Exploratory Case Study on Sustainability Awareness with a Startup for Business Models

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***Abstract*—Start-up businesses are often not primarily concerned with the overall sustainability impact of their business idea. However, designing sustainability into the start-up business idea from the start may improve their long-term impacts and success but requires additional knowledge and time. In this paper, we perform a case study of the start-up Partneur, who are developing an online platform for developing business ideas according to the Business Model Canvas. We show the usage of our artifact-based analysis approach and discuss observations and lessons learned. The approach provided new insights to Partneur, and might, in turn, inform their future users on how to incorporate sustainability into their business idea as well.**

***Index Terms*—sustainability awareness; requirements engineering; evaluation research; artifact orientation;**

I. Introduction

Society's innovation and progress has come with many costs whether in environmental, economic, societal, technical, and many other dimensions. In general, sustainability is a concern of rising importance for companies [5]. There is an increasing number of startups, yet these new businesses have limited resources and lack extensive knowledge on sustainability. As a result, they resort to focusing on the development of a minimum viable product [27]. The rise of startups has radically changed not only the tech industry but also commerce as a whole. The startup scene is fed by young developers and entrepreneurs, many of which are just about to graduate from college. To give them a better foundation in skills that are relevant to getting a business off the ground, CSULB founded the College of Business Administration "Business Incubator" (https://www.csulb.edu/cba-graduate-programs/cob-incubator). The Business Incubator consists of a group of engaged young entrepreneurs that leads a series of talks on topics relevant to startups. The Business Incubator is advised and supported by a business administration professor, Prof. Wade Martin. Over the course of a semester, interested students can participate in the talks and receive mentorship.

Designing sustainability into a start-up business idea from the beginning may improve the long-term impacts and success of the business. The problem is that such efforts require additional knowledge and time in terms of research, and then integrating the acquired knowledge into business plan drafts, while sustainability is not yet integrated into the traditional curriculum and standards of business planning [18] nor requirements engineering [23]. Despite showing up in research over the past ten years, there is little strategic support by RE for integrating sustainability into the subsequent design process [3]. As a result, there is no strategic support tailored towards explicitly integrating sustainability into the subsequent design process of a start-up business plan. In order to incorporate sustainability into the long-term vision of a business, we apply an artifact-based approach that visualizes the potential goals and their impacts on sustainability in the different dimensions.

Our contribution to easing the challenge of limited resources and sustainability knowledge when developing a business idea is a set of diagrams (e.g., stakeholders, goals, use cases) and guidelines for sustainability awareness (e.g., five dimensions of sustainability) as initially proposed in [23].

We contribute a case study that serves as an example to start-ups demonstrating how they can visualize the goals of their business and align them with sustainability. While we do this for a business that uses the Business Model Canvas (BMC) as their main guideline to develop their prototype, we are not attempting to constructively critique any specific type of business model but instead offer an artifact-based approach rooted in requirements engineering to explore any type of business model with regards to their sustainability impacts.

The diagrams and models serve as a mapping of concept to clarify and help in the development of their business idea in the short run and long run. The implementation of sustainability principles (as proposed, e.g., in the Karlskrona Manifesto [4]) from the start of a business idea diminishes long run risks and allow for greater success [15]. This paper completes a case study with a local startup, Partneur (www.partneur.com) and provides models of their stakeholders, goals, system vision, use cases, and sustainability awareness diagram. They give an overview of the most important requirements for the system development of Partneur. With the analysis, Partneur is equipped with the resources and knowledge needed to gear their business toward a resilient and sustainable business.

The impact of this case study of an artifact-based approach to systems engineering for sustainability serves as an example for other companies in early development stages, or even companies that are further down the road and want to improve the long-term plan for their business. The case study of this

paper can be followed and replicated to provide businesses with the guidance they may otherwise not yet have available. Thus, the study contributes to a knowledge base [29], [3] and facilitates designing sustainability into new business idea and systems development.

II. Related Work and Background

We introduce our foundation work on Requirements Engineering for Sustainability and sustainability awareness diagram that helped assess the Partneur prototype.

A. Requirements Engineering for Sustainability (RE4S)

Partneur is developing a software system to support their business process, and requirements are the key leverage point for practitioners who want to develop sustainable software-intensive systems [3]. We use the term RE4S as defined in previous work [21]: Requirements Engineering for Sustainability (RE4S) denotes "the concept of using requirements engineering and sustainable development techniques to improve the environmental, social, and economic sustainability of software systems and their direct and indirect effects on the surrounding business and operational context" [21]. In order to develop such systems, we need awareness (by education) and guidance (e.g., by training), and creativity (to find better solutions). The RE4S approach uses an artifact model, guiding questions, checklists, and reference models to elaborate the requirements for a system under development. The entire approach is described in detail in [21] and example specifications have been provided in [26], [7]. Furthermore, example artifacts are provided in the results section of this article. A customized version of the AMDiRE artifact model [10], the RE4S artifact model as adapted for this case study is depicted in a simplified manner in Fig. 1. It contains a stakeholder model, a goal model, a system vision, a usage model, and a sustainability awareness diagram (explained in detail in the next section).

B. Sustainability Awareness Diagram

The Sustainability Awareness Diagram (SuSAD) [3] is a diagram to provide an overview of the impacts of system on the five dimensions of sustainability [24] in the three orders of effect [13]. The dimensions are environmental, economic, social, individual, and technical [3]. The environmental dimension refers to the usage and protection of natural resources. The economic dimension refers to the ability to preserve value and capital. The social dimension refers to the ability of societies to preserve the solidarity and services. The individual dimension refers to the ability of the people to live their lives and express themselves in freedom. The technical dimension relates to the longevity of socio-technical systems. Impact on sustainability can be observed via impact on one or more of its dimensions. As a result, it is advocated that sustainability requires simultaneous consideration of these interrelated dimensions [4]. Nevertheless, interdependencies exist between these dimensions including tradeoffs that may have to be negotiated for a system under analysis [3]. In addition, we can also consider the five dimensions in relation to three orders of impacts or effects of software systems [4], [6]. Immediate effects are attributed directly to the lifecycle of the system through the resources used for its production, usage, and disposal. Enabling effects are caused by the usage of the system in its application environment, and potentially by many users over a period of time (months to a couple of years). The structural effects show when accumulating the aggregated effects of usage by many users over an extended period of time (years or decades) [13].

The work by Seyff et al. [29] presented a tabular version of the sustainability analysis using as elicitation method a modified WinWin Negotiation Model and the EasyWinWin method to support the negotiation of requirements and their impact on sustainability. This includes identifying affected sustainability dimensions, discussing how immediate, enabling and structural effects are manifested, and how these effects should be taken into account in the development of a system. The results support the authors' view that every requirement affects sustainability and each such effect should be considered if the full view of the system's impact on sustainability is to be observed [29].

C. Case Study: Partneur

This explorative study was conducted with the start-up company Partneur. They were selected upon discussion with various start-up companies based on the common interest of learning more about how Partneur could strengthen their business vision in terms of sustainability. Furthermore, the Partneur founders are involved in the Business Incubator that serves as multiplier and knowledge disseminator amongst aspiring start-up founders on campus but also from the public community in and around Long Beach.

Their main business idea is to provide an online platform for collaboration on the development of business plans. The underlying model they use for these business plans is the Business Model Canvas (BMC) [18].

D. Business Model Canvas

As explained in [18], a business model can "best be described through nine basic building blocks that show the logic of how a company intends to make money". The nine blocks cover the four main areas of a business: customers, offer, infrastructure, and financial viability. The business model is like a blueprint for a strategy to be implemented through organizational structures, processes, and systems. The original business model canvas is a template with blocks for customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure. An organization serves one or several customer segments. It seeks to solve customer problems and satisfy customer needs with value propositions. Value propositions are delivered to customers through communication, distribution, and sales channels. Customer relationships are established and maintained with each customer segment. Revenue streams result from value propositions successfully offered to customers. Key resources are the assets required to offer and deliver the

previously described elements by performing a number of key activities. Some activities are outsourced and some resources are acquired outside the enterprise to key partnerships. The business model elements result in the cost structure [18].

Note that this paper does not endorse one type of business plan over another but that our case study partner Partneur is developing an online platform to enable people to collaboratively work on a business model canvas, and that is the business idea that we are analyzing using the artifact-based requirements engineering for sustainability (RE4S) approach.

III. Research Design

This exploratory case study [9] was carried out in the Fall semester of 2018 at the California State University, Long Beach. The research objective was to perform a structured approach to requirements engineering and a sustainability awareness diagram for a local startup company.

The selection of the case study partner was based on availability and potential for impact. Partneur is a local start-up company in its first steps that is founded by four young entrepreneurs who graduated from CSULB and run the Business Incubator on campus. Thus, a successful application of the RE4S and SuSAD approach could inform many start-ups in the making and support their business and system development as the Business Incubator serves as a knowledge disseminator.

The research objective was to apply the artifact-based requirements engineering approach including the sustainability awareness diagram to the case of a local start-up company in their early development stages, and to evaluate the usability of the approach for the (inexperienced) requirements engineers and usefulness of the results for the founders.

IV. Case study: Results

This section presents the results from the requirements elicitation that was performed by analyzing an early prototype of the Partneur online platform and in interview sessions with two of the founders.

A. Stakeholder model

In the requirements engineering domain, a stakeholder is commonly defined any individual, group or a business who has a stake in the system, i.e, an entity who is affected by the system and/or affects the system through some component [1], [28], [12]. But this doesn't mean that every stakeholder is interested in the project's success. For example, although legislators influence the way a company or system works, they are usually unaffected or little affected by the system's success or failure. Stakeholders can be identified through iteratively analyzing the goals to deduce key role-players who influence the system, inspecting the business and operational context of the system under development, instantiating a generic reference list, and so on. In general, stakeholders can be classified based on their roles and function. A generic list of categorizing stakeholders by their roles are: users, creators, developers, institutions etc. Based on their functions, stakeholders can be categorized into the following groups: Decision makers, Information providers, Regulatory, Implementers, End Users and Post Implementation support [25]. A stakeholder model is used to define the various stakeholders of a system, and visually represent them along with their connection to the system. It can be represented through UML actor hierarchies, informal hierarchical graphics or natural language [25].

The stakeholder diagram is a UML representation of the different classes of stakeholders of Partneur. Here, the stakeholders are classified into groups based on their role in the system. Firstly, we have the founders of Partneur who presently have a majority stake in the system. They are the founders and key innovators of this tool. They are responsible for the planning, decision-making, execution and control of the system. They are advised by a team of Experts, namely Business Analysts and Domain Experts. Business Analysts advise the Owners on the best ways to optimize the business, predict future trends for the system and improve the decision-making process. Domain Experts provide feedback and solutions about a specific topic or area of interest in this industry.

Next, we have a team of developers who are collectively responsible for the creation, maintenance and security of the Partneur website and online tool. They include Engineers, IT Security, Troubleshooting team and Testers. We also have a Marketing team to analyze the positioning of the product, devise strategies to gain more users and effectively reach out to the target market. Further, there is a Legal team and a team of Online regulators to check the decorum of the users in using the tool, safeguard the intellectual property of the system and keep a check on disruptive teams or negative activity.

The primary users of Partneur are individuals with little or almost no background in business. The aim of the tool is to guide the users through a step by step process in a creating a business plan for their idea and assisting them until they launch the product. The secondary users are students in universities across the country. The tool would serve as an educational tool in building a business plan for initiatives or student clubs encouraging entrepreneurship. Mentors are experienced individuals with several years of experience in the field of Entrepreneurship. They voluntarily take the initiative to provide guidance to the teams and advise them in their key decisions. Educational institutions, Partners and Sponsors provide visibility and support to Partneur. They assist in marketing efforts to gain more users and help in growing the platform with insights and/or monetary aid. Finally, Competitors are other online platforms that provide support for creating a business plan from scratch. A few of Partneur's key competitors are liveplan.com, businessplanpro.com, and planbuildr.com. However, Partneur are the only ones who focus especially on team building around a business plan in the making.

B. Goal model diagram

Goals are targets for achievement, which determine the driving force behind the system. They help in establishing a framework for the system. They define the high-level objectives of the system and guide decisions at various levels

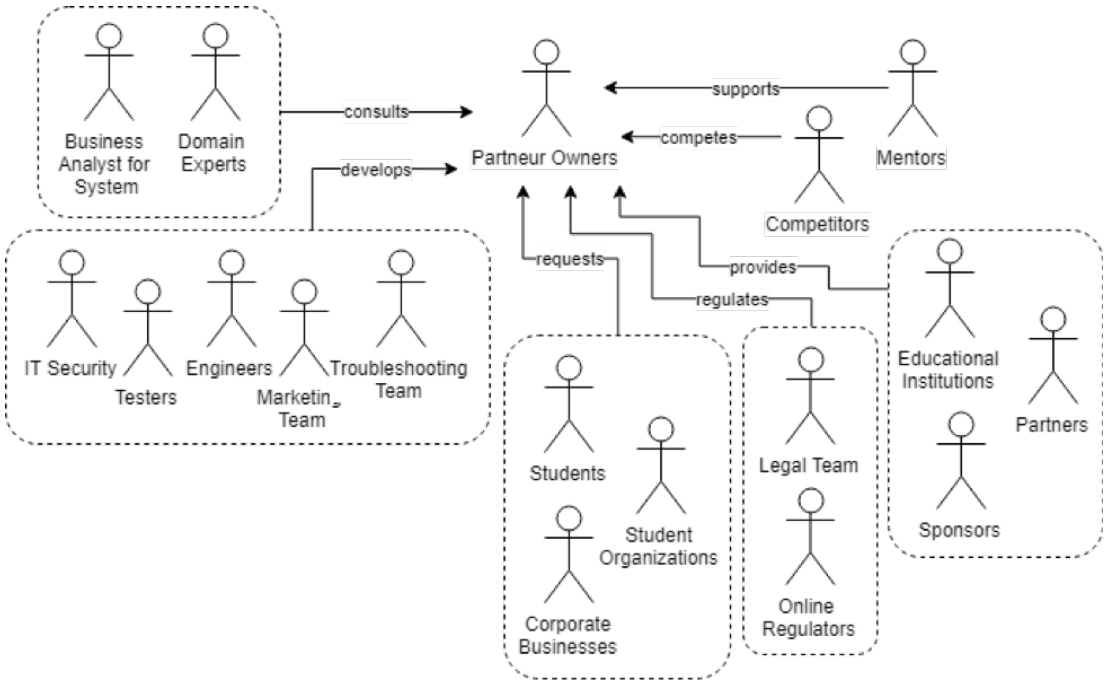

Fig. 1. Stakeholders of Partneur

within the enterprise [10], [32]. Goals are subdivided into three categories: Business goals, Usage goals and System goals. Business Goals are the key goals of the business that lay the foundation for other goals. They have a direct impact on the entire system and provide motivation for the system. Usage Goals determine how the primary, secondary and tertiary users work with the system. They are related to the functional context of the system. System Goals explain how the system is supposed to work to achieve the above goals. They are system-related goals that target system characteristics [22].

Each goal can be further decomposed into smaller sub goals. These sub goals ensure that certain pre-requirements are met before moving on to achieving the larger goal. This helps in addressing issues and resolving conflicts during the implementation of the system. Further, the goals are analyzed to see if they have a sustainable factor, i.e., does the goal bring out sustainability in any of the five dimensions (individual, social, technical, economic and environmental).

A goal model diagram is used to depict the decomposition of goals into subgoals, and the respective interdepencies between the goals. This forms the basis for early identification and resolution of conflicts, and defining the rationale of a requirement. In most cases, a Primary Goal is subdivided into several Business goals which are further decomposed into Usage goals followed by System goals. Further, every goal improves the sustainability factor of the dimensions listed at the top of the goal.

The goal model diagram depicts the goal model for Partneur. At the top, we have the primary goal of Partneur. This is the mission statement of Partneur which is to "formulate, build and execute business ideas". This primary goal is decomposed into several Business goals (which are highlighted in blue). The business goals include: attracting possible investors to fund the projects, impacting the Long Beach community with the launch of these innovative projects, creating a reliable interface for users to connect and build these projects, providing a transparent, financial model to users so that they know exactly what they are paying/signing up for, and finally aiding educational institutions and users by providing them Partneur as a learning tool.

The Usage goals (highlighted in yellow) tell us about what the users can achieve with the system. By attracting investors (Business Goal), the users can network and make connections with the investors and can create a pitch deck of their project to show them. Users can create innovative, impactful projects which will in turn benefit the Long Beach community at large. Using the reliable interface of Partneur, users can connect with a team, discuss and share skills and information securely, and legally protect their project ideas. Transparency in the financial model can be achieved by having few economic variables for the membership pricing: i.e. the membership pricing may depend only on a few key factors like number of projects etc. Users can learn and apply real-life skills in their projects and receive mentoring. This way, Partneur succeeds in providing an online learning tool for individuals.

The System goals (highlighted in green) are broad system-related goals, which relate to the overall functioning of the system. They include high availability the total system (includes website, security, privacy and mentoring), excellent system security to protect user's information and privacy, and easy navigation features which will enable the system to be a user-friendly interface.

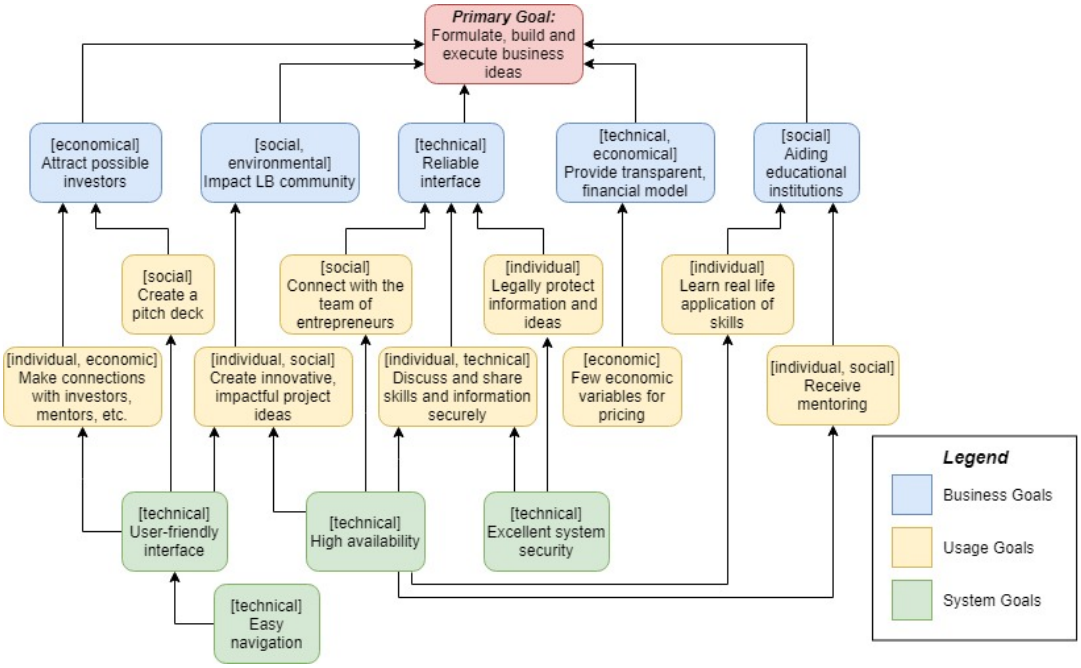

Fig. 2. Goals of Partneur

Usually, the parent goals and subgoals work toward improving a common sustainability dimension. For example, the Business goal of impacting the Long Beach community helps in expanding the Social dimension of sustainability by improving the community and standard of living. It also positively enhances the Environmental aspect of sustainability by launching projects which are aimed at being eco-friendly and bringing about a "green" change in the society. This can be followed by the Usage goal of connecting a team of entrepreneurs. It positively impacts the sustainability of the social dimension by bringing people closer in a community and creates an environment where people can work collectively to achieve a common goal. Lastly, the Usage goal can be achieved by having a user-friendly interface (which can be achieved by having an easy navigation amongst other things) and a high availability of the system. These goals enhance the technical aspect of sustainability by ensuring that the system functions according to the requirements set by the developers and/or expectations set by the users.

C. UML use case overview diagram

Use cases are used to represent a business function, process, or activity performed in the modeled business. A business actor represents a role played by some person or system external to the modeled business, and interacting with the business. A business use case should produce a result of observable value to a business actor [22]. An adapted UML depiction of these use-cases (Fig. 3) outlines all the possible use-case scenarios of the primary, secondary and tertiary users of the system.

Partneur has three types of end users: Individual users, Investors and Mentors. Each of these users are business actors to Partneur and play a particular role in the system. The

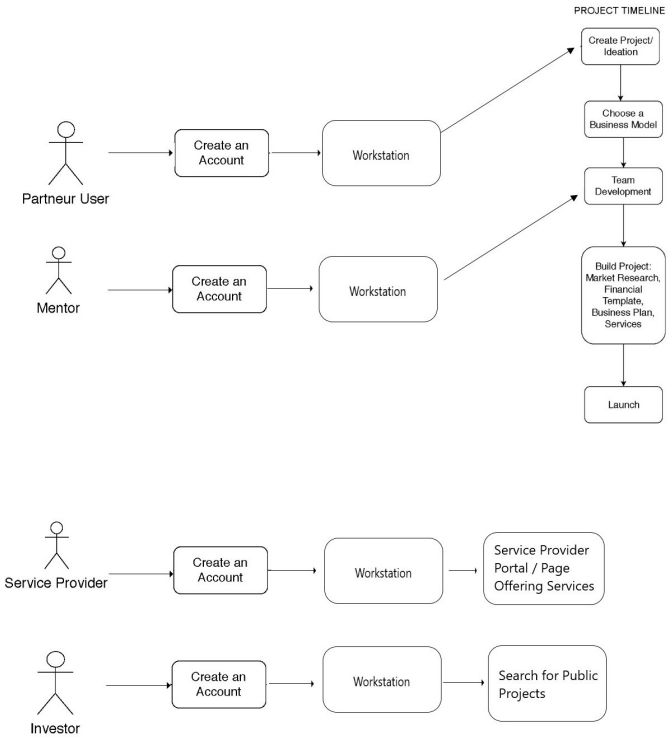

Fig. 3. Use case flow of Partneur

primary user is an individual user, who is seeking to utilize the Partneur tool in bringing his business idea to life. He can choose to initiate a project or simply join an existing team. He takes the first step by creating an account with the website. Next, he can choose to create a project of his own and choose

a Business model best suited to his idea. This is followed by the Team Development process which includes connecting with people to create a team. If an individual user doesn't choose to initiate a project, then he can request to join an existing project. The Team Development phase is followed by the Development phase. It includes Market Research, choosing a Financial Template, creating a Business plan and choosing the Services required to develop the project. A Mentor is a secondary user of the system who provides his valuable insights and assists the team in making key decisions in the Development phase of one or more projects. Service providers are tertiary users of the system. They are not key business actors since they don't create an account with the system and are not personally involved with the project which the goal of success. However, they do impact the system by providing their services (such as Accounting, Website development etc.) to various teams who contact them for their services. Finally, Investors are important business actors of the system. They are secondary users of the system who launch the various projects after they are completed. First, they create an account with Partneur. Next, investors choose certain criteria about the kind of projects they would be interested in funding. And finally, they select one or more project and help in launching them by providing monetary funding.

D. System Vision as Rich Picture

A system vision diagram is a joint vision of the system agreed by all stakeholders. One way we can create this big picture is through graphically depicting the entire system in a rich picture format. A rich picture is a holistic thinking approach for a complex system with several stakeholders [22]. It consists of text, symbols, icons and thought bubbles to illustrate the main elements and relationships that need to be considered in trying to intervene in order to create some improvement. It includes a broad view of the stakeholders, processes and elements of the system. The thought bubbles are queries/thoughts/ideas of the specific stakeholder in this situation. A rich picture helps in understanding the complexity of an entire situation. It points out relationships and connections that we may otherwise miss. A rich picture helps to open discussion and come to a broad, shared understanding of a situation. We have used icons from the sustainability library that was created at the ICT4S 2018 conference [31].

The system vision diagram (Fig. 4) depicts the system vision of Partneur in a rich picture format [17]. Firstly, let's begin with the owners of Partneur. They overview and manage all the processes and key decisions of the system. They own the Partneur website and are responsible for its overall functioning and issues. The owners are usually concerned about issues such as: How to get more users? How to get more schools on board with Partneur? How to achieve credibility of the system? How to manage legal issues? How to get more funding?

Next, we have the team of IT Developers who develop the code and database to build the website. They work together with the Support team to ensure that the system has a reliable, secure, user-friendly interface with high availability. In addition to individual users, we also have students from schools/educational institutions who are the secondary users of Partneur. Thus, Partneur has partnerships with a few local schools/institutions who utilize Partneur as a learning tool to enhance the teaching process. Next, we have the Mentors who overlook the teams and projects and provide guidance throughout the process. Some Mentors might belong to an educational institution but not necessarily. Next, we have motivated, passionate individuals who have signed up and created an account with Partneur. They may belong to an educational institution, but not necessarily. Since these individuals usually have little or no prior experience in entrepreneurship, they have concerns such as how to identify suitable partners, how to obtain funding, and how to estimate operating costs. Further, these individuals form separate teams to create their projects. Each team member has concerns like "I hope this team sticks together", "I hope our ideas are not stolen" etc. Every team works on one or more projects. They create a Business model and pitch deck. Investors fund the project if they like the pitch deck. Investors think about factors such as Does the project has a high ROI, low risk etc. A legal team backs the project pitch deck to ensure that the Intellectual Property (IP) is protected. After the investment in the project, the project proceeds to becoming a final product. The final product ends up having a positive effect on the community at large.

E. Sustainability Awareness Diagram (SuSAD)

Now that we have a clear picture of the whole system, its processes, stakeholders and motivation, we can combine our insights to create a sustainability awareness diagram of the system. This is a diagram which details the immediate, enabling and systemic effects of the entire system. A SusAD diagram can be graphically represented in several forms. Here, we have utilized a pentagon radar diagram. Each side of the pentagon represents one of the sustainability dimensions.

The diagram is split into three levels. At the innermost level, the immediate effects of the system are listed, according to the dimensions of sustainability that they impact. Immediate effects include the direct effects of the production, use and disposal of the software systems. The middle level and the outermost level detail the enabling effects and systemic effects of the system. Enabling effects arise from a system's application over time. This includes the opportunities to consume more or lesser resources amongst the other changes induced by the system. System effects represent the "persistent changes observable at macro level".

One way of making use of the contents of the SuSAD is to connect this to sustainability patterns, which can be found in the Sustainability Pattern Catalogue (https://patternscatalog.herokuapp.com) [8]. Table 1 shows which patterns we have identified as applicable for Partneur.

In detail, these patterns are characterized by the following. For details on examples from companies where these patterns have been successfully applied, please see [8].

HR 2: Data Privacy and Security Policy — With the raise of the Internet of Everything (IoE), people can now share

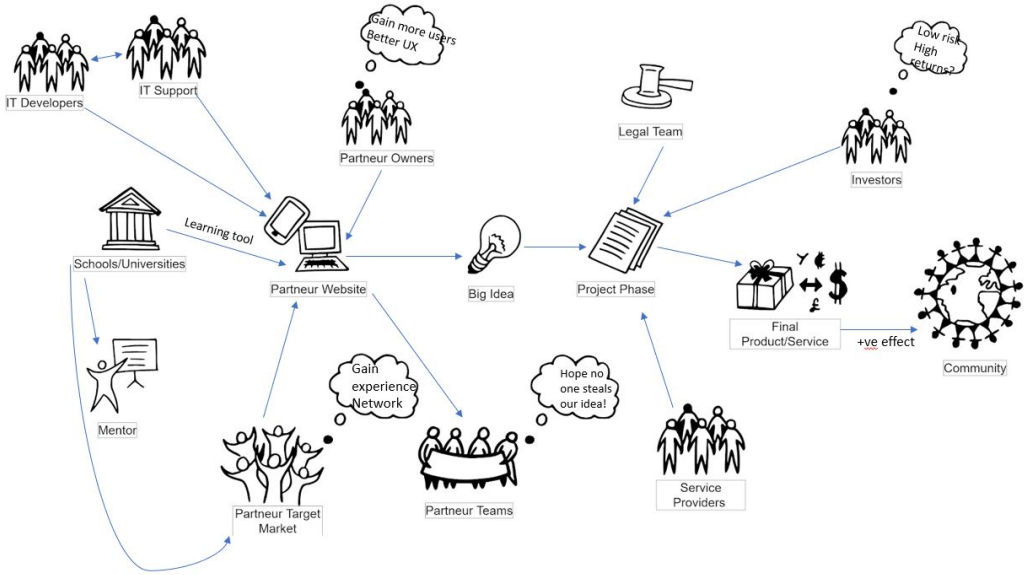

Fig. 4. System Vision of Partneur

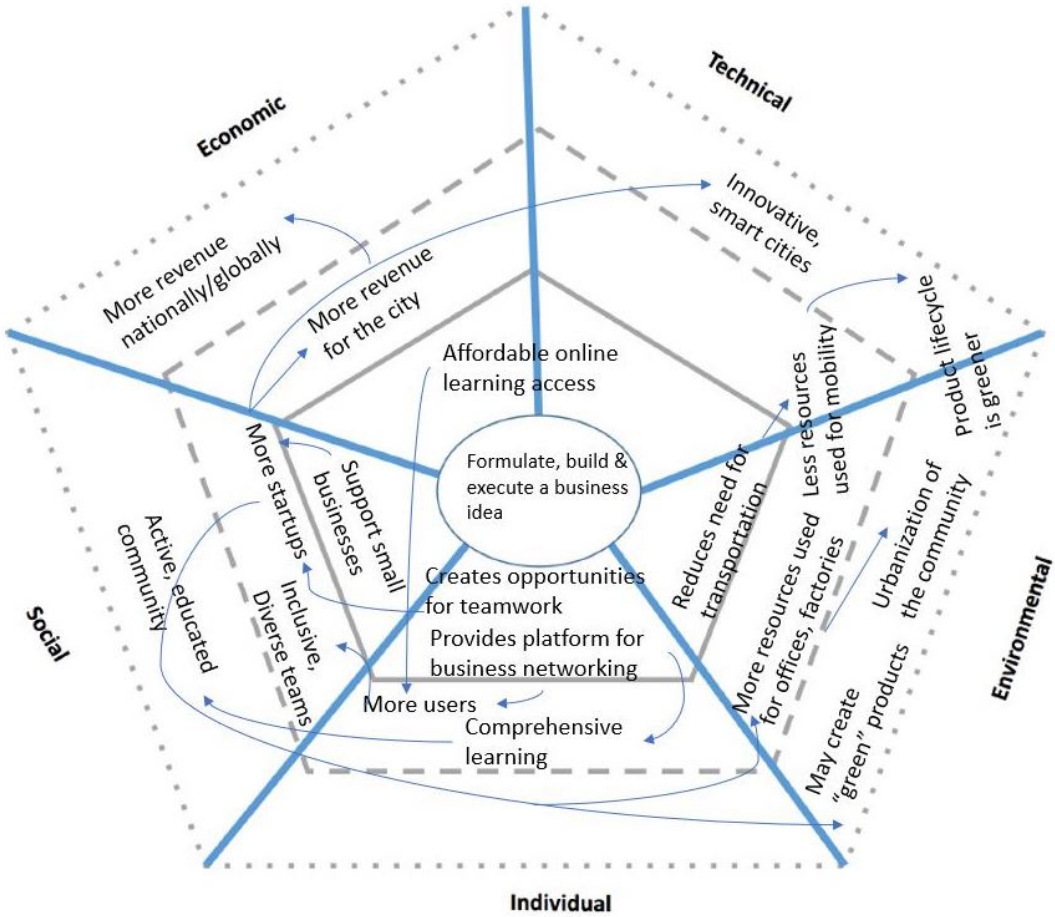

Fig. 5. Sustainability Awareness Diagram of Partneur

	1st order	2nd order	3rd order
individual	HR2: Data Privacy and Security Policy		
social			G3: Collaborate with peers
technical		ENV4: Resource Efficiency	
economic	G5: Transparency		
environmental		ENV3: Design ecological products	

TABLE I
PATTERNS FROM CSR CATALOGUE THAT CAN BE USED TO IMPROVE THE IMPACTS IDENTIFIED IN THE INDIVIDUAL CELLS OF THE SUSTAINABILITY AWARENESS DIAGRAM.

and access business or personal data from anywhere at any time. Therefore, data privacy and especially security is a huge concern in the world, especially for the IT industry that is at the basis of this IoE. To fight these issues, 75% of the companies established a Data Privacy statement where they explain how they use our data. These statements constantly evolve to meet the new regulations as we saw recently in Europe. Moreover, since the most private data is the one that is unreachable, companies also include Data Security in the conception of their products or services that allows them to increase the trust of their customer.

G3: Collaborate with peers — According to the UN, collaboration is one of the keys to meet Sustainable Development Goals. By participating to the creation of laws or standards companies, most of the companies try to increase their cooperativity. Moreover, most of the companies also decided to go further than local regulation in different places where they operate, especially when they are in the third world. These initiatives can lead to an international recognition in specific fields for companies, and even sometimes to be defined as "an example to follow". Finally, local and internal cooperation is also very important this is why more than half of the companies implemented stakeholder engagement mechanisms to define their own sustainability objectives (see pattern G1).

G5: Transparency — Publish sustainability data to the public audience and make pricing transparent. All of the 20 companies investigated in [8] provided environmental data such as CO2 emissions, electricity consumption, resources consumption, etc. They also published their different donations, and few even reported their political contributions or stated that they weren't involved in it. On one hand, this practice, allows companies to keep a track on the level of advancement of their different sustainability strategies and give the possibility for public institutions to confirm it. On the other hand, they can inform customers about their different impacts on sustainability.

ENV3: Design ecological products — In order to reduce their environmental impacts, companies decided to design more ecological products regarding the materials used to build them. This is concretely translated in two ways. First, reuse materials into the manufacturing process, also known as circular economy. Second, reduce or eliminate the proportion of toxic or harmful materials from the products. In order to be even more efficient, this strategy is most of the time combined with the implementation of an end of life management program which allows companies to directly refurbish, recycle or reuse the products they sold (see patterns CONS1).

ENV4: Resource efficiency — To limit their resources' consumption companies, and then reduce their environmental negative impacts, companies decided to set up initiatives to economize different type of resources. Most of them decided to focus on waste generation from office and water efficiency both from office and from operations. We can also notice that more than half of the companies decided to set up paper efficiency strategy, mainly by optimizing their printing policies. To maximize the impacts of this strategy, employees need to be fully aware with environmental issues [8].

V. ANALYSIS AND DISCUSSION

This section analyses and discusses the results of the case study summarized in the above presented artifacts.

A. Usability of artifacts & approach by the requirements engineers

In creating each diagram for the case study, we found a fresh perspective in understanding the system. It helped us get a thorough big picture of the stakeholders, functions, processes, goals, possible use-case scenarios and sustainable dimensions underlying in the system.

While creating the Stakeholder model diagram, we started by categorizing the possible stakeholders of the system into three groups: Individual, Business and Systemic. Each group represents an increasingly larger set of people. Individual stakeholders are single body stakeholders who play a role in the system such as an owner or an individual user. Business stakeholders are enterprises or organizations that play a role in the system for example competitor businesses, educational institutions etc. System stakeholders are larger, organizational bodies that play a role in the system for example the local community, environment etc. It was important to remember that these stakeholders can be affected directly or indirectly by the system. Not all stakeholders are direct users of the system. We derived the list of stakeholders by iteratively assessing the generic lists of stakeholders based on their functions and roles and critically analyzing the possible stakeholders that could exist in the three categories (Individuals, Business, Systemic). In the future, it is planned to expand the stakeholder analysis to include other sustainability actors (environment, future generations etc.).

Next, we assessed each of the different stakeholders from the different ways in which they are categorized and derived a list of goals specific to each stakeholder. Then we organized the goals into a hierarchy of three categories, Business goals, Usage goals and System goals, based on their overall objective. Business goals are usually set by the Owners, Advisors, higher level management etc. Usage goals are the standards

or expectations set by the direct users of the system. System goals are goals about the system-characteristics which are set by the development team to ensure the success of system. Collectively, these goals work together to ensure the success of the previous higher hierarchy of goals and ultimately the Primary goal or the mission of the system. Finally, for each goal, we noted which dimensions of sustainability satisfied or improved by it. We noticed that these dimensions of sustainability are common for related goals in the hierarchical order, i.e., parent and child goals collectively improve common dimensions of sustainability. Further, every goal higher up in the hierarchical order (i.e., Business and Usage goals) must have more than one subgoals. This ensured the cohesiveness of the goals of the entire system.

We followed this by creating a UML use case diagram. Out of the list of stakeholders, we focused on the direct users of the system. These are the primary, secondary and tertiary users of the system. We mapped out all the possible scenarios and actions they can perform in the system and created a consolidated UML diagram. This diagram depicts the relations between the direct users and their action flow in the system. Next, we created the Rich picture diagram to provide a big picture which is inclusive of all the stakeholders in the system. It details all the processes occurring in the system and interdependencies between the stakeholders of the system. Every stakeholder can impact several processes. Further, to enhance the big picture, the concerns of every stakeholder are represented in their thought bubbles. This shows us how different stakeholders have different objectives from the system.

Finally, we consolidate all the insights and information from the above assessment of the system and produce the SusAD diagram. We critically assessed the various stakeholders, their goals, interdependencies and actions to achieve these goals in the entire system to derive the possible immediate, enabling and structural effects it creates. We classified the effects based on the dimensions of sustainability they impact. This provided us with the overall impacts created by the system and the underlying process behind them. This helped in identifying the ways in which we can optimize the processes of the system and update the goals to make it more sustainable and impactful.

B. Usefulness of the results for the start-up founders

We elicited and structured information under the dimensions of sustainability that the founder team had not previously thought about in that manner. Their perspective was more informed by an economics background and therefore applying a software and systems engineering approach brought new insights. In addition, the sustainability awareness diagram gave more of a long-term view than the planning horizon a start-up would usually analyze. While resources in terms of working power and time are limited, just a discussion of 2 hours brought a more than adequate amount of insights for the time invested in the task. For example, the founders saw some good points to highlight sustainable businesses on their platform. All together they gave us the **feedback** that they gained some **additional insight** from the analysis that can be **beneficial** to their company going forward.

The visual library used for the system vision had been developed at ICT4S 2018 [31]. It was perceived as a useful and adequate set of illustration icons by both the requirements engineers and the start-up founders.

C. Lessons Learned

Looking back on the analysis of the research, there are a couple of ways in which we could optimize the research to improve the preciseness of details, results and impact of this case study. An alternative way to initiate the sustainability analysis part of the research from scratch would be by interviewing the founders of Partneur about their perspectives of sustainability, their sustainability analysis for the system thus far and their future goals. In our case we had a general interview and then some document analysis, which also led to a number of insights but it would be interesting to compare the two ways of approaching the creation of the sustainability analysis and understand which way is potentially more effective and/or efficient.

After eliciting the requirements and concepts from the information given to us, in a replication of this study we could equally focus on drafting a clearer picture of the system vision in direct iterative collaboration with the founders and brainstorming the impacts of the system instead of creating a draft and checking with them. This could be enhanced with several in-depth conversations about the details of the processes, the motivations of the stakeholders and creating solutions for the concerns of every stakeholder.

In this exploratory case study we have only one system under development and therefore there was no ground to perform any type of quantitative analysis, but once we can replicate this study with several companies [2], it would be interesting to reuse rating scales for usability and usefulness from previous work in the evaluation of artifact-based requirements engineering [20], [16], [19].

D. Limitations and Threats to Validity

The main **limitation** of the approach, i.e., what the approach is suitable and intended for and what exceeds that, is that it looks at a given scenario or situation in a development setting and extrapolates the impacts that could potentially occur if the system was going to be wildly successful. It does currently *not* include the support for looking at alternative scenarios, which, in the case of Partneur, could involve taking a closer look at circular economy informed models [11], [30] or regenerative approaches [14].

The **threats to validity** include that of the three researchers working on the analysis, two were only recently introduced to the techniques that were applied. Furthermore, we could only interview two of the four founders of Partneur, but the other two were looped in by email to confirm preliminary results and double-check we had not misunderstood anything in our conversations.

VI. Conclusions

Most businesses and startups today depend on or are facilitated by software. This paper showed a case study that employs requirements engineering for sustainability and a sustainability awareness diagram to help in the long-term estimation of sustainability impacts. It is an artifact-based approach that relies on several types of diagrams end our partner was a start-up company for online business model and team development.

The presented diagrams and analysis are tools that can support the critical assessment of the system or idea under development. Stakeholder modeling and goal modeling can help to resolve conflicts and find solutions for stakeholder concerns, as well as explore the motivations of the stakeholders. The sustainability awareness diagram helps to get better awareness for the dimensions of sustainability impacted by the system.

In order to further this research, we plan to observe Partneur and follow them through their 5-year plan. Questions of interest are: Are there differences in their long-term impacts because they explicitly incorporated sustainability goals? What are positive impacts? Are there negative side effect? How to assess and judge that value difference?

We are currently planning the next iteration and phase via a facilitated team workshop with moderated discussions of the sustainability dimensions with regard to Partneur's latest development status.

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