Article

Acceptance of Mobile Phone Return Programmes for Increased Resource Efficiency by Young People—Experiences from a German Research Project

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Abstract: The need for recycling obsolete mobile phones has significantly increased with their rapidly growing worldwide production and distribution. Return and recycling rates are quite low; people tend to keep old, unused phones at home instead of returning them for recycling or further use because of a lack of knowledge and acceptance of return programmes. Thus far, individual use and recycling behavior has not shown any trend towards more sustainable patterns. Consequently, an increased awareness is needed for the high environmental and social impact throughout the whole value chain of a mobile phone—there is simply a lack of information and knowledge regarding sustainability issues around the mobile phone. A teaching material was therefore developed in a German research project, based on the concept of the ecological rucksack, presenting comprehensive information about the value chain of a mobile phone. Its application in different schools led to an increased awareness and interest among pupils for the connection between sustainability, resources and mobile phones. Based on these research results, this paper analyses young people's knowledge of sustainability issues linked to their mobile phones and their acceptance of more sustainable behavioral patterns regarding their mobile, including return and recycling programmes.

1. Introduction

The mobile phone industry is developing at a fast pace. In 2010, more than one billion mobile phones were produced globally and these numbers are increasing every year. That same year, around 1.6 billion phones were sold, from which 19% were smart phones [1]. In terms of mobile phone contracts, there were approximately 6.4 billion contracts all around the world last year, and in Europe, there were 123.3 contracts per 100 inhabitants [2]. In recent years, this trend has been highly supported by the booming smart phone industry; conventional mobile phones are replaced by smart phones even though they might have been used only for a relatively short period of time.

In Germany, the industry sold around 29 million mobile phones in 2011 [3]. Again, smart phones are gaining importance in mobile phone sales; from 13 million smart phone users in 2010 to 20 million in 2011. Especially young adolescents are using mobile phones in their daily routines; in 2010 more than 97% of all Germans between 12 and 19 years old owned a mobile phone—a massive increase from only 8% in 1998 [4]. Within this group, 14% owned a smart phone.

Such highly developed and disseminated mobile communication systems entail a lot of (personal) advantages for people's daily life, such as new ways of participation and information everywhere possibly leading to a higher quality of life and flexibility. However, they come with substantial environmental and social problems all along the value chain, from resource extraction to production, use and disposal. This dynamic development of the mobile phone industry is linked to a rapidly increasing use of natural resources and energy. Mobile phones are made of a large number of different substances, almost 28% of a mobile phone is made of metals—some of them are "technology metals", which are essential for future technologies such as electronic cars or the solar industry. They include platinum group metals, palladium, tantalum, indium, lithium, silver, and gold [5].

Some of these metals can be recycled with today's highly sophisticated technologies; however, only a small number of mobile phones (and other ICT-products) are being recycled so far. In 2008, Nokia conducted a worldwide consumer survey, which showed that only 3% of all mobile phone users return their old, unused phones to a recycling point. Half of them said this is because they do not know any places they can return them [6].

Overall, there seems to be no public discussion about sustainability issues underlying the mobile phone industry. Without being openly discussed, these problems cannot become part of a general understanding of the connection between sustainability and mobile phones leading to more sustainable practices and behavioral patterns in this area, including recycling practices. Therefore, the following research question is set here for this article:

> How can the acceptance of mobile phone return programmes be increased and a more sustainable use of mobile phones be facilitated by using the concept of the "ecological rucksack"?

This paper addresses the concept of the "ecological rucksack" applied on mobile phones (Section 2) in order to show the environmental and social problems along the value chain of a mobile phone. Following this, the paper briefly discusses some of the core results from quantitative (survey) and qualitative (World Cafés) studies showing the lack of understanding and awareness of sustainability issues of mobile phones among young adolescents (Section 3). Here, the behavioral model of

Matthies [7] is used for analyzing the problem of lack of awareness as barrier for a sustainable use of mobile phones. Based on that, the ecological rucksack is discussed as a communication tool for increasing problem awareness and, thus, facilitating sustainable use and recycling habits of mobile phones (Section 4).

This article is based on a research project that is currently conducted at the Wuppertal Institute for Climate, Environment and Energy in collaboration with the Institute for Advanced Sustainability Studies (IASS), Potsdam (see Box 1).

Box 1. Overview of research project.

Research and Communication Project for the Return and Use of Old Mobile Phones as a Starting Point for Sustainable Consumer Behaviour in the Context of the Science Year 2012—Project EARTH: Our Future (initiated by the German Federal Ministry of Education and Research)

In Germany, approximately 83–85 million mobile phones are stored in private households although they are no longer used. Taking into account the relatively low participation of mobile phone users in recycling programmes, research in this area can have a high political, economic and social importance.

Therefore, this research projects aims to increase the understanding of consumer behaviour in the context of sustainability focussing on individual recycling behaviour. Furthermore, economic potentials are investigated that could result from a regulated return of mobile phones.

Based on this, recommendations are developed for different stakeholders in the value chain. Additionally, a comprehensive communication campaign "Die Rohstoff-Expedition." Entdecke, was in (d)einem Handy steckt!"/The Resource Expedition—explore the content of your mobile phone!" [8] for mobile phone recycling was prepared and supervised, extending the scope of previous approaches. In this context, a number of educational and communication materials were developed based on the concept of the ecological rucksack. The campaign, including its teaching material, aims at informing individuals about the resource intensity of mobile phones and preventing them from disposing of their old phones in household waste. In the long run, the campaign tries to encourage consumers to act more sustainably when using not only their mobile phones but also other electronic devices in their daily life. The target group of the project and the campaign are children and (young) adolescents at the age of 9–18 years.

Core research questions are:

- What are the possibilities and potentials for a regular mobile phone return and recycling programme?
- What can a more sustainable value chain of mobile phones look like and to what extend will scarce resources promote a (sustainable) transition in the future?
- How can current consumer behaviour be characterized?
- What are the main barriers for a regulated return of mobile phones, preventing previous recycling campaigns from being successful?
- Are programmes for return and recycling of mobile phones a sustainable option in general?
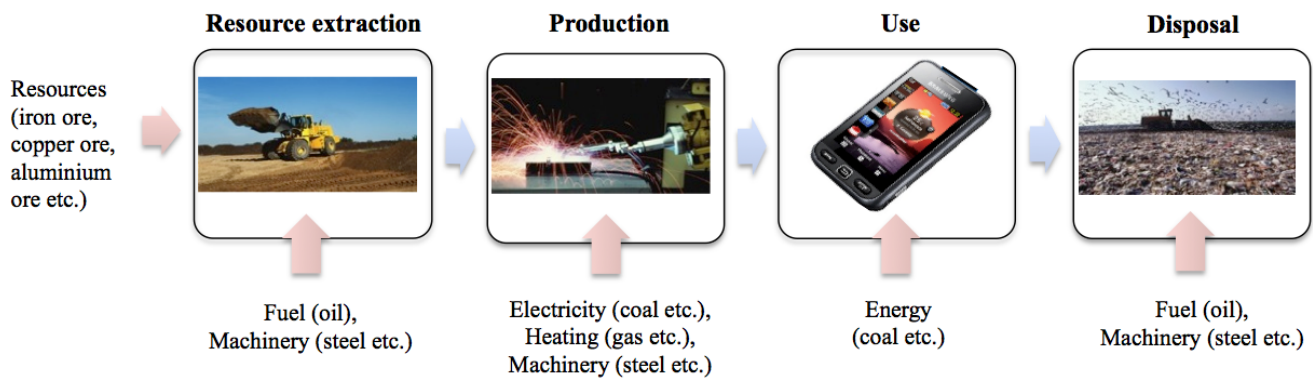
See Figure 4 in Section 3.1 for the research design.

Client/sponsor: German Federal Ministry for Education and Research (BMBF).

2. Visualizing Environmental Impacts in the Value Chain by Using the Ecological Rucksack

In order to analyze consumer behavior for sustainable use and disposal of mobile phones, a lifecycle-wide assessment is needed (see Figure 1).

Figure 1. Lifecycle of a mobile phone.

Such a lifecycle-wide perspective can be used to assess all environmental impacts of a product as well as the amount of (natural) resources used to produce the respective product. This perspective is important because a consumer cannot see these aspects in a product when buying and using it; therefore, education and information regarding these invisible resources behind a product can lead to an increased awareness and can ultimately influence consumption patterns.
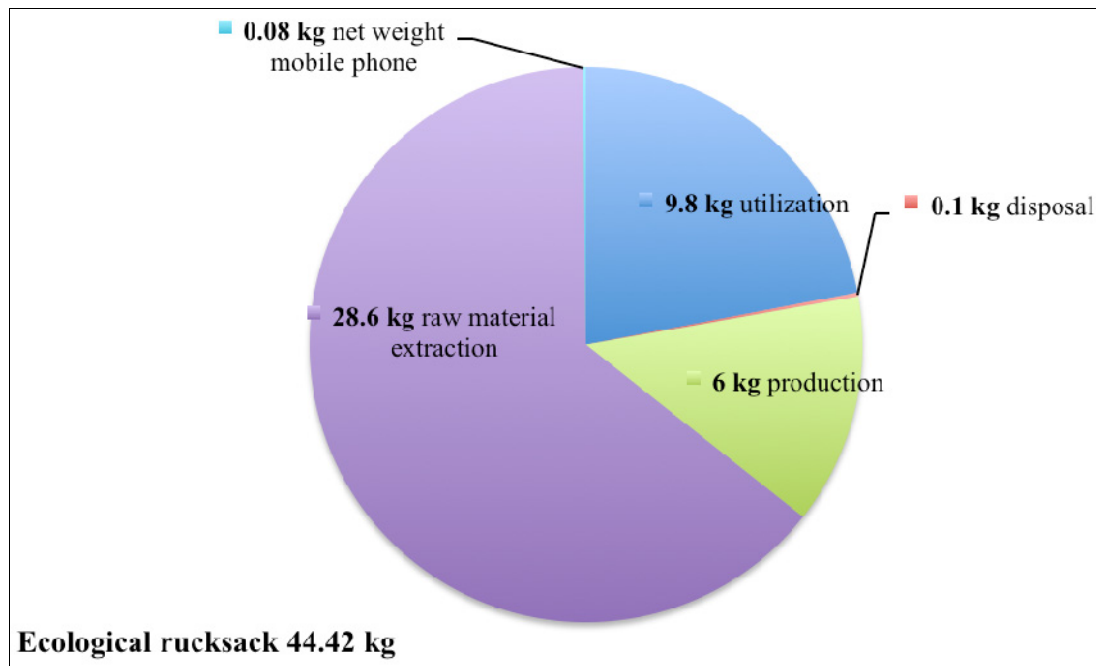
The total resource use of a product along all lifecycle phases can be presented as an "ecological rucksack" of a product. This scientific concept summarizes all resources that were used for each lifecycle phase of a product—from resource extraction up to disposal—and quantifies the complete resource use of the respective product [9–12]. These resources are measured using the MIPS concept (Material Input per Service Unit) in five natural resource categories: abiotic materials (metallic and non-metallic minerals such as ores, rocks, sand *etc.* in addition to fossil energy carriers such as coal, mineral oil, natural gas), biotic materials, soil (including erosion and earth movement), water, and air. Whenever a product, e.g., a mobile phone, is bought, the consumer also buys its ecological rucksack, often without knowing it. The mobile phone itself does not show its ecological rucksack; therefore, a consumer cannot see or assess all natural resources that were used along the product's value chain [13,14]. This ecological rucksack is, however, very heavy for most products and outweighs the actual product by far. Figure 2 shows the ecological rucksack of a mobile phone, including only abiotic and biotic materials, based on existing data for a standard mobile phone (no smart phones). In this figure, the weight of the product itself (80 g) is contrasted with the weight of its ecological rucksack (44.42 kg)—the latter weights more than 550 times more than the actual product (the Material Input calculation of the rucksack excludes the weight of the product itself). The weight of the ecological rucksack accounts for the turnover of primary resources extracted from nature and does not refer to a static amount of materials (see Figure 2).

Figure 2 clearly shows that the first phase (resource extraction) of the lifecycle has the highest resource use, even though some of the metals are calculated as secondary resources (recycled metals). Second comes the use phase; here, the electricity use of a mobile phone is important and accounts for

almost one quarter of the total ecological rucksack. Third comes the production phase with a total of 6 kg, followed by the end-of-life phase with only 0.1 kg of resources used.

All four phases are described in more detail in the following paragraphs, explaining some of the environmental and social problems in each phase.

Figure 2. Ecological rucksack of a mobile phone, divided into all four lifecycle phases [15] (p. 37).

2.1. Resource Extraction

Mobile phones contain a number of different metals, such as ruthenium, silver, cobalt, bismuth, tantalum, and indium. Many of these metals are also used for other technologies, e.g., indium is needed for photovoltaic appliances; palladium and lithium are used in the automotive industry for hybrid and electronic cars. This leads to some sort of competition for using these metals between different industries.

These metals and other resources used for the production of a mobile phone are extracted and produced all around the world. The working conditions vary from country to country; especially in developing countries, the extraction of ores comes with severe social and environmental problems. While industrial mining is dominant for many metals, some metals such as gold, tantalum and tin are still extracted by hand, mainly in Central Africa and Asia. This is done under difficult conditions, the workers earn very low wages and have no social security [16], the work is dangerous without any security standards in place, and there are toxic chemicals used for extracting the metals from the ore [17]. Another problem is child labor, which is quite common in the mining industry [16,18–21]. Apart from these social problems, there are environmental issues due to a lack of environmental specifications and standards. They cause a pollution of air, water and ground, which leads to scarce fresh water supplies, limited agricultural land and chronic diseases among the local communities [22,23].

2.2. Production

Five large companies—Samsung, Apple, Nokia, ZTE and LG Electronics—who possess around 57% (in 2012) of the market share, dominate the mobile phone market [24]. All five of them have distributed their production sites all around the globe; their mobile phones and components such as chips, batteries, display and cases are produced mainly in developing countries in Asia. Every second mobile phone produced today comes from China [25], especially from the Pearl River Delta Guangdong, which has turned into a large centre for the production of electronics. Apart from that, production for the mobile phone industry takes place in Taiwan, South Korea, Hong Kong, Indonesia, and the Philippines [26].

These countries have been chosen for the companies' production sites due to their low wages and standards; this, however, leads to many social and legal but also environmental problems in the production processes of mobile phones.

2.3. Use
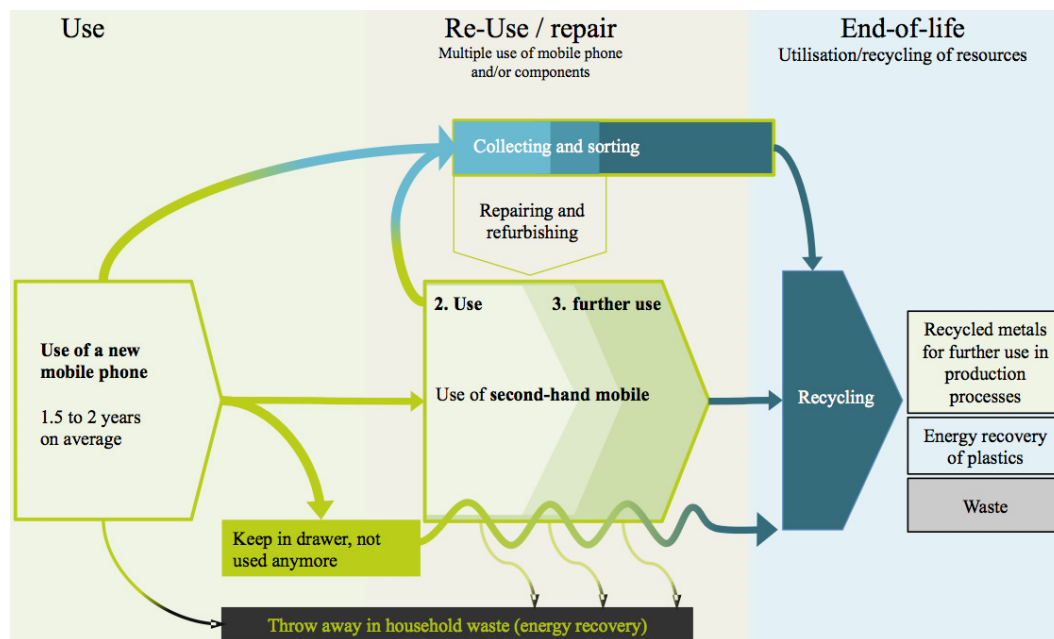
Mobile phones are not only a commodity item but they have turned into an everyday companion for many people. Communication is the most important function of these items; however, it is no longer focused on phoning and short message services but these basic functions have been complemented by internet use and email, music, camera, navigation and many more. The user gets the feeling of a world without barriers, being connected to friends and family wherever they are. Therefore, the mobile phone has become an integral part of people's social life [27].

This leads to a strongly intensifying use phase of mobiles and increasing data flow; a trend, which is accelerated by the smart phone market. During this phase, energy consumption is one of the most important environmental pressures. This includes not only the direct energy consumption of the mobile itself but also the indirect energy consumption of the mobile communications network (fixed part, antennas, switching centers, line systems, *etc.*). All in all, the use phase of a mobile phone has an ecological rucksack of approximately 9.8 kg of resources mainly due to its energy consumption [15]. Calculations are based on the amount of kWh consumed, which are converted into natural resources used for providing this amount of energy (using material input indicators and based on an average energy mix).

From a sustainability perspective, an important aspect is the useful life of a mobile phone—in other words, how often a new one is bought. In many cases, a mobile phone is thrown or stowed away even though it is still useful and not necessarily broken. Therefore, a second (or third) life as used mobile phone is quite important in order to extend its useful life and safe natural resources. This can be supported by repair services or embellishments, either of the complete mobile or single components of it.

The following figure shows different ways of using and disposing of a mobile phone (see Figure 3).

Only few mobile phones are professionally recycled at the end of the lifecycle. According to estimations, this only applies to around 2%–3% globally [28]. There are no reliable numbers on how many mobile phones actually end up in normal household waste, and estimations vary between 4%–21% (e.g., [28]). However, even small amounts imply a loss of resources.

Figure 3. Use and disposal of mobile phones (own presentation based on [29–31]).

2.4. Disposal

The last phase of the lifecycle refers to the disposal of a mobile phone. This includes recycling, a process to re-extract the resources contained in the phone, mainly metals, and to prevent harmful substances from ending up in normal household waste. The recycled materials are called secondary resources, in contrast to primary resources, which are extracted, for example, from mines directly. If disposed of in normal household waste, these secondary resources are lost and can no longer be used for other purposes.

The disposal and recycling of mobile phones causes some severe problems of both environmental and social nature. In Germany or Europe, unused phones can be recycled, remanufactured or directly sold for second-hand use. Quite often, however, they are shipped to Asia or Africa for further use, because the market for second-hand use of mobile phones is relatively small in Europe. The major part of global electronic waste goes to Hong Kong and China, followed by Western Africa, particularly Ghana and Nigeria, though many of these exports are illegal [25,32,33]. The problem is that the recycling logistics in these countries are by far not as sophisticated as in Europe and many phones are recycled in illegal backyard workshops leading to severe environmental and social problems. People in these backyard workshops do not possess advanced recycling machinery and knowhow; they mainly burn the electronic waste without any protective clothing or filtering system in order to extract copper; another method consists of acid bathing for extracting (precious) metals [33–37]. This releases numerous toxic materials such as heavy metals, dioxins and furans, which pose severe danger to the health of the recyclers, their families and other people living in the area. Additionally, these recycling techniques are by far not as efficient as professional recycling, leading to a substantial loss of metals and other materials.

Therefore, professional recycling of mobile phones can lessen the environmental, social and political issues linked to primary resource extraction but also prevent environmental and health problems in developing countries that occur due to backyard recycling.

In Germany, there are approximately 83–85 million unused mobile phones [38]. Together, they contain a large amount of valuable resources, e.g., 745 t of copper, 325 t of cobalt, 22 t of silver, 2 t of gold, and 0.7 t of palladium. Compared to primary resource extraction, the density of, for instance, gold is much higher in mobile phones—one ton of gold ore contains as much gold as 40 mobile phones [39].

Many of these materials are bound to supply and price fluctuations due to a competition for using these metals between different industries. Furthermore, their extraction and processing has a high environmental and social impact and some of them cause dangerous social or political tensions, e.g., the so-called conflict mineral tantalum. A professional recycling of these resources is, thus, a prerequisite for sustainable development.

Against this background, a sustainable organization of the whole value chain is needed, including (but not limited to) a professional end-of-life management (recycling). It should be focused on sustainable production and more sustainable behavioral patterns regarding mobile phones because recycling can help closing and reducing cycles of materials but is not enough for a sustainable organization of the whole lifecycle of a mobile phone. There will be no substantial reduction of environmental impacts due to an efficient use or resources and professional recycling, as long as the production of mobile phones increases at such a rapid speed as can be seen today. This leads to an increasing energy and resource use, which levels the positive effect of recycling. Thus, recycling is only part of the solution and there is a need for fostering more sustainable consumption patterns regarding mobile phones (and other ICT-products) because the average life of a mobile phone is much shorter than its possible (technical) lifetime. This leads to approximately 5000 t of electronic waste each year—most of it does not get back into global material cycles [40,41]. Therefore, a sustainable use of mobile phones needs to be strengthened by creating problem awareness for sustainability issues linked to mobile phones.

3. Methodology and Results

3.1. Methods

Thus far, there are no studies on mobile phone usage behavior of young people with a particular focus on not regularly used or broken mobile phones. Therefore, this study had an explorative character. By using interdisciplinary approaches and mixed methods [42–44], the issue of young people's behavioral patterns concerning mobile phones was approached carefully. Such a mixed methods approach ensures a more comprehensive and complete picture of the subject of study [42]. While being a mainly qualitative study, it included quantitative data as well using semi-standardized questionnaires. The goal was to receive detailed information about mobile phone use and recycling behavior of the target group (young people between 9 and 18 years). A further specification of the target group concerning demographic characteristics apart from age (such as gender, school type, *etc.*) was not provided within the project context (see Box 1 in Section 1).

The aim of this project was to conduct an interpretive, explorative study to explore and understand mobile phone usage behavior in general. In addition, there are statements about the willingness of young people to recycle mobiles and the connection between sustainability knowledge and mobile

phones. More detailed results and causal conclusions were not the aim of this project and therefore remain subject for further studies.

Following the main goal of the project, three methodological approaches were combined. This "triangulation of methods" enables the researcher to connect data from quantitative (surveys) and qualitative (World Café and interviews in households from different social milieus) research in order to balance different methods and their weaknesses as well as compare and evaluate the results at the same time [45]. In addition to that, it shows identical and different perspectives on specific issues, which can be incorporated in further studies. The surveys followed the two leading research questions: *What are the main motivating factors and barriers for recycling of mobile phones by kids and young people? How can the acceptance of mobile phone return programmes be increased and a more sustainable use of mobile phones facilitated by using the concept of the "ecological rucksack"?* Following these two research questions, the three main topics analyzed by the mixed method design referred to consumer behavior, knowledge about the resource problem, and recycling behavior. For this article, however, only the second research question is highlighted (the first one was part of the research project, but will not be focused on in this article).

In a first step, a research paper on the "analysis of consumer behavior" was written in order to analyze consumer behavior on the basis of existing literature and the evaluation of selected mobile phone recycling campaigns. The analysis answered the following research questions: (1) what are the main barriers and motivating factors influencing recycling behavior of mobile phones? And (2) what are the key success factors for mobile phone recycling campaigns?

In addition to the research paper, a semi-structured interview was conducted. The sample frame comprised 717 pupils from ten high schools in North Rhine–Westphalia (Germany). Most questions were set as closed questions, some with open answers, and three open-ended questions. The design of the questionnaire was part of a discursive process, which incorporated all project partners. The questionnaire was clustered according to four thematic areas within the following specific sub-topics:
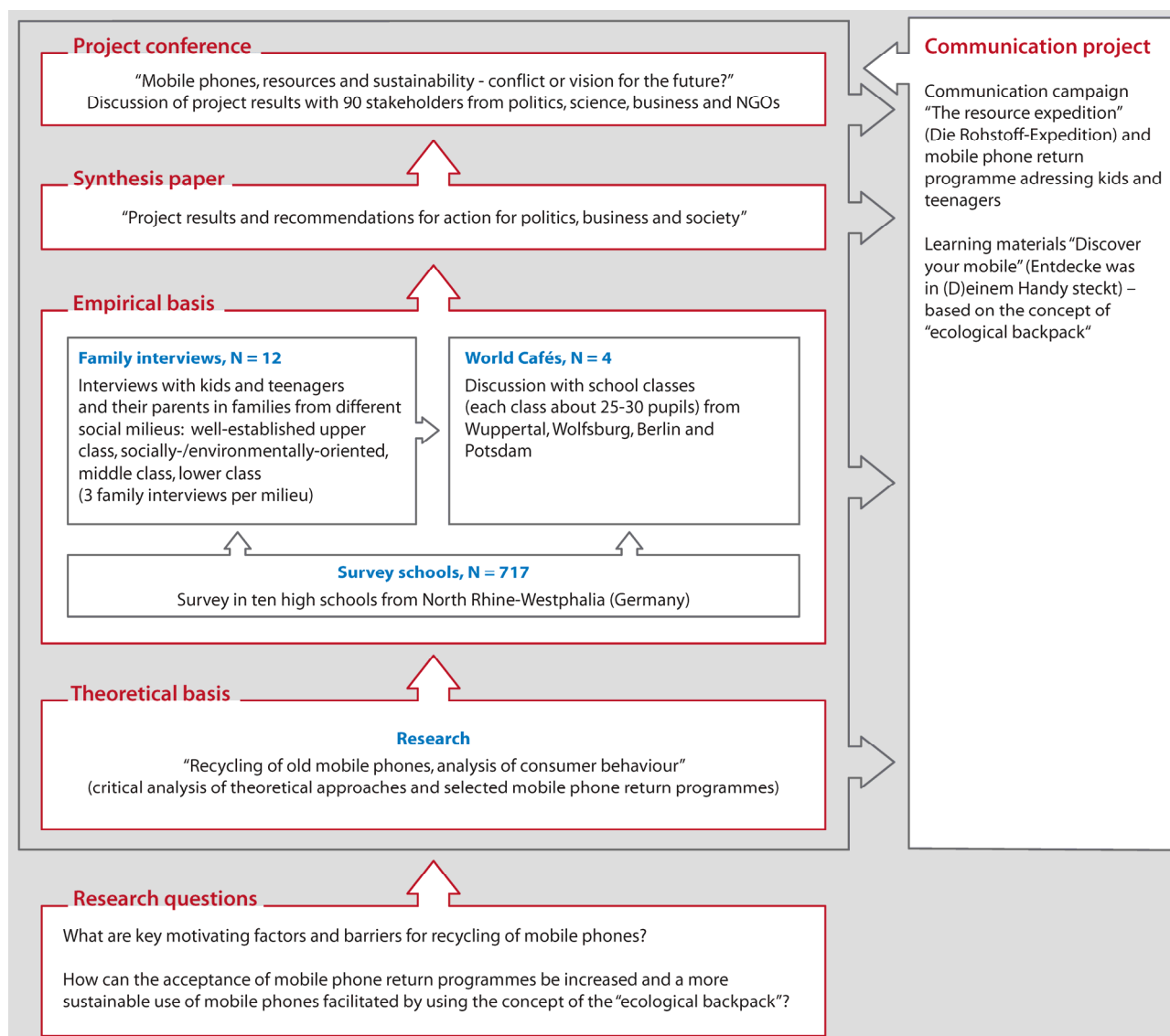
- Mobile phone ownership and use; e.g., meaning, time of usage, number of old mobiles, recycling, and storage (barriers and motivating factors);
- Mobile phones and sustainability; e.g., material/resources in a mobile phone, and individual perception of the connection between resource use of mobile phones (ecological rucksack) and sustainability;
- Your idea (collection of ideas, which can motivate young people to return old, unused mobiles).

After a pre-test, the questionnaire was revised according to the feedback from the pre-test. The final version was used for the survey, which was conducted by teachers in the selected schools in North Rhine–Westphalia. It needs to be mentioned that this survey was not a representative study as it was not tested whether the data structure of the participating pupils fits with the structural data of schools and pupils in North Rhine–Westphalia.

A total of 717 pupils at the age of 9–18 years participated in the survey; all respondents were included in the evaluation. The data recording was conducted by external (project) partners counting all returned questionnaires.

Figure 4 shows a graphical overview of the research design including all applied methods as described in the previous and following paragraphs.

Figure 4. Research design of the project "Return and use of old mobile phones"; target group 9–18 year old youths.

Project conference
"Mobile phones, resources and sustainability - conflict or vision for the future?"
Discussion of project results with 90 stakeholders from politics, science, business and NGOs

Synthesis paper
"Project results and recommendations for action for politics, business and society"

Empirical basis

Family interviews, N = 12
Interviews with kids and teenagers and their parents in families from different social milieus: well-established upper class, socially-/environmentally-oriented, middle class, lower class (3 family interviews per milieu)

World Cafés, N = 4
Discussion with school classes (each class about 25-30 pupils) from Wuppertal, Wolfsburg, Berlin and Potsdam

Survey schools, N = 717
Survey in ten high schools from North Rhine-Westphalia (Germany)

Theoretical basis

Research
"Recycling of old mobile phones, analysis of consumer behaviour"
(critical analysis of theoretical approaches and selected mobile phone return programmes)

Research questions
What are key motivating factors and barriers for recycling of mobile phones?

How can the acceptance of mobile phone return programmes be increased and a more sustainable use of mobile phones facilitated by using the concept of the "ecological backpack"?

Communication project
Communication campaign "The resource expedition" (Die Rohstoff-Expedition) and mobile phone return programme adressing kids and teenagers

Learning materials "Discover your mobile" (Entdecke was in (D)einem Handy steckt) – based on the concept of "ecological backpack"

In addition to the survey in schools, a number of qualitative interviews were conducted in selected families in order to gather greater in-depth information about the use and return of old mobile phones by young people in the context of their individual budget and family setting. The methodological approach for these family interviews included problem-focused interviews [46,47]. The selected families represented four different social milieus outlined on the basis of the social milieus approach developed by the German Sociovisions Institute [48]. The social milieus approach analyses people's social status and values orientation and outlines social groups whose lifestyles are similar. For the purpose of this project the representative families from four social milieus were chosen: well-established upper class; socially/environmentally oriented; middle class; lower class (three family interviews per milieu) [48].

A total of three interviews were conducted per family. Each set of interviews consisted of:

- A 40–45 min problem-centered interview with the teenager, without a parent (here, the teenager was from 14 to 19 years old); focused on ICT, communications, mobile phones and mobile phone return and associated emotions;

- A 20–25 min problem-centered individual interview with a parent; focused on everyday recycling practices in the family, sustainability awareness and education about sustainability;
- A 20–25 min conversation with a youth and the parent together focusing on parent–child interaction (possibly with some elements of participant observation); focused on communication within the family, ideas for the use of old mobile phones.

The interview data were collected based on detailed minutes (*i.e.*, detailed protocols not complete transcripts) of each interview. These minutes were later synthesized in an interview report.

Based on the results of the previous questionnaire survey and the qualitative family interviews, four "World Cafés" [49,50] were conducted with school classes from different German cities (Wolfsburg, Berlin, Potsdam and Wuppertal). The goal was to challenge and/or support previous results, by taking advantage of the methodological benefits of the World Café. The openness of the World Café allowed to take up more aspects in the discussion, which might have been ignored in the surveys before, and qualify previous results. Furthermore, the World Café can be modified to meet a wide variety of needs. Specifics of context, numbers, purpose, location, and other circumstances are factored into each event's unique invitation, design, and question choice, based on the following five components of the basic model: (1) Setting: Create a "special" environment, most often modeled after a café, *i.e.*, small round tables; (2) Welcome and Introduction; (3) Small Group Rounds: The process begins with the first of three or more twenty-minute rounds of conversation for the small group seated around a table. At the end of the twenty minutes, each member of the group moves to a different new table. They may or may not choose to leave one person as the "table host" for the next round, who welcomes the next group and briefly fills them in on what happened in the previous round; (4) Questions: each round is prefaced with a question designed for the specific context and desired purpose of the session. The same questions can be used for more than one round, or they can be built upon each other to focus the conversation or guide its direction; (5) Harvest: After the small groups (and/or in between rounds, as desired) individuals are invited to share insights or other results from their conversations with the rest of the large group. [49] Similar to the survey and the family interviews, the World Café included three main topics: use of mobile phones, production, recycling. The classes were divided into three groups, rotating between the three tables and discussing one of the three topics in each group. This method allows for a multi-layered discussion and can reveal the emotional background of statements and assumptions due to its open format and intensive communication. The results of the four World Cafés were collected based on flip charts, posters and detailed minutes from each of the three tables.

3.2. Results

In line with the research design (see Figure 4 Section 3.1), the project results are presented in a three-stage process: first, the school surveys were analyzed, evaluated and synthesized in a paper. This synthesis gave some initial information on current trends and main statements. Following this, interviews with families and World Cafes provided a deeper understanding of these first impressions, revealing more details and confirming the previous key statements. In the final phase of the project, all results were critically discussed with experts from research, politics and business during a conference. This conference had two core workshops dealing with recycling and raw materials in mobile phones (workshop 1) and with education and communication measures for a sustainable use of mobile phones

(workshop 2). All involved partners from politics (Federal Ministry for Education and Research, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety), business and industry (Deutsche Telekom, Vodafone, E-Plus, Telefonica, Teqport, Vere, Take-e-way, Electrocycling) and science (Wuppertal Institute, IASS Potsdam, Leuphana University) agreed on the need of installing such a project in a long-term and holistic perspective in order to facilitate a change in awareness and behavior among the target group. One of the key success factors identified here was the close cooperation between research and practical application; therefore, a network between all partners was discussed at the conference.

All key project results are presented in the following paragraphs; divided into the life cycle stages of production, use and recycling in line with the introduction section.

3.2.1. Production

Overall, the knowledge of the production of mobile phones, the use of resources and associated environmental and social problems among young people is very fragmentary. The school surveys identified large differences between the pupils in terms of their knowledge of resources included in a mobile; gold was named most often (45%) as being part of a mobile phone, followed by copper (29%) and silver (17%). Only in some cases did pupils possess a detailed knowledge of the metals' countries of origin and working conditions under which these metals are extracted. They named child labour, discrimination and dangerous working conditions with insufficient security standards. In addition to that, they brought up the issue of an unequal distribution of natural resources and profit from these resources on a global scale. In contrast to this existing knowledge of social problems along the value chain, the pupils had difficulties to connect their mobile phone with environmental problems. They were aware of environmental problems only in the first phase, resource extraction, due to toxic substances used for extracting the metal from the ore. Apart from that, the teenagers had very limited knowledge about environmental problems along the value chain of a mobile phone. They did not see any or at least only a very limited connection between the usage of a mobile phone and sustainability issues. The question concerning this link was answered only by a small number of the respondents and most of them that answered this question said, "I don't know." The idea that mobile phones pollute the environment came up in very little questionnaires; if so, it was connected to the increasing amount of new mobile phones produced every year, problems of disposal, or the finite nature of (some) natural resources. Furthermore, the product life of mobile phones was mentioned as a problem; a longer use of a mobile phone is more sustainable than replacing it after a few months. One of the comments here was "I think my way of using a mobile phone is comparatively sustainable because I use it as long as it cannot be repaired any more."
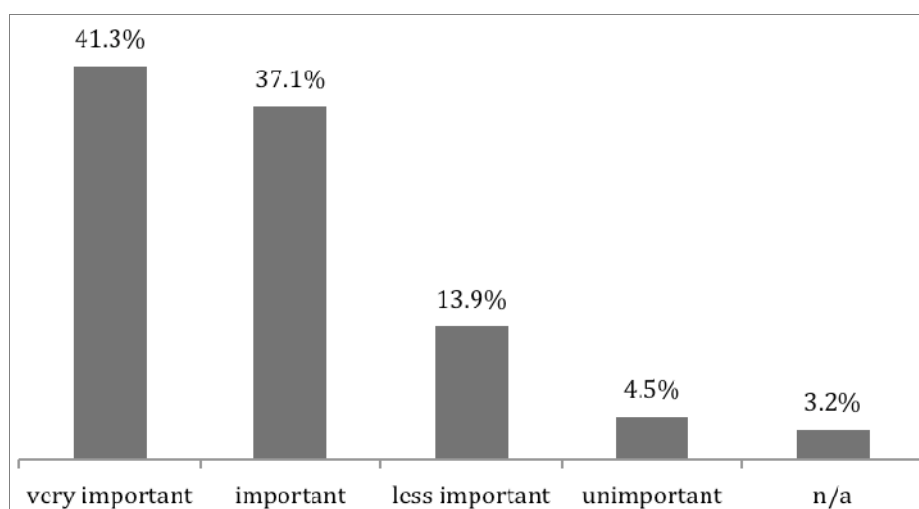
The family interviews showed that the topics concerning resource use of a mobile phone and its "ecological rucksack" are of great interest. The relationship between sustainability and mobile phone production was more easily comprehensible for the interviewees than issues on resource conservation and recycling—which raw materials—related to environmental protection and conservation, information about delivery and recycling/collection points for old mobiles. The latter issues needed more explanation from the interviewer.

3.2.2. Use

The project confirmed that mobile phones have become an everyday item for children and teenagers and are not only used for basic communication but also for personal information, entertainment and personal data storage. Mobile phones are becoming more and more a prestige object for this target group [51]. Next to its communication and information function, an emotional level is added to a mobile phone, which is increasingly perceived as a personal accessory—it is almost indispensable for many pupils and this is very unlikely to change in the future.

The analysis of the questionnaires shows that it is very important (41.3%) or important (37.1%) to own a mobile phone for the majority of the interviewed pupils (see Figure 5). Only 13.9% said it is less important and 4.5% said it is unimportant. These numbers emphasize the importance of owning a mobile phone among the target group. Quotes from the household interviews like "the mobile phone is like a (body) part of me" shows that the phone is much more an expression of personal style than being "only" an everyday commodity. Like many other accessories mobile phones also document the personal development and history. The emotional component is one of the important factors that influence user behavior. This represents an additional barrier to returning phones—even if they are old and no longer in use.

Figure 5. Importance of mobile phone ownership (in %, *n* = 717).
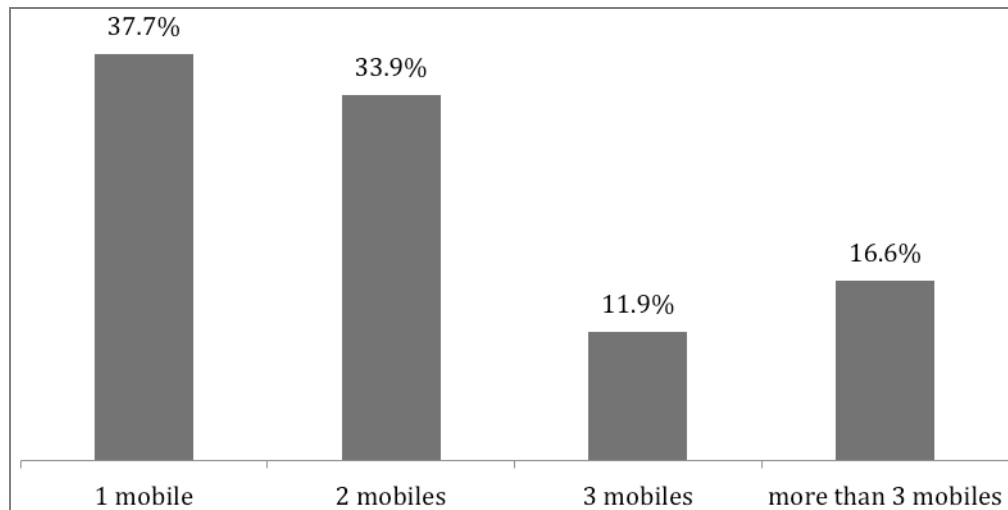
More than half of the respondents (58%) indicated that they own more mobile phones than they actually use. Approximately one third of them own two mobiles in addition to the one they are actually using; 11.9% own three, and 16.6% own more than three unused mobiles. 414 respondents declared to own at least one mobile phone that is not used on a regular basis (any more). However, 446 respondents answered the question about the number of unused mobile phones. Thus, there is a slight variation in the answers given to these two questions; still, some interpretations can be made by trend. (see Figure 6).

The family interviews and World Cafés underlined the point that the topic of sustainable use of mobile phones (e.g., long-term use instead of buying new models or energy saving) has hardly any relevance for the target group of the project (or their parents). They neither get enough information about the importance of this topic in the context of a global resource problem when buying a new

mobile phone nor in school and in the media. There is no discernible public discourse on this issue. This, obviously, also has consequences for their recycling behavior.

Figure 6. Number of phones that are not used on a regular basis (in %, *n* = 446).

3.2.3. Recycling

The project results confirm that recycling is not a relevant issue for most of the children and teenagers. Although many of them own one or several mobile phones (see figure above), they do not care about recycling. They do, however, act in a sustainable way even without knowing it because in most cases, the teenagers pass their old mobile phone on to other members of their family (approximately 59%), thus extending the mobile phones life cycle. A large number of the respondents keep it in case their currently used mobile phone gets lost, stolen, broken, *etc.* (approximately 48%); some of them said they will sell their old mobile phone (24%) or give it to friends (7%). Recycling is not an option for most of the interviewed pupils, especially if it is still working. This is partially due to a lack of knowledge of places where they can bring their old phones, and because they do not want to give their mobile to any large cooperation without any financial incentive. Only a small number of respondents had heard about the return programmes of the Deutsche Telekom AG or Vodafone, while other companies with similar programmes were not mentioned at all (see Table 1).

Interestingly, more than half of the respondents (55%) do not only keep their old mobile phones that are still working but also their broken ones that are no longer working. Approximately 12% of them dispose of their broken mobile phone in their normal household waste; 11% return their broken mobile to a shop when buying a new one and 10% give it to someone, who does some handicraft work with the old phone. Around 9% of the pupils bring their old mobile phone to a collection box. The questions about their use of old mobile phones (still working and broken) were answered hypothetically as well as based on real experiences/actions (see Table 2).

As indicated above (Section 2.3), the everyday relevance of the problems of using mobile phones in the context of sustainability is very low, which is also reflected by the behavior of young people.

The aspect of "knowledge" is an important driver for recycling behavior. The actor must know exactly how and where he/she can return the old phone. If this knowledge is available (e.g., instructions have clearly been communicated in an information campaign), it increases the probability

of recycling. Additionally, the associated personal costs need to be low in order to facilitate sustainable behavior. These costs are not only monetary costs but apply to time, freedom, comfort, pleasure, status, or loss of habit. High personal costs for recycling may arise when the infrastructure for returning old mobiles is complicated or not congruent with individual habits and routines.

Table 1. What do you do with your old mobile phone if it is still working? (multiple answers possible, total number of answers = 1306, in %, *n* = 717).

Number/answer	Options/usage/	Frequencies
1	Sell	23.6%
2	Used by another family member	58.6%
3	Give it away	6.6%
4	Keep it as second mobile	48.1%
5	Household waste	1.4%
6	Return it to mobile phone shop	2.8%
7	Mobile phone collection box	3.2%
8	Return to (charity) organisation	1.5%
9	Yellow bin for electronic waste	1.1%
10	Recycling bag of mobile phone provider	0.4%
11	I didn't know where to return is, therefore I kept it	11.2%
12	I have never given thought to returning it, therefore I kept it	18.1%
13	Other	1.7%
14	n.a.	3.9%

Table 2. What do you do with your old mobile phone if it is broken? (multiple answers possible, total number of answers = 790, in %, *n* = 717).

Number/answer	Options/usage	Frequencies
1	I sell it to someone doing handicraft work	8.2%
2	I keep it	54.8%
3	I throw it away	11.6%
4	I return it to the shop when buying a new one	11.3%
5	I bring it to a mobile phone collection box	8.5%
6	Other	8.8%
7	n.a.	7.0%

Another barrier of mobile phone recycling is the mistrust due to non-transparent recycling processes as discussed in the World Cafés and family interviews. The young people are afraid that others could enrich one's own mobile phone or misuse personal data. Therefore, they prefer to keep their old mobile phone. In addition, they named the problem of illegal dumps and "backyard recycling" in developing countries when talking about recycling. The way of recycling old mobile phones seems to be difficult and incomprehensible for the respondents.

An important motivating factor for the return of mobile phones is the idea of economic incentives. The analysis of the survey data revealed that an incentive system that relies on the direct material compensation of users motivates more people to recycle their old phone. Coincidentally, the respondents mostly quoted money or other benefits (free minutes, discounted new phone) to return the phone.

In addition, a number of the respondents expressed the need for informational campaigns and educational material. In this context, the approach of the "ecological rucksack" gains in importance as an instrument of environmental and social issues along the value chain of a mobile phone.

The results of the school survey, family interviews and World Cafés confirmed that the knowledge of mobile phone recycling infrastructures is very low. Even if some of the teenagers already heard of mobile collections or has participated in some of them, there are usually actions that have occurred only sporadically without changing daily routines in peoples' recycling behavior. This lack of knowledge about mobile phone recycling infrastructure was one of the key aspects in dealing with this topic.

4. Discussion: The Ecological Rucksack as Communication and Education Measure for Sustainable Mobile Telephony

In order to foster motivation and awareness for a sustainable use and recycling of mobile phones it is important to communicate knowledge about the resource consumption of these products along their value chain, including social and environmental problems associated with such extensive resource use. The results of the project "return and use of old mobile phones" show that there is hardly any knowledge about these issues among the target group.

However, the data from family interviews and World Cafés revealed an increasing interest in the issues of resource use of mobile phones and sustainability as soon as the interviewed pupils were confronted with more detailed information about the value chain and related problems in the context of sustainability. This underlines the assumption that at least some mobile phone users can be motivated towards a more sustainable use and professional disposal by providing them with detailed and specific information on sustainability issues underlying the use of mobile phones.

The respondents' ideas for increasing knowledge and awareness for these issues were mainly based on information and (formal and informal) education. Here, some of them asked for a more active role from scientific organizations and research institutions in providing the respective information.

In this context, the concept of the ecological rucksack is quite suitable for presenting and communicating knowledge about the resource consumption of mobile phones (and other ICT-products) in an easy, comprehensible and transparent manner in order to sensitize the target group for underlying sustainability issues.

This was done by the development of a set of teaching materials for the campaign "Die Rohstoff-Expedition"/"The Resource Expedition" (see additional "communication project" in Figure 4 in Section 3.1), which was accompanied by the aforementioned project on the return and use of mobile phones. These teaching materials were developed along the value chain of mobile phones, based on the concept of the ecological rucksack. The didactical framework was the method of "open didactical exploration" (Offene didaktische Erschließung, ODE), a method for providing pupils or students with the ability for creative thinking and exploring complex problems as well as developing competencies for interpretation and analysis based on social norms and values [52].

Apart from its application in teaching and learning materials, the concept of the ecological rucksack shows great potential for an environmental impact assessment of ICT-products as a basis for developing an eco-label for this product group. Today, there is very little information on sustainability issues of mobile phones available for the public; thus, consumers can hardly find any information on

the environmental impact of their mobile. There is a trend among mobile phone producers and traders for labeling their phones with self-created labels, which are quite limited in scope and depth and do not provide the consumer with reliable and comprehensible information about the environmental impact of the product. They are rather used to ease a bad conscience that might come up when buying new mobile phones in a short period of time—it is used to provide the consumer with a "feel-good, doing-good" experience. Thus, in most cases, it is a marketing and advertising instrument. Therefore, a transparent presentation of the ecological rucksack of the mobile phone would provide the consumer with clear and comprehensible information on the respective product.

An important barrier for using the ecological rucksack is, however, a limited database. In order to calculate the rucksack, detailed information on the product is needed, including production processes and resources used for the different components. The producers keep such information strictly confidential, and sometimes they might not even be able to pinpoint every single process, factory or material due to the highly complex value chain with a large number of third parties involved. Therefore, a transparent presentation of this information is needed in order to calculate the ecological rucksack and prepare them for the specific target group–a challenging task for the industry, science and politics.

5. Conclusions

The project results underline the fact that the issue of sustainable use of mobile phones, including recycling, is of no particular relevance to the target group. The young adolescents are much more interested in new models of mobile phones, with the apps and gadgets that come with every new model; it is much less important what happens to their old phone.

This might be due to the fact that there is no noticeable public discussion about sustainable use and recycling of mobile phones; therefore, they are rarely confronted with these problems. They therefore do not receive adequate information from the media, school, or at home that creates an awareness of this issue. Additionally, there is insufficient communication about return and recycling possibilities, and obvious and easily accessible recycling infrastructures as well as (financial) incentives for recycling are still missing.

Overall, this article demonstrates the high relevance of concepts, such as the ecological rucksack, which can be used for practical application and communication of (often difficult) scientific issues. They show the responsibility of science not only for research but also for applied knowledge transfer, taking the ecological rucksack as an excellent example. Furthermore, such concepts can help to start a public and political debate about difficult or inconvenient topics.

To gather more detailed knowledge about the target group's use and recycling behavior and to foster awareness of a sustainable use of mobile phones, comprehensive and targeted communication and education measures are necessary to ensure a thorough understanding of the problem. The target group needs to be able to link their own everyday actions and personal consumption choices with sustainability issues. Therefore, selected communication channels, which are frequently used by teenagers, should be used and internet media such as social networks (Facebook, Twitter) should be involved more often. In addition, the project results show that only knowledge campaigns through different media may not be enough—rather direct communication and confrontation within the peer group is required.

Conflicts of Interest

The authors declare no conflict of interest.

References

1. Gartner Web Page. Gartner Says Worldwide Mobile Device Sales to End Users Reached 1.6 Billion Unites in 2010; Smartphone Sales Grew 72% in 2010. Available online: http://www.gartner.com/it/page.jsp?id=1543014 (accessed on 2 May 2013).
2. ITU Web Page. The World in 2013: ICT Facts and Figures. Available online: http://www.itu.int (accessed on 12 April 2013).
3. BITKOM Web Page. BITKOM zum Handymarkt. Available online: http://www.bitkom.org/files/documents/BITKOM_Presseinfo_Handy-_und_Smartphone-Markt_15_08_2011.pdf (accessed on 2 May 2013).
4. Medienpädagogischer Forschungsverbund Südwest (MPFS). *JIM 2010 Jugend, Information, (Multi-)Media Basisstudie zum Medienumgang 12- bis 19-Jähriger in Deutschland* (in German); Landesanstalt für Kommunikation Baden-Württemberg (LFK): Stuttgart, Germany, 2010.
5. Hagelüken, H. *Recycling kritischer Metalle—Anforderungen, Verfahren und deren Grenzen* (in German); Evangelische Akademie: Bad Herrenalb, Germany, 13 January 2013.
6. Nokia Web Page. Environmental Report 2008. Available online: http://www.nokia.com/environment/our-responsibility/environmental-report-2008/2008-in-short (accessed on 2 May 2013).
7. Matthies, E. Wie können PsychologInnen ihr Wissen besser an die PraktikerIn bringen [in German]? *Umweltpsychologie* **2005**, *1*, 62–81.
8. Die Rohstoff-Expedition Web Page. Available online: http://www.die-rohstoff-expedition.de (accessed on 2 May 2013)
9. Schmidt-Bleek, F. *Wieviel Umwelt braucht der Mensch?: Faktor 10-das Maß für ökologisches Wirtschaften* [in German]; Birkhäuser Verlag: Basel, Switzerland, 1994.
10. Schmidt-Bleek, F. *Das MIPS-Konzept. Weniger Naturverbrauch–mehr Lebensqualität durch Faktor 10* (in German); Droemer Verlag: München, Germany, 1998.
11. Schmidt-Bleek, F. *Nutzen wir die Erde richtig? Von der Notwendigkeit einer neuen industriellen Revolution* [in German]; Fischer Taschenbuch: Frankfurt, Germany, 2007.
12. Schmidt-Bleek, F.; Bringezu, S.; Hinterberger, F.; Liedtke, C.; Spangenberg, J.; Stiller, H.; Welfens, M.J. *MAIA Einführung in die Material-Intensitäts-Analyse nach dem MIPS-Konzept* [in German]; Birkhäuser Verlag: Basel, Switzerland, 1998.
13. Liedtke, C.; Wiesen, K.; Teubler, J.; Bienge, K.; Greiff, K.; Lettenmeier, M.; Rohn, H. Resource intensity analysis at micro level: Measuring dematerialization at product, company and household level. *Resources* **2013**, submitted.
14. Lettenmeier, M.; Liedtke, C.; Rohn, H. Roadmap to lifestyles of low resource consumption—New perspectives on sustainable transformation processes on the level of households. *Resources* **2013**, submitted.

15. Bienge, K.; Kennedy, K.; Kristof, K.; von Geibler, J. *Spezifische Politkansätze zur Ressourceneffizienzsteigerung von IuK-Produkten* [in German]; Wuppertal Institut für Klima, Umwelt, Energie: Wuppertal, Germany, December 2010.

16. D'Souza. Briefing Note: Artisanal Mining in the DRC. In Proceedings of the DRC Donor Coordination Meeting Facilitated by CASM; Kinshasa, Zaire, 15–17 August 2007.

17. International Labour Organisation. The Production of Electronic Components for the IT Industries: Changing Labor Force Requirements in a Global Economy. In Proceedings of the Tripartite Meeting, Geneva, Switzerland, 16 April 2007.

18. Nordbrand, S.; Bolme, P. *Powering The Mobile World: Cobalt Production for Batteries in the DR Congo and Zambia*; SwedWatch: Stockholm, Sweden, November 2007. Available online: http://makeitfair.org/news_listing/the-facts/reports?set_language=en (accessed on 2 May 2013).

19. Global Witness Web Page. Faced with a gun, what can you do? Available online: http://www.globalwitness.org/library/global-witness-report-faced-gun-what-can-you-do (accessed on 1 February 2013).

20. U.S. Department of Labor Web Page. U.S. Department of Labor's List of Goods Produced by Child Labor or Forced Labor. Available online: http://www.dol.gov/ilab /programs/ocft/PDF/ 2011TVPRA.pdf (accessed on 2 May 2013).

21. International Labour Organisation. *Girls in Mining: Research Findings from Ghana, Niger, Peru and United Republic of Tanzania*; International Programme on the Elimination of Child Labour; Cornell University ILR School: Geneva, Switzerland, 24 August 2007.

22. GreenhouseGasMeasurement.com (GHGm). *Social and Environmental Responsibility in Metals Supply to the Electronic Industry*; Guelph, Canada, 20 June 2008. Available online: http://www.eicc.info/documents/SERMetalsSupplyreport.pdf (accessed on 2 May 2013).

23. The Blacksmith Institute. The World's Worst Polluted Places. The Top Ten of the Dirty Thirty; New York, NY, USA, September 2007.

24. Der Spiegel. Handy-Marktanteile: Samsung und Nokia vor Apple [in German]. Available online: http://www.spiegel.de/netzwelt/apps/handy-marktanteile-samsung-und-nokia-vor-apple-a-883462. html (accessed on 2 May 2013).

25. Nordbrand, S.; SwedWatch; de Haan, E. *Mobile Phone Production in China, A follow-up Report on Two Suppliers in Guangdong* [in German]; SwedWatch: Stockholm, Sweden; SOMO: Amsterdam, the Netherlands, December 2009. Available online: http://makeitfair.org/ news_listing/the-facts/reports? set_language=en (accessed on 2 May 2013).

26. Bormann, S.; Plank, L. *Under Pressure: Working Conditions and Economic Development in ICT Production in Central and Eastern Europe*; WEED (World Economy, Ecology and Development): Berlin, Germany, September 2010.

27. Wilska, T.A. Mobile Phone Use as Part of Jung People's Consumption Styles. *J. Consum. Policy* **2003**, *26*, 441–463.

28. Nokia Web Page. Recycling. Available online: http://press.nokia.com/ corporate/media/3824/ photo/nokia_recycling_10/ (accessed on 1 March 2013).

29. BITKOM Web Page. 83 Millionen Alt-Handys [in German]. Available online: http://www.BITKOM.org/files/documents/BITKOM_Presseinfo_Althandys_30_12_2011.pdf (accessed on 1 March 2013).

30. LAGA (Bund/Ländergemeinschaft Abfall). Anforderungen zur Entsorgung von Elektro- und Elektronik-Altgeräten (Altgeräte-Merkblatt) (in German). Available online: http://www.laga-online.de/servlet/is/23874/M31_Merkblatt_Elektroaltgeraete.pdf?command=downloadContent&filename=M31_Merkblatt_Elektroaltgeraete.pdf (accessed on 2 February 2013).

31. Hellige, D. Die informationstechnische Wachstumsspirale: Genese, skalenökonomische Mengeneffekte und die Chancen für einen nachhaltigen IT-Konsum. In *Systems of Provision & Industrial Ecology: Neue Perspektiven für die Forschung zu nachhaltigem Konsum* (in German); Weller, I., Ed.; Artec Forschungszentrum Nachhaltigkeit Universität Bremen: Bremen, Germany, 2009; pp. 135–195.

32. Sander, K.; Schilling, S. Optimierung der Steuerung und Kontrolle grenzüberschreitender Stoffströme bei Elektroaltgeräten/Elektroschrott [in German]. *Texte* **2010**, *11*, 1–133.

33. Brigden, K.; Labunska, I.; Santillo, D.; Johnston, P. *Chemical Contamination at e-Waste Recycling and Disposal Sites in Accra and Korforidua, Ghana* [*in German*]; *Greenpeace Research Laboratories Technical Note 10/2008*; Greenpeace International: Amsterdam, The Netherlands, August 2008.

34. Leung, A.O.; Duzgoren-Aydin, N.S.; Cheung, K.C.; Wong, M.H. Heavy metals concentrations of surface dust from e-waste recycling and its human health implications in southeast China. *Environ. Sci. Technol.* **2008**, *42*, 2674–2680.

35. Huo, X.; Peng, L.; Xu, X.; Zheng, L.; Qiu, B.; Qi, Z.; Zhang, B.; Han, D.; Piao, Z. Elevated blood lead levels of children in Guiyu, an electronic waste recycling town in China. *Environ. Health Perspect.* **2007**, *115*, 1113–1117.

36. Manhart, A. *Key Social Impacts of Electronics Production and WEEE-Recycling in China*; Öko-Institut e.V.: Freiburg, Germany, June 2007.

37. Schluep, M.; Hagelueken, C.; Kuehr, R.; Magalini, F.; Maurer, C.; Meskers, C.; Mueller, E.; Wang, F. *Recycling—From E-Waste to Resources. Sustainable Innovation and Technology Transfer Industrial Sector Studies*; United Nations Environment Programme & United Nations University: Paris, France, 2009.

38. BITKOM. Fast 86 Millionen Alt-Handys zu Hause [in German]. Available online: http://www.bitkom.org/files/documents/BITKOM_Presseinfo_Althandys_09_12_2012.pdf (accessed on 2 May 2013).

39. Bayerisches Staatsministerium für Umwelt und Gesundheit Web Page. Handy Clever Entsorgen; Warum Wir Althandys Sammeln: Hintergrundinformation (in German). Available online: http://www.handy-clever-entsorgen.de/hintergrundinformation/index.htm (accessed on 22 April 2013).

40. Hagelüken, C. "Urban Mining" ist wichtiger Beitrag zum Klimaschutz (in German). *Dow Jones Trade News Emiss.* **2009**, *5*, 14–16.

41. Reller, A.; Bublies, T.; Staudinger, T.; Oswald, I.; Meißner, S.; Allen, M. The mobile phone: Powerful communicator and potential metal dissipater (in German). *GAIA—Ecol. Perspect. Sci. Soc.* **2009**, *18*, 127–135.

42. Flick, U. *Triangulation: Eine Einführung* [in German], 2nd ed.; VS Verlag für Sozialwissenschaften: Wiesbaden, Germany, 2007.

43. Jonson, R.B.; Onwuegbuzie, A.J.; Turner, L.A. Toward a definition of mixed methods research. *J. Mixed Methods Res.* **2007**, *1*, 112–133.

44. Tashakkori, A., Teddlie, E., Eds.; *Handbook of Mixed Methods in Social and Behavioural Research*; Sage Publications: New York, NY, USA, 2002.

45. Pickel, S. Die Triangulation als Methode in der Politikwissenschaft. In *Susanne Pickel, Gert Gert Pickel, Hans-Joachim Lauth und Detlef Detlef Jahn (Hg.): Methoden der vergleichenden Politik—Und Sozialwissenschaft. Neue Entwicklungen und Anwendungen* [in German]; VS Verlag für Sozialwissenschaften: Wiesbaden, Germany, 2009; pp. 517–542.

46. Witzel, A. Das problemzentrierte interview. *Forum Qualitative Sozialforschung* **2000**, *1*, Article 22. Available online: http://nbn-resoving.de/urn.nbn.de0114-fqs0001228 (accessed on 2 May 2013).

47. Mayring, P.; Gläser-Zikuda, M. *Die Praxis der Qualitativen Inhaltsanalyse* [in German]; Weinheim: Basel, Switzerland, 2005.

48. Schipperges, M. *Socio-Milieus 2010* [in German]; Sociodimensions Institute for Socio-cultural Research: Heidelberg, Germany, 2010. Available online: http://www.sociodimensions.com/files/milieus_2.pdf (accessed on 2 July.2013).

49. Brown, J.; Isaacs, D. *The World Café: Shaping Our Futures Through Conversations That Matter*; Berrett-Koehler Publishers: San Francisco, NC, USA, 2005.

50. Brown, J.; Isaacs, D. *Das World Café. Kreative Zukunftsgestaltung in Organisationen und Gesellschaft* [in German], 1st ed.; Carl-Auer Verlag: Heidelberg, Germany, 2007.

51. Kuhlhay, J. *Die Mediengeneration. Jugendliche, Ihre Medienkonsum und Mediennutzung-Ausarbeitung zum Forschungsstand* [in German]; Konrad Adenauer Stiftung: Berlin, Germany, 2013.

52. Bliesner, A.; Liedtke, C.; Welfens, J.; Baedeker, C.; Rohn, H. "Norm-oriented interpretation learning" and resource use: The concept of "open-didactic exploration" as a contribution to resource awareness-building. *Resources* **2013**, submitted.