and how it affects overall sustainability of the wider system of which it will be part of.

System visibility is a necessary precondition and enabler for sustainability design. Strive to make the status of the system and its context visible at different levels of abstraction and perspectives to enable participation and informed responsible choice.

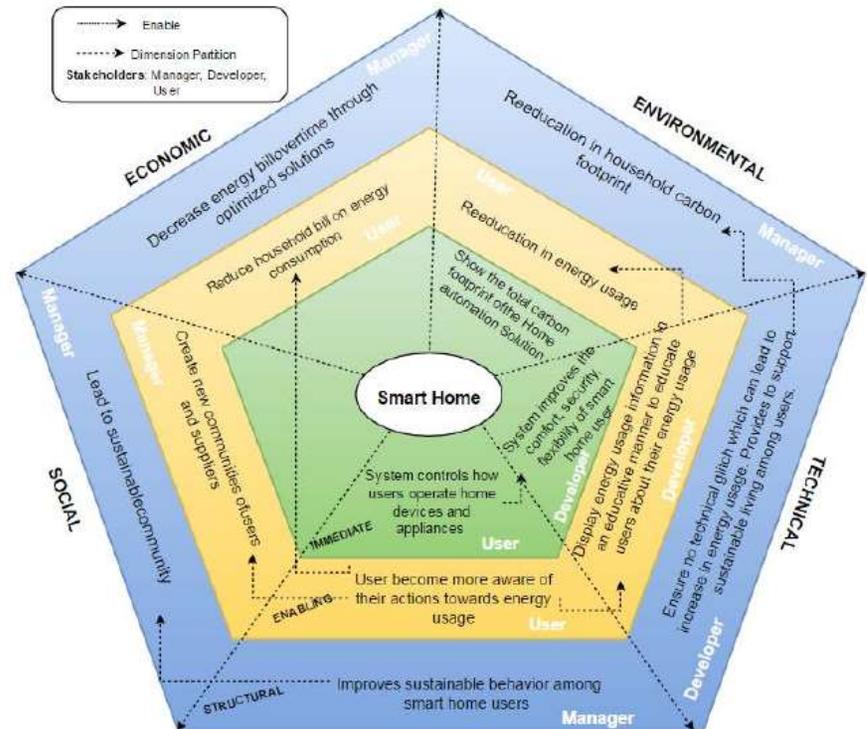
Sustainability requires action on multiple levels. Seek interventions that have the most leverage on a system and consider the opportunity costs: Whenever you are taking action towards sustainability, consider whether this is the most effective way of intervening in comparison to alternative actions (leverage points).

It is possible to meet the needs of future generations without sacrificing the prosperity of the current generation. Innovation in sustainability can play out as decoupling present and future needs. By moving away from the language of conflict and the trade-off mindset, we can identify and enact choices that benefit both present and future.

Sustainability requires long-term thinking. Consider multiple timescales, including longer-term indicators in assessment and decisions

The Karlskrona Manifesto for Sustainability Design

Dimensions of sustainability in the Karlskrona Manifesto



Do we really know what we are building? Raising awareness of potential Sustainability Effects of Software Systems in Requirements Engineering

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Linköpings Universitet



Methods for incorporating sustainability considerations into software design.

Abstract—Integrating novel software systems in our society, economy, and environment can have far-reaching effects. As a result, software systems should be designed in such a way to maintain or improve the sustainability of the socio-technical system of their destination. However, a paradigm shift is required to raise awareness of software professionals on potential sustainability effects of software systems. While Requirements Engineering is considered the key to driving this change, requirements engineers lack the knowledge, experience

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SUSAF
- THE SUSTAINABILITY
AWARENESS FRAMEWORK

The workbook
- fill me in step by step.



Little evidence as to how practitioners conceive of or are influenced by sustainability considerations.

- What aspects of sustainability are of concern to software practitioners?
- How do software practitioners address sustainability in their practice, if at all?
- What resources do software practitioners rely on when addressing sustainability, if anything?

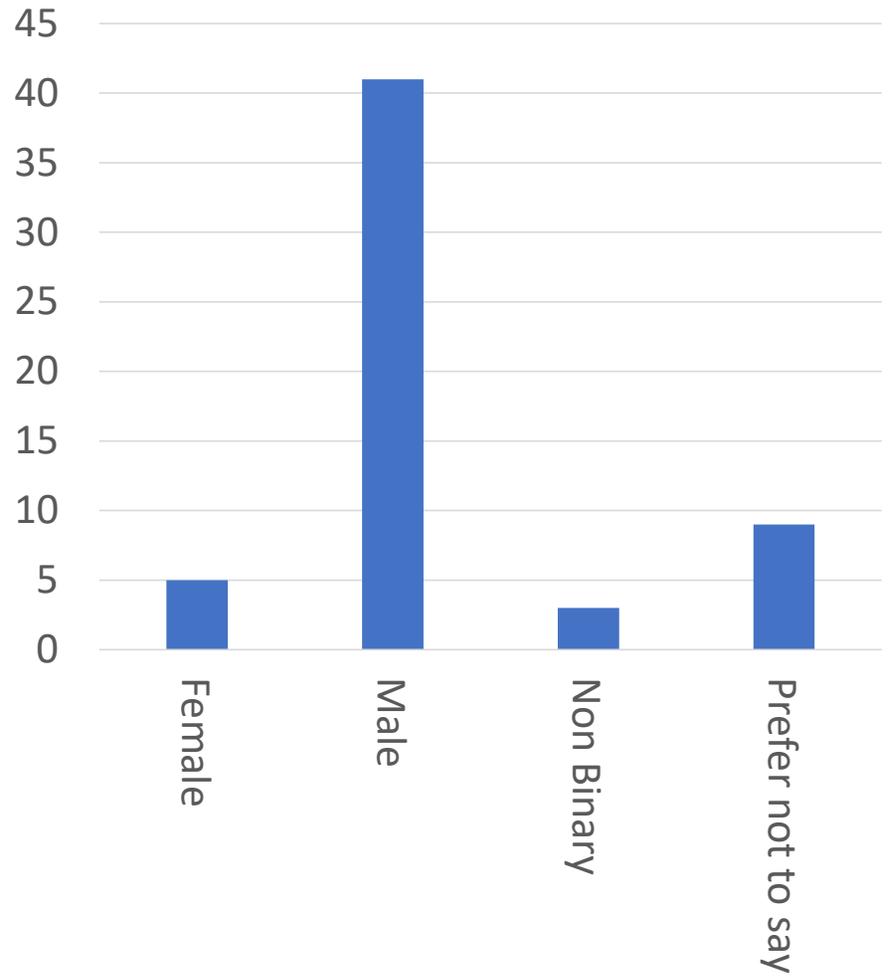


Survey Design

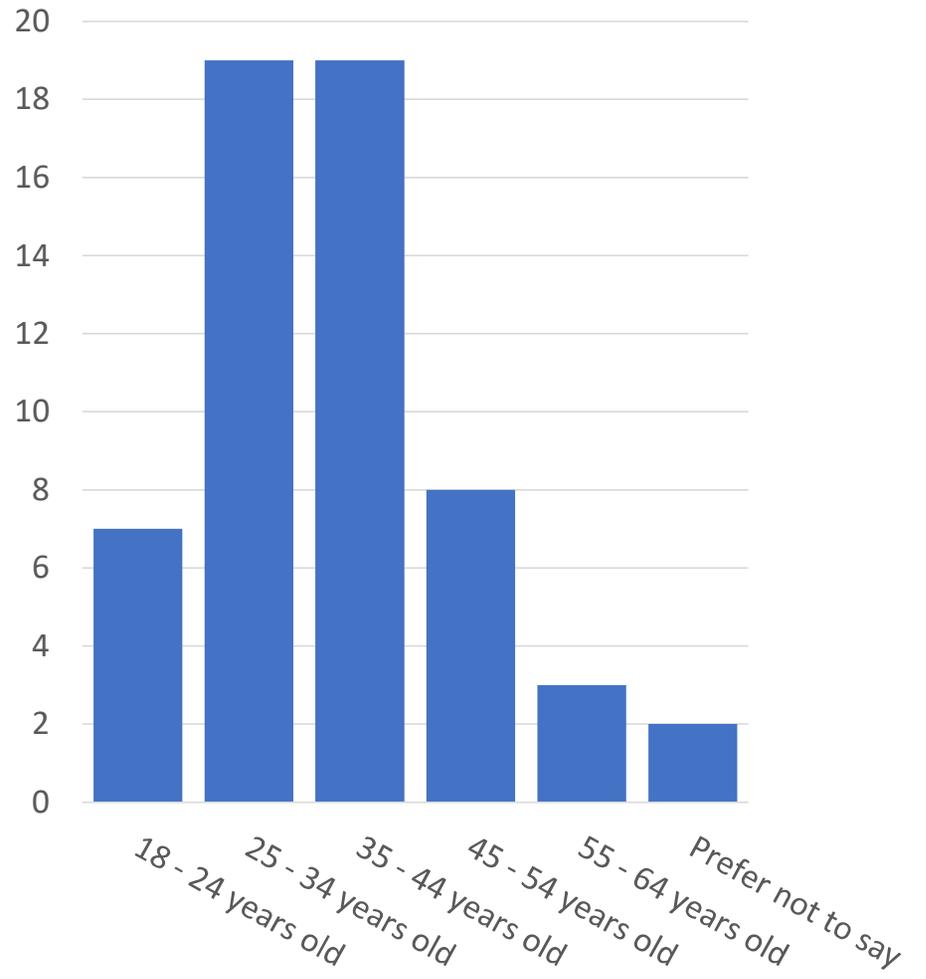
- Lightweight/exploratory intended to gather initial perceptions and potential recruits for follow on focus groups.
- Opportunistic sampling. ~70 respondents to date (58 analysed here).
- Gathered
 - Demographics
 - Perceptions of sustainability in software practice
 - Experience of incorporating sustainability in software practice.

<https://glasgow-research.onlinesurveys.ac.uk/sustainability-in-software-practices-survey>

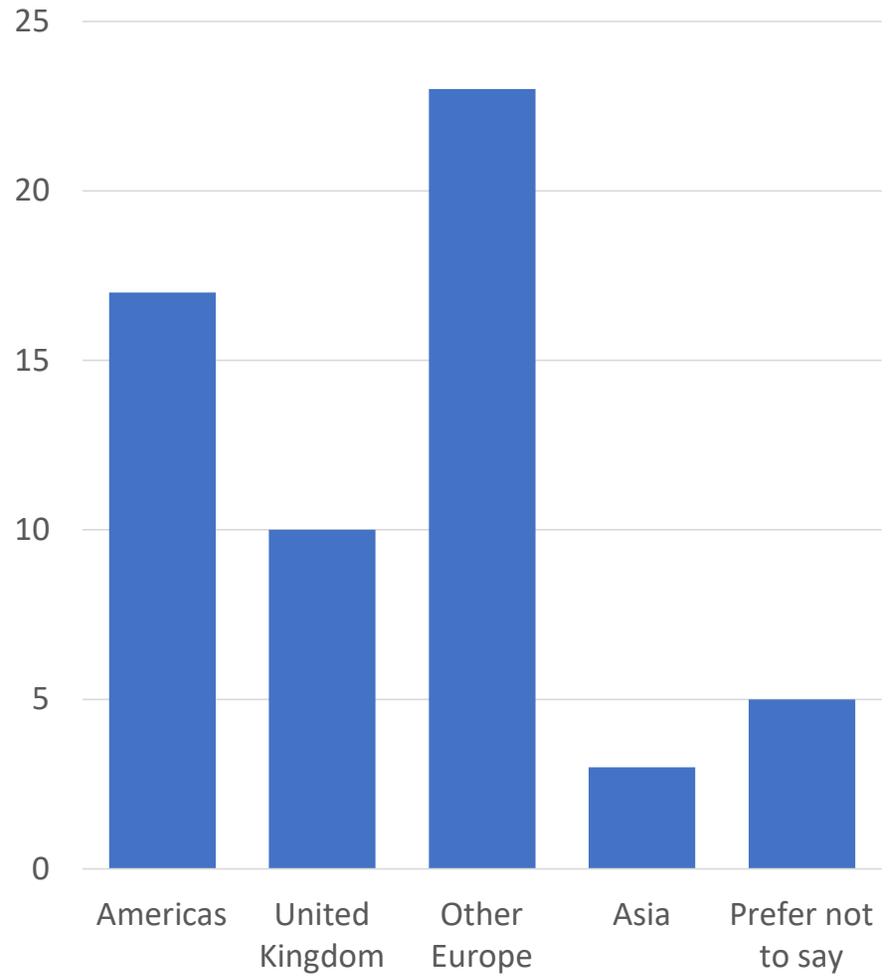
Respondent gender



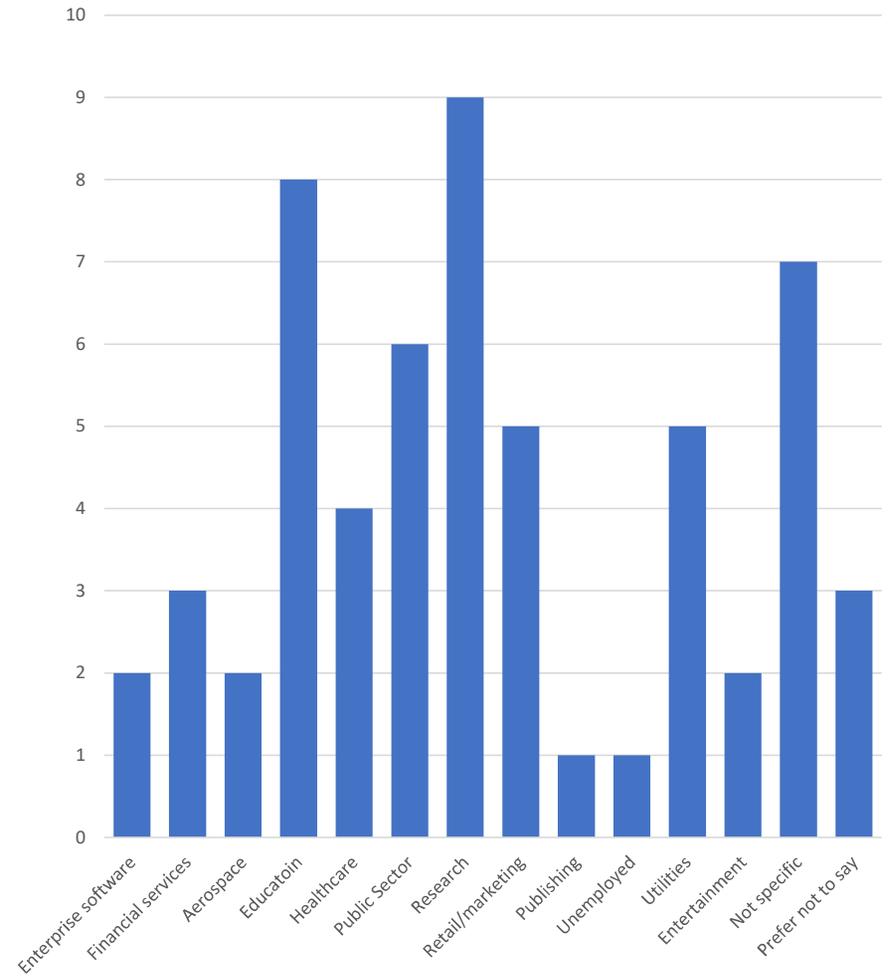
Age



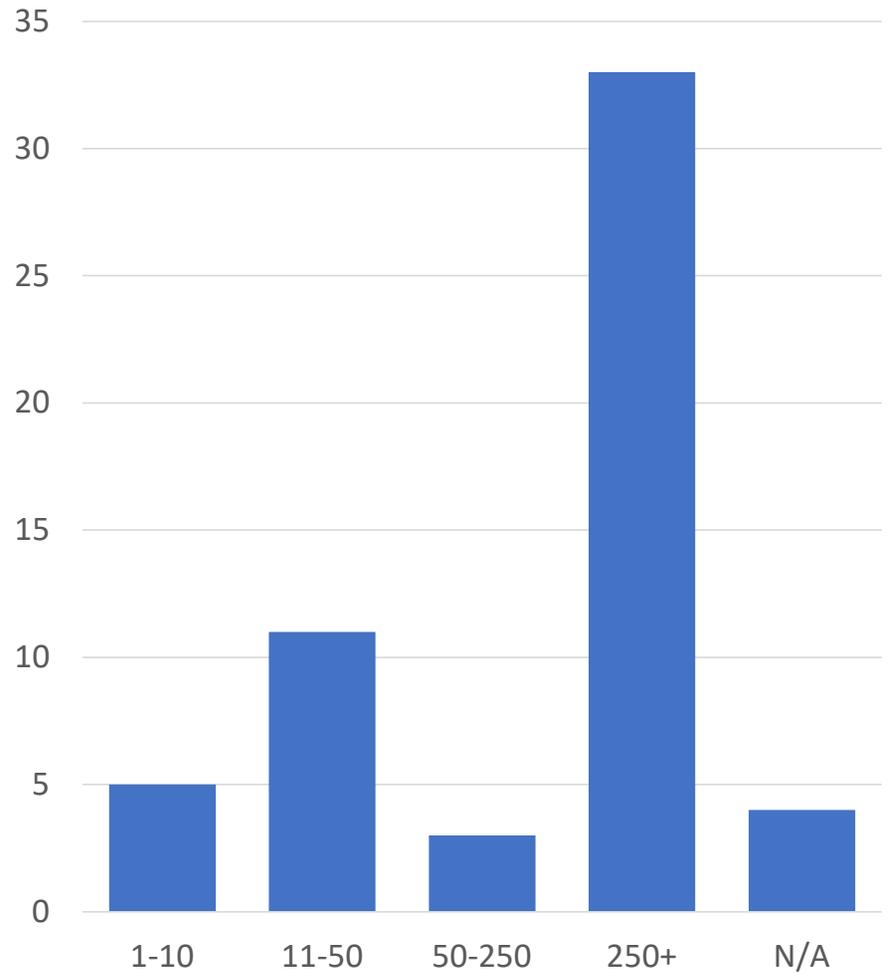
Residency



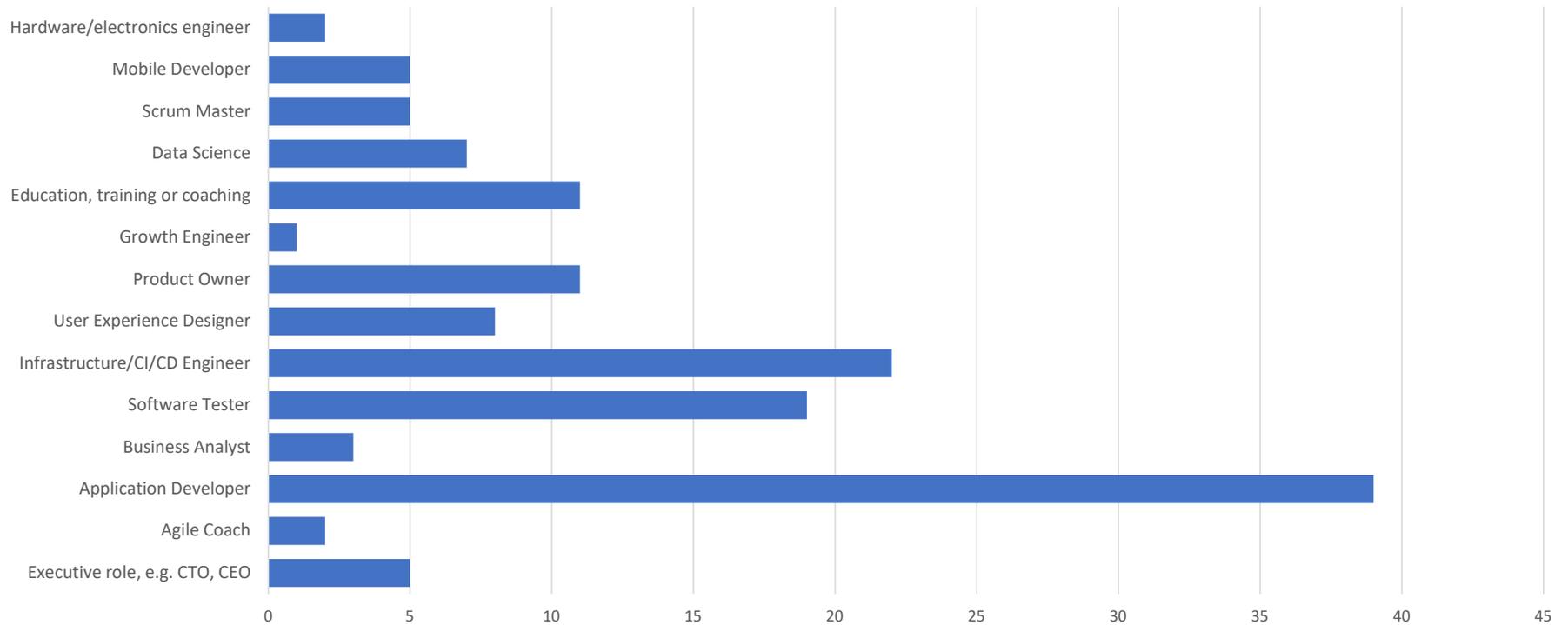
Sector



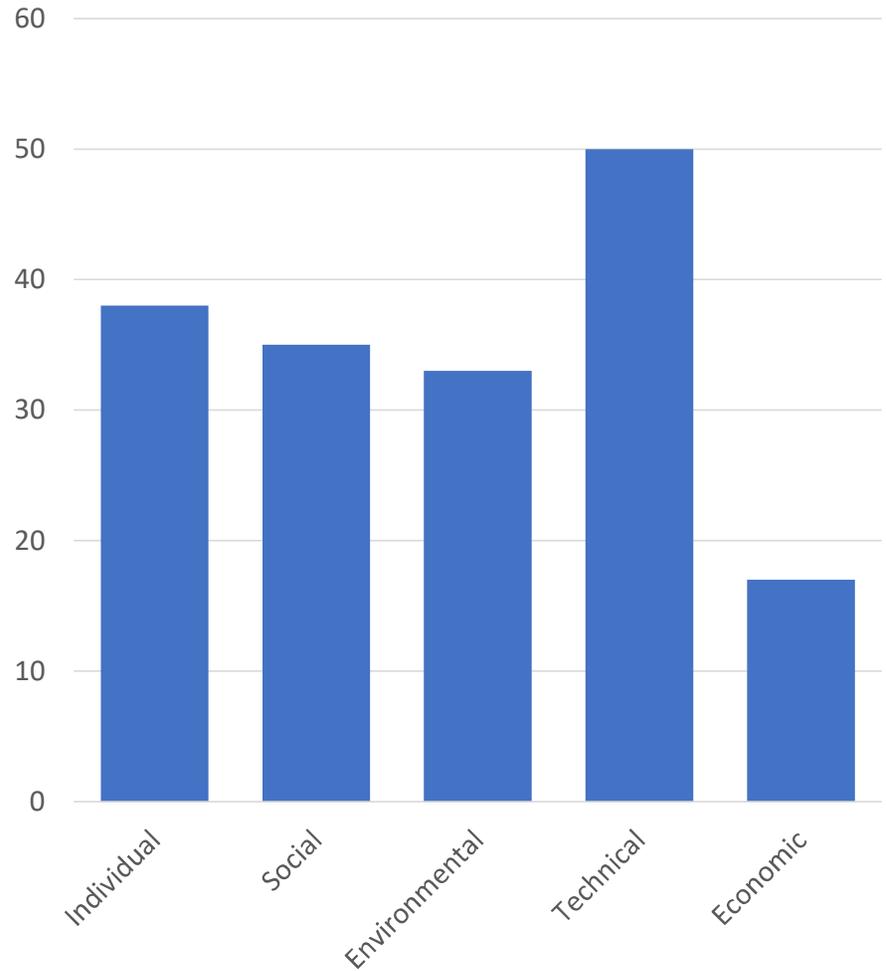
Organisation size



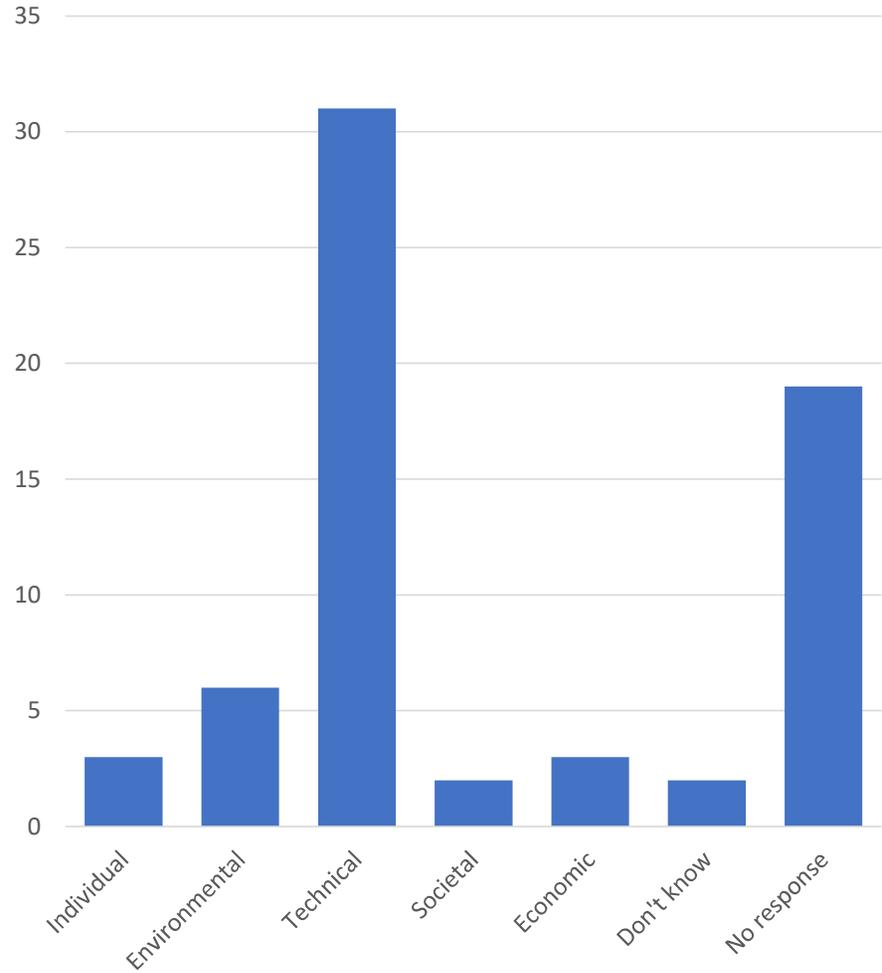
Roles (multiple)



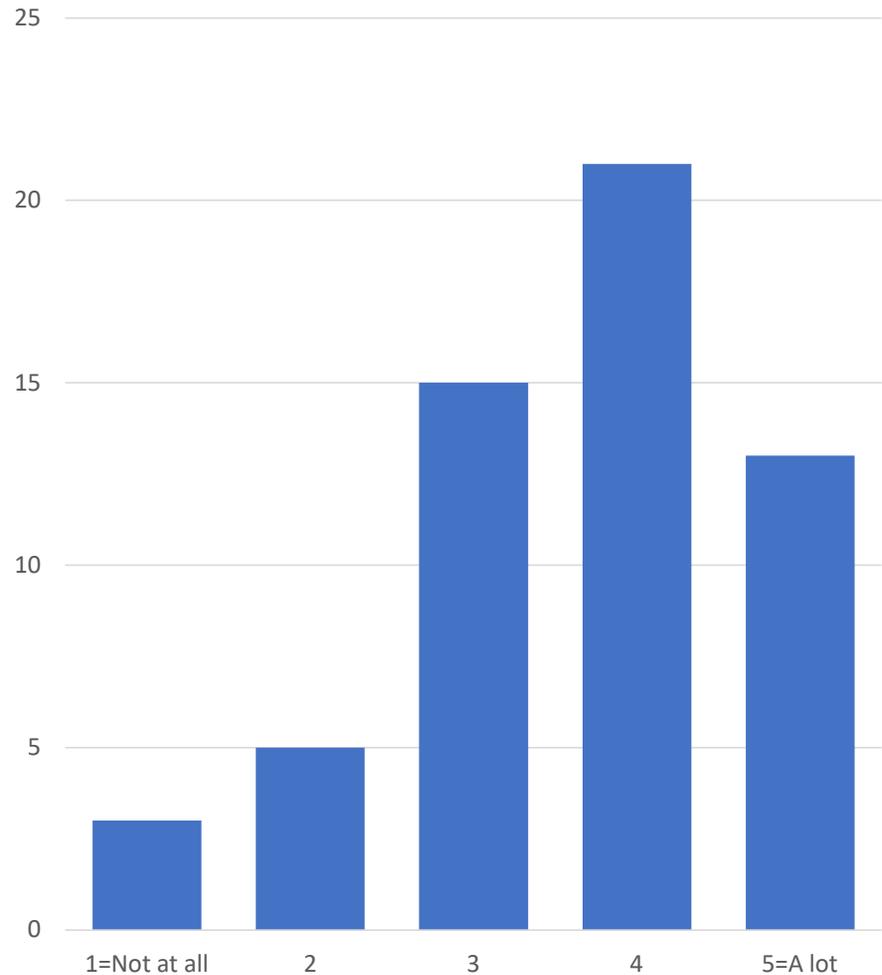
Which of [the Karlskrona Dimensions of Sustainability] do you consider to be relevant to your software practice?



Explanations of sustainability focus on technical concerns.



10. To what extent do sustainability considerations influence your software practice?



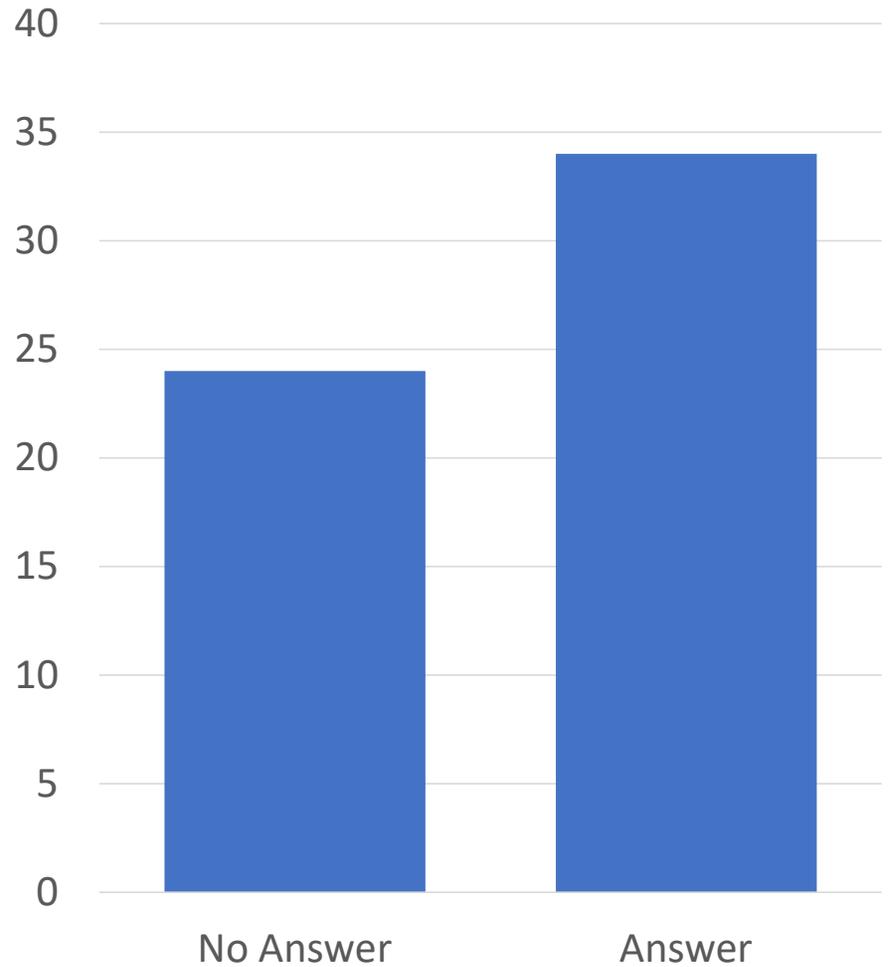
Increasing the
lifetime and
portability of
software.

- *“writing software that will last”*
- *“Longevity of the generated software/hardware.”*
- *“Reducing tech debt at a minimum”*
- *“ensuring the software is longlasting. E.g. if it can't run on older devices, then it requires new devices and is wasteful”*

Assumed
relationship between
efficiency and
environmental
sustainability.

- “Low energy/resource use”
- “Building small and efficient software. And not writing software when it's not needed.”
- “developing with performance in mind, limiting the feature scope”
- “Making simple, efficient, and as energy-efficient as possible”

Can you give an example of how you a sustainability consideration has influenced your practice?



- “open and text based file formats where possible”
- “Our software is open-source, ensuring that others can continue to develop it even if we cannot.”

Emphasis on open standards, FOSS

Re-using
hardware/software
rather than buying
or creating new.

- “Choosing established, supported software frameworks over new and experimental ones.”
- “I try to fix my computer instead of buying a new one”
- “refactoring repeated solutions into reusable components.”

- “I stopped using frameworks built upon frameworks built upon frameworks ... and am trying to build solutions as low-tech and simple as possible.”
- “Less includes, less media, more handmade code.”

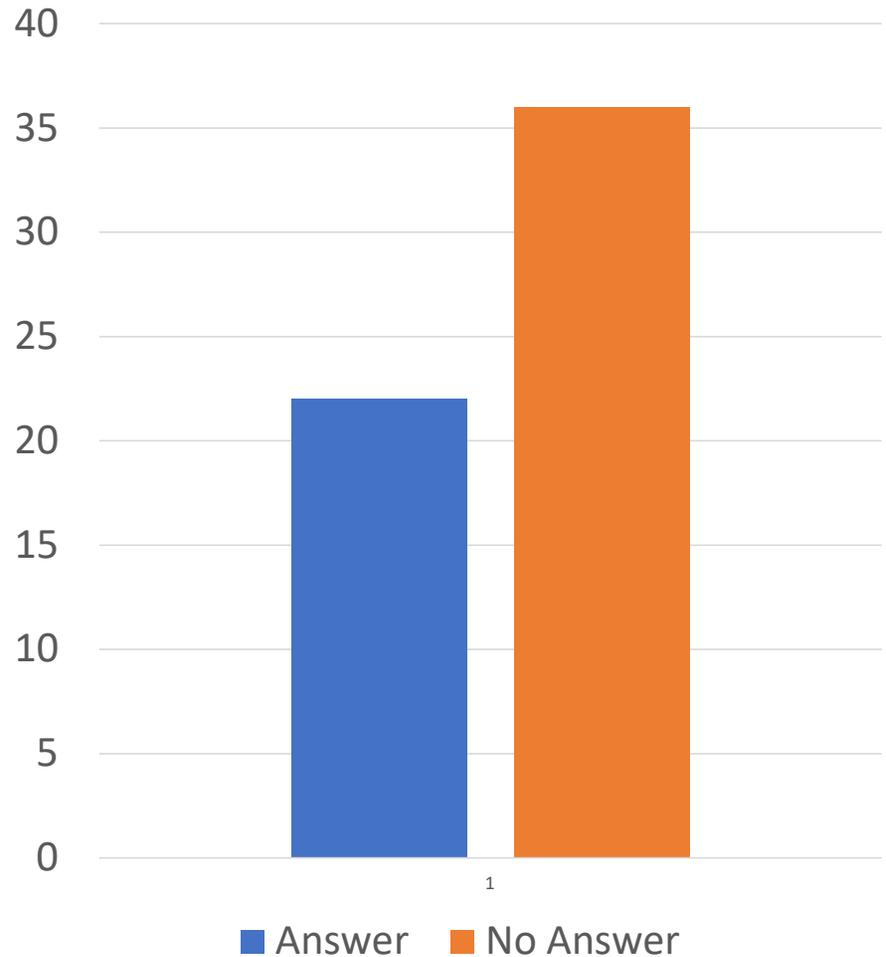
Avoiding frameworks and adopting simpler solutions, custom, fine tuned code.



- *“In the web domain, the biggest and most obvious hinder to sustainability is JavaScript.”*
- *“I believe compiled languages are ...usually less resource-consuming than interpreted programs like those written in python and Java.”*

Blame the language

Can you give an example of how the main organisation you work for prioritises sustainability?



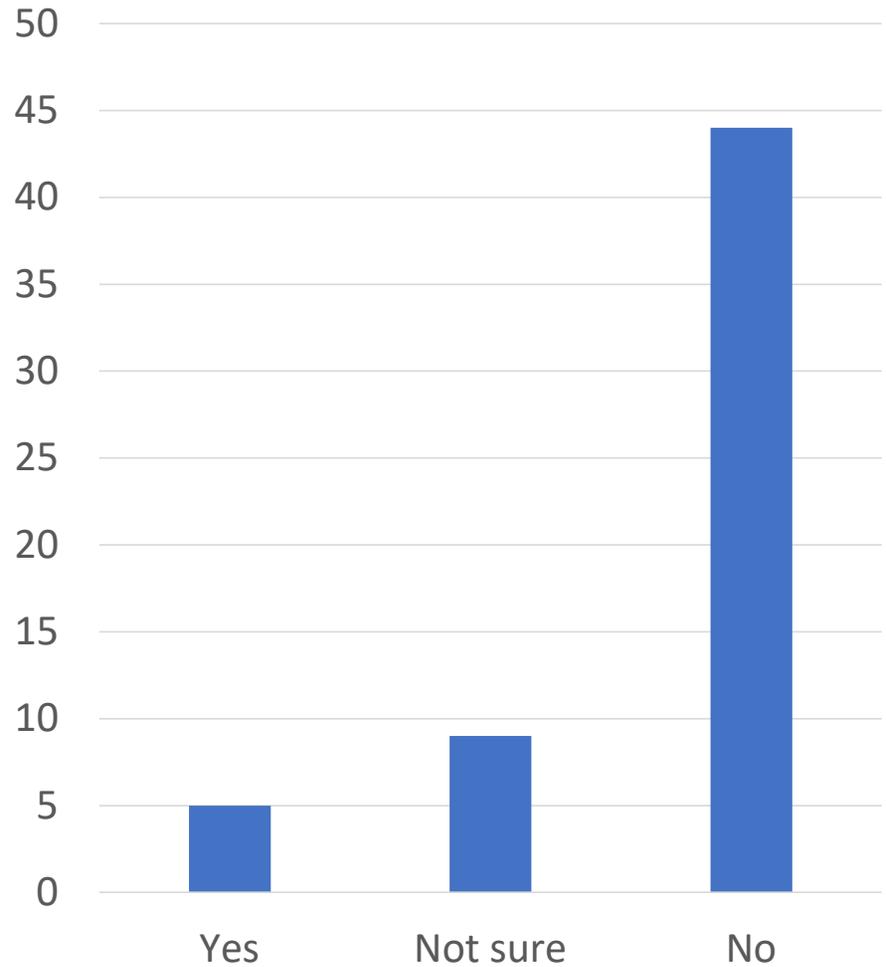
Q. 13. Can you give an example of how the main organisation you work for prioritises sustainability?

“No idea”

Q. 13. Can you give an example of how the main organisation you work for prioritises sustainability?

- *“...does not prioritise sustainability in software.”*
- *“I don't see it prioritized or seen as central to the service/product development in any way though.”*
- *“I doubt every sustainability... statement my university makes”*
- *“Inside of work there is active resistance to anything sustainable.”*
- *“My employers stated this as an explicit non-goal when meeting deadlines.”*

Have you used, or are you aware of support training or forms of support that help you to implement sustainability into your practice?



Have you used, or are you aware of support training or forms of support that help you to implement sustainability into your practice?

Two respondents:

- Using recycled hardware
- Promoting use of FOSS in schools
- Carbon calculators
- Green hosting checkers
- Branch Magazine, Low tech magazine
- Community knowledge sharing

Beyond technical considerations, sustainability is not a core consideration for software practitioners.

“This is very important, but it still somehow feels orthogonal to the day to day - particularly the social implications of decisions”

Software practitioners are pessimistic (and cynical) about the prospects for change.

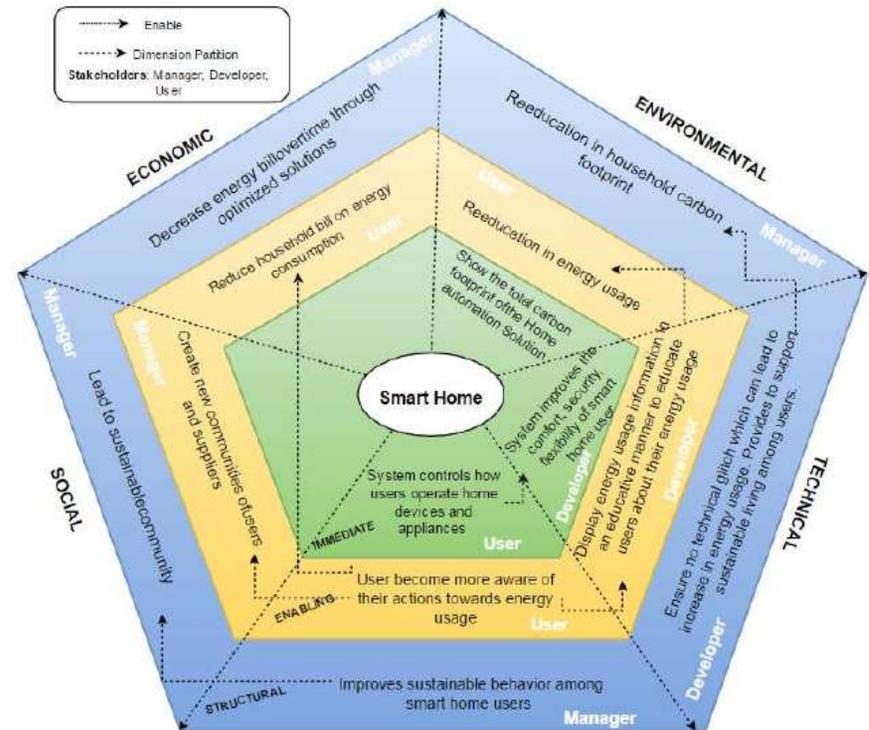
“developers don't have the agency...Business decisions are driven by profit and growth, which is driven by consumptive culture. Developers can, to some extent, cut around those issues by promoting FOSS, but that has its own sustainability issues.”

“I think we need to be educated using practical examples which can help us see the benefit of ‘sustainable software development’. A comparison between two projects (i.e., with and without sustainability considerations) could help us see the difference perhaps.. “

A call for more evidence!

Some reflections

Predominant focus on *technical* sustainability, and to some extent, environmental sustainability.



Assumption that environmental sustainability in computing means efficient compute, but practitioners are unclear how to measure this.

“simple, efficient, and as energy-efficient as possible”

Recognition of the need to extend hardware lifetimes.



How can I safely recycle my old PCs ...
theguardian.com



What Can You Extract from a Laptop ...
seamservices.com



Recycling Old Tech Hardware: How and ...
gvec.net



How To Prepare A Computer For Dispos...
ecogreenitrecycling.co.uk



Revive IT Recycling Computer Disposal ...
reviveit.co.uk



Recycle your old laptops, smartphones ...
greenerkirkcaldy.org.uk



vs



Apparent tension
between technical
and environmental
sustainability in
software practices
and decision making.

“I think computing as a whole has an irresponsible view that energy and resources are infinite”

How we approach
Computing Science
Education.

<https://glasgow-research.onlinesurveys.ac.uk/sustainability-in-software-practices-survey>

Please share!



Thanks and
questions

Green Software Manifesto