Environmental Sustainability IN Agile Processes: the AMELI (Acting, MEasuring, Learning and Improving) Model - Extended Abstract

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Abstract

Sustainable development requires to be performed just using the necessary needs of the present without compromising future generation's needs. Agile software development is a perfect framework to deploy sustainable models with concrete activities and measurements that could assist agile practitioners to be aware about the sustainability in their agile processes. This work presents the AMELI model, which prescribes a set of activities and measurements that practitioners can use to learn from them in order to achieve future sustainability improvements in their agile processes. In this work, we present the environmental dimension of AMELI.

Keywords

Agile, Process, Sustainability, Green, Environmental.

1. Introduction

Agile software development should have a strong commitment in such a way agile processes and their assets should be sustainable-aware [3], [10], [11]. Sustainability addresses three main dimensions [1][2][4]: Environmental, Social and Economic. In this work, we present the environmental dimension of a sustainability model for agile practitioners sustainable-aware agile processes, called AMELI (Acting, MEasuring, Learning and Improving). It prescribes activities to measure sustainability indicators that allow one to learn how to improve sustainability in next sprints or projects [16]. As a result, AMELI provides agile practitioners to have a continuous feedback about the green degree of their agile processes.

2. The AMELI (Acting, Measuring, Learning and Improving) Model: Environmental Dimension

The AMELI model has been conceived to support sustainability IN agile processes [13], [15], [17] through some activities and measurements derived from a set of main questions about agile process. The environmental dimension addresses the questions: Where, How, What and When.

WHERE? This question is about where the agile process is conducted, i.e. the place where the agile team works. The place where our agile process is adopted provide us valuable information about our environmental sustainability degree [18]. AMELI prescribes to calculate the indicator of **Place Environmental Waste** by using the main indicators (energy, paper, plastic and water) that vary throughout the working progress of the team (see equations, Figure 1). The Energy Place Waste equation provide us the power consumption in kilowatts per hour (kWh) (see Eq.3), the Paper Waste is measured using an integer number that corresponds with the number of A4 sheet papers (see Eq.4), the

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Plastic Waste is measured in an integer number (see Eq.5), and the Water Waste is measured in liters (see Eq.6). Finally, the Place Environmental Waste is the sum of all this values (see Eq.1), providing a number that we should try be improved sprint to sprint. Since this sum has different measurement units, it is important to normalize the values applying the Z normalization, which consists in scaling the values of each component using its mean value and its standard deviation. In addition, it is important to emphasize that the place not only generates waste, it can also generate environmental value. This value can be achieved by actions of the company that are independent of the agile process but help to reduce the waste footprint of its agile process adoption. This value is called **Place Environmental Value** (see equations, Figure 1). The organization may perform actions to generate new energy by installing photovoltaic panels in the building where the agile team is working, also the company can be involved in actions of afforest o reforest by planting trees, as well as actions about harvesting or desalination of water, or even, its recycling. The Energy Generation equation provide us the power generation in kilowatts per hour (kWh) (see Eq.7). The Paper Generation is measured using an integer number that corresponds with the number of A4 sheet papers (see Eq.8) (a tree is 45 feet high and 8 inches across has between 10.000 sheets of paper). The Plastic Recycling is measured in an integer number that represents the number of plastic items that have been recycled by the team (see Eq.9), and the Water facilitation is measured is the liters of water that has been harvested, desalinated or recycled through initiatives that the company has been participated (see Eq.10). Finally, the Place Environmental Value is the sum of all this Z normalized values providing a number that should be improved sprint to sprint. In addition, the difference among the *Place Environmental Value* (see Eq.6) and the *Place Environmental Waste* (see Eq.1) will provide a value about our sustainable degree from the where perspective (see Eq. 11), which is called **Where Sustainability Degree**:

Place Environmental Waste = Energy Place Waste + Paper Waste + Plastic Waste + Water Waste (Eq.1)
Energy Place Waste = Lights Power Consumption + Computers Power Consumption + Air Conditioning Systems Consumption + Heating Systems Power Consumption **(Eq.3)**
Paper Waste = TransformToNumberA4Sheets (Number of Post-its + Number of Booknotes * Number of paper sheets + Number of Other Kind of Papers) +Number of A4 paper sheets **(Eq. 4)**
Plastic Waste = Number of elements of plastic used not recyclable (bottles,glasses,bags,straws,cutlery,dishes,etc) **(Eq.5)**
Water Waste = Water Consumption of the bathrooms **(Eq. 6)**
Place Environmental Value = Energy Generation + Paper(Oxygen) Generation + Recycling + Water Facilitation (Eq.2)
Energy Generation = Power Generated from photovoltaic panels of the building **(Eq.7)**
Paper(Oxygen) Generation = (Number of trees restored from degraded forests,afforested and/or reforested) *10.000 + Number of recycled paper elements **(Eq. 8)**
Plastic Recycling = Number of recycled plastic elements **(Eq. 9)**
Water facilitation = Water harvesting,desalination and recycling **(Eq.10)**
Where Sustainability Degree = Place Environmental Value - Place Environmental Waste (Eq.10)

Figure 1: Calculation of Where Sustainability Degree

Finally, there are other **non-quantitative actions** that can be performed in the team's working place in order to improve our Where Sustainability Degree. They consist in promoting habits to the agile team that in the medium term will be materialized in quantitative sustainability results, e.g. switching off computers, screens or other electronic devices when they are not used.

HOW? This question is about how the agile team conducts its agile process. The agile process is articulated by using a set of development tools and hardware devices. The selection of this hardware and software components is also critical in our environmental sustainability, since they will incur a degree of power consumption depending on their properties and they will provide a degree. Therefore, it is important to select the most suitable sustainability components without losing the required properties to successfully develop the agile process. The How question must be analyzed from two different moments: the selection and the use, which are described as follows.

Selection. Before starting the agile process, the selection of the hardware and software setting has to be determined to adopt the agile process. In AMELI, we promote the selection of this setting by taking into account the energy consumption reduction. To that end, the selection process should be proceeded as follows:

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Hardware/Software Selection
Precondition: The hardware/software provides the required support for the agile process conduction
Process:
    1.  SELECT the hardware device/software tools FROM all hardware devices/software tools of the same type
            1.1.  SELECT the hardware device/software tool FROM the previously selected WHERE the power consumption is
                  the lowest.
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Code 1. Hardware Software Selection

There is a lot of advances in the measurement of power consumption and the design of sustainable hardware. Therefore, the power consumption of hardware devices is detailed as a norm in their specification, and the selection of the most suitable hardware for supporting the agile process is easy.

However, a lot of work is still pending in software and we do not have this power consumption information. There are initiatives and tools that support software measurement [5], [6], [7].

Use. Once, the tools have been selected from the established selection criteria. AMELI defines the **Environmental How Sustainability Degree**, i.e. the power consumption of the agile process (see Eq.11).

$$Environmental\ How\ Sustainability\ Degree = \left(\sum_{1}^{n} kWh\ software\ tools\right) * hours * sprint\ days \quad (Being\ n\ the\ number\ of\ used\ software\ tools), \tag{11}$$

WHAT? This question is about the product that is being developed. Depending of the system under development, it may have hardware components or not. In these cases, to apply a sustainable hardware selection process of the hardware components that will constitute the system is required. To be sustainable, the hardware components of the product must be selected with the same selection process of Code 1. On the other hand, the sustainability of the software development tools [19] used for constructing the product as well as the software development techniques applied to this construction are critical for the environmental sustainability of our product. As a result, it is necessary to take into account the development tools presented in Figure 2.a selecting them using existing studies comparing them from a sustainability point of view, or making the comparison using the selection process of Code 1. In addition, it is important to promote the developing techniques described in Figure 2.a, i.e. refactoring on the fly and well-known green patterns that boost the sustainable software execution [8], [9], [12], [14], and evidencing the energy saving of the improvement by measuring the product execution after these refactoring. The What Sustainability Degree can be measured with two different units: the power consumption of the product (see Eq.12) and the level of the What Sustainability Degree, i.e. the performed sustainability actions related with the product are marked for calculating the value (see Figure 2.a).

$$Power\ Consumption\ of\ the\ What\ Sustainability\ Degree = Power\ consumption\ of\ the\ developed\ product\ under\ execution + Power\ consumption\ of\ all\ the\ devices\ under\ the\ product\ execution, \tag{12}$$

a) What Sustainability Degree

Activity	Degree	Mark (0 or 1 or n/a)
Evaluation of Development Tools Power Consumption	Development tools	
	DBMS	
	Deployment tools	
	Operation tools	
	AI Algorithms	
	Languages	
	Others	
Adoption of Developing Tecniques to Reduce Power consumption	Programming Patterns	
	Architecting	
	Refactoring	
	Continuous Power Consumption Monitoring	
	Stakeholders diversity in areas and themes	
Sustainability BY	The product supports	*
	What Sustainability Degree:	Σ(marks)

*Total number of SDG supported

b) AMELI adoption in the Agile Process

Agile Phase/Activity	AMELI Adoption
Initial Product Backlog Creation	Calculation of the Where Sustainability Degree
Workshop / 1st Sprint/Pregame	Calculation the Environmental How Sustainability Degree
Sprint	Adoption of non-quantitative enviromental actions
	Adoption of Developing Tecniques to Reduce Power consumption
	Continuous calculation of the Power Consumption of the What Sustainability Degree
Review	Demonstration of the Power Consumption of the What Sustainability Degree
Retrospective	Calculation of the What Sustainability Degree
	If New Actions --> Recalculation of the Where Sustainability Degree
	If New Actions --> Recalculation the Environmental How Sustainability Degree
	If there is no iteration 1 --> Calculation of the Improvement of previous iteration

Figure 2: What and When adoption

WHEN? the When question addresses when to apply this actions and measurements throughout the agile process. AMELI defines the guideline presented in Figure 2.b, and prescribes to also use a specialized retrospective board/sailboat method for the analyzing the positive/negative/improve aspects of the environmental dimensions of sustainability.

3. Conclusions

This work presents the AMELI (Acting, MEasuring, Learning and Improving) model as a mechanism to address sustainability IN agile processes by smoothly integrate it into the agile activities. In this work we address the environmental dimension. As future work, we plan to define the activities of the economic and social dimensions, as well as to evaluate the model in a real setting to analyze the feedback of practitioners in order to extend/reduce the model to facilitate its adoption.

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