RE-USE SYSTEM FOR NOTEBOOKS – THE GOALS AND RATIONALE OF THE RUN PROJECT

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Abstract

Used electronic equipment, such as notebooks, contains a variety of natural resources which are not recovered in today's material recycling loops. The RUN ('ReUse Notebook–Collection, Refurbishment and Distribution System') project addresses this issue. Its main goal is to implement a large-scale system for collecting and purchasing, inventorying, refurbishing and remarketing used notebooks from private households/ SMEs (small and medium sized enterprises). This requires handling small batch sizes down to one piece. It unlocks so far neglected sources for used appliances and extends the scope for professional refurbishment of IT (information technology) products. This paper introduces to the RUN approach, presents the rationale of the consortium and its goals.

Keywords: re-use, RUN project, electr(on)ic appliances, collection system, eco-innovation

1. INTRODUCTION: ECO-INNOVATION FOR LOWERING ENVIRONMENTAL BURDENS

The consumption of natural resources has overshot the natural boundaries. The current use of renewable natural resources is about 50% above these boundaries [1]. Since the 1970ies there has been a still ongoing debate about the consequences of this growth and material growth itself has been discussed to become 'uneconomic in a full world' [2,3,4].

Industry, facing the sustainability challenge, is not only affected by societal demands for greening their products and businesses but also from rising prices for scarcer raw materials. This scarcity is addressed by industry and policy makers not only by efforts for manufacturing products more efficiently but also by recycling approaches for closing the materials' loop. [5,6].

Approaches for lowering the environmental burdens are discussed under the term 'eco-innovation'. An eco-innovation in general is defined as

> *"all measures of relevant actors […] which develop new ideas, behaviour, products and processes, apply or introduce them [but also] contribute to a reduction of environmental burdens or to ecologically specified sustainability targets" [7, p.325].*

Accordingly, 'green' or sustainable products and services conserve resources or reduce waste [8]. The concept of eco-innovation is centred on the environmental impact. It is not about how innovation emerges or is structured e.g in open innovation theory [9,10,11] or innovation as destructive force [12]. Employing this definition, all approaches which reduce the environmental impact of economic activities are included: From manufacturing products more resource friendly, to designing products more efficient during their use phase and recycling approaches. However, in innovation practice the concept of eco-innovation seems to be biased in some respect since it favours incremental innovation and neglecting more radical approaches to innovation [13]. Innovative recycling approaches are discussed by Slowak and Regenfelder [14] as loop-closing innovation: By closing the raw materials loop, an eco-innovator not only considers one-point-in-time value

creation but multiple value creation. After a first use phase, the innovator refurbishes or remanufactures a product and then enables a second use phase in the same use case or switches to another use case with lower requirements on the product. Finally, if re-use is no longer possible because of technical or market reasons, the materials' loop is closed by functional materials recycling. This concept focusses on re-valuation of used products and conservation of material's value as last step. Consistently, sustainable innovation is described as way to yield the most possible utility from natural resources as soon as they are brought into the industrial system, no matter if they are incorporated in a product, component or as materials [15]. This approach therefore is not only technically-centred. Innovation can also be rooted in radically new or improved business models or patterns of interaction between consumers, firms and other actors [16, 17].

This paper will discuss an example for eco-innovation by loop-closing from a take-back and redistribution system for used notebooks. First, the environmental benefits from the re-use of notebooks are introduced. Then, an outline of the rationale and structure of the EU (European Union)-funded project RUN ('ReUse Notebook–Collection, Refurbishment and Distribution System') is given. Finally, it is discussed how this project contributes to eco-innovation and loop-closing.

2. ENVIRONMENTAL BENEFITS BY THE RE-USE OF NOTEBOOKS

Notebooks create environmental burdens throughout their product life; from production and use phase to recycling/disposal. They are products which contain manifold raw materials which cause a huge environmental impact by their primary extraction. Ecological benefits from re-use therefore result from the substitution of new production. The lowest boundary for the substitution is assumed that one re-used notebook substitutes 0.2 new notebooks [18].

An average notebook causes environmental impact during its product life, the main share as outcome of its production [18]. The following Table 1 shows for example the results of product carbon footprints for CO_2 (equivalent) emissions resulting from production of different notebooks (impact is also dependent on device's size and weight as well as on assessments' boundaries).

Table 1 – Overview of CO_2 (equivalent) emissions from manufacturing of selected notebooks

Type	**CO_2e emissions**	**Data Source**
14,1" Fujitsu EcoLeaf	96 kg	[19]
12,1" HP	155 kg	[20]
14" Dell Latitude E6400	250 kg	[21]
11" MacBook Air	352.6 kg	[22]
15" MacBook Pro	704 kg	[23]

End-of-life notebooks are shredded in Europe's today's recycling practice and materials such as copper, gold and silver are recovered.Table 2 provides an overview of raw materials which are incorporated in an average year-2012-notebook. Note that many of those materials are labelled as scarce or as of strategic relevance by the EU because of their economic importance in high-tech applications or supply risks [5,24,25]. In addition, their functional end-of-life recycling rates are mostly very low [26,27] and recovery technology is developing insufficiently [6]. Consequently, re-using those devices is the only option if the other metals listed in Table 2 shall not get lost after a first use phase/ end-of-life.

Table 2 – Average usage of critical metals per notebook [28, Table 23]

Material	**Weight in mg**	**Used mainly in component**

cobalt	65,000	lithium-ion battery
neodymium	2,100	spindle motor, speakers, voice coil actuator
tantalum	1,700	capacitors
silver	440	(main) circuit boards
praseodymium	270	voice coil actuator, speakers
gold	100	main circuit board
dysprosium	60	voice coil actuator
indium	40	display
palladium	40	(main) circuit board
platinum	4	hard disks
yttrium	1.8/ 1.6	background lighting

The material consumption and the low functional recycling rates also entail waste generation. Over its whole product life an average office notebook generates 11.240 kg of non-hazardous waste and 1.482 kg of hazardous waste; the latter mainly during its recycling/ disposal [29]. In this respect, it is coherently that policy makers address the end-of-life treatment, e.g. in the European Waste Framework Directive [30] or on national level e.g. in Germany [31]. Both regulations rule that re-use is to prefer to recycling, (energy) recovery and disposal.

The importance of these figures is underlined when having in mind the absolute figures of the market for notebooks. While in the year 2014 in the German target market of the RUN project 5,436,000 notebooks were sold to private consumers [32], in 2013 the worldwide market was expected to reach 180.9 million devices [33].

These market figures refer vastly to newly produced notebooks. Under resource efficiency issues, there is strong indication that the re-use of notebooks is preferable to the replacement by new devices: The presumably slightly lower energy consumption in use of new product generations does not counterbalance the impacts of production introduced above. Especially since notebooks are on average replaced every three years -which equals about two product generations- and energy efficiency already was an industry issue in the past years. [34]

3. THE RUN PROJECT

3.1. Introduction and Rationale

The RUN project started in November 2014 with a run-time of 36 months. Its main goal is to build and implement an integrated large-scale system for purchase, refurbishing, inventory and remarketing of notebook computers from private households and SMEs. It thus covers the whole value chain of re-use and offers a complete service package to the customer. The service package contains peripheral innovative service add-ons, such as data provision of personal data and certified data erasure. The project partners are from Germany (Dr. Brüning Engineering UG (haftungsbeschränkt), Ebelt-Beratung UG (haftungsbeschränkt), Exmt – Büro für Programmierung und Design UG (haftungsbeschränkt), SAPOS gGmbH and ReUse-Verein (gemeinnützig)), Austria (Demontage- und Recyclingzentrum (D.R.Z.) as part of Wiener Volkshochschulen GmbH and i4next international computer trading & leasing GmbH) and Poland (Laura Sp. Zo.o).

Private households and SMEs as source for used notebooks are at the moment still neglected by professional refurbishers. Professional refurbishment for notebooks focusses on batch sizes of several hundred devices which mostly originate from huge companies or are returned from leasing contracts. So far, there is no professional large-scale service system targeting notebooks from private households and SMEs because this

implies handling small batch sizes and large variety of notebook types. Also, it is unknown which types of notebooks are returned, how their condition is, are they re-usable or to recycle and which number of devices such a system can generate as soon as it is well-established.

Most urgent will be the set-up of the reverse logistics system. The RUN project will offer its customers several possibilities for the take-back of used appliances: From shipping by mail to pick-up service and additional services. Figure 1 shows the planned or assessed (in terms of economic viability) reverse logistics and distribution channels.

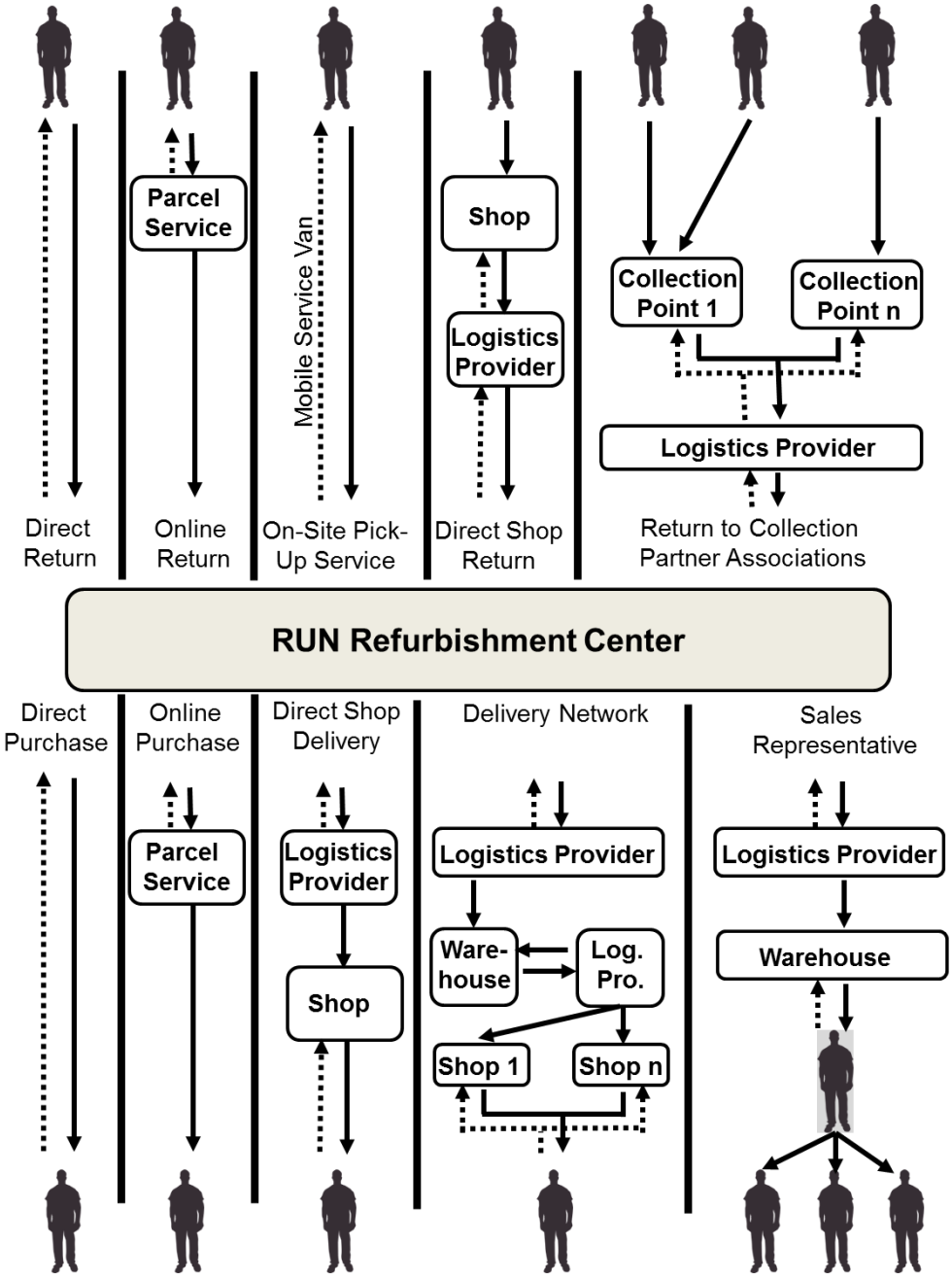

Figure 1 – Assessed Reverse Logistics and Distribution Channels

The partners have to face a business environment with the following characteristics:

- There are no large scale competitors aiming on these small batch sizes from private households and SMEs because of the challenging handling process.
- A market is expected for safe data erasure. This is often neglected in SMEs or private households and will create additional value for the customers.
- So far, the types and condition of notebooks which can be collected by private households and SMEs is unclear. These aspects have strong impact on the sale price of the refurbished notebooks and the economic benefits. The quota of collected notebooks, which will only be recyclable for their materials, is unclear.
- The partners will start with regional pilot systems in Berlin, Germany and Vienna, Austria for the take-back system. Possible partner associations for pick-up points and shops are contacted.
- After these pilots, Poland and Croatia will be accessed, mainly for the remarketing and market replication.

The rationale of the RUN project therefore is to unlock private households and SMEs as source for used notebooks, thereby avoid competition and offer to those customers additional benefit by new services which guarantee data safety.

3.2. Structure of the Project

The work programme of the RUN project will develop the technical and organisational preconditions for a collection, refurbishment and remarketing network. It will establish an enterprise network for this purpose. Thereby, the RUN project will contribute to resource efficiency and enhance reuse business models for customers and SMEs. The RUN project consists of eight work packages (WPs) including one WP for project management activities.

WP-02: 'Collection and procurement concept': Acquisition of partners and locations, setting up the collection process and the collection network for used notebooks. The bundle of activities will serve to find partners and secure abundant used notebooks as input for the refurbishment process. Therefore marketing strategies for creating the willingness to abandon used devices have to be defined. A fully integrated web site for easy handing in old devices must be implemented.

WP-03: 'Extraction and provision of personal data, data erasure' will develop and implement the procedure for the innovative service add-on of personal data extraction and subsequent its provision on secured web servers or data carriers of customers' choice. This service add-on will be topped off with certified data erasure measures (as described, for project's target groups also an innovative approach). Those innovative services must also be available on-site for SMEs and households.

WP-04: 'Refurbishment'. This WP will design, develop and implement the refurbishment procedure specifically for the requirements of notebooks. It will develop the technical and organisational requirements for a well-operating refurbishment process.

WP-05: 'Distribution, sales and marketing strategies' will establish a cost-efficient distribution network for facing the logistics challenge. The definition of the sale process will determine refurbished notebook's sale destination and its country specific price. Besides, the presentation of the shop area and the refurbished goods will be defined for a uniform appearance. As second, the consortium will expand the website to a fully integrated and automated web platform to user-friendly access for the customers to look for a 'new' used notebook. For sales, the same work will be done as for collection but reverse (internet, shops and business partners). The partners then will extend the fully integrated and automated web platform to ensure on the one hand user-friendly access to the project for the customers (easy buying) and on the other hand to guarantee revenues are generated for the partners from the RUN project. Analogue to the collection marketing activities, this WP will create incentives for buyers and raise awareness for the new platform.

WP-06:'Copy the concept - transfer to other European countries through project partners' will raise the ecological and economic impact of the project by transferring the RUN concept to other European countries, including necessary adaptations.

WP-07: ‘Business plan and exploitation’ will implement RUN's vision as written and long-term business goals and shows how the project partners will exploit the results of the project.

WP-08: ‘Dissemination activities’ gives an overview of the predefined and project specific dissemination activities of the project partners. This will require information and cooperation with all other WPs. Also potential customers and partners shall be reached and informed about the possibilities and services developed in this project.

3.3. Impact and Eco-Innovativeness

The partners of the RUN project plan to collect and to sell several ten thousand devices at least during the three years of project runtime. Thereby the ecological benefits described in Chapter 2 are realized for this number of devices. Also, it contributes to the goals of the European Waste Framework Directive which promotes re-use and aims to raise the re-use quota [30]. Not every device will fulfil requirements for refurbishing or customers’ demands on a refurbished notebook because of technical reasons. Notebooks which are not re-usable will be manually dismantled before materials recycling. This will increase the yield and quality of the recycling process compared to shredding whole appliances [35].

After the project’s runtime, there shall be a profit generating system which accesses a market for collection of several hundred thousand notebooks per year in Germany and Austria and replicates this concept in a number of other European countries.

Referring to the concept of eco-innovation as discussed in Chapter 1, the RUN project matches several of its criteria: It has a positive ecological impact by prolonging the lifecycle of notebooks. Thereby the incorporated natural resources are kept in the industrial cycle and the environmental impact from notebook production is delayed. If this is not possible, a best-practice recycling process will recover materials. This contributes to loop-closing, value conservation and is in line with zero-waste approaches. [14,36,37]

Moreover, it is innovative to unlock a new source for the used appliances. This entails a new cost-efficient logistics concept which is able to handle very small batch sizes down to one piece. A new business model is developed around this issue; it is not only technical innovation but also organisational innovation and thus business model innovation. The full-service approach and the office-and home-service with safe data erasure complement the offer to the customer

4. CONCLUSIONS

This paper started with an introduction on eco-innovation for increasing resource efficiency and approaching circular economy. Then this is put into context of the RUN project. The ecological impact from manufacturing of new notebooks is depicted, also the insufficient end-of-life materials recycling and the notebook market. In the following, the RUN project for the re-use of notebooks is presented. Its rationale and structure are described. Finally, the eco-innovativeness of this project is discussed. It is a business model innovation unlocking new sources of used appliances for professional refurbishment.

Next steps in the project will be the roll-out of the collection concept in the two pilot cities Berlin and Vienna as well as the ongoing search for collection partner organizations. Also the market entries in Poland and Croatia will be prepared.

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