BPMS-Game: Tool for Business Process Gamification

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Abstract. Recent years have seen an increase in the concern for the environment, with attempts being made to raise public awareness about the need to have sustainable development that enables the use of any resource in the present, without compromising its future. This concept of sustainability should be applied in the lifestyle of individuals, but also in companies or organizations that deal with business process management, known as BPM. This would allow the creation of business processes that are more sustainable and which use resources more efficiently; this is the concept of Green BPM. It is thus of prime importance to find an incentive for the workers in the companies to get involved in these sustainable initiatives. This has led to a consideration of the need to incorporate gamification, i.e., the use of game elements in non-game contexts in an effort to induce certain behaviors in people. The aim of these games would be to enhance participation and foster commitment to sustainable development. With all these issues in mind, in this article the BPMS-Game tool is described; the tool combines the concepts of gamification, sustainability, and business processes to support the definition of games that promote sustainability in BPM environments. A set of base and derived measures have been defined to evaluate the user behavior with respect to sustainability in their daily work when using a BPMS system. The contributions that BPMS-Game can offer are illustrated with a representative example.

Keywords: Business Processes, Gamification, BPMS, Sustainability, Green BPM.

1 Introduction

The lifestyle of our present-day society is threatening the future existence of the resources we employ. This makes it necessary to promote sustainable development, thus avoiding endangering the environment. We define sustainability as the ability to employ any resource at the present time without compromising the use of this resource for future generations to be able to meet their own needs, thereby ensuring a balance between economic growth, social welfare and the environment [1]. All individuals

and organizations really need to become aware of the importance of action in this area, and they should get involved in the quest to achieve a high degree of sustainability. If we focus on the information technology industry, different initiatives have appeared in recent years; their goal has been to improve energy efficiency, and consequently achieve greater sustainability [2]. These trends have led to a current area of action that is known as Green IT; this is based on cost reduction, and focuses on issues that adversely affect the environment, both in the design and construction of computer systems [3].

These Green IT trends can have a great influence on the paradigm of BPM, which strongly relies on the use of Information Technologies, and is focused on efforts to optimize the organization's business processes. In an effort to improve productivity, effectiveness and efficiency of systematic management processes, these have to be modeled, automatized, integrated, monitored and optimized continuously [4]. Business process management can thus contribute to Green IT initiatives, facilitating these and helping to create business processes that are more sustainable and more efficient as regards the resources employed [2, 5]. The synergy between BPM and Green IT has given rise to the term Green BPM, also known as sustainable management of business processes [6]. The human factor is one of the main elements of success as regards a proper implementation of the Green BPM tendency in the organization [7, 8]. This means that it is essential to consider the influence that people and their interactions can have on business processes, and take into account the importance of their being involved in sustainable initiatives.

This article tackles the above issues, looking at the potential benefits that can be obtained by improving sustainability in a business environment and addressing these from the perspective of the human factor. It does this with special reference to companies or organizations that have evolved in recent years towards developing business process management. In that sense, it has been seen that the potential impact of a proper application of the concept of gamification in promoting sustainability should be highlighted, since this approach has indeed experienced tremendous growth in recent years. Gamification can be defined as the "use of elements of game design in the context of non-game" [9]. To put it another way, it is the application of thoughts and game mechanics in more serious environments to induce certain behavior in people who are interacting with the game. At the same time, it seeks to improve the participation, motivation and commitment of a user while performing a particular task. We might also say that gamification takes those characteristics that make games fun and attractive (and even addictive) and uses them to improve the player experience in a non-gambling environment, such as those of business or education [10].

The purpose here, then, is to employ gamification with game mechanics and dynamics and to attempt to use these to motivate workers of an organization to follow a series of green initiatives in the business processes they interact with. The main objective of the work presented in this article is the development of an environment that promotes business processes with a higher level of sustainability by encouraging users of BPMS platforms to be more environmentally friendly in their daily work. The tool

analyzes the logs of BPMS systems and tries to engage users, motivating them to be more sustainable in their work by means of gamification mechanisms.

The rest of the paper is organized as follows: In section 2, the related work is set out, including the background of the topics addressed. Section 3 presents the proposal for the measures that are used to evaluate the behavior of users with regard to sustainability. The BPMS-Game tool is explained in section 4, where an example of the use of the tool developed is presented. Lastly, the main conclusions and proposals for future work are put forward in section 5.

2 Related work

We have found that there is a certain lack of studies addressing the notion of combining the concept of sustainability and business process management so that Green BPM [11] comes about as a result. To date, the vast majority of relevant studies deal with sustainable IT projects. Recker et al.'s work [6] shows the importance of measuring the sustainability in business processes, and introduces an analysis method for measuring the carbon dioxide emissions produced by the execution of a business process. If we focus on the sustainability of information technology, many of these studies aim to measure the sustainability of the processes solely in the hardware infrastructure. Aleksic [12] points to the need to measure the energy consumption of the IT infrastructure used, showing the different activities that can be used to save energy, thereby improving Green IT. Betz and Caporale [13], for their part, focus on the importance of measuring the sustainability of the software applications that are used. Another important work is that of Cappiello et al. [14], which shows an approach that promotes an efficient use of energy by the design of processes that have low energy consumption.

Concerning the measures, the authors divide these into several different types: according to the amount of energy consumed, (which is the most popular measure), the number of emissions generated, the number of raw materials or resources used, and other types of measures [2, 5, 6, 11, 12, 15]. In this context, Welter et al. [16] have carried out a systematic mapping on the green metrics that can be used by organizations that are responsible for software development.

The term sustainability has grown in popularity, as has another term, i.e. gamification; the latter has attracted significant attention in various domains such as mobile applications or education, among others [17]. Several authors have shown the advantages and benefits of employing gamification, such as Hamari et al [18], through a literature review. It was concluded in this work that the application of gamification actually works, but it is really necessary to take certain into account caveats. For instance, gamification is based on very basic game mechanics in some cases (points, levels or classifications); more advanced aspects, such as social interaction or mobility issues, should also be taken into consideration.

In recent years, a large proportion of the research work has focused on how to apply gamification in software engineering environments. It is a considerably young line of research because, as can be seen in a systematic mapping [10] of existing studies in the field of gamification in software engineering, the first articles date only from 2010. Regarding the type of game elements and the mechanics applied to the existing proposals, award-badge systems based on points were the most relevant, followed by the rankings of classification, social elements, and dashboards. There are at present a number of different commercial tools that provide support to the software engineering process by incorporating the basic mechanisms of gamification mentioned above; some examples are RedCritter, PropsToYou, ScrumKnowsy, Masterbranch, CodeHunt, The Continuous Integration Game, or the plugin Jenkins, among others. There are also some gamification platforms which, applied together with corporate tools of an organization, help to create a gamification environment. These include platforms of general gamification such as: Badgeville (www.badgeville.com); Gamify - (www.gamify.es); Bunchball Nitro - (www.bunchball.com/nitro).

3 Proposal of sustainability measures for business processes

The key aspect of the gamification environment provided by BPMS-Game is a suitable evaluation of the behavior of users, in an effort to promote more sustainability in their work. To achieve this, first of all various entities which may be involved for each of the types of tasks described in the BPMN standard [19] have been identified, since, depending on the type of task that is being executed, one type or another can be applied. For example, for the type of tasks related to sending and receiving, the different IT resources (computers, communication devices, etc.) have been identified as the main entities. For manual tasks, a number of different entities have been identified, apart from IT resources. These include software applications other than the BPMS environment, manufacturing machines that are used in the process, or vehicles that may be needed for transportation of either people or goods in the execution of a task in a process. Once the entities that might be involved for each of the types of tasks described in the BPMN standard are identified, it is necessary to define what measures can be used to determine the sustainability of the participant entities. We divide the proposal of the measures selected into two types: on the one hand, the base measures, which are measures of an attribute that do not depend upon any other measure, and whose measurement approach is a measurement method; and on the other hand, the derived measures, which are the measures derived from other base or derived measures, using measurement functions as measurement approaches [20].

The base measures have been extracted from a systematic literature review whose main aim was to identify the entities, attributes, and measures that can be used to evaluate the sustainability of the business processes. This revision includes primary studies published between 2010 and 2016. Table 1 shows a list of the base measures that have been selected from the primary studies with reference to the attributes considered.

Attribute	Measure	Comments	Source
Energy	Power consumed (W)	Amount of power needed to operate the corresponding entity.	[2, 12, 13, 15, 21]
	Energy consumed (kWh)	Amount of energy consumed per hour of work.	[13, 14, 15, 21]
	PUE (Power usage effectiveness)	The result of dividing the total power of a CPD between the power available for the computer equipment.	[22]
	DCE (Data Center Infraestructure Efficiency)	The inverse of the PUE	[22]
	DCeP (Data Center energy Productivity)	It serves to quantify the useful work produced compared to the energy required.	[22]
	Maximum kWh	Maximum amount of kilowatts (kW) consumed in one hour.	[14]
	Work done / energy consumed	A derived measure used to measure energy efficiency.	[21, 23]
Emissions	g. CO_2/h	Measures the amount (in grams) of carbon dioxide (CO2) per hour of run.	[5, 13, 22, 24]
	g. CO_2/Kg paper	Amount of CO2 (in grams) produced per kg. of paper used.	[25]
	g. CO_2 by km	Amount of CO2 (in grams) produced per km. traveled using a vehicle with fuel.	[5, 25]
	g. CO_2/kWh	Amount of CO2 (in grams) produced by generating each kilowatt hour spent.	[25]

Attribute	Measure	Comments	Source
Consumption of resources or raw materials	Kg of paper	Amount (in kilograms) of paper used in each task.	[5, 13, 15, 24]
	l. of water	Amount (in liters) of water used in each task.	[5, 24]
	l. of fuel	Amount (in liters) of fuel used in each task.	[5]
	l. Printing ink	Amount (in liters) of printing ink used in each task.	[5, 15]
Waste	Amount of toxic materials	Amount of toxic materials discarded when a task is carried out.	[13, 15]
	Number of discarded electrical devices	Amount of electrical devices (computers, printers ...) discarded due to their obsolescence or breakage over a given period of time.	[13, 15]
Software	Number of lines of code (LOC)	An estimate of lines of code. Can affect performance of an application.	[23]
	Number of Loop Cycles	Can affect performance of an application.	[23]

Table 1. List of measures extracted from a review of the existing literature on sustainability measures.

In addition, a proposal for derived measures—which allows us to assess the sustainability of the execution of a specific case or a complete implementation process—has been formulated. The derived measures are those coming from other base measures using a measurement function. In other words, a derived function is an algorithm or a calculation based on combining two or more base or derived measures [20]. Table 2 shows the resulting list of measures proposed to assess sustainability. In the example of the use of the application, (Section 4) how these measures are employed will be explained in detail.

Id	Derived measures	Comments
Md1	**Total power required in a BP case (Md1 = Σ Watt (W) per task)**	The sum of all the powers necessary for the implementation of each of the tasks of a business process case.
Md2	**Total energy consumed in a BP case (Md2 = Σ kWh per task)**	The sum of all the energy consumed for the execution of all tasks belonging to a BP case.
Md3	**Activity that consumes most energy (kWh) in a BP case**	The task executed that consumes most energy in a BP case.
Md4	**Activity that consumes most energy (kWh) on average in a BP case**	The task of a BP case that consumes most energy on average of all executions in that case.
Md5	**Work done / energy consumed of each of the tasks**	Energy efficiency resources consumed by each of the tasks of a BP.
Md6	**Overall energy efficiency of a BP case (Md6 = Σ Md5)**	The overall efficiency of a BP case, taking into account the efficiency of each of the tasks executed.
Md7	**Activity with the highest energy efficiency in a case**	The task executed in a BP case has the greatest energy efficiency.
Md8	**Quantity emissions (CO 2) generated in a BP case (Md8 = Σ g.CO_2 per task)**	The sum of emissions of CO 2 in the execution of a BP case.
Md9	**Activity that generates the greatest amount of CO 2 in a BP case**	The task that generates the greatest amount of emissions among those executed to finalize a BP case.
Md10	**Activity that generates the greatest amount of CO2 on average in a BP case**	The task of a BP case generating most emissions on average of all executions in the case
Md11	**Amount of fuel used in a BP case (Md11 = Σ l. fuel per task)**	The sum of the amount of fuel consumed in the execution of all tasks belonging to a BP case.

Id	Derived measures	Comments
Md12	**Amount of ink used in a BP case (Md12 = Σ ml of ink. per task)**	The sum of the amount of printing ink spent in the execution of all tasks belonging to a BP case.
Md13	**Amount of water used in a BP case (Md13 = Σ l. water per task)**	The sum of the amount of water used in the execution of all tasks belonging to a BP case.
Md14	**Amount of paper used in a BP case (Md14 = Σ kg. Paper per task)**	The sum of the amount of paper used in each of the tasks of an executed BP case.
Md15	**Average energy consumed in BP cases**	The calculation of the average power consumed in the execution of all BP cases.
Md16	**Average emissions generated in BP cases**	The calculation of the average emissions generated in the execution of all BP cases.
Md17	**Average energy efficiency of the cases in a BP**	The average energy efficiency of the execution of all BP cases.
Md18	**Average raw material used in a BP**	The amount of average raw materials used in the execution of all BP cases.
Md19	**Activity that has the highest energy efficiency in a BP**	The task executed in a BP that has the greatest energy efficiency.
Md20	**Most energy-consuming activity of a BP**	The task executed in a BP that consumes most energy.
Md21	**Activity that generates most emissions in a BP**	The task executed in a BP that generates most CO2 emissions.

Table 2. List of derived measures proposed to assess sustainability

4 BPMS-Game tool

BPM provides organizations with a tool for automating and managing their processes, usually by monitoring and optimizing variables related to time, effort, cost, and quality. In addition to those traditional management variables, we can also use process variables related to sustainability of the processes. In this section, the BPMS-Game is described, firstly by presenting its main features in the application of gamification to business process management. The objective is to improve process sustainability based on the relevant information that can be extracted from the execution logs in BPMS systems. The potential contribution of the tool is also illustrated by means of an example of its application.

The main functionalities that the BPMS-Game tool supports are:

- The BPMS-Game tool is applicable to any BPMS system, thus enabling the information on the execution of business processes from execution logs, defined in the standard format XES (Extensible Event Stream), to be obtained. General information about the process and each of the tasks executed is extracted from each of the logs processed by the tool. This includes information on the elements that allow gamification to take place, namely the name of the task, the human resource executing the tasks (if not run automatically), the number of tasks, or the time it takes to complete them, taking performance indicators into consideration. Information concerning the sustainability of each of the tasks that have been executed is also extracted. This information constitutes the base measure on which to define the indicators that are to be evaluated in the rules of the game.
- The application allows the management of users participating in the system; these are the human resources taking part in the project.
- BPMS-Game automatically performs a calculation of the base measure with the information about the sustainability of tasks that is used afterwards to create rules.
- The tool should allow the creation of the rules of the game, as well as achievements established for each of the rules.
- Once the objectives have been achieved, the application will allow users to redeem their achievements for rewards or gifts, and will provide a visual display of the progress achieved in the game.

Figure 1 shows the UML diagram of the domain model of the application. As can be seen in the domain model, the BPMS-Game application is composed mainly of the processes that have been extracted from the execution logs of a BPMS, along with the users that participate in it, either as managers or players, and the rules that are created by the administrator; through a rules engine, the rules are evaluated in real time by continuous monitoring of the execution logs. A player reaches a reward any time he/she fulfills some of the rules defined; these may be in the form of badges, levels or points, which are the mechanics employed to create a gamification environment in the BPMS-Game tool. The points obtained by each of the players can be redeemed for various prizes that the administrator has entered into the system.

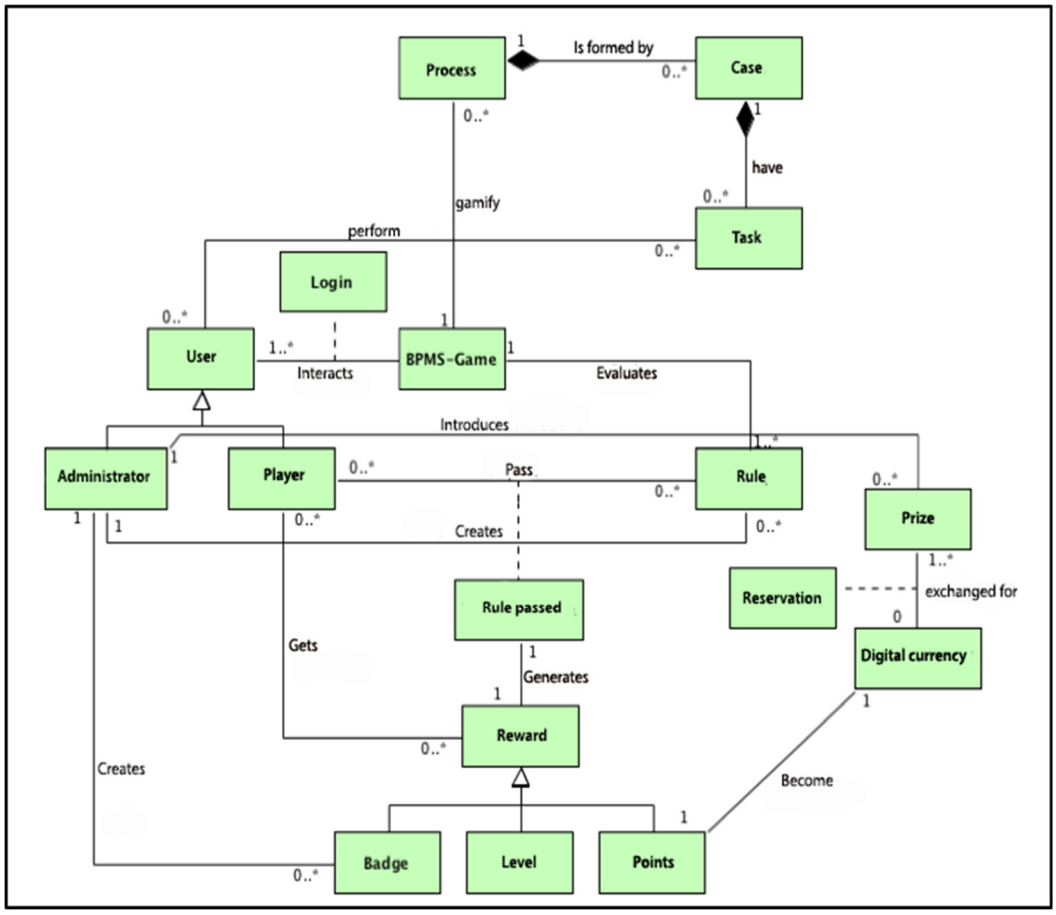

Fig. 1. BPMS-Game Domain Model

The tool should allow the administrator to create badges as mechanics of the implemented gamification. These badges are composed of an image, a code (which must be unique for each of the badges) and a representative name.

BPMS-Game allows the management of the different prizes that players can obtain according to the points they are getting. To that end, the Administrator must create awards; these awards may also be modified or deleted. An attribute of awards is the Value; this value is defined in GCoins, which is a virtual currency created so that users can redeem their points for the prizes that the administrator has previously entered into the system. In addition to all the features already mentioned, an option has been added whereby users can share general game information, such as their points and the level they have reached on trending social networks (Facebook, Twitter, and Google+).

4.1 BPMS-Game: Example of Application

In this section, an example of application, which serves as a proof of concept of the potential utility of BPMS-Game, is described. The scenario chosen to illustrate the sustainability assessment of a business process is a process for picking up patients from care homes for the elderly to take them to the hospital. Fig. 3 shows the BPMN2 model of the business process.

In this process, three different roles can be identified: the nursing assistant, who is responsible for giving the order to pick up patients; the ambulance driver, who must evaluate the requests and pick up the patients to then drive them to the hospital; and the orderly, who fills in the pick-up document of the patients. The patient pick-up process includes seven tasks: three belong to one kind of user, two are manual, one is a call to a service, and there is another task.

It is necessary to know which particular entities are involved in each of the tasks defined in the process. For example, for Task 1, the entities identified are the hardware resources used (presumably the computer and a printer) and the software responsible for generating the patients' documentation. For tasks 4 and 5, which are of a manual type, the only entity identified is the ambulance used to transport patients.

Once the entities in all the tasks of the business process are identified, the measurement of the sustainability of each of these must be carried out using the measures defined above. The measurement process has been simulated for this example using only some of the proposed measures. Table 3 shows the data of the simulated measurements for tasks 2 and 4.

Once all the data have been simulated for each of the process tasks, the sustainability of a specific execution case can be evaluated, using for that purpose the derived measures that are shown in Table 2.

Task	Entity	Measure	Data
Task 2	Tablet	Consumed energy (kWh)	0.050 kWh
		g. CO_2/kWh	33 g. CO_2
	Software application	Energy impact on resource (kWh)	0.015 kWh
Task 4	Ambulance	g. CO_2 Km	800 g CO_2 Km
		l. of fuel	0.330l Km

Table 3. Simulated data for Task 2 and 4.

We evaluate the sustainability of a concrete case (Fig. 3) below, where the following tasks are performed: Task 1 – Task 2 – Task 3 – Task 4 – Task 5 – Task 6 – Task 2 – Task 7. For this example, we will use only measures about the energy consumed,

as well as the quantity of CO2 generated. When we have data on the measures of each of the tasks, we can calculate the results of the chosen measures.

- Total consumed energy (Md1) = Σ Consumed energy (Task *i*):

Md1= 0.37+0.065+0.365+0.065+0.37+0.365+0.065+0.065 = 1.73 kWh ·

- Total CO2 generated (Md8) =Σ CO2 generated (Task *i*):

Md9= 33+10000+33+302+12000+33+33+302= 22736 g. CO2 ·

In Fig. 3 a short excerpt of the execution log is displayed. One of the problems encountered when evaluating BPMS-Game is that most BPMS tools currently represent the logs in a proprietary format, so it was necessary to generate the log in XES from the process execution manually in several cases with multiple users, using the functionality offered by some BPMS to monitor the execution of the processes. XES log files already contain the general information about the process, as well as the sustainability information of each of the tasks that the resources have executed. Once the system has processed the information of XES logs, the administrator is responsible for creating users on the BPMS-Game platform with their profile information, along with the badges that users can obtain as rewards and the prizes that they can redeem.

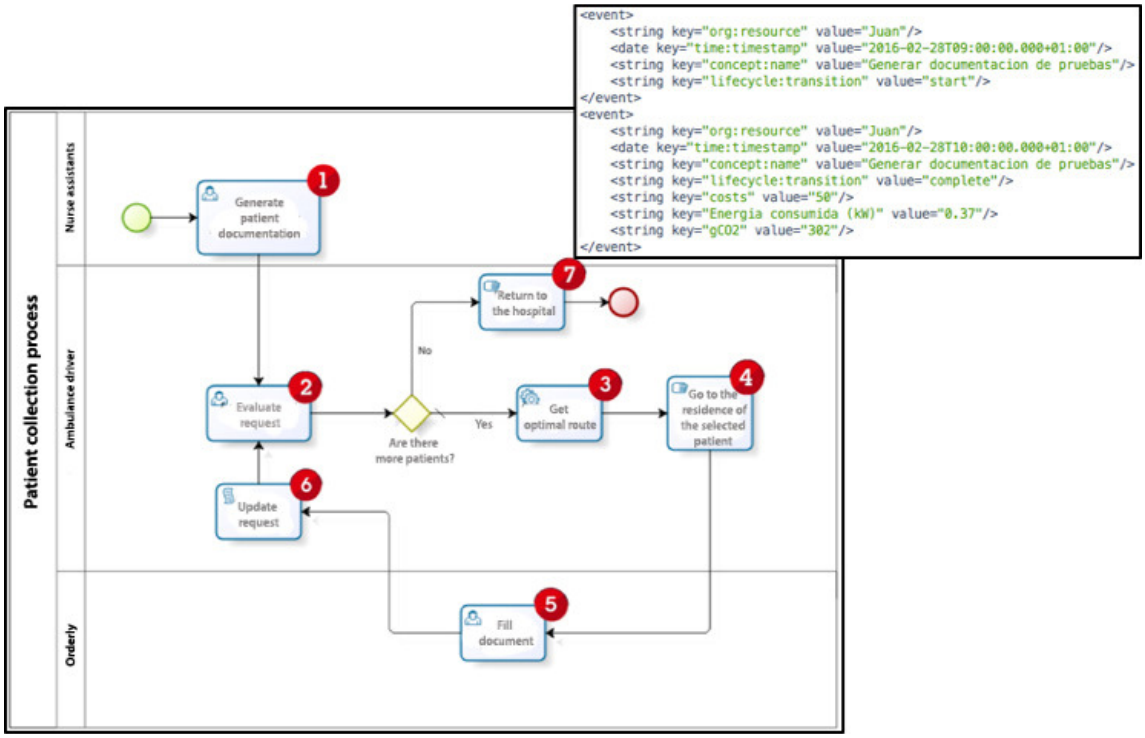

Fig. 3. Application Example of BPMS-Game

The administrator can also create the rules of the game that will subsequently be evaluated by the tool automatically, assigning rewards to the users, rewards that are associated with success in the challenges presented by the rules. To define the rules, the administrator may use performance indicators (number of completed tasks) or sustainability indicators, such as energy consumed in completed tasks. Fig. 4 shows the creation of a new rule, using sustainability indicators, for employees that consumed less than 50kWh in the execution of their tasks.

Once the administrator has created the sustainability rules, the application is automatically responsible for evaluating these rules; it allocates rewards to each player who has been successful in fulfilling the rule, thereby performing gamification. Fig. 5 displays some players who have been successful in performing according to the two rules related to sustainability that had been created previously by the administrator.

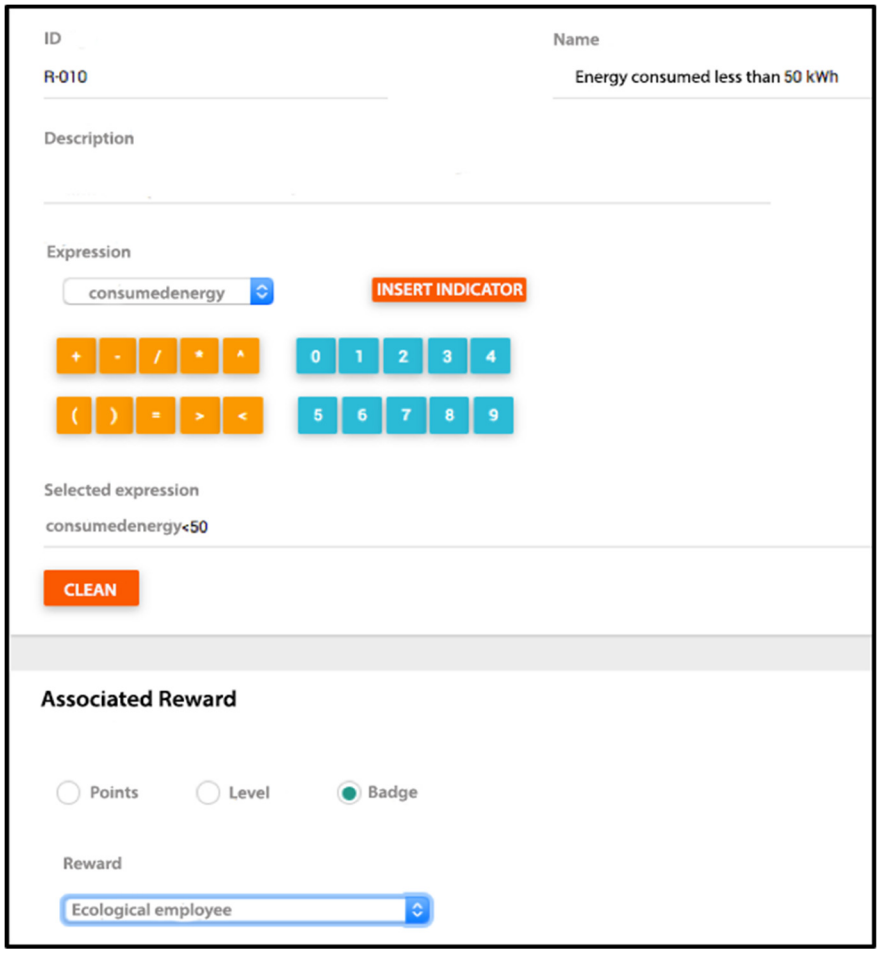

Fig. 1. BPMS-Game: Creation of a new rule.

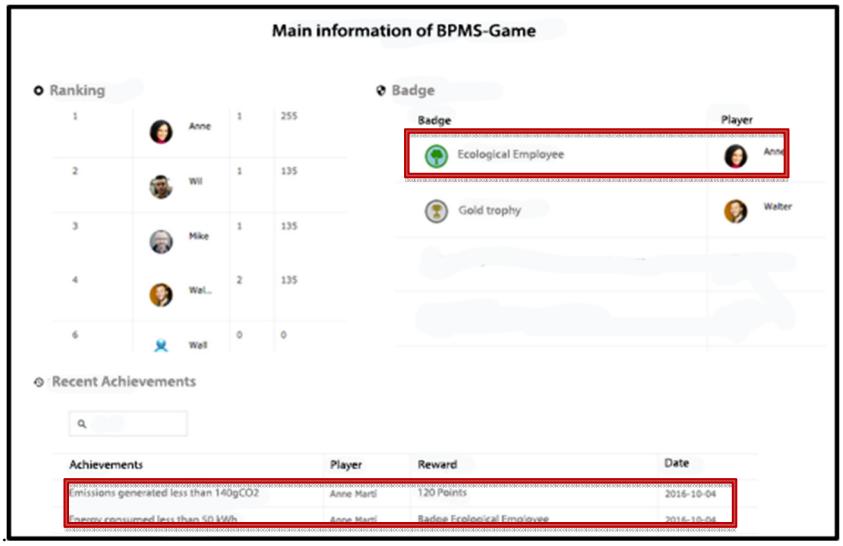

Fig. 2. BPMS-Game: Ranking and Achievements.

As can be seen in the example, the BPMS-Game tool includes the different derived measures that have been defined in the proposal, and which allow a gamification of the users to be carried out using the indicators of sustainability.

5 Conclusions and future work

The aim of this paper is to establish a proposal of different measures for measuring and improving the sustainability of business processes. To achieve that goal, an analysis of the existing sustainability measures in the related literature has been carried out. Using the measures found, a set of derivate measures that can evaluate the sustainability is proposed. It is important to highlight that these measures consider the different entities that are involved in the business process.

The BPMS-Game has been presented in this work, as a tool that supports the definition of games on BPMS platforms and enables their evaluation from execution logs of such platforms in the quest to improve the sustainability of business processes.

The contribution that BPMS-Game offers in the field of BPM is that by introducing gamification alongside the concept of sustainability, user involvement is promoted and this motivates them to participate in business process tasks. Furthermore, it encourages users to be more environmentally friendly in their daily work, remembering that people are one of the main components on which BPM and its BPMS applications are based.

The intention—for future work— is to define a set of indicators that serve as an analysis model to assess whether the sustainability result obtained is acceptable or not, or to give a degree of its compliance. Likewise, with respect to sustainability in

business processes, the intention is to create an energy classification model of business processes, similar to those used in other fields, such as housing or appliances, allowing the assignment of a quantitative mark to business processes according to the evaluation of their sustainability.

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