CREATING SUSTAINABLE VALUE THROUGH BUSINESS EXPERIMENTATION
A STUDY OF CLEANTECH START-UPS

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ABSTRACT

This paper explores the business experimentation processes of start-ups in creating sustainable value in the cleantech sector. Especially for sustainability-oriented innovations and eco-innovations, the business development process can be long and challenging. Also, there is not a clear understanding of the capability building and learning processes and activities of business experimentation in start-up. Based on the findings from seven start-up companies in cleantech, a conceptual model is created to demonstrate how start-ups conduct business experimentation, learn, and build capacity together with their customers and their stakeholders in (co-)creating sustainable value. The key theoretical contributions of the paper include further development of the Lean Startup model and our understanding of the specific learning and capability-building activities in purposeful and explorative experimentation of start-ups. The managerial implications of the study stress the application of super lean business experimentation through selling demos and fast failure, and creating sustainable value by expanding the scope of technology-driven business experimentation through a joint learning and capability-building process.

Keywords*: business experimentation, business experimentation process, sustainable value creation, eco-innovation, start-up, cleantech*

1. THEORETICAL AND EMPIRICAL BACKGROUND AND RELEVANCE

Experimentation has been recognized as an essential work method for companies to test and introduce radical sustainable innovations to existing markets for greening the economy and societies (e.g., Bocken et al, 2015; Antikainen et al., 2017; Hildén et al., 2017; Weissbrod and Bocken, 2017). Larger companies and incumbents experiment by doing process innovations in their environmental management systems, or creating green electricity offerings or new EV car models, while smaller companies and new entrants tend to experiment with new sustainable product designs (Hockerts and Wüstenhagen, 2010). Experiments are seen as a way to produce innovative solutions and promote sustainable entrepreneurship in more sustainable future societies (Antikainen et al., 2017).

When experiments are transdisciplinary, iterative, and participatory, they better enable common goal formulation and allow the stakeholders to interactively develop the solution, as, for example, in climate governance-related experiments (Hildén et al., 2017). In contrast, for new ventures and start-ups it is natural to experiment in search of proper identification of their value proposition by trialing (Van de Ven and Polley, 1992;

Bocken, 2015). It may even be stated that new ventures or start-ups are series of experiments seeking to match solutions with problems and opportunities in the market (Curley and Formica, 2013). However, little is known of the types and process of business experimentation applied by start-ups (Ries, 2011; Blank, 2013). Typically the Lean Startup model by Ries (2011) is suggested as the key model in exploring business experimentation in start-ups. In this study we build on the existing theories and models exploring beyond conventional business experimentation, to establish new knowledge and a new business experimentation process model for sustainable start-ups. In doing so, we apply the Lean Startup model and recent research that suggests and applies business experimentation in a sustainable business context and as a key capability to transition to a sustainable business (Bocken et al., 2015; Weissbrod and Bocken, 2017, Bocken et al., 2018). For example, Hart and Milstein (2003) have created a sustainable-value framework linking the challenges of global sustainability in creating sustainable value to stakeholders. In their study, they identified exploration by firms as a crucial practice for the sustainable development of clean technology.

Sustainability-driven ventures face, on top of normal entrepreneurial challenges, the additional institutional challenge of providing solutions to non-existing markets with an additional layer of complexities (e.g., Hall et al., 2010) induced by additional legitimization problems. However, when considering start-ups with limited resources, the experimentation is not always as purposeful. Instead they are more real-life experiments (Bojovic et al., 2018). It appears that certain strategic sustainability innovation practices are more prevalent in SMEs, and thus they may be more capable in introducing more radical sustainability-oriented innovations and in creating sustainable value through business experimentation. Sustainable innovations in particular require interaction and experimentation with external actors (e.g., customers, authorities, and research institutes), which can improve the innovation capability of SMEs (Klewitz and Hansen, 2014).

This also implies that learning is a key activity of the business experimentation process (Murray and Tripsas, 2004; Andries et al., 2013, Bojovic et. al, 2018). Murray and Tripsas (2004) examine two ways in which firms can learn about their environments: unplanned trial-and-error learning and purposeful experimentation. The conscious, deliberate, and purposeful nature of purposeful experimentation differentiates it from trial-and-error learning, revealing the two opposite types of experimentation. Furthermore, Bojovic et al. (2018) present a framework showing two opposite forms of experimentation—purposeful interactions and experimental projects—and their influence on the roles of experimentation: learning, signaling, and convincing. According to Murray and Tripsas (2004, p. 70) purposeful experimentation happens "when firms engage in clearly articulated problem-solving, based on the identification of a problem or decision, the establishment of a hypothesis, and the testing of that hypothesis through organizational activity." They present a four-step approach toward experimentation where the entrepreneur: 1) identifies a problem or decision, 2) builds a hypothesis about the likely outcome, 3) takes action to test the hypothesis, and 4) evaluates the results. This study elaborates on this research in exploring the types and process of business experimentation among green start-ups.

Literature emphasizes that eco-innovations and sustainability-oriented innovations are difficult to commercialize and sell to customers due to their complex implications (Klewitz and Hansen, 2014). The process of creating eco-innovations that are

commercializable requires capability building and learning in the company, be the organization a large corporation or a small enterprise or start-up (Roome, 2012; Engert et al., 2016). Thus, more research on the processes for capability building and learning with organizations regarding sustainable innovations has been called for (Siebenhühner and Arnold, 2007; Klewitz and Hansen, 2014). In addition, more research is requested on the capabilities and capability-building processes required in companies focusing on sustainability-oriented innovations (Klewitz and Hansen, 2014).

In this study we focus on exploring this research gap by providing empirical knowledge on these capability building and learning processes of start-ups in creating sustainable value through business experimentation processes. Factors as stakeholder management, organizational learning and knowledge management processes, manager attitude, organizational culture, and investment costs add to the complexity of implementing sustainability and experimenting the solutions (Engert et al., 2016). On the other hand, green entrepreneurs and cleantech start-ups have the possibility to experiment more freely with their solutions (Saari and Joensuu-Salo, 2019). They can do this internally and externally. When testing the perceived sustainable value of their innovation externally, they are at the same time experimenting internally on their technological scope. Thus, the research objective of this study is to provide new insight and knowledge about how business experimentation processes are conducted by green start-ups in creating sustainable value. This leads to the following research question: *How are business experimentation processes conducted by start-ups in creating sustainable value?*

2. RESEARCH DESIGN

The exploratory case study approach was selected to ensure a methodological fit between the research question and the status of prior theory (Edmondson and McManus, 2007). Case study methodology is suitable for acquiring rich, detailed data (Eisenhardt and Graebner, 2007) and for identifying emerging themes and patterns (Eisenhardt, 1989). It is appropriate for creating new knowledge about how and why events occur in situations with little theoretical background (McCutcheon and Meredith, 1993).

The rationale behind the selection of the case study design was to explore the concept and practices of business experimentation and sustainable value creation through cleantech start-ups. Through the international start-up event SLUSH 2017, seven cleantech start-ups were selected to explore the concept. In each of the seven case studies, data were collected via documentation studies and qualitative, semi-structured interviews with one or two informants responsible for the business experimentation and value creation of the companies. The seven case companies included in the study were selected based on four case selection criteria. The selected case companies should:

1) Be start-ups as defined by Luger and Koo (2005, p. 19). Thus, the case companies "did not exist before during a given time period (new), which starts hiring at least one paid employee during the given time period (active), and which is neither a subsidiary nor a branch of an existing firm (independent)."

2) Have actual and recent experiences with business experimentation processes creating value for customers through specific activities.

3) Be engaged in sustainable value creation through projects developing sustainable offerings, products, and services aimed at solving specific sustainable issues of the case companies' customers.

4) Have demonstrated successful sustainable value creation (as identified by the customers and industry standards) and carried out projects delivering products/services successfully to or together with customers

The selected case company informants had the roles of CEO, COO, CFO, and account manager (see Table 1) and were selected due to their specific knowledge of the business experimentation processes and the capabilities applied (and requested) in the case companies in creating sustainable value.

Table 1. Case companies and informants

Case	Informants	Stage of the start-up	Cleantech sector
C1	CEO	Going to market	Energy, Transport & Automotive
C2	Account Manager	Growth and scale	Transport & Automotive
C3	CEO and CFO	Growth and scale	Energy, Transport & Automotive
C4	CEO	Growth and scale	Energy
C5	COO	Going to market	Energy, Transport & Automotive
C6	CEO	Growth and scale	Energy, Transport & Automotive
C7	CEO	Going to market	Energy, Transport & Automotive

2.1 Data collection

The primary data were collected through exploratory interviews with the help of a semi-structured interview guide focusing on the motivations, initial ideas, business experimentation, and value creation activities and stages in the development of the sustainable business. The semi-structured interviews were conducted in Jan–Feb 2019 with the selected SLUSH contestants of successful cleantech start-ups. The length of each interview was approximately 1.5 hours. The majority of the interviewees were founders or members of the founding team, and only one of the respondents had joined the team at a later stage. The interviews were first recorded, then transcribed and validated by the interviewees. The business experimentation processes and specific activities conducted in creating sustainable value were used as the unit of analysis and explored through the interview sessions.

2.2 Data analysis

Each interview was coded deductively as we looked for evidence of business experimentation activities and how sustainable value was created. Following the methodology of Gioia et al. (2013), we engaged in a second analysis where we coded inductively, looking for patterns that could explain how start-ups apply business experimentation in their sustainable value creation in understanding the interplay

between business experimentation and value creation in start-ups. The results of our analysis are shown in Table 2. The table portrays the data analysis of mapping first-order concepts based on the quotes from the interview sessions and the derived second-order themes in leading up to the aggregated dimensions of the business experimentation processes, capabilities, and activities identified through the data analysis.

3. RESULTS

The results of the study are presented in Table 2 following the data analysis approach of Gioia et al. (2013). The derived aggregated dimensions identify specific activities necessary for a successful start-up business experimentation process in creating sustainable value for the customers.

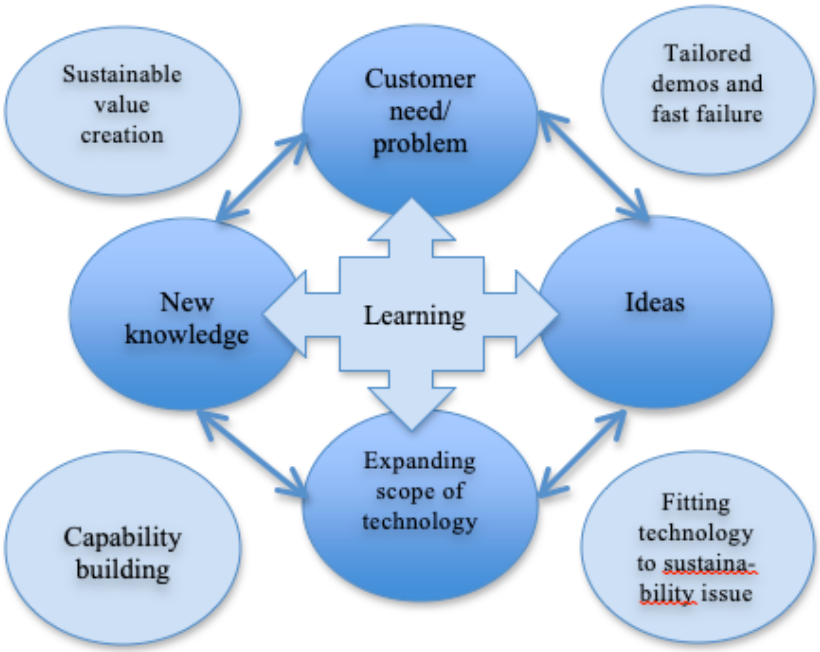
Table 2: Data analysis overview

First-order themes	Second-order themes	Aggregated dimensions
"We had to do this kind of bold thing, and that way fail fast" "They are buying the demonstration project…they paid the original price, but all the repairs and all the corrections has to be paid by us then" "Everything can be done, first we have to sell it" "Most of the customers, they really don't have any idea what they actually want" "We hadn't that money to make those prototypes and test them in our lab, so our customer buys the project, and then we go with our prototype to demonstrate something"	Sell demo and fail fast Learning through failing Experimenting with value creation Selling first, experimentation afterward	**Super lean business experimentation through tailored demos and fast failure**
"We took a good guess and then we went and did a pilot with the customers" "We did all kinds of prototypes" "We provided for them…this learning area" "When the pilot starts and we come up with the problems that we couldn't foresee beforehand" "Quite strict requirements and compliance against the requirements" "They give us a vehicle that they want to use and then we fit it with our technology and then they test it"	Open experimentation Learning during pilot drives experimentation Tailored experimentation	**Business experimentation as a simultaneous learning process combining customer requests and needs**
"We are a five-person company, of course we use a lot of subcontracting" "We have our shareholders…none of them gets paid" "We have very powerful names (owners) who are invested in our company and willing to win with us"	Subcontracting Create and engage the networks for value creation Built-in flexible resources	**Capability-building activities across the value chain and ecosystem are necessary for successful business experimentation**

"We have a marketing professional, who has her own company, and she's kind of acting as our marketing manager"		
"We very soon found out that this is not a business, and expanded the scope" "Each of us wants to save the world, but as a company we're purely focused on technology" "We're a politically, charged team and…our product itself is part of a big political battle"	Creating sustainable value by expanding scope Mixing an environmental outlook with technology competences	**Creating sustainable value by expanding the scope of technology-driven business experimentation**
"For me it's important that whatever I do, people benefit from it" "The founder drives an electric vehicle for the last 15 years, and he is really into that" "The biggest drive I have, why I'm being doing this for seven years is, in big picture, it's about saving the planet" "I wouldn't be doing this, this long time, if it wasn't for the greater good"	"Creating a better world" as an intrinsic driver for business development Continuous long-range focus on creating greater good	**Strong tech capabilities and intrinsic "better world" motivations of cleantech start-ups driving the successful sustainable value creation**

The findings from the study are summarized in Model 1, illustrating the start-up business experimentation process for sustainable value creation, which is later discussed in the discussion and compared to the original Lean Startup model by Ries (2011) and the business experimentation approaches and typologies, as described by Murray and Tripsas (2004), Andries et al. (2013), Bojovic et al. (2018), etc.

Model 1: Business experimentation process models for sustainable value creation



Source: Authors' own development

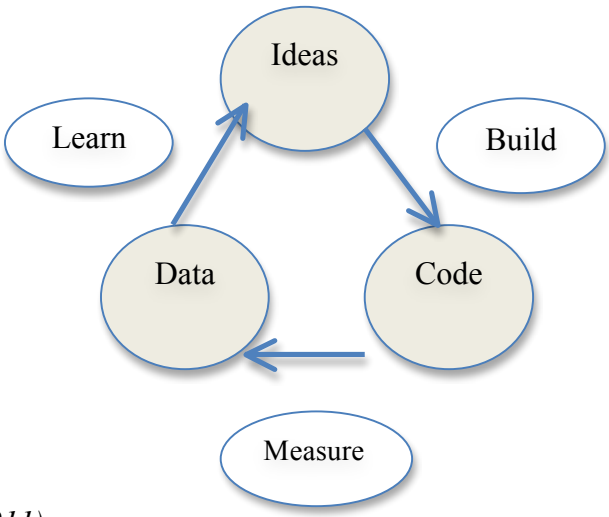
4. DISCUSSION

Different forms of business experimentation have been explored by Murray and Tripsas (2004) and Bojovic et al. (2018), who presents typologies of opposite forms of business experimentation: purposeful experimentation and explorative experimentation and purposeful interactions and experimental projects. The study showed that the projects explained and carried out among the seven cleantech case companies varied across these business experimentation opposites. However, the findings revealed that the same learning and capability-building activities were necessary in developing sustainable value through business experimentation in any of the different experimentation forms. Thus, capability building was a central activity in all business experimentation process in creating sustainable value by fitting technology to sustainability issues as portrayed in Model 1.

This finding supports the study by Hart and Milstein (2003), who identified that exploration is a crucial practice for the sustainable development of clean technology. So whether the clean tech company's business experimentation approach is *purposeful* or *explorative/experimental* (Murray and Tripsas, 2004; Bojovic et al., 2018), a high level of exploration is still needed. This may very well be caused by the condition that cleantech technology innovations and the sustainability requirements are increasing by the minute, so exploration is an intrinsic part of any type of business experimentation for sustainable value creation in knowledge-intensive industries like cleantech.

Also, as stressed by Roome (2012) and Engert et al. (2016), the process of creating eco-innovations requires capability building and learning in the company, be the organization a large corporation or a small enterprise or start-up. This study shows that a continuous learning process was carried out across the entire business experimentation project and its activities of all the projects explored in the seven case companies. Therefore, "learning" is put in the middle of Model 1, and not as an activity at the end of the model, as in the Lean Startup model by Ries (2011) illustrated in Model 2.

Model 2: Lean Startup model



Source: Ries (2011)

A further contribution to the Lean Startup model as illustrated here in Model 2 is that the arrows in Model 1 go back and forth as business experimentation for sustainable

value creation is a trial-and-error/back-and-forth business experimentation process, as sustainability is defined by the customer and not by the company. This is because the sustainable value of a solution is defined together by the customer and the company with their stakeholders, so tailoring and learning with the customer becomes the key activity in the business experimentation processes for sustainable value creation. Another addition to the works of Ries (2011), is that the business experimentation starts and is driven with the (sustainability) problem of the customer and not just an idea. The study of the seven case companies revealed that the business experimentation processes for sustainable value creation had many similarities to *innovation co-creation processes*, as the customers were exploring and creating the solution with the case companies (their suppliers).

Another finding revealed that the context of cleantech and knowledge-intensive start-ups as represented in the seven case companies had a direct impact on the process flow and need for agility. Knowledge-intensive cleantech business experimentation can be both complex and lengthy, and thus expensive, and in addition, the high level of exploration for sustainable value creation adds to the length of the process. The cleantech start-ups do not have time or resources (money) for these lengthy and comprehensive business experimentation processes, so they engage in what we in the aggregated dimensions have called *super lean business experimentation through tailored demos and fast failure*. All seven case companies skipped straight to the demo in their business experimentation processes and built directly on the demos to speed up the process and to fail faster and forward. This saved them both time and money and speeded up the co-creation of the business experimentation with the customers.

Furthermore, this study presents new knowledge by further developing on the research conducted by Bojovic et al. (2018) on the business model experimentation process of green start-ups. Their study also put *learning* as a key activity and in addition stress *signaling* and *convincing* as the two other important activities. Compared to our findings and business experimentation process model (Model 1), *signaling* here relates to the technical quality of the sustainable/eco-innovation solution, where *convincing* is the cleantech company's ability to create actual sustainable value to the customer by ensuring the technical soundness and eco-friendliness of the solution.

Finally, the findings also revealed a very strong intrinsic "do better" motivation among all the cleantech start-up informants, who were all driven and highly motivated by finding unique solutions to create truly sustainable value to the customer and society as well. This again emphasizes the focus on exploration and the ability to expand the scope of technology and build capabilities to be able to deliver innovative and relevant sustainable value to the customer. Summarizing all the points above, for sustainable/cleantech companies to be able to do business experimentation for sustainable value creation successfully – interactive learning together with the customer and stakeholders is central and capability building is critical.

5. CONCLUSION

The objective of this study was to explore and provide new knowledge of how business experimentation processes are conducted by start-ups in creating sustainable value. In answering the research question of the study, we selected and conducted an explorative

case study in the context of cleantech start-ups. The study revealed that the business experimentation process of the seven cleantech start-ups contained the same or very similar activities. However, their business experimentation process appeared to be differed and even "leaner" than the well-established and often applied start-up process model of Lean Startup (Ries, 2011). The theoretical contributions to this model emphasized capability building (internal and external) and expanding the technology scope to fit the sustainability issue of the customer by providing sustainable value as valued by the customer and beneficial for the environment and society. The findings revealed that creating sustainable value through technology solutions (as in cleantech) does require a very knowledge-intensive, iterative, and explorative business experimentation process, heavily engaging the customer and several other knowledge partners in discovering the technologies that drives the sustainable value creation specifically requested by the customer.

The theoretical contributions of the study reveal new knowledge and understanding of the process of how start-ups conduct business experimentation (as requested by Ries, 2011; Blank, 2013) and specifically of the processes for capability building and learning with organizations in developing sustainable innovations, as called for by Siebenhühner and Arnold (2007) and Klewitz and Hansen (2014). In comparing to existing literature and conventional process models for business experimentation (e.g. Lean Startup model by Ries, 2011), it appears that the activities of business experimentation change when the objective of the business experimentation is sustainable value creation. The sustainability of the value creation provided through the business experimentation process is in the end defined by the customer. However, to be able to offer sustainable solutions, cleantech companies have to renew themselves continuously, as the requirements by customers and in society for more innovative, sustainable value creation and the development of cleantech technologies are escalating at high speed. Thus, our study confirms that continuous learning plays an absolutely critical role in business experimentation processes for sustainable value creation, which supports the arguments by Murray and Tripsas (2004) and Andries et al. (2013). The business experimentation process activities identified in this study and as illustrated in Model 1 did not appear to change between projects, emphasizing the two opposites of purposeful experimentation versus explorative experimentation. Although more time and efforts would in some of the project cases be put into the individual activities of more explorative business experimentations, the process model activities were the same. Also, the study elaborates on the research by Bojovic et al. (2018) by further exploring the actual content of the three activities—learning, signaling, and convincing—in the context of business experimentation processes for sustainable value creation.

A key theoretical contribution of the study relates to the further development of our knowledge of how business experimentation is conducted in start-ups and the specific explorative and capability-building activities of these processes. The study findings reveal that learning is not an isolated activity, as illustrated in the Lean Startup model by Ries (2011), but an ongoing and continuous learning process throughout the business experimentation carried out together with the customer. This is especially true as both the customer and the company are learning as they build capabilities together while extending the scope of new and existing technologies in creating sustainable value. Also, the business experimentation process is not a linear A–B process; it is interactive and goes "back and forth." Business experimentation in highly knowledge-intensive industries, like cleantech, does require capability building and expanding the technology

scope to fit sustainability issues that are often moving targets and require totally new, innovative and non-conventional solutions. These findings represent a theoretical contribution to our existing models and understanding of business experimentation processes.

The managerial implications of the study underline how business experimentation changes, when the context is cleantech and the output is sustainable solutions/eco innovations. Managers of these start-ups need to build capability continuously throughout the learning process together with customers, universities, and suppliers in the business experimentation processes to be able to continuously and successfully create sustainable value tailored to "solve" the customer's sustainability issues. Furthermore, in skipping phases in the business experimentation process by selling demos and failing fast and failing forward, managers can enhance the operational agility of the start-ups, which may be a key to survival in the first years of the start-up, as technology-driven business experimentation can be lengthy and expensive processes.

Finally, the study also presents implications for policy-makers as facilitating the opportunities and easy access to capability building. For example, platforms or events supporting industry/university collaborations, mentorships with technology experts, and technology knowledge transfer exchange programs are just some of the various supportive actions to be taken into account.

A key limitation of this explorative study relates to the limited amount of data. However, the objective of this study has been exploration of the specific content start-up business experimentation processes for sustainable value creation in a specific context of cleantech start-ups. Thus, further research through a larger quantitative study of cleantech would assist in generalizing the findings and the business experimentation process model across the context of cleantech and potentially other knowledge-intensive industries. Also, such a study could assist evaluate which activities are of higher importance in certain contexts compared to other (e.g., tech vs. non-tech start-ups).

The limitations of the study also constitute opportunities for further research. For one, the case study was conducted among seven companies within one industrial sector, cleantech. Further research could entail an exploration of the business experimentation process identified in this study through a cross-sector case study in exploring the impact of the industrial context on business experimentation processes and activities. The start-up business experimentation processes for sustainable value creation has been a main research focus of this paper. However, a comparative study of business experimentation in sustainable/green start-ups vs. conventional start-ups would be interesting to pursue to explore to what extent the business experimentation process may change and how the business experimentation activities may vary due to changes in value creation focus of the start-up or customer. In addition, a comparative study between successful and unsuccessful cleantech start-ups could verify the identified activities as critical to successful business experimentation processes and outcomes.
The geographical context of the study has been Finland due to the placement of the 2017 SLUSH event. Comparing start-ups from SLUSH events from different countries could reveal whether culture, national start-up policy, and the origin of the start-up as well as the individual entrepreneurs have an impact on the way business experimentation is conducted. This would be interesting and relevant to explore due to the increasing number of born-global entrepreneurs and open start-ups.

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