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The Procurement system

This example is based on a real system from a big energy company which is given the fictitious name of Oil.B . We consider the evolution proposed by the authors for exemplifying answers to the questions.

A detailed description of the system and references can be found at the Appendix 1.

Summary of the original system:

Oil.Br uses an in-house developed **procurement system to purchase goods** (base oils, additives, packaging, equipment, computers, paper, pens, etc) **and to contract services** (e.g. maintenance, painting, health, security, etc). This is a large system, implemented mostly using Oracle technology, that aims to **reduce costs**, to **ease the process** of purchasing and contracting, and to **ensure compliance** rules. In order to hire services or buy products, these must be previously registered in the system and having passed Oil.Br's approval process. See Appendix 1 for details. Oil.Br's procurement system encompasses three types of purchases: **direct, urgent** and **ordinary**. In the direct purchase, there is a pre-selected supplier this is justifiable when there is only one licensed supplier of an item. The urgent purchase is a quicker process due to an urgent need for a product or a service, such as the replacement of a broken production equipment. The ordinary purchase starts when an **employee (requester) asks for items**, which must be **approved by his assigned superior (approver)**. Upon approval, the system creates a pre-order and send it to the registered **suppliers for quotation**. Then, suppliers inform the prices of the requested items, payment conditions and delivery times. After the quotation, a **supplier is chosen** and the system sends the pre-order to two external systems for payment and tracking.

Summary of the proposed extension:

The extension aims to minimize the three impact orders of the system. The first order of effect can be reduced by: (1) using an existing **ergonomic system** that blocks the system when its usage becomes excessive and (2) using an existing **energy monitoring system**, that informs the IT when energy usage is overcoming certain thresholds, so that improvements can be discussed and implemented.

Second and third orders of effect are mitigated by **adapting the ICLEI Procura+ methodology** to Oil.Br's context. This adaptation includes an analysis of the products, services and suppliers with respect to social, economic and environmental issues. To this end, the system adopts the concept of "**sustainability**

levels" for products, calculated from the sustainability levels of the supplier and items, the means of transport to delivery the items, and the type of packaging.

1) **Registering items**: This allows sustainability information to be registered for three groups of items: most requested items, direct items (which are used directly in the products sold by Oil.Br, such as base oils, additives, and packaging for lubricants), and critical items (with high impact on sustainable development). As the system is in production, the calculation of sustainability levels for registered products is done gradually and supported by the system. See Appendix 1 for details.
2) **Requesting items**: The system shows the sustainability levels of alternative items, leaving the decision to the requester's discretion. For this reason, it is necessary to provide training to the staff about the company's commitment to sustainable procurement.
3) **Approving Quotation**s: The approver should take into account the sustainability level of the quotation, in addition to the usual criteria of price, payment condition and delivery time. The system compares the price of a more sustainable item with the purchase history of alternative items, warning the approver when a request generates a significant increase in costs for Oil.Br.

Sample Answers

1. Social

1.1. Sense of Community

1.1.1. The procurement system allow to make all **purchase decisions through the system** (*immediate effect*). As a result, there may be **less interaction between staff** *(enabling effec*t, s*ense of community, social*) members and the procurement process becomes more impersonal.

1.1.2. Since the procurement system follows the **Procura+ guidelines** (immediate effect), which encourages the **exchange of ideas with suppliers**, the **staff feel closer to suppliers** (*enabling effect, sense of community, social*) . This may be especially the case with the local suppliers, because the system makes **staff reflect on the origins of the products** (*enabling , sense of community, social*).

1.1.3. The constant conversation between the Oil.Br and the suppliers may create a **better sense of community** between them (*systemic effect, sense of community,,social*)

1.1.4. If Oil.br and many other companies following **sustainability criteria** *(immediate effec*t) **buy products from local providers** (*enabling effect, economic*) , it can **strengthen the local markets** (*systemic effect, economic*)*

* As a brainstorming tool, note that the keywork (in this case, sense of community) can prompt ideas in other dimensions.

1.2 Trust

1.2.1. The **staff that has access** to the system (immediate effect) may develop a **greater trust on the Oil.Br's** (enabling effect,trust, social) procurement process, because using such a system makes the **process** for buying products and services more **transparent** (enabling effect, trust, social). That means it **allows tracing** the decision process, the buying process and the delivery process (immediate effect)

1.2.2. The **staff that does not have access** to the system cannot know who approves or how much money is spent on purchases. They might develop **distrust in the Oil.Br**, as they may feel that the company is overspending or that certain staff or groups are favored. (enabling effect, trust, social)

1.2.3. Since the **sustainability information** is **added to products slowly** - i.e. it is not done retroactively - (immediate effect), there may be **distrust with respect to the system purpose**. That is, that it is truly fulfilling its sustainability purpose. (enabling effect, trust, social)

1.2.4. Staff who do not trust the company may **disseminate negative messages** about company internally and externally (enabling effect, trust, social), which could lead to **public distrust** in the company (systemic effect, trust, social)

1.2.5. If all companies' procurement **processes were more transparent and sustainable** (enabling effect,) , there could be a greater sense of trust between the society and businesses. (systemic effect, trust, social)

1.2.6. Staff that does not trust the company may be more likely to **leave the company** (enabling effect, economic)

1.2.7. The fact that some staff trust the company while others don't, may cause **conflict within the company** and **hurt the sent of community** (enabling effects, social)

1.3 Inclusiveness & Diversity

1.3.1. The system predetermines the products, services, suppliers, requesters and approvers. The type of products and services that one can request/approve depends on the person's department and role. Because of this, some staff may perceive others as more (or less) important, because they have (or not) "privileges" on the system. (immediate effect, inclusiveness and equality, social)

1.3.2. There is no information on whether the UI of the system can accommodate people with disability or different levels of computer literacy. However, for the later, it is reasonable to assume that staff have sufficient computer literacy to interact with the system. (immediate effect, inclusiveness and equality, social)

1.3.3. Staff who are not allowed to request certain items or to issue an urgent request may try to find ways around it (sending an e-mail, asking others to do for them), affecting the traceability of the procurement process. (enabling effect, technical)

1.4 Equality

1.4.1. The system does not make automatic decisions. It only **informs the quotation from suppliers and the sustainability levels** of products, services and providers (immediate effect). As long as the **criteria is transparent** , including who is allowed to request what (immediate effect), the system does **treat people's requests equally**.

1.4.2. The system **predetermines the products, services, suppliers, requesters and approvers** (immediate effect). The type of products and services that one can request/approve depends on the person's department and role. Some **staff may resent other roles and/or departments** for being allowed to request certain items or for being able to issue urgent requests (enabling effect, equality, social). These staff members may **feel they are not being fairly treated**, since

their **unmet needs** (enabling, equality, social) are also legitime but may not be predicted in the rules of the system.

1.4.3. If some staff members resent others for for having “privileges” in the procurement process, there may be **more conflicts** within the company (enabling effects, social) or some may feel **less devoted to the company** (enabling effects, economic), eventually leading **to less productivity** (enabling effects, economic)

1.4.4. The system only allows purchases from **suppliers who have passed Oil.Br’s approval process**, which may lead to **Oil.Br always buying from the same providers**. If a large amount of companies did the same, it could be more **difficult for new businesses** to enter the market. (systemic effect, economic)

1.4.5. If it is more difficult for suppliers to enter the market, there could be **more concentration of wealth** (systemic effect, economic) and **less equality in the society** (systemic effect, social). If **local and small businesses are favored** (enabling effect, economic) in the **calculation of sustainability levels** (immediate effect) , there could be l**ess monopoly by big businesse**s, a better **distribution of wealth** (systemic effect, economic), and **greater equality** (systemic effect, social)

1.5 Participation and Communication

1.5.1. The procurement system itself makes all the communications on the procurement process electronic and asynchronous, including the communication between the staff and the between the Oil.Br and suppliers. (immediate effect, participation, social). This can make the process more impersonal and reduce the bonds between staff. (enabling effect, participation, social).

1.5.2. The system creates a dialog between the Oil.Br and the suppliers about sustainability issues, also allowing them to give feedback. (immediate effect, participation, social), strengthening the bonds between the company and the suppliers. (enabling effect, participation, social)

1.5.3. As the sustainability criteria also considers the delivery modes and distances, it can encourages face-to-face or over the phone dialog with local suppliers, strengthening the local people and the company. (enabling effect, participation, social)

2. Individual

2.1 Health

2.1.1. By informing the sustainability level of products and services, the system may contribute to the staff’s health. For example, for catering services, the system may favour providers that use organic products. For a office furniture, the system may favour providers of ergonomic products. (enabling affect, health)

2.1.2. Depending on the approval process (for which items and who has to approve), some staff may feel undervalued or dependent, for example, if simple decisions are denied or delegated to superiors without a reasonable explanation. (immediate or enabling effect, emotional health)

2.1.3. If staff can feel the health benefit of products and services in the company, it may favor their opinion regarding the company and they may be more inclined to stay. (enabling effect, economic)

2.1.4. If staff can feel the health benefit of products and services in the company, they may feel encouraged to make healthier choices in their personal lives (enabling effects, individual) and if that is extrapolated to many people, we could have a healthier society (systemic effect, social)

2.2 Lifelong learning

In order to successfully deploy the system, the Oil.br would follow the guidelines of the Procura+ guidelines. This includes training the purchase staff, creating awareness of the Oil.br's sustainability strategy and helping employees in identifying priority items, requesting more sustainable items and approving more sustainable quotations. It also includes gathering information about suppliers, making them aware of Oil.Br's commitment to sustainability. Finally the system constantly reminds staff of Oil.br of the commitment by displaying the sustainability level of the items.

2.2.1. By providing training and encouraging the purchase of sustainable products and services, Oil.Br and the system educate the users on sustainability issues. (immediate effect, education, individual)

2.2.2. By talking to suppliers, Oil.Br educates their suppliers on sustainability issues. (immediate effect, education, individual)

2.2.3. If a large number of companies brought sustainable items, that could create a stronger market for sustainable products and services. As a consequence, there could be more demand for knowledge and education on this area. (systemic effect, education, economic, individual)

2.2.4. If a large number of companies bought sustainable items, they would likely also buy from smaller and local suppliers, and buy products that are healthier and that have been produced with smaller environmental impact. This in turn could lead to a better wealth distribution, to positive effects on the health of the population and to the reduction of negative effects on environment. (systemic effect, economic, individual)

2.3 Privacy

2.3.1. The system does not use sensitive information in the procurement process. The only personal information are the names, roles and contact of Oil.Br employees and suppliers.

2.3.2. Staff could feel exposed because the system keeps record of all her requests for purchases. (immediate effect, privacy, individual)

2.4 Safety

2.4.1. The system could make people exposed to physical harm (or feel more exposed to physical harm), if the safety of products and services are not considered in the selection of products and services to be registered in the system, but that is unlikely. (immediate effect, individual)

2.4.2. If staff felt that their safety is constantly being put on risk in favor of other things (e.g. costs savings), employees may lose trust in the company and eventually leave. (enabling effect, social economic).

2.5 Agency

2.5.1. Staff can only buy pre-registered products and services and from pre-registered suppliers. Staff may feel that they cannot buy what they need or choose the supplier they prefer. That could be aggravated if passing the Oil.br approval process for new suppliers is slow.

2.5.2. Even for urgent items, there is a process to follow. If that is not quick enough to solve a particular problem (e.g. a broken machine), staff may feel powerless to take action in urgent situations. (immediate effect, agency, individual).

2.5.3. If people in charge of projects often need to escalate decisions about purchases, they may feel unable to properly manage their projects, specially if waiting for quotations from suppliers and decisions take longer than they require. (immediate effect, agency, individual)

2.5.4. The system only allow pre-registered suppliers that passed the Oil.br approval process. Depending on the procedure for assessing new providers (periodically, on demand, etc), new providers may feel this is an unfair entry barrier. Suppliers who have not been approved, may feel that the decision was unjust. Oil.br may have no procedures in place to listen to concerns of new providers. (enabling effect, agency, individual)

2.5.5. If Oil.br does not have a procedure to disagree with the sustainability levels of products and services, the staff and the suppliers may feel unable to raise their disagreements with criteria. (immediate effect, agency, individual)

2.5.6. If staff feel unable to take action in urgent situations or raise their disagreements about criteria, they may feel the company do not trust or listen to the, and may be less proactive in their jobs. (enabling effect, economic)

2.5.7. If a large number of people in many companies feel that they are not trusted to take actions or that their concerns are not heard, then the population may start to be more skeptical of businesses. (systemic effect, economic, social?)

3. Environmental

3.1 Material and Resources

3.1.1. The system evolution will increase the consumption of raw materials if it requires the update of hardware infrastructure (immediate effect, materials, environmental).

3.1.2. The system can decrease the consumption of materials by informing the sustainability level of products and services. E.g. recycled materials, materials produced from renewable sources, etc. (immediate effect, materials, environmental).

3.1.3. Staff may start to buy products that consume less material in their personal lives because the system makes them more aware of sustainability issues (enabling effect, social, environmental).

3.1.4. If a large number of companies and people favored products and services that reduced the consumption of materials, the replenishment rate of natural resources would improve (systemic effect, environmental). If such products and services were more expensive to produce and recycle, it could increase the costs of the products and services in the market (systemic effect, economic), it could decrease the profit margins of companies producing and buying these services (systemic effect, economic).

3.2 Soil, Atmospheric and Water Pollution

3.2.1. The system may help to produce less or recyclable waste, and may promote recycling depending on the criteria used for calculating the sustainability level of products and services. For example, it may favor supplies made of recyclable material or that are delivered without packaging (e.g. oil through pipes). (immediate effect, waste, environmental).

3.2.2. By making the procurement process more efficient and possibly less costly, it could also encourage employees to buy more (or have more budget to do so), which in turns increase the waste. (enabling or systemic effect, waste environmental).

As in previous:

- See 3.1.3
- See 3.1.4

3.3 Energy

3.3.1. The system may help to change the occupation of land depending on the criteria used for calculating the sustainability level of products and services. For example, catering services that uses products from sustainable agriculture may decrease the amount of land required for crops (by rotating what is planted). Conversely, organic meat may increase the land occupation. (systemic effect, occupation of land, environmental)

3.3.2. Similarly, depending on the criteria used for calculating the sustainability level of products and services, it can also change plants and animal lives. These effects play especially if many companies use such systems. For example, catering services that use organic farming (systemic effect, occupation of land, environmental)

As in previous:

3.3.3. See 3.1.3

3.3.4. See 3.1.4

3.4 Biodiversity and Land Use

3.4.1. The new version of the system may increase energy consumption if it has more demanding processes or if requires more energy consuming hardware (immediate effect, energy, environment)

3.4.2. The system is monitored by another system that informs the IT and sustainability teams when energy usage is overcoming certain thresholds, so that improvements can be discussed and implemented. So, it can help to save energy in the mid.term. (enabling effect, energy, environmental)

3.4.3. The system may help to reduce energy consumption, depending on the criteria used for calculating the sustainability level of products and services. For example, it may favor equipment that is more energy efficient. (immediate effect, waste, environmental).

As in previous:

3.4.4. See 3.1.3

3.4.5. See 3.1.4

3.5 Logistics and Transportation

3.5.1. The new version of the system may increase energy consumption if it has more demanding processes or if requires more energy consuming hardware (immediate effect, energy, environment)

3.5.2. The system is monitored by another system that informs the IT and sustainability teams when energy usage is overcoming certain thresholds, so that improvements can be discussed and implemented. So, it can help to save energy in the mid.term. (enabling effect, energy, environmental)

3.5.3. The system may help to reduce energy consumption, depending on the criteria used for calculating the sustainability level of products and services. For example, it may favor equipment that is more energy efficient. (immediate effect, waste, environmental).

As in previous:

3.5.4. See 3.1.3

3.5.5. See 3.1.4

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1. If a large number of companies and people favored products and services that use less energy, there would be have less consumption of non-renewable sources of energy (systemic effect, environmental)

4. Economic

4.1 Value

4.1.1. The system may help to reduce the distance or encourage more sustainable types of transportation, depending on the criteria used for calculating the sustainability level of products. For example, it may favor purchases from local producers. (immediate effect, waste, environmental).

4.1.2. The system may help to change the need for transportation depending on the criteria used for calculating the sustainability level of services. For example, it may favor an online training course. (immediate effect, waste, environmental)

4.1.3. If a large number of companies and people local producers, that would strengthen the local market, reduce the monopoly of big firms, and increase wealth distribution. (systemic effects, economic)

As in previous:

4.1.4. See 3.1.3

4.2 Customer Relationship Management (CRM)

4.2.1. The staff may have a higher opinion of the Oil.Br because the company invested in the system to optimize the processes (immediate effect, CRM, economic)

4.2.2. The staff may have a higher opinion of the Oil.Br because it favors local and more sustainable products and services (immediate effect, CRM, economic)

4.2.3. The staff will have a lower opinion of the Oil.Br because it thinks that it is unnecessarily spending money on local and more sustainable products and services (immediate effect, CRM, economic)

4.2.4. The staff may ignore the sustainability levels when requesting and approving products and services, defeating the goal of the system (immediate effect, CRM, co-destruction, economic)

4.2.5. Employees turnaround decreases/loyalty to company increases because staff see that the companies are contributing to a more sustainable society (enabling effect, economic)

4.2.6. If a large amount of companies had procurement systems that favored sustainable products and services, the general population would expect greater social and environmental responsibilities from the employers (systemic effect, social)

4.2.7. If a large amount of companies had procurement systems that provided transparency in the purchase of products and services, the general population would expect greater efficiency in the processes of their employers (systemic effect, social)

4.3 Supply chain

4.3.1. The procurement system is used for all company's purchases and therefore directly affects the supply chain is several ways: defines a clear sustainability criteria for classifying products and services, it favours local and sustainable providers, it only register providers that passed the Oil.Br assessment process, it allows for direct requests (immediate effect, supply chain, economic)

4.3.2. The procurement system only allows purchases from suppliers that passed Oil.Br's approval process. If a supplier's capacity to deliver what it is being requested changes, the supplier may not be able to satisfy Oil.Br's expectation, which could lead to internal and production problems (immediate effect, supply chain, value co-destruction, economic)

4.3.3. If a supplier fails to respond to Oil.Br questions about sustainability or does not want to engage in a conversation about sustainability, the goals of the systems may be jeopardized. (enabling effect, supply chain, value co-destruction, economic)

4.3.4. Buy purchasing products and services from small and local providers, the company strengthen the local market. (enabling effects, economic)

4.3.5. If many companies favored the purchase of sustainable products and services, it would increase the demand and strengthen the market for this kind of products and services. More companies would be interested in sustainability, ultimately reducing the impact on the environment. (systemic effects, economic, environmental)

4.4 Governance & Processes

4.4.1. The of the system follows the guidelines of the Procura+. It therefore creates new activities in the procurement process for evaluating the sustainability of products, services and providers, and for establishing dialogs with suppliers to exchange ideas and receive feedback. These new activities consume the company's resources (in terms of personel's time). (enabling effect, process, economic)

4.4.2. The system changes the relationship between Oil.Br and the suppliers because it encourage dialog with them to exchange ideas about sustainability. This can lead to greater sustainability innovation and more competitiveness for these companies in the national and international

scenario. (systemic effect, economic)

4.4.3. If a large amount to companies established dialogs about sustainability with suppliers, there would be more sustainability innovation, reducing the negative impact on economy, society and the environment (systemic effect, all)

4.5 Innovation and R&D

4.5.1. Money would be spent on evolving the system, which may reduce the money available for other aspects of the business, including R&D. (immediate effect, R&D, economic)

4.5.2. Help suppliers to be competitive nationally and internationally by providing market to sustainable products (enabling effect, R&D, economic)

4.5.3. If many companies favored the purchase of sustainable products and services, it could increase the demand and suppliers are more likely to invest in R&D for offering sustainable products and services. (systemic effects, economic)

5 Technical

For the technical dimensions, two scenarios exist:

- (a) conceptual idea. I.e. no technical solution has been designed or implemented
- (b) a software system exists (system evolution) or at least a technical design exists

5.1 Maintainability

5.1.1. The original system is built mostly on Oracle technology, which can make maintenance very dependent on the evolution of the technology and expertise on the technology. Depending on how the Oracle platform will evolve, it might not be so easy to maintain in ten years time. (enabling effect, maintainability, technical)

5.1.2. There is no information about to maintain the list of products, services, providers or sustainability criteria. Without a process for continuous or periodic review (remove or add products, services and providers), they database might get out of date and more difficult to maintain. The sustainability criteria may become irrelevant. (enabling effect, maintenance, technical)

5.1.3. If many companies start to be interested in sustainable procurement processes, it may increase in the market offers for off-the-shelf products for sustainable procurement, which facilitates the maintenance of the system. (systemic effect, maintenance, technical).

5.2 Usability

5.2.1. The system will be used by staff, who is usually competent with digital systems. First-time users are expected to use the system without training. There is no information about shortcuts for experienced users to achieve their objectively efficiently. The evolution does not change the type of interaction offered by the system. (enabling, technical)

5.2.2. The sustainability criteria may not be easily understood by all and cause confusion to users

(immediate effect, usability, technical)

5.2.3. If people cannot understand the sustainability criteria (e.g. if training is inefficient), they might not take the shown sustainability criteria into consideration. (enabling effect, trust?, individual?)

5.3 Extensibility & Adaptability

5.3.1. The original system is built mostly on Oracle technology, which can make extensions very dependent on the capabilities of the technology and expertise available. (enabling effect, maintainability, technical)

5.3.2. If a system is very difficult to extend because it is very dependent on a given technology, it may get abandoned, may be completely replaced, or may be very costly to evolve or replace (need for specific skills that might not be so popular in the future). (immediate, technical)

5.3.3. If many companies start to be interested in sustainable procurement processes, it may increase in the market offers for off-the-shelf products for sustainable procurement, which may ease extensions, as there may be several plugins available for it, or just the opposite, as it now depends on how the new features offered by the product. (systemic effect, maintenance, technical).

5.4 Security

5.4.1. Assets of interest include financial information about the company, information direct products (i.e. used in the production) that might be valuable to the competitors, information about who authorises each type of purchase, and identify and contact information of the users. These information could be used by unscrupulous competitors or suppliers, or by scammers. Vulnerabilities are unknown. (immediate, technical)

5.5 Scalability

5.5.1. Being an internal system, it is unlikely that will have to support much load or be adapted to different contexts. (immediate, technical)

Sample SusAD Diagram

To be completed

Appendix 1: Sustainability

A.1 Sustainability

The concept of sustainability can be understood in the field of software and requirements engineering as the “capacity” of a system “to endure” [Oxford dictionary]. A closely related term, sustainable development, was defined by the Brundtland Commission as “meeting the needs of the present without compromising the ability of future generations to meet their own needs”. Increasingly, it is advocated that sustainability requires simultaneous consideration of five interrelated dimensions (environmental, economic, individual, social, and technical) and their orders of effect:

A.2 Sustainability Dimensions

Becker et al. 2016:

- The individual dimension covers individual freedom and agency (the ability to act in an environment), human dignity, and fulfillment. It includes individuals’ ability to thrive, exercise their rights, and develop freely.
- The social dimension covers relationships between individuals and groups. For example, it covers the structures of mutual trust and communication in a social system and the balance between conflicting interests.
- The economic dimension covers financial aspects and business value. It includes capital growth and liquidity, investment questions, and financial operations.
- The technical dimension covers the ability to maintain and evolve artificial systems (such as software) over time. It refers to maintenance and evolution, resilience, and the ease of system transitions.
- The environmental dimension covers the use and stewardship of natural resources. It includes questions ranging from immediate waste production and energy consumption to the balance of local ecosystems and climate change concerns.

A.3 Orders of Effects

LES model, Hilty & Aebischer 2015:

1. Life-cycle/immediate effects: What is the direct resource usage and output creation (including waste) of the production, runtime maintenance, and end-of-life of the system?
2. Enabling effects: How does usage of the system change user behavior in their context?
3. Systemic effects: How could extensive usage (by many users) of the system over a long period of time (e.g. a decade) change the wider context of the system or the society (e.g. a local community, a city, or even a country or the world)?

Appendix 2. Detailed Description of Procurement System

This example is based on a real system, as reported by Bomfim et al. [1]. We consider the evolution proposed by the authors for exemplifying answers to the questions.

A.1 Original System

Oil.Br (fictitious name) is a energy company that "uses an in-house developed procurement system to purchase goods and to contract services. This is a large system, implemented mostly using Oracle technology. [...] we refer to such system as refer to such system as IProc - Integrated Procurement System. IProc aims to reduce costs, to ease the process of purchasing and contracting, and to ensure compliance rules. In order to hire services or buy products, these must be previously registered in the system. Examples of services are maintenance, painting, health and security services. Products, in turn, are classified direct or indirect. The former are used directly in the products sold by Oil.Br; examples include base oils, additives, and packaging for lubricants. The latter are all other products used by Oil.Br's employees during processes, such as computers, paper and pens. Both products and services must be supplied by registered companies who have passed Oil.Br's approval process, which normally consists of attesting that the supplier is reliable and has the capacity to provide what is being requested. However, there are services and goods that require certain certifications from the supplier, such as environmental management (ISO 14001 [24]) and occupational health and safety (OHSAS 18001 [25]). Examples of these are the services that require specialized equipment, and products that require especial care for waste disposal. In such cases, the corresponded certification is also verified in the approval process. The IProc system assumes that products, services and suppliers have been previously registered. For convenience, we refer to both the purchasing of products and the hiring of services as the purchasing of items. Oil.Br's procurement system encompasses three types of purchases: ordinary, directed and urgent. The first represents the main purchasing process. In the direct purchase, there is a pre-selected supplier this is justifiable when there is only one licensed supplier of an item. The urgent purchase is a quicker process due to an urgent need for a product or a service, such as the replacement of a broken production equipment. The model includes the three types of purchases, but due to space constraints, only the first one is discussed in this paper. In summary, the ordinary purchase starts when an employee (requester) asks for items, which must be approved by his assigned superior (approver). Upon approval, the system creates a pre-order and send it to the registered suppliers for quotation. Then, suppliers inform the prices of the requested items, payment conditions and delivery times. After the quotation, a supplier is chosen and the system sends the pre-order to two external systems, referred to as PayTrack - Order Payment Tracking System and DeTrack - Order Delivery Tracking System. PayTrack is responsible for issuing the purchase order to the supplier, as well as following up its payment. DeTrack controls the delivery of the product or the execution of the service. Requested items can be cancelled at any time. In addition to the presented process, the IProc system has three other aspects of interest: (i) it

keeps track of all purchases, including information of who ordered or approved a particular item and which items were associated with the same purchase; (ii) it ensures that all requesters and approvers are registered in the system, along with their respective restrictions, such as the family of items that an employee can request or approve; and (iii) it allows users to request modifications to the system on the IT team, subject to approval."

A.2 Proposed extension

The proposed evolution of the system follows the ICLEI's Procura+, a methodology to support government agencies to implement sustainable procurement. The methodology defines the following relevant guidelines:

"Watch continuous improvement: The decision criteria of purchases and contracts should go beyond price, time and quality, also assessing aspects such as the replacement of polluting sources, waste reduction and recycling, water and energy savings, combating of slave labour, social inclusion and improved relationship with communities;
Watch the product: Evaluate the product life cycle, analysing the money spent and the social-environmental impacts arising from the acquisition, use, maintenance, transportation and proper disposal;
Watch the buyer: Purchasing staff must be aware of the company's sustainability strategy and must be trained on the sustainability criteria and best practices. Furthermore, buyers need the support of an sustainability expert;
Watch the supplier: Criteria of sustainability in purchases and contracting must be checked. Dialogue must be established with suppliers to exchange ideas and receive feedback.**"**

Description:

The proposed extension includes two existing systems and a new role, within the company:

"Ergonomic System: Oil.Br's system responsible for the well-being of employees using the company's software;
EnergyMo: Adaptation of an Oil.Br's software for monitoring the used of energy by the companies IT systems;
Sustainability team: Oil.Br's employees responsible for creating and evaluating the sustainability criteria of products, services and suppliers (compliance monitoring department already exists within Oil.Br)."

"Sustainability goals aim to minimize the three impact orders of the system [...] The first impact order refers to the effects directly caused by the production and use of the system. Two opportunities to reduce this impact" are: to monitor the energy consumption and to preserve the health of the user. These will be explained later. "Second and third impact orders are mitigated by adapting the ICLEI Procura+ methodology [2] to Oil.Br's context."

"This adaptation includes an analysis of the products, services and suppliers with respect to social, economic and environmental issues. To this end, the system adopts the concept of "sustainability levels" for products, services and suppliers, calculated from sustainability criteria and their respective weights.

This classification is supported by the system, but achieved in a gradual manner with the help of a sustainability team, as it is explained later. Information obtained from such classifications are taken into account in the sub-processes for registering items, requesting items and approving quotations."

"1) Registering items: This allows sustainability information to be registered with items. In the extended model, the system supports the registration of sustainability information for three groups of items: most requested items, direct items (which are used directly in the products sold by Oil.Br), and critical items (with high impact on sustainable development). The first group is automatically recognized by the system. The latter two must be informed when registering the item. [...] An employee registers a product or a service and informs whether this item is critical to sustainability or directly used in Oils.Br's products [...]. If the newly registered item is critical or direct, the system sends a request to the sustainability team asking for the corresponding sustainability information to be included [...].

" 2) Requesting items: As Oil.Br's procurement system is in production, items are already registered without any sustainability information. When requesting items, there are two sustainability-related opportunities: the first is to identify direct and critical items without registered sustainability information and request it to the sustainability team. The second is to consider the available sustainability levels and choose among alternative items. [...] Also, periodically, the system checks the purchase history, identifying the most requested items [...]. If an often requested item does not have sustainability information associated to it, the system informs to the sustainability team [...] who in turn register "the sustainability criteria with their relative weights and values. These are defined by the sustainability team, so that the system can calculate the sustainability level of products and services. [...] Finally, the request for an item must be approved. [...] In order to contribute to sustainable development, one must ensure that only the necessary items are being ordered. Therefore, the external system DeTrack informs the amount of that item in stock and this information is made available in the system [...]. This information should be taken into account by the approver when verifying that an item is actually needed. It is important to note that the system does not force a requester to choose the most sustainable item; it only shows the sustainability levels of alternative items, leaving the decision to the requester's discretion. For this reason, it is necessary to provide training to the staff, so that everyone can be aware of the company's goals with respect to sustainable procurement, being able to judge if a give purchase is really necessary, and understand the impact of their choices."

"3) Approving Quotations: Once requested, items are grouped together and sent for quotation and approval. In this sub-process, suppliers respond to a letter of invitation and the approver compares quotations from different suppliers, choosing from whom to purchase. The approver should take into account the sustainability level of the quotation, in addition to the usual criteria of price, payment condition and delivery time. The sustainability level of a quotation is calculated from the sustainability levels of the supplier and items, the means of transport to delivery the items, and the type of packaging. The latter two are important because items may have sustainable features, but the transport used for its delivery or packaging may generate a high environmental impact. Likewise, a vendor may have multiple warehouses at different locations, which can alter the sustainability level of a given request. The price is also considered. The system compares the price of a more sustainable item with the purchase history of alternative items, warning the approver when a request generates a significant increase in costs for Oil.Br."

4) User Health and Resource Monitoring: these objectives are for minimizing the first order impact of the system. "The external Ergonomic system monitors the time of continuous system usage and the amount of keystrokes, temporarily blocking the system when these become excessive. This system also

shows, periodically, a reminder for the user to rest. This practice is already adopted by Oil.Br. [...] An existing monitoring system, EnergyMo, can be adapted to inform the IT and sustainability teams when energy usage is overcoming certain thresholds, so that improvements can be discussed and implemented."

[1] C. Bomfim, W. Nunes, L. Duboc and M. Schots, "Modelling sustainability in a procurement system: An experience report," 2014 IEEE 22nd International Requirements Engineering Conference (RE), Karlskrona, 2014, pp. 402-411. doi: 10.1109/RE.2014.6912291
[2] S. Clement, C. Erdmenger, T. Held, R. Barth, I. Oehme, R. Pierrard, B. Lackner, and V. Fuhr, "The Procura+ Manual: A guide to cost effective sustainable public procurement," Tech. Rep., 2007.