A methodology to integrate sustainability evaluations into vendor rating

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Abstract. This paper is meant to presents a concrete methodology to integrate the vendor rating into a Request for Quotation process carried out in a sharing economy context where MaaS digital platforms are exploited. After an analysis of the current state of the art of sustainable decision making into vendors' selection and simplified LCA techniques, the different steps of the methodology are in depth illustrated: the Resource instantiation, the Sustainability Suppliers Ranking and the Quotation-specific impacts calculation. The methodology deployment in the manufacturing context is then described, focusing on the resource instantiation phase that allows a rapid, but rigorous environmental characterization of suppliers offer. The described path, developed and tested in the MANUSQUARE EU project, could be easily adapted to other digital platforms and further extended to different industrial sectors.

Keywords: simplified LCA, vendor rating, digital platforms.

1 Introduction

The sharing economy, that is, digitized platforms for peer-to-peer exchanges, has gained momentum in several sectors of the economy [1]. The value delivered through this kind of platforms can derive from a simplification of transactions between stakeholders, or by providing services or products on the top of technological building blocks used as a foundation. According with Evans & Gawer [2], in certain cases Multi Sided Platforms can play both roles, facilitating exchanges or transactions between different users, buyers, or suppliers relying on a product or technology provided as foundation [3]. In the context of Manufacturing as a Service, companies are more and more willing to sell (and buy) manufacturing capacity instead of new equipment. The success of this market largely depends on the ability of easily connecting B2B customers minimizing efforts, reducing costs and shortening times in the interaction and provision of services, being able to create the desired level of trust among parties, allowing transactions to take place. The integration of sustainability oriented concerns, first in the creation of trust among parties, and then in the selection of the most interesting vendor has recently gained consensus as a critical decisional factor [4], [5]. Rarely, sustainability is however taken into consideration with digital platform ecosystems.

In this work we propose a methodology to integrate sustainable decision making into vendors' selection within the boundaries of MaaS digital platforms. The methodology has been designed in order to ease the environmental sustainability evaluation of the manufacturing processes offered by adopting a simplified LCA approach. This decision, in line with the context of a digital platform, limits time and resources needed to provide the assessment, still maintaining the scientific approach provided by LCA in impacts calculation.

2 Relation to existing theories and works

2.1 Simplified LCA for decision making

In the last decades, LCA has evolved as mainstream tool for guiding more sustainable decisions at industrial level and by policy makers, encouraged by the increased research in the field and the increased number of LCA-based EPDs in industry [6]. Since the early 2000s, LCA has been promoted as an instrument for green decision-making in EU policy [7]. Indeed, LCA allows to measure the cumulative impacts associated with the flow of energy and material in production systems, according to ISO 14044:2006, thus providing solid information on upstream and downstream activities useful for decision making both at company and supply chain level [8]. Yet real application cases of LCA in decision support activities related to the supply chain management are remarkably sparse in literature [9], [10]. Applying LCA in practice still results to be a convoluted process [11], that requires high level of knowledge on different methodological choices and high availability of data to perform data inventory. This has led to investigations on how to simplify LCA, though retaining the comprehensive nature of life cycle approach: according to the ISO standard, "the level of detail of an LCA study depends on the subject and the intended use of the study", thus simplifications need to be in line with this definition and the intended application of the study. From a recent literature review [12], in most cases simplifications are motivated by time constraints, limited resources and scarce data availability, resulting in different adopted approaches: partial neglect of upstream/downstream processes, reduction of the evaluated environmental impacts, use of a threshold to determine which components are studied, combination of qualitative and quantitative data, use of secondary data [13]. Screening LCA and streamlined LCA are the two most addressed strategies in literature for life cycle simplification, differing mainly in the scope and the impact categories. In [14], the authors provide a further classification of the simplified approaches based on literature studies and applied case studies, recognizing 10 approaches, differing in the goal, the accuracy of the inventory and the comprehensiveness of the impact assessment.

Among these, two approaches are used in combination in this study: the screening approach combined with the use of tool/database approach has been applied to simplified LCA for supporting vendor rating based decisions, reducing the effort in the inventory phase, thanks to the acceptance of lower data quality. The combination of these approaches, that will be presented in the following chapter, fits with the goal of the study to assess several impact categories and to make results readable to practitioners in order to take decisions.

2.2 Vendor rating systems

Violation of corporate ethics and national laws caused by a lack of environmental and social responsibility in supply chain operations, together with a growing concern for the lifecycle impact of supplied products and services [15], [16], have drawn the attention of companies towards sustainable supplier selection (SSS). These approaches are meant to support supplier selection in the constitution of consolidated, sustainable supply chains [17]. In the last years, among the three types of indicators constituting an SSS cockpit (Economic, Environmental, Social) the environmental ones gained particular momentum. According to a recent literature review [4], the most cited indicators exploited to integrate environmental conscious supplier selection can be considered as follows: green image, environmental management system, environmental competencies, pollution control, green product, resource consumption, ECO-design and green technology innovation. While these indicators are largely adopted and suitable to assess and rank suppliers with the objective of setting up stable relationships in a B to B environment, these are not applied in a digital platform ecosystem where fast and dynamic transactions, subject to network effects, take place. In a digital platform, the rating system is strictly connected with the concept of vendor/supplier trust: all transactions require a minimum level of trust between participants in order to occur. This is because any exchange requires a credible commitment that no parties will renege on their side of the agreement after the fact. Without this, transactions may not occur even if they would benefit both parties [18]. To achieve this level of trust, indicators are adopted to rate customer or suppliers behaviors and are generally quantified in terms of stars or points on a 1 to 5 scale [19]. These indicators can be objective, i.e. deriving from the type, number, quality of the transaction, and subjective, usually related with users' reviews. The integration of these two types of rating systems is able to strongly influence consumer purchase decisions and buying behavior [20]. Rating and review systems, especially in a business environment, are meant to complement certification and warranty instruments and tend to become relatively more effective than them, the larger the number of transactions that the platforms facilitate [21]. However, none of the previous described schemes addressed the need of calculating and providing evidence of the supplier environmental performances in the context of a digital platform.

3 Methodology design and description

This section is meant to present in detail the methodology designed and deployed to integrate the assessment of the sustainability performances of suppliers into vendor selection process in the context of a digital platform. The platform, being developed within the MANUSQUARE project[1], supports the matchmaking of manufacturing resources by not limiting its capabilities to the sole manufacturing equipment sharing, but extending the potential to the resources of the whole manufacturing ecosystem value network [22]. By starting a Request for Quotation (RFQ), a customer can identify, in

[1] MANUSQUARE (H2020 GA 761145) project aims to create a European manufacturing platform for the exchange of the unused resources and production capacity.

the platform ecosystem, the suppliers that best match its request in terms of resource offered, cost of transaction and environmental impact of the supplied resource.

Through the calculation of the appropriate environmental indicators, the MANUSQUARE Sustainability Assessment (MSA) aims therefore at supporting customers in introducing into the decision-making process the evaluation of the environmental performances, as a choice parameter. On the other side it provides suppliers in the evaluation of the environmental impacts of their process, making them aware of the current level of performance and allowing to determine possible improvement interventions. This is to be performed into three moments of the RFQ process, in order to (automatically) rank and pre-select the suppliers and then to ponder each quotation from the sustainability point of view: i. the Resource instantiation, ii. the Sustainability Suppliers Ranking and the iii. Quotation-specific impacts calculation.

3.1 Resource instantiation

Along the RFQ process, the Resource instantiation is a propaedeutic step since allows that each supplier belonging to the digital platform environment can characterize their manufacturing processes form the environmental point of view, formalizing a simplified, guided, but effective, LCI data gathering and LCIA data generation.

In order to guarantee the sustainability assessment comparability of the manufacturing capabilities, Process Templates (PT) are created. PT have indeed a twofold scope: (i) to allow to describe the LCI data of similar processes in a coherent way, thus enabling their LCA comparability; (ii) to guide and support suppliers in process modeling by ensuring a simplified but reliable and representative description of their manufacturing operations from a sustainability perspective. PT are meant to formalize the LCI description of the processes, where for each specific process, inputs (e.g. electricity, steel) and outputs (e.g. steel scrap, wasted oil) are identified and quantified. In this context, all similar processes are characterized by the same list of inputs and outputs, while it is possible to change their quantities that are distinctive, passing from a supplier to another one or, within the same supplier, from an equipment to a different one.

For each PT, default LCI data and the related environmental impacts (LCIA data) are obtained exploiting the Ecoinvent database. Each PT is related to a specific Functional Unit, that is meant to quantify the function of the process in analysis, e.g. 1 kg of removed steel for milling.

Starting form Ecoinvent background data, the percentage contribution of inputs and outputs to the selected environmental indicators is evaluated in order to identify process parameters critical from the LCA point of view. For instance, concerning the Climate Change indicator of the milling operation, it has been calculated that the inputs “Electricity” and the “Factory operation (heat)” represent above 80% of the indicator value.

Through this Pareto analysis, performed by MANUSQUARE LCA experts, whenever a new operation type is introduced into the ecosystem, it is determined which are LCI data that are actually affecting most of the process environmental impacts. The identified crucial parameters are thus considered as “free” parameters that, starting from the default value proposed by the MANUSQUARE platform, can be customized by the supplier in order to better represent its manufacturing operation, thus determining more specific indicators values.

3.2 Sustainability Suppliers Ranking

After resource instantiation, the MSA is meant to support the first step of the RFQ process, where the customer is inserting its request and the MANUSQUARE platform is to pre-select the potential suppliers of the manufacturing processes identified by the request in order to provide the customer with a restricted and ordered list of suppliers that is automatically prepared by the MANUSQUARE platform considering, amongst the other parameters, their environmental performances calculated by the MSA. Since in this RFQ phase most of the technical information concerning the manufacturing operations required are not yet detailed by the customer or are described in way that is impossible to be automatically retrieved by the MANUSQUARE Platform, the calculation of sustainability indexes related to the request of the customer is based on an "average" impacts evaluation, but maintaining at the same time a connection with the specific RFQ. For each process contained in RFQ and for each supplier that is able to provide the list of operation identified in the RFQ, the MSA is meant to exploit the PT that have been already generated by the suppliers during their environmental characterization. Specifically, the Functional Unit of each PT included in the request is fixed to the unitary value. Then, a total impact related to the RFQ in analysis, is calculated by the MSA for each supplier by summing the impacts of the unitary PT involved in the request. After this calculation, it is possible to define a sustainability ranking of the suppliers made considering that the higher are the index values calculated, the lower is their position in the classification. As an example, Fig. 1 reports the ranking of three suppliers (JPM, S2 and S3) that have been pre-selected since they are able to provide the two manufacturing operations required by the RFQ (milling – M- and boring - B). The ranking is carried out considering the Average Sustainability Impacts (ASI) for each process performed by each supplier. After that, the ASI of each process are summed for each supplier in order to obtain the Environmental Imapcts (EI) of each Supplier. Thanks to different EI_{Sn} calculated, the MANUSQUARE Platform is able to rank suppliers considering the impacts generated during the realization of the processes included in the RFQ, advantaging the lower EI.

3.3 Quotation-specific impacts calculation

After suppliers ranking and a possible further selection of suppliers directly performed by the customer, the suppliers interact with the customer in order to detail the RFQ, gathering all the information that are missing from the first request.

By receiving process details of each quotation, the supplier performs a feasibility and financial evaluation (STEP 1) and can calculate the specific impact value related to the offered processes (STEP 2) and provide customer with the real expected manufacturing impacts. In STEP 2, the calculation of the environmental indicators is performed exploiting the PT of the operation involved by the RFQ and using specific quantifications of the functional unit. The supplier retrieves the PT, instantiates them with the specific RFQ data and calculates the related environmental impacts that then are provided to the customer with the other information that characterize the offer (price, expected time to delivery…).

4 Methodology deployment in Resource instantiation

The crucial point for the deployment of the methodology here presented is the Resource instantiation: the possibility to characterize the vendor offer from the sustainability point of view in a rapid, uniform, standardized and scientifically sound way. For this reason, this section is specifically focalized on the description of the Resource instantiation process supported by the MSA.

Resource instantiation is meant to prepare and characterize the supplier offer thanks to the PT definition. A preliminary set of manufacturing processes have been analyzed in order to select a baseline list of processes and populate a database to be offered to vendors and customers. The identification of the production processes has been carried out by mapping the most adopted processes in existent MaaS ecosystems. The following classes are the ones considered: Type (e.g. CNC, 3D printing), Sub-Type (e.g. for CNC: milling, turning), worked material (e.g. for milling: metal or plastic); specific worked material (e.g. for milling, metal: steel, brass…). Considering the possible combinations, a total of 62 manufacturing processes have been identified.

In order to characterize the supplier operation, the list of the classified processes has been matched with the available dataset into the Ecoinvent database[2]. In addition to the class above mentioned, Ecoinvent is also considering the degree of finishing for chipping metal working processes and the geographical location (e.g. impacts data on milling performed in EU). The main result of the matching with Ecoinvent is that most of the operation identified can be characterized considering both the LCI and LCIA point of view, with the exclusion of 3D printing that is not available in the v3.3 Ecoinvent version analyzed. The next step in resource instantiation is the preparation of the PT. The identified dataset from Ecoinvent is downloaded and then imported into the MSA that, exploiting the Unit Process (UPR) data (the inputs and outputs expressed in terms of other Ecoinvent dataset) and the related environmental impacts, is able to perform a pareto-like analysis that is meant to highlight the most impactful LCI data. The MANUSQUARE LCIA experts mode allows to determine a threshold percentage as a parameter that can be chosen by the expert.For a selected manufacturing process, this evaluation is performed on the complete set of the IMPACT2002+ indicators methodology that is offering both a midpoint and endpoint vision. For a specific process, the LCI parameters identified through the pareto analysis are the relevant ones from the environmental point of view. After that, the PT is ready and available to be exploited by the supplier that can thus modify this limited set of parameters using primary data gathered from a specific process, assuring at the same time a better representation of the specific process impacts compared to the one obtained via default values (taken from Ecoinvent). The vendor can decide to customize only a part of the set, considering

[2] https://www.ecoinvent.org/

the trade-off between the input relevance its measurement capability, data availability and measurement costs.

5 Conclusion

In this paper, a methodology to integrate sustainability oriented decision making into vendor rating selection, in the context of MaaS digital platforms, has been presented. The defined methodology and the related software provide suppliers with the possibility to rapidly obtain an LCA of their manufacturing processes, allowing them to give a quantitative analysis in terms of environmental impacts of the manufactured products. To provide an instrument suitable to a digital platform environment, the Life Cycle Inventory phase, the more expensive in LCA, has been extremely eased, exploiting the use of well-founded background data, but, at the same time, giving to suppliers the possibility to personalize suppliers' operation information in order to obtain the calculation of environmental indicators that are actually able to represent the impacts related to the specific process. The adoption of Process Templates, standardizing the way LCIA is applied across the different suppliers, allows the comparability of the provided data, making them suitable for the creation of suppliers ranking. The methodology has been deployed on a set of manufacturing processes and is now ready to be tested in the industrial scenario. As a next step, the methodology will be extensively validated implementing it in the operational environment of the MANU-SQUARE platform. A subset of users will be taken as reference to assess to which extent this methodology enables to reduce the effort required to implement LCIA analysis.

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