A Vision Towards a Method for Identifying and Mitigating Unsustainable Practices in Organisations

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***Abstract*—Sustainability is a major concern of our time. Companies can have a considerable negative impact on the environment, as their productive processes often contribute to the emission of greenhouse gases, generate toxic waste and consume natural resources. As such, they also have a great share of the responsibility towards our sustainable development. This paper presents a vision for a method to identify and mitigate unsustainable practices in business organisations. The method is inspired on the KAOS Framework, in the sense that it offers catalogues for the identification and resolution of obstacles to sustainability. The method will be complemented by a metamodel, a semi-structured language and a knowledge base, to eventually allow automation.**

1. Introduction

The negative impact of human activities are more noticeable than ever. Companies productive processes can often contribute to the emission of greenhouse gases, the excessive consumption of natural resources and the generation of waste. Sustainability is arguably in the strategic path of many companies, but for decades their environmental, social and governance activities have been disconnected from this vision. Many companies still launch ad-hoc initiatives simply to enhance their "green credentials", to comply with regulations or to deal with emergencies; rather than viewing sustainability as something with a direct impact on their business results [4].

Gradually, many companies are recognising this impact and the need to incorporate sustainability practices into their business. A 2016 survey [2] of 1,000 CEOS from 27 industries across 103 countries found that 89% of CEOs believe their commitment to sustainability translates into a real impact on their industries and the lack of short-term financial return is no longer a reason not to embrace sustainability. Consistent with this view, 85% of them claim to have incorporated sustainability into their business, even when they cannot quantify the benefits. While the survey observes that the CEOs are showing a growing understanding of sustainable development and are making deeper commitments to solve global challenges, it concludes that there is still room for improvement.

We argue that in order to contribute to our sustainable development, companies need to understand which of their practices negatively affect sustainability and to seek alternatives or compensations for these practices. We will start from the environmental dimension of sustainability [2] [13] and, as therefore, we define the following research question:

"How to identify practices in business operations that negatively affect the environmental sustainability and seek ways to mitigate these practices?"

This paper describes a vision for a method with this very purpose. The method is inspired by the well-known KAOS Framework, a goal-oriented modelling technique in Requirements Engineering [15]. Adapting the goal-obstacle analysis in the KAOS Framework, we propose the concepts of "sustainability goal" and "sustainability obstacle" and envision a method that will offer catalogues for identifying and mitigating sustainability obstacles (i.e. unsustainable practices) in business organisations. The method will be complemented by a sustainability metamodel, a semi-structured language and a knowledge base to eventually support the automatic identification and resolution of sustainability obstacles. Once realised, this vision can advance the field of Requirements Engineering for Sustainability as it will help companies to identify and mitigate unsustainable goals in their systems and operations.

The paper is organised as follows: Section 1 motivates our work; Section 2 summarises the most important concepts

that inspired our vision; Section 3 describes our envisioned solution; and finally, Section 4 concludes the paper.

2. Background

This section briefly explains fundamental concepts related to our vision: sustainability, goal-oriented requirements engineering and sustainability models/metamodels.

2.1. Sustainability

Sustainability is a complex and interdisciplinary concept that has been defined in many ways. Yet, the term can be essentially understood as the "ability to endure" [1] [3]. Possibly, the most widespread related concept is the one of sustainable development, defined as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [12]. These definitions imply that a society that is not sustainable cannot be maintained in the long run and will cease to function at some point in time [7].

Sustainability is composed of several dimensions. The three best known are environmental, social and economic, often referred as the three pillars of sustainability. However, other dimensions start to be considered; such as the human and the technical [6] [13]. The paper focuses on the environmental dimension, which addresses the effects of long-term human activities on natural systems, including issues related to ecosystems, climate change, food production and waste, among others.

However, in order for sustainability to be effectively achieved, other dimensions must also be considered. We believe that analogous solutions to the one described here can be developed for the remaining dimensions.

2.2. Goal-Oriented Modelling and KAOS

Goal-oriented Requirements Engineering (GORE) has emerged as an attempt to solve many of the problems of traditional requirements engineering, including incorrect assumptions about the environment, the little attention given to understanding the need for a particular system and to whether its specifications really captured the needs of stakeholders [9]. Therefore, GORE encompasses the elicitation, assessment, design, structuring, documentation, and analysis of software requirements [9]. There are several approaches and methodologies that enable its application.

The KAOS is a well-known GORE framework, whose acronym means "Keep All Objectives Satisfied". KAOS is composed of a modeling language and a method for developing software requirements. The most important KAOS concepts for our vision are: agent, goal, obstacle, resolution and goal-obstacle analysis. These concepts are explained below [15]:

An **agent** is an active component of the system that plays a role in meeting a goal. Agents can be humans, devices, software, etc; they perform operations assigned to them. A **goal** is a prescriptive statement of intent that a system must meet through the collaboration of its agents. Goals range from high-level business goals, whose satisfaction requires the cooperation of multiple agents (e.g., "Maximize [Profit]", to low-level technical goals, whose satisfaction depends on a single agent (e.g. "Achieve[Calculated Product Tax]").

In a goal model, goals are organised into AND / OR refinement structures. An AND refinement connects a goal to a subset of goals, i.e. the goal will only be satisfied if all its children are satisfied. An OR refinement connects a goal with an alternative set of refinements, i.e. the goal will be met if at least one of the refinements is met. The KAOS Framework draws attention to the fact that often the goal model is initially developed in an "idealized" way. That is, it fails to consider exceptional conditions in the application domain that may violate these goals. To build a more realistic model, the KAOS Framework defines **goal-obstacle analysis**. This analysis takes a pessimistic view of the elaborated model seeking to identify exceptional conditions (obstacles) and ways to mitigate them (resolutions). Therefore, an **obstacle** is a situation that, if occur, can prevent a goal from being satisfied. Thus, every obstacle generated needs to be solved in one way or another [10]. Critical obstacles are normally resolved through countermeasure goals, while non-critical ones can be monitored or resolved when they occur. In any case, one needs to determine the appropriate **resolutions** for each obstacle. KAOS has an obstacle resolution catalogue that can be used to reduce or mitigate obstacles.

2.3. Sustainability Models and Metamodels

There are currently sustainability models that help to incorporate sustainability into organisations and/or systems. Some of them are summarised below:

Cabot et al. [5] advocate the use of a sustainability taxonomy combined with goal-oriented techniques. They explore a preliminary method for modelling and integrating sustainability issues in business (in general) and software projects (in particular) through the use of the i * Framework. To do so, they explicitly represent the sustainability effect of each business or project alternative, thus enabling stakeholders to understand the commitments between sustainability and other business goals and to make the best decisions.

Stefan et al. [14] use goal-oriented requirement engineering techniques to help organisations to make more effective decisions for achieving their sustainability goals. Their method provides systematic techniques for refining goals into sub-goals, managing goal conflicts, identifying and resolving obstacles to goal achievement, and exploring and evaluating alternatives to goal achievement.

Mahaux, Heymens and Saval [11] use requirements engineering techniques to describe requirements that seek minimal environmental impact. Their work aims to provide insight into how sustainability requirements can be discovered, what existing tools or techniques can facilitate this task, and what their limitations are in this regard.

Penzenstadler and Femmer [13] present a reference model for software development projects that breaks down sustainability into its environmental, human, social, economic and technical dimensions. The model provides a series of activities and relates them to the values they support and the indicators against which they can be evaluated.

Models, such as Cabot et al.'s , Mahaux et al.'s and Stefan and Letier's , are specific to the problem they seek to solve and cannot be used as a reference for business organisations in general. Penzenstadler and Femmer's model, on the other hand, seeks to be more generic and, although designed for software development companies, can be adapted to business processes in general.

3. Envisioned Solution

In order to position themselves as sustainable businesses, companies need to routinely analyse their own practices to identify opportunities to become more sustainable. We envision a method to allow companies to recognise unsustainable practices in business operations and to modify, replace or compensate them with alternative practices.

3.1. Underlying concepts

The method is inspired by the goal-obstacle analysis of the KAOS Framework. Therefore, we refer to the aforementioned harmful practices as sustainability obstacles and to the alternative practices as sustainability resolutions. We extended the KAOS Framework to define these concepts as:

A **sustainability goal** is *a prescriptive statement of intent that contributes to a long-term positive impact on one or more sustainability dimensions*. That is, just like in KAOS, a goal is something that needs to be achieved, but in this case, it also needs to have a long-term positive impact on one or more sustainability dimensions.

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- A **sustainability obstacle** is defined as *a precondition for the non-satisfaction of a sustainability goal*. That is, an obstacle is a situation that occurs that prevents a goal from being reached.
- **Sustainability resolutions** are *alternatives that can alleviate or avoid a particular sustainability obstacle*.

In a simplified example, a company may have high-level goals such as "*Maximize[Environmental sustainability]*" and lower-level goals like "*Reduce[Carbon emissions from product delivery]*". In KAOS, a goal-obstacle analysis would first negate the goal (e.g. "*NOT Reduce[Carbon emissions from product delivery]*)" to then find obstacles that lead to the negated goal. So, an obstacle could be "*Delivery car consumes diesel"* and a possible resolution could be: "*Achieve[Product delivery by bike]*", as shown in Figure 1.

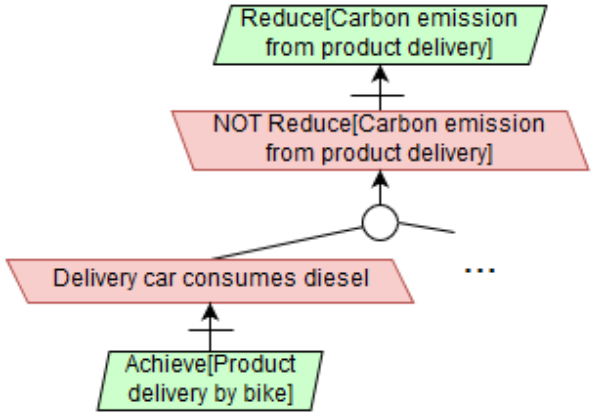

Figure 1: Sustainability goal-obstacle analysis.

3.2. The Method

Similar to KAOS, we envision a method that identifies unsustainable practices from a sustainability obstacle catalogue and potential mitigation strategies from a sustainability resolution catalogue. We also envision the semi-automation of this process through the definition of a metamodel, a semi-structured language, rules and a knowledge base.

Therefore, the method will have the following elements, whose relationship is represented in Figure 2. These are described below:

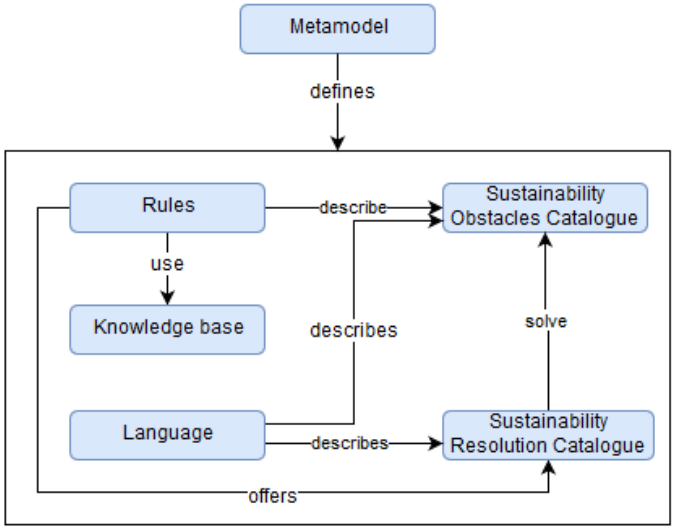

Figure 2: Elements of the envisioned solution.

- A sustainability **metamodel** will describe the basic sustainability concepts that underlie the solution.

Therefore, it will be the basis of the sustainability obstacle and resolution catalogues, of the language and rules that describes them, and of the knowledge base. We envision that the metamodel will have elements such as "goal", "obstacle", "resolution", "agent", "resource", "environmental impact". We intend to extend the work of Penzenstadler and Femmer [13] to create the metamodel.

- A **catalogue of generic sustainability obstacles**, listing possible environmental problems resulting from common company practices. The catalogue will help to identify the obstacles to sustainable business operations. At least two types of obstacles will be covered: "pollution" and "resource scarcity". The former will be concerned with obstacles that contribute to different types of pollution (including water, air and soil), while the latter refers to the scarcity of natural resources.
- A **catalogue of sustainability resolutions**, also generic, will detail different alternatives to solve or mitigate sustainability obstacles. The catalogue will contain, among other things, alternative resolutions for generic obstacles and concrete examples of such resolutions.
- A **semi-structured language and rules** will describe sustainability obstacles and resolutions, as well as rules to automate the resolution search. We envision that the language will not only formalise the description of sustainability obstacles and resolutions, but will also make it easier to identify them through the use of a knowledge base. The language will also facilitate the understanding and the communication of sustainability obstacle and resolutions, as everyone involved understands the meaning of the concepts.
- A **knowledge base** will be created for different industries to allow the automatic identification and resolution of sustainability obstacles, possibly using predicate logic and Prolog.

4. Conclusion

Sustainability has become a major concern for the society. Large companies like Google, Microsoft, and Apple have been criticised for not prioritising sustainable practices, such as the use of energy efficient data centres [8]. While, companies have grown their understanding of and commitment towards sustainability, they can still do more [2]. This paper presents a vision for a method inspired in the goal-obstacle analysis of the KAOS Framework for identifying and mitigating unsustainable practices in business organisations. In order to realise this vision, we have planned the following steps: (1) a more in-depth bibliographic study of the KAOS framework; sustainability models/metamodels; and recommendation systems. (2) The creation of a data-model for the envisioned method; (3) The development of the obstacles and resolution catalogues; (4) the design of a semi-structured language, rules and a recommendation tool; and, finally, (5) the creation of a knowledge base for the recommendation tool. We plan to develop this solution initially for a single domain, starting with a real case study on retail, to then extend to other domains.

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