Proceedings of the 1st CIRP Industrial Product-Service Systems (IPS2) Conference, Cranfield University, 1-2 April 2009, pp280

Commercializing Sustainable Innovations in the Market through Entrepreneurship

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Abstract

The system innovations for sustainability require changes at multiple-domains (social, cultural, institutional and technological) and multiple-levels (micro-, meso-, and macro-levels) of the socio-technological system. From a sustainable production and consumption view, systems innovations can be enhanced through a PSS strategy at organisational level. This can be achieved through new entrepreneurial entries because of their potential in commercialising sustainable innovations and consequently bringing the necessary institutional change that favours such innovations.

This paper aims at investigating how sustainability-driven entrepreneurs enhance the commercialisation of sustainable PSS and the consequences of this process and the potential role of design in it.

Keywords:

Sustainability, (Product-Service) System Innovations, Entrepreneurship

1 INTRODUCTION

Increasing demand for resources coupled with increasing world population suggest that we need radical changes, also often referred to as system innovations, to create larger jumps in societal systems' efficiency and achieve the goals of sustainability. A system innovation means a shift from one socio-technological system to another (e.g. transport, energy, food) and requires changes on different domains: social, cultural, institutional and technological [3]. The multi-level concept divides the socio-technological system into micro-, meso-, and macro-levels, i.e. niches, regimes and socio-technical landscape, respectively. The changes occur either in a *bottom-up* fashion or a *top-down* fashion, i.e. "… breakouts at the micro-level find fertile soil at the macro-level, or a break through at the macro-level can be accompanied by suitable initiatives at the micro-level" [14]. From this perspective, the focus of this paper will be the organizations that execute innovation experiments at the micro-level and how they may influence the other elements of the societal system and bring the required radical change at meso-level and consequently at macro-level, which are more resistant to changes.

From a sustainable production and consumption view, the concept of product-service systems (PSS) has been suggested as a promising strategy for organisations operating on the micro-level of socio-technical systems. The elements of PSS consist of a system of products, services, network of actors and supporting infrastructure [11] that corresponds with the multiple dimensions of the socio-technological system: social, cultural, institutional and technological. The elements of PSS should be designed and continuously adjusted to each other aiming at sustainable system innovation and optimisation [11].

Besides the elements of PSS and sustainability criteria, the institutional environment (i.e. meso-level) in which the organisations operate is an important consideration since it affects the success and institutionalisation of the PSS. The institutional environment is characterised by a set of norms, expectations, procedures, standards and routines [6]. There is a need for the change of the institutional environment that favours sustainable solutions and their acceptance by the society. According to van den Hoed [6], there are five sources of institutional change: (1) shocks; (2) market changes; (3) new entrepreneurial entries; and (4) institutional entrepreneurship; and (5) new technologies. In the overall picture of the recent 25 years history of sustainable production and consumption, only new entries and new technologies have contributed to relevant changes, while shocks (not to manage anyway) and market changes almost have not occurred.

Therefore, from the perspective of radical change, there is a need to focus here on the role of entrepreneurship in relation to sustainable PSS innovation. In this study we are particularly interested in the role of the combination of new entrepreneurship and design in the development of successful radical new product-service systems. In this framework, this paper aims to explore the following main and sub-research questions:

How can sustainability-driven entrepreneurs enhance the introduction and success of sustainable PSS?

- *What is the role of design in this process?*
- *What are the consequences of this process regarding institutional environment, infrastructure and user practices?*

In order to do so we first discuss and define PSS, entrepreneurship and the role of design. Next, three case studies will be presented to explore and analyse the impact of entrepreneurship and design on the success of sustainable PSS.

2 PSS IN THE CONTEXT OF TRANSITIONS

As previously indicated in the introduction, system innovations require changes on different domains: social, cultural, institutional and technological - comprising elements such as technology, regulations, user practices and markets, cultural meanings, infrastructure, etc. [3].

From a demand side perspective, technology plays an important role in fulfilling and realizing functionalities in user contexts which are made up of users, their competences, preferences, cultural values and interpretations; and shaped by a variety of existing products, infrastructures and regulations. On the supply side, technology is produced, distributed and tuned with existing user contexts, requiring aspects like technological knowledge, machines, various actors, skilled labour,

capital, natural resources, distribution networks and regulations (Figure 1). The term 'socio-technological system' represents the co-dependence and interrelatedness of demand and supply aspects [3].

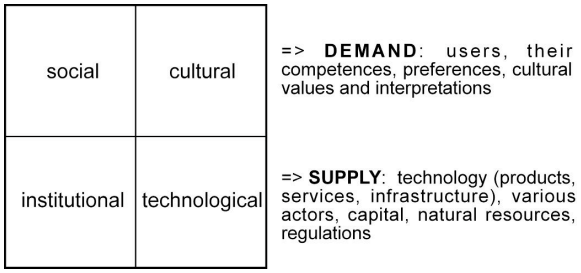

Figure 1: Different domains of the socio-technological system

In this framework, the concept of product-service systems (PSS) is a promising strategy for organisations operating on the micro-level of socio-technical systems. The elements of PSS consists of a system of products, services, network of actors and supporting infrastructure that corresponds with the multiple domains of the socio-technological system: social, cultural, institutional and technological - involving new markets, user practices, regulations, infrastructures and cultural meanings (Figure 2). The elements of PSS should be designed and continuously adjusted to each other aiming at system innovation and optimisation [11].

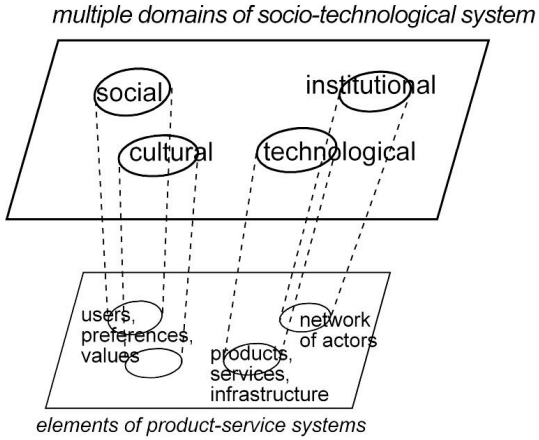

Figure 2: The correspondence of PSS elements with the multiple domains of socio-technological system

The significant role of infrastructure should be underlined here since it has a direct effect on individual consumption patterns and environmental impacts. Infrastructure is co-dependent to products which influence the shaping of infrastructure. Because products have shorter innovation cycles, the design and development of products are easier than infrastructure. However, product improvements through redesign provide maximum factor four improvements. Moreover, it is a shared opinion that factor 10, 20 or higher improvements are necessary to keep within the limits of the environmental impact of the year 1990 in the year 2025. This requires improvements beyond product level including infrastructure [11].

2.1 Defining PSS

Based on the aforementioned PSS elements and sustainability criteria, a PSS is defined as [11]:

"… a system of products, services, networks of actors and supporting infrastructure that continuously strives to be competitive, satisfy customer needs and have a lower environmental impact than traditional business models."

Therefore, PSS is not merely selling physical goods or services but designing a combination of products and services where the focus is given on environmental concerns, economical feasibility of the systems and social issues [19]. In a PSS strategy, the concept of *product* is not just the result of traditional production processes but rather the result of a system of physical products and services which are mutually combined to satisfy a specific client demand. The central value of products is exchanged with the value of utilization where the customers pay for performance [10]. In such a scenario, different types of relationships have to be established so that the system will be more favourable to customers than the traditional production system.

At the **customer side (or demand side)**, consumption is a satisfaction-based process and tangible products are not the only way of providing this to customers. In other words, customers are not searching only for products or services but rather for a system of products and services that satisfy their needs and desires [20]. Therefore, a PSS should be designed in a way that will be more desirable to customers than tangible products alone [15]. The added value of a product previously came from the production processes that transform raw materials into products. But today this is changing and the added value come from all the non-material aspects of a product, which are technological improvements, product image, brand name and aesthetic design [10]. At the **business side (or supply side)**, therefore, companies are moving away from mass production to mass customization and using more and more services to compete and differentiate in the market [10]. This means that the companies should better understand its customers, which requires a tight relationship of customer and the company.

Such an approach, furthermore, brings different kinds of partnerships with other producers and suppliers, public bodies and non-profit organizations for an integrated solution to satisfy customer needs [20]. A "sustainable" PSS strategy forces the industry to focus on a system thinking [8] with the aim of optimizing the interests of all the bodies involved in the PSS and also improving resource usage and environmental quality.

Besides the elements of PSS and sustainability criteria, the institutional environment (i.e. meso-level) in which the organisations operate is an important consideration since it affects the success and institutionalisation of the PSS. Institutions do not only comprise regulations and legislations but also the societal norms, ethical rules and established patterns and lifestyles. Therefore, they play a significant role on the way the business is structured and consequently the consumption patterns of the society [11].

On the other hand, there is a need for the change of the institutional environment that favours sustainable solutions and their acceptance by the society. Entrepreneurship is one of the sources of institutional change since new entries can alter power structure within the institutional context providing opportunities for a new dialogue and discussion. This, consequently, may lead to a renegotiation of established institutions. The reason why new entrepreneurial entries are likely to be more innovative than establishes firms is that they are less constrained by the vested interests and developed

routines and consequently propose new practices [6]. Furthermore, fast-decision making, flexibility and allocating resources external network increase the likelihood of developing and implementing new products and services [1].

Besides entrepreneurship as a change agent, it plays a significant role in commercialising the PSS. The concept of PSS has been deeply studied at the academic level and knowledge has been created regarding its characteristics, potential benefits, barriers, design tools and methods. However, this knowledge has barely found applications in practice [22]. From this perspective, entrepreneurship is being suggested to play a critical role in enhancing the introduction of successful PSS.

2.2 Entrepreneurship

Although there is a variety of definitions of entrepreneurship in literature; entrepreneurs, in general, are defined as individuals who conceive new business opportunities and take on risks required to convert those ideas into commercial reality [16]. As economist Joseph Schumpeter [17] described, they are often agents of 'creative destruction', which transform old-ways of doing through a dynamic pattern of innovative upstarts that unseat established firms. Hart and Milstein [5] argue that economy is driven by firms that are able to capitalize on the "new combinations" and entrepreneurs creating new processes, products, and markets tend to be the key actors in this process of change - such as in transition from coal-age technologies to oil-age technologies which are now giving way to information-age technologies. The emerging challenge of global sustainability is a catalyst for a new round of creative destruction which offers unprecedented opportunities to entrepreneurs with the foresight to capitalize on it [5].

The field of **sustainable entrepreneurship** is interdisciplinary by nature. From the entrepreneurship perspective, it focuses on the activities of individual entrepreneurs and the impacts they have on the wider socio-economic system. From the sustainability perspective, it focuses on the development of sustainability of whole societies and ecosystems. Therefore, sustainable entrepreneurship links the micro-level entrepreneurship with macro-level sustainable development through the organisations that operate at meso-level of the societal system. The significant role of organisations in this link is that they function as an essential tool of the entrepreneurs whilst they constitute a huge part of the institutional landscape of the society [12].

The real sustainability gains will be made by harnessing the innovative potential of entrepreneurship to resolve environmental challenges with innovative PSS solutions.

2.3 The role of design

Entrepreneurs can contribute in several ways to sustainable (product-service) system innovation [11]. The four elements of PSS mentioned previously can serve to design of new, significantly more sustainable PSS. For instance, an entrepreneur can choose to develop a service, using a relative lower number of existing products or can develop a product based upon a new technology, like solar energy. But also a new organization or more efficient use of existing infrastructures can contribute to the new system. The role of design in this context mainly to adapt, improve and innovate physical products as enablers of new PSS systems. In this sense they are the part of the creative –destructive- approach of usually new entrepreneurs, able to map potential future consumer needs, to value the potential of new product technologies and to develop novel products that stimulate radical changes in production and consumption.

3 RESEARCH METHODOLOGY

Building upon the work of Berchicci on sustainable entrepreneurship [1], in this study we are particularly interested in the role of the combination of new entrepreneurship and design in the development of successful radical new product-service systems. For this purpose a case study research was carried out.

This case study research is of an explorative nature and primarily expects to derive descriptive and explanatory findings from the cases through company profiles and interviews. The subject matter of the case study is young entrepreneurial firms in process of commercializing sustainable PSS innovations. The three companies which have been investigated are:

(1) Enviu (www.enviu.org)

(2) Tuk Tuk Company (www.tuktukcompany.nl)

(3) Evening Breeze (www.evening-breeze.com).

Most of the data are derived from personal interviews with the representatives of the company with in addition internet pages and company documents. An attempt is made to classify the three cases according to the PSS-framework as developed by Mont [11] and to draw some first preliminary conclusions.

Each case will be classified in the following categories: Activity of company (project development, competition, incubation, business model development, venture planning), type of product(s) (redesign, new design), type of service (support services, point of sale services, various concepts of product use, maintenance services, and end-of-life services), network of actors (existing chain, new chain) and infrastructure (existing, new).

4 CASE STUDY

4.1 Enviu

Enviu is an international non-profit organization by and for young professionals, students and young entrepreneurs with mainly a business, economic or design background. Enviu has a relative small staff of 11 professionals, however each year more than 2.000 volunteers are participating in the program. Via their work, study and in free time they are involved in projects aimed at delivering sustainable solutions to the market.

The mission of Enviu is to cooperate on developing sustainable solutions to environmental issues. This is done on the basis of requests (i.e., demand), which means that an issue must be recognised locally, and local stakeholders must have expressed their desire to solve it [2].

Beside the position of Enviu in relation to sustainability, stakeholder dialogue (SHD) (Figure 3) between the different layers of society is an important consideration during the development of projects [2].

The added value of SHD is the strengthening capacity of and between local stakeholder groups, realisation of the stakeholder dialogue, facilitation and stimulation of the processes to initiate more sustainable practices with the emphasis on a business approach with a social face and delivering applied socio-economic and business knowledge and access to knowledge networks [2].

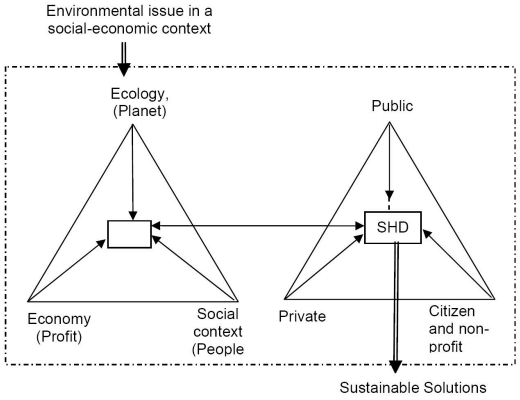

Figure 3: The vision and operating procedures of Enviu

The core activities of Enviu include executing specific projects that contribute to sustainable solutions, developing activities that create awareness and commitment among young people and collecting and developing knowledge about different fields related to sustainable development. The most important activities in projects consist of supporting partners in capacity strengthening, applied research and to facilitate the realisation and execution of stakeholder dialogue. This approach is also reflected in the type of projects initiated:

The Sustainable Dance Club (SDC)
The SDC is a spin-off company of Enviu together with Döll that aims to green the clubbing scene. Central element in this club has been the design of the "energy flux floor" (Figure 4), enabling dancing people to generate electrical energy by moving the floor elements [13]. The floor has two versions: **permanent** integrated into an existing club, and **mobile** for hiring.

Figure 3: Energy flux floor

Besides the floor, other elements have been added to the sustainable dance club concept, from water and waste reduction measures to improved bar logistics, personalized new drinking devices and energy reduction via sound equipment redesign [4, 7, 18]. Furthermore, the design of a mini-sustainable dance club emerged that can be used at events like festivals and expos. In all sub-projects new business chains have been created and improved and totally new designed products have played an important role, where Enviu is the main initiator and facilitator.

Besides the existing and new products, SDC as a company offers services to clubs that want to adopt the system, such as: sustainability scan (calculating the carbon footprint of clubs and events), consultancy for the possible improvements regarding environmental impact, economical and organisational aspects of the company (ie. clubs), workshops demonstrating sustainability implementation into the business, promotion, food and beverages.

In the Netherlands the concept has diffused to other clubs such as the 058Podium in the north of the country. Here, a new organization was created, under the name Entertain&Sustain aiming at integrating pleasure and sustainability issues among the youth in a natural way [21].

The Hybrid TukTuk Competition
The Hybrid TukTuk project is an international competition for the redesign of the existing tuk tuk taxis for the lower end of the market in India. In large cities across Asia, a million auto-rickshaws serve as one of the most important means of transportation every day. At the same time, these auto-rickshaws cause considerable air pollution and a large amount of CO_2 emission. The auto-rickshaw drivers are part of the poorer groups of society and earn on average $3 to $4 a day. Through this project Enviu aims to actively involve young entrepreneurial people in the development and introduction of a Hybrid Tuktuk upgrade kit through their study, work and free time. The guiding concept is to have different prototypes or test model upgrade kits which make existing tuk tuks environmentally sound in an effective and affordable manner and to simultaneously improve the socio-economic situation of the tuk tuk community. The project goals are:

- To improve the air quality in large Asian cities through the reduction of the CO_2 emission of auto-rickshaws by 40% to 60%

- To improve the economic situation, and with that the social position, of the auto-rickshaw drivers and their families by lower fuel costs and more efficient motors

This competition will take off in 2008, with the involvement of a number of international teams of industrial design and automotive engineers. Existing tuk tuk platforms, additional equipment and financial support will be provided by sponsors from different backgrounds (http://hybridtuktuk.com).

The Rotterdam Innovation Lab
In collaboration with financial organizations, the Rotterdam Harbour Authority, Hogeschool Rotterdam and YES!Delft (the incubator of Delft University of Technology), Enviu is creating an incubator for sustainable entrepreneurship and new ventures for the sustainable future of Rotterdam as a harbour city. Particularly the aim is to develop the right conditions to bring sustainable solutions to the marketplace, and do it on a profitable way.

4.2 Tuk Tuk Company

Tuk tuk is increasingly recognized as an alternative to the taxi for the inner city transport in Europe. In parallel to the hybrid tuk tuk project of Enviu, Tuk Tuk Company (TTC) is currently engaged in the improvement of the existing Thai tuk tuk and the development of a new sustainable tuk tuk.

The company started in 2006 to challenge the existing taxi business since the taxis are currently not very affordable in the Netherlands and as a result most of them are waiting for customers in front of train stations and taxi stops. Tuk tuks were imported from Thailand and adapted to the European standards. Currently 55 tuk tuks are driving on the roads of Amsterdam, The Hague and Rotterdam. TTC has seen the opportunity and the need to make the tuk tuks more sustainable which lead to: 1) the

improvement of the existing tuk tuks and, 2) the development of a new sustainable electric tuk tuk.

Redesign of the existing tuk tuk

After having tested the tuk tuks in Dutch cities, TTC determined that Thai tuk tuks lacked reliability and comfort levels of European standards and customer expectations, which lead to the re-design of the existing tuk tuks (Figure 4). The company set three goals for the re-design: sustainability, weather independency and maintenance reduction [9]. The tuk tuks were built with LPG tanks in order to make them as green as possible for now. Furthermore, Thai tuk tuks do not have a front break. RDW (Rijksdienst Wegverkeer – the Dutch agency which controls the licenses for Dutch roads) demanded a front break which led to the adaptation of the front wheel construction.

Figure 4: Redesigned tuk tuk

New design of an electric tuk tuk

The new tuk tuks (Figure 5) in development will be electrical, fully emission free and will replace the old tuk tuks. The E-tuk (E stands for electric) is being currently developed in cooperation with the Delft University of Technology and the University of Arnhem. TTC aims to maintain the heritage of the old tuk tuk and make it suitable for the European city environment. Tuk tuks have a very low radius in personal transport. In other words, they do only short drives of 1-2 kilometres, whereas other types of personal transport such as cars and taxis have bigger radius which makes them dependent on the infrastructure (i.e. for charging) or force them go hybrid to enlarge the radius. Small radius of transport of tuk tuks makes it independent of the infrastructure and allows different charging options (i.e. fast or slow).

In addition, for a small company like TTC with relatively small cash flow, it's difficult to find resources to finance the innovations. The company acknowledges the financial support of the Dutch government for the development of E-tuk.

Figure 5: E-tuk

Business model

TTC has a franchise scheme, which fosters scaling up of the system. The company delivers tuk tuks to entrepreneurs/drivers who franchisees the concept, making themselves responsible for their earning by selling singular drives on the streets. They are also responsible for the maintenance of the vulnerable tuk tuks which decreases the maintenance costs for the company. The company also offers drivers services such as PR and local marketing. TTC hopes to start including microfinance for drivers into their business model.

Because the tuk tuks are rented for the cost price, they bring no profit. The main income of the company is the advertisements at the roof of the tuk tuks, however this often fluctuates. For that reason, TTC plans to collaborate with an advertising company to create a win-win situation for TTC through the network of the advertising agency and for the agency through the shares of the advertisement incomes.

Apart from the advertisements the company profits from events. When a specific group that needs to be transported at a specific time from A to B and back, TTC coordinates everything. They have a wide range of customers for events such as companies, event agencies, hotels/tourists, and other companies in the leisure industry (for example canal companies in the Netherlands which organize canal tours for tourists).

Barriers

The local governments of Amsterdam, The Hague and Rotterdam do not offer TTC parking places for tuk tuks as long as they are not electric. Currently this is the main challenge for the company which prevents them building their customer base. The drivers stay 'stand-still' anywhere on the streets but not in parking position. For this reason, TTC has recently signed a cooperation agreement with the Rotterdam Central Taxi (RTC). The tuk tuks are being offered to public and tourist in the centre of Rotterdam.

Social aspect

In addition to its commitment with the environment, the company has also the ambition to offer a social service to the community with their GoodWerk (in English: GoodWork) project. The project is being developed for refugees and disabled people to allow self-employment through entrepreneurship. The company helps refugees and disabled people to start their own business with tuk tuks or offer employment allowing them to use tuk tuks. TTC is subsidized by DWI (Dienst Werk en Inkomen – service for employment and income) for each refugee that is being trained.

4.3 Evening Breeze

Evening Breeze is a spin-off venture which has been started in 2006 at the Design for Sustainability Programme of the Delft University of Technology. The company determined - together with some other environmental experts - that air conditioning accounts for 80% of the energy use in tropical hotel rooms, which results in high energy bills for the resort management and an environmental load for the community. Moreover the experimented comfort of the current air conditioning systems is disappointing. A research revealed noise and draft to be the biggest complaints.

To overcome these challenges, Evening Breeze designed and developed the Evening Breeze bed (Figure 6) - an air conditioned canopy bed which provides the sleeper with a

comfortable sleeping environment while reducing the cooled space from the entire room, approximately 80 m^3, to the bed, a mere 8 m^3. The company is currently in process of the first demonstration projects in Mozambique, Caribbean, and South Africa.

Figure 6: The Evening Breeze bed at Sefapane, South Africa.

The Evening Breeze Bed

The system comprises of a low capacity high efficiency cooling unit. According to the user's preferences the air is cooled, dehumidified and filtered and gently spread over the sleepers through a porous section in the ceiling of the canopy bed (Figure 7). A matching mosquito netting protects the sleeper against unwanted intruders and enhance the air circulation.

Figure 7: The Evening Breeze bed climate system

A huge greenhouse gas emission reduction is realised with the Evening Breeze bed. The annual 5 MWh/year saving potential exceeds the electricity consumption of a West European household and causes 3 tons of CO2 emission. Moreover harmful emissions are reduced by minimizing transport and cooperating with local suppliers. The application of environmentally friendly materials minimises the ecological footprint. The R410A coolant contains no chlorine that reduces the damage to the ozone layer and allows more efficient operation, due to the higher heat transfer.

Commercialisation

Demo beds were tested at some of the beach resorts located on the island of Bonaire, Dutch Antilles. Subsequently some resorts in South Africa were equipped with an Evening Breeze bed. Reactions of the first users were positive and provided the input for the optimisation phase. The first resort to completely adopt Evening Breeze beds will open in the beginning of 2009 in Mozambique. The beds for this project are locally manufactured in Zanzibar.

Business Model

The industry value chain of the company is shown in Figure 8. Evening Breeze is the link between suppliers and the local installation partners; however the resorts and end users are important for the company not only for marketing activities but also for their feedback on the design of the Evening Breeze bed.

Figure 8: Industry value chain

The company strives for excellent partners in sustainability and teams up with bed manufacturers to deliver the beds to its customers. For the African and Caribbean market local manufacturers are preferred, for the American and European market branded manufacturers are chosen. Although there are some design guidelines for the bed, there are no standard beds, i.e. the local companies are responsible for their own design with different materials and style.
The mosquito nettings are produced by the South African based Kiwinet and the Thai based TanaNetting. Both companies excel in their sustainable business model. Kiwinet mainly employs previously disadvantaged women and TanaNetting is the preferred supplier of the WHO.

The installation partners are responsible for the service and maintenance of the Evening Breeze bed and receive marketing and technical support from Evening Breeze.

The company itself is divided into two departments: the **commercial** department focused on the installation partners, resorts and end users; the **technical** department focused on the suppliers and responsible for the design and assembly.

Besides the suppliers, installation partners and resorts, Evening Breeze currently works with an advisory board which supports the company with knowledge on sustainable tourism, market insights and the local network.

The first three years Evening Breeze has a negative cash flow and consequently needs financing. Currently, financial support comes from different channels, such as government subsidies (both Dutch and local governments), local NGOs, banks, informal investors who also couch the company in terms of organisational matters and networking. Apart from that, it receives knowledge support from different consultancies, as well as the Delft University of Technology.

5 DISCUSSION

The findings of this exploratory case study have been summarised in the following tables (1,2,3) for each case. The cases have been classified in the PSS-framework of Mont [11], involving the design of products and services and the consequences of this on the infrastructure and network of actors.

Enviu innovates in different ways. In the SDC project (= new company, in which Enviu, Watt and Döll cooperate) the role of design is both creating total new club products/experiences and integrating existing best practices. The Hybrid Tuk Tuk project is an international competition, in which redesign is the key, and is preceding future green entrepreneurship, if the results are successful. The Climate Innovation Lab is a special incubator project, focussing on selecting green new ventures by students for the Rotterdam Climate Program.

The activities of Enviu cover a mix of new design, redesign, setting up new organizations, improving services and using/adapting existing infrastructure. The key is that not only Enviu is a green entrepreneur, building on best practices and total new design, but that this is also the point of departure for the facilitation (birth and growth) of succeeding new green ventures.

Tuk Tuk Company has innovative projects regarding the different aspects of sustainability. By redesigning the existing tuk tuk, the company aims to improve it in terms of its environmental performance, reliability and comfort for European customers. Likewise, the new E-tuk project aims to improve the environmental performance of the tuk tuk by integrating a new technology and preceding green entrepreneurship. In both projects design has a crucial role of making use of the old and new technologies, understanding customer needs and contextual conditions of both company and design environment, and bringing future scenarios of use. Additionally, E-tuk project requires design of new facilities for charging the tuk tuks which requires changes in infrastructure.

The business model of the company enables scaling up of the project since this way individual entrepreneurs are offered different support services and encouraged for self-employment. Similar to franchising concept is the GoedWerk project which has a social aspect as well.

Apart from redesigned and newly designed products with better environmental performance, the projects of TTC create new partnerships within local and international chains that create economical and social benefits.

Evening Breeze is a young company in the process of implementing its first demonstration projects in Mozambique, Caribbean, and South Africa. This results in new business chains through collaborations with different local stakeholders including air-conditioner installation companies, manufacturing companies, eco-resorts, as well as different suppliers. The innovation of Evening Breeze bed is mainly in the use phase of the product, which reduces energy consumption up to 80%. The technology used in the product is not new, but it is a combination of existing technologies adjusted for the bed. The company sees the opportunity of leasing the cooling system to increase its efficiency by allowing different resorts to use it at different parts of the year, however the necessary capital for leasing do not exist due to the company's size and age.

		Design		**Consequences**	
Project	*Activity*	*Product(s) type*	*Service*	*Infrastructure*	*Network of actors*
Sustainable Dance Club	Combination of old & new companies in one new company (SDC)	Radical innovation (dance floor) and product adaptation and existing products	*To clubs:* Sustainability scan, consultancy, workshops *To the end users:* Adapted drinking and bar service	Adapted building	Existing and new chains, volunteers, strong links to universities
Hybrid Tuk Tuk	International competition to stimulate sustainable design and entrepreneurship	Redesign of existing tuk tuk with new technology	*To the participants of the competition:* Couching *To the end users:* Training and maintenance	Existing	Existing and new chains
Rotterdam Innovation Lab	Incubation of start-ups	Old and newly designed products	Fostering sustainable innovation from young entrepreneurs	Adapted building	New organisation and cooperation

Table 1: Findings of the exploratory case study for Enviu

		Design		**Consequences**	
Project	*Activity*	*Product(s) type*	*Service*	*Infrastructure*	*Network of actors*
Redesign of existing tuk tuk	Project development	Redesign of existing Thai tuk tuk based on European standards	Delivery of an alternative public transport for short distances within the city for a wide range of customers	Existing	Existing and new chains, strong links with universities
E-tuk	Project development	New design of an electrical tuk tuk	Delivery of an alternative public transport for short distances within the city for a wide range of customers	Existing and adapted (charging stations)	Existing and new chains, strong links with universities
Franchise scheme	Business model development	Redesigned and new products	PR, local marketing and training for entrepreneurs	Existing	New contracts with multiple actors
GoedWerk	Project development with a social mission	Redesigned and new products	PR, local marketing and training for refugees and disabled people	Existing	Existing and new chains

Table 2: Findings of the exploratory case study for Tuk Tuk Company

		Design		Consequences	
Project	*Activity*	*Product(s) type*	*Service*	*Infrastructure*	*Network of actors*
Evening Breeze bed	Project development and new venture planning	Redesign of existing cooling system and bed with an innovative use phase	Delivery and maintenance of the system	Existing	New chain, strong links with universities

Table 3: Findings of the exploratory case study for Evening Breeze

6 CONCLUSIONS

This paper aimed at investigating how sustainability-driven entrepreneurs enhance the commercialisation of sustainable PSS and the consequences of this process and the potential role of design in it.

For that reason, an explorative investigation has been made on three companies which are in the process of commercialising such innovations. The cases have been classified in a PSS-framework involving variables such as products, services, network of actors and infrastructural elements. The results show that all four variables might lead to a sustainable product-service system in different ways. For instance, as in the case of Sustainable Dance Club and Climate Innovation Lab, existing products (either used as they are or redesigned) in combination with new/adapted services may be developed as new business concepts which bring institutional and infrastructural innovation into the system. Complete new design of products making use of new technologies (E-tuk), new organisations/partnerships (Rotterdam Innovation Lab, GoedWerk), making use of existing business models (the franchise scheme of TTC) or bringing new ways of use through existing products (Evening Breeze bed) are all different opportunities for companies in creating sustainable innovations.

In conclusion, this paper suggests that the required systems innovations for sustainability can be enhanced through a PSS strategy at an organisational level. This can be achieved through new entrepreneurial entries because of their potential in creating new solutions, building up the required scientific and business wise networks, commercialising sustainable innovations and consequently bringing the necessary institutional change that favours such innovations.

7 ACKNOWLEDGEMENTS

The authors would like to thank A. Idil Gaziulusoy and Oriol Pascual for their valuable comments and contributions.

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