# An Adaptive System for Proactively Supporting Sustainability Goals

# (Extended Abstract)

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## 1. INTRODUCTION

We have developed a software application for a new, emerging approach to sustainability reporting, where a multi-agent system is an integral part of the overall architecture. The agent-oriented approach readily achieves the functionality required for this application, and the Belief Desire Intention (BDI) agent framework assisted in clarifying system behaviour across our heterogeneous, cross-disciplinary research team.

It has recently been suggested that current reporting practices are failing to capture the full picture of whether an organisation's practices are sustainable, e.g. [5, 1, 2]. This is due, in part, to the way economic issues are often considered independently from environmental and social issues, and vice versa. Moreover, sustainability reporting is typically addressed using either locally defined *or* external, standardised indicator sets. This forces a choice between measuring what is most relevant to the organisation, on the one hand, and what allows for comparability with other organisations, on the other. There is a need to support organisations to use a combination of indicators that capture specific local concerns *and* indicators which can be used to communicate and compare the organisation's performance externally.

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Our research group of computer and social scientists has been developing a software system that aims to facilitate sustainability reporting in accordance with a new reporting framework that has recently been proposed to address these issues [5]. The software needs to support organisations to combine their own locally defined indicators with global standards, in a sustainability reporting template, and to look at their performance holistically. It should do this in a manner that both adapts to and guides the user. That is, the application ought to be responsive to end user preferences as to how to perform tasks and define indicators, but also proactive with respect to the goals of the underlying philosophy. For example, the system should allow users to define their own indicators, guide them to identify a set of indicators that holistically monitors their performance, and suggest the use of standard indicators when compatible with their needs.

The system we are developing currently exists as a continually evolving prototype (see Figure 1), being trialled with case study participants for ongoing feedback. The multi-agent component mediates between an interactive web interface and an extensible RDF-based data store for capturing information about sustainability projects, and the specific indicators used to measure them. Fundamental properties of the BDI agent paradigm have readily met our above-mentioned needs: the proactive, goal-oriented features enable us to easily guide and support the user; and, the context-sensitive manner in which agents achieve their goals allows us to build a system that can readily adapt to specific user needs. Also, the goal-plan framework lends itself to the easy addition of automated reasoning support, and allows quick adaptation of the prototype system in response to case studies.

Furthermore, the BDI framework, and the available design tools, have facilitated a highly interactive collaboration by providing an effective structure for communication between the computer and social scientists in our research team. We have found that the agent oriented entities of goals, events, plans and beliefs are sufficiently intuitive and jargon-free, that it is possible for non-technical team members to understand and contribute to the agent design much more directly than we believe could happen using a more traditional approach.

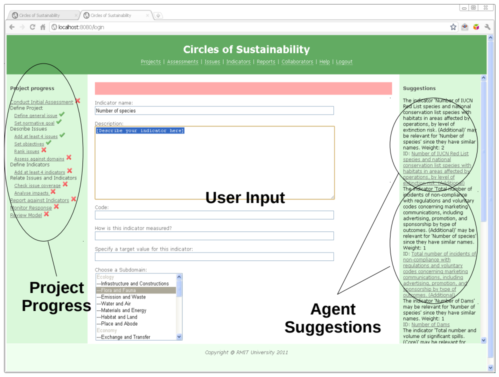


**Figure 1: Screen shot of indicator suggestion.**

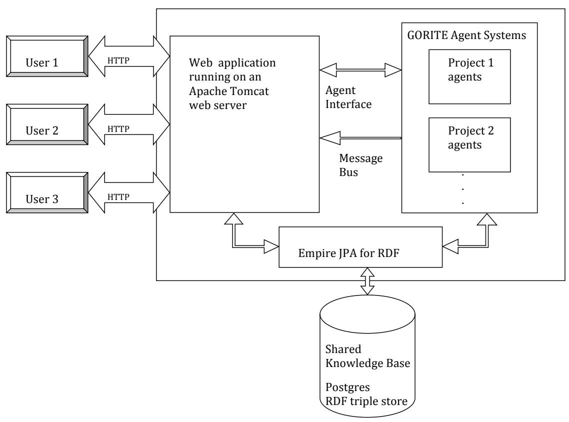


**Figure 2: Overall architecture of system**

## 2. SYSTEM DESCRIPTION

The system architecture needs to support multiple users accessing multiple sustainability projects simultaneously via the web. Though an individual user may be associated with multiple projects, in a single browser session they can only be connected to one project. This led us to design the four main components of our architecture as shown in Figure 2. **Users** access the system via any modern web browser; the **Web application** running on an Apache Tomcat web server handles session management (including authentication), interaction with users via HTTP, sending and receiving messages to and from the agent system, and storing and retrieving information in the knowledge base; the **Agent system** has a separate instantiation that manages each project; and the **Knowledge base** provides a persistent store for shared knowledge about sustainability indicator sets as well project-specific knowledge.

## 3. COMPARISON WITH OTHER SYSTEMS

We conclude by briefly comparing our application with other sustainability reporting systems, highlighting advantages offered by our use of agent systems.

Numerous commercial vendors have developed systems for environmental sustainability reporting, such as VERISAE, Cloudapps, TBL2, IHS and SIMPLIFi. Ecological Footprint calculators are the most widely used examples of such software, and can be used by individuals, enterprises, cities and countries to measure the embodied biocapacity to sustain production of goods and services [4]. While such tools are very useful in calculating specific measures, they are built using specific and inflexible assumptions, and are generally designed to measure only environmental (not social or economic) aspects of sustainability.

More closely related to our application is a widely-used online reporting tool, the MDG Dashboard [3], that supports visualising different sustainability data sets taken from the UN MDG indicator database. The MDG allows other datasets to be used, but requires specialist technical knowledge to prepare them, and once created, does not allow for multi-user editing. Our application is similarly holistic in philosophy to this system, but is far more customisable in terms of the types and relationships between indicators. It also differs in allowing multiple indicator sets to be applied to a single project, and for these to be edited by end users.

Web-based multi-user collaborative environments, such as wikis, blogs and social networking sites, have become increasingly popular for documenting and reporting on projects. Such systems, even where they support structured data sets (such as semantic wikis), still required considerable customisation for the specialised case of sustainability reporting. Hence, while *flexible*, they do not offer the *guidance* necessary for developing complex indicator reporting structures.

Existing systems support an impressive array of reporting approaches. However none sufficiently address the challenges of "bottom-up" sustainability reporting – supporting a high degree of flexibility without sacrificing context-specific guidance. While extensive qualitative and quantitative processes exist in the literature for "bottom-up" reporting, to date these have not made their way into supporting software. By using agent systems to provide unobtrusive support to the process of developing sustainability indicators, our application facilitates flexible collaboration and structured guidance in a novel way.

## 4. ACKNOWLEDGEMENTS

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