Il consumo di energia nel software: nuovo attributo di qualità?

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How to evaluate the Sustainability of software?

… from the perspective of software developers

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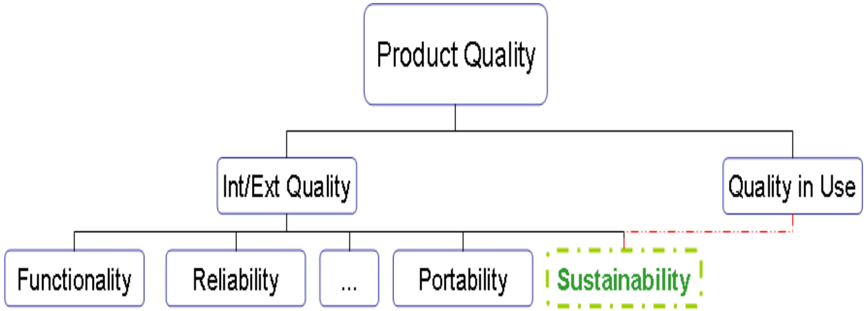


Metrics-based approach

Direct Effects	Sustainability Assets				
	People	Project infrastructure	Processes	Organizational context	Product
Power	---	Tool efficiency Tool suitability	Process Efficiency Process Predictability Process Capability	Team location	Algorithmic / code efficiency
Effort/time	Team composition	Tool efficiency Tool suitability	Process Efficiency Process Predictability Process Capability	Team location	Maintainability
Material production	---	Avoidance of environmentally hazardous materials	---	---	Avoidance of environmentally hazardous materials
Paper	---	---	Dematerialization	---	---
Fuel	---	Teleconferences	---	Flexi-work Team location	---

Examples of Sustainability Metrics

Flexi-work	**Measure Id.**	% of work time spent at home (WAH)
	Measure Formula	MHO=amount of Man Hours spent at Office by project team; MHH=amount of MAN Hours spent at home by project team; WAH=MHH/(MHH+MHO)
	Measure Rational	The most appropriate value depends on the specific local conditions. Note: WAH can be used to properly balance the quality of produced work with the available 'quality time' for doing it, avoiding time wastes for travelling a … task. It is useful also to let peopl … inabilities stay involved. On the cont … much time at home in order to do not r …

Algorithmic/ code efficiency	**Measure Id.**	Computational cost of software (CCS)
	Measure Formula	NF=number of functionalities implemented by software; NPC_i=average CPU cycles required by the functionality i^{th} implemented by software; $CCS=NPC_1+NPC_2+ \ldots + NPC_{NF}$
	Measure Rational	The lower CCS, the more power saved. Note: CCS allows the control of the computational cost of software independently of the target hardware environment.

Teleconferen-ces	**Measure Id.**	% teleconference meetings (PTM)
	Measure Formula	NT=Number of teleconferences; NF=Number of face-to-face meetings. PTM= NT / (NT+NF)
	Rational	The higher PTM, the more fuel saved. Note: PTM allows the monitoring and control of the number of travels due to meetings related to project's activities.

Team Composition	**Measure Id.**	Fitness for Role (FfR)
	Measure Formula	RP= number of competences and skills required by the project role; AP=number of actual competencies and skills of the person allocated to the project role. FfR=AP/RP
	Measure Rational	The higher FfR the better. Note: The fitness-for-role of the people involved in a project allows a saving in terms of effort spent.

Software Sustainability
a Process-centric Perspective

The principal sustainability factors directly impacted by the process are:

- ***Power consumption***: Inefficient processes require unnecessary workload with a consequent waste of power and then avoidable CO_2 emissions.
- ***Paper consumption***: the amount of paper consumed in a software development project depends on the media used for sharing information and knowledge within the organization.
  Knowledge management and communication infrastructure as well as their usage depend on the procedures defined in the processes.
- ***Fuel consumption***: travels and face-to-face meetings can be reduced (with a consequent reduction of fuel consumed) both introducing suitable technologies and defining suitable processes to guide their usage.
  The scheduling of activities over the working day may impact also.

Software Sustainability
a Process-centric Perspective

Definition of models to evaluate sustainability of software processes

Definition of sustainability-specific processes representing the activities to be addressed in order to introduce and integrate sustainability culture in the software process

Process Sustainability Levels

Definition of models to evaluate sustainability of software processes

Sustainability Level 5:
Optimized Sustainable Process
P.A. 5.1: Sustainable Process Innovation
P.A. 5.2: Sustainable Process Innovation Implementation

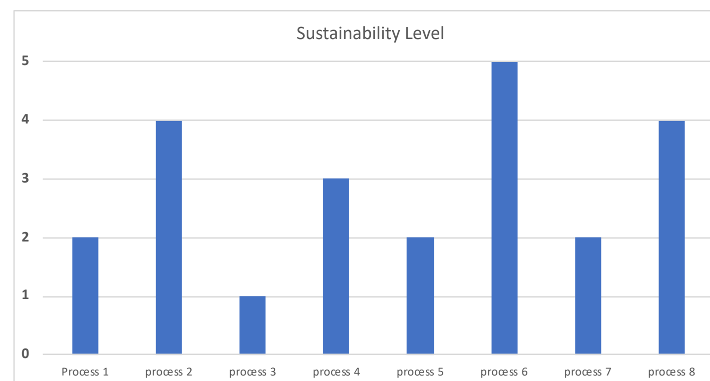
Sustainability Level 4:
Measured Sustainable Process
P.A. 4.1: Quantitative Sustainability Analysis
P.A. 4.2: Sustainable Process Control

Sustainability Level 3:
Defined Sustainable Process
P.A. 3.1: Sustainable Process Definition
P.A. 3.2: Sustainable Process Deployment

Sustainability Level 2:
Managed Sustainable Process
P.A. 2.1: Sustainability Management
P.A. 2.2: Sustainable Work Product Management

Sustainability Level 1:
Performed Sustainable Process
P.A. 1.1: Process Performance
P.A. 1.2: Process Sustainability

Sustainability Level 0: Incomplete



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Definition of sustainability-specific processes representing the activities to be addressed in order to introduce and integrate sustainability culture in the software process

Sustainability in Software Processes

Sustainability Management

Process ID	SUS.1
Process Name	Sustainability Management
Process Purpose	The purpose of the Sustainability Management Process is to ensure that products, services and life cycle processes meet sustainability objectives.
Process Outcomes	As a result of the successful implementation of the Sustainability Management process: 1) Sustainability objectives and criteria are established. 2) The scope of the sustainability-related activities for the project is defined. 3) Activities for achieving sustainability objectives are planned and implemented. 4) Tasks and resources necessary to complete the activities for sustainability are sized and estimated. 5) An organization structure for sustainability (responsibilities, roles, reporting channels, interfaces with other projects or OUs …) is established. 6) Activities for sustainability are monitored, sustainability non conformities are reported, analysed, and resolved. 7) Agreement on sustainability policy and requirements for supplied products or services is achieved. 8) Supplier's activities for sustainability are monitored.

Definition of sustainability-specific processes representing the activities to be addressed in order to introduce and integrate sustainability culture in the software process

Sustainability in Software Processes
Sustainability Engineering

Process ID	SUS.2
Process Name	Sustainability Engineering
Process Purpose	The purpose of the Sustainability Engineering process is to ensure that sustainability is adequately addressed throughout all stages of the engineering processes.
Process Outcomes	As a result of the successful implementation of the Sustainability Engineering process: 1) Factors affecting sustainability (e.g. resource consumption sources) are identified 2) Sustainability analysis is performed in order to determine the sustainability impact of factors affecting sustainability 3) Sustainability objectives are defined for the product development 4) Green principles are applied to development processes to identify techniques and methods suitable to achieve the sustainability objectives. 5) Techniques and methods for sustainability are applied 6) Impact on sustainability of change requests is analysed

Definition of sustainability-specific processes representing the activities to be addressed in order to introduce and integrate sustainability culture in the software process

Sustainability in Software Processes

Sustainability Qualification

Process ID	SUS.3
Process Name	Sustainability Qualification
Process Purpose	The purpose of the sustainability Qualification process is to assess the suitability for sustainability of external resources when developing a software or system.
Process Outcomes	As a result of the successful implementation of the Sustainability Qualification process: 1) Sustainability qualification strategy for external resources is developed. 2) Sustainability qualification plan is developed and executed. 3) Sustainability qualification documentation is released. 4) Sustainability qualification report is produced.

Conclusions

- Increased awareness of sustainability issues
- Several possible approaches to evaluate sustainability in software development
- Need of standard methodologies

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