Identifying the "Do's" and "Don'ts" for a Trust-Building CCU Product Label

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Abstract: Carbon Capture and Utilization (CCU) is a technological approach to reduce CO_2 emissions and fossil resource depletion by using CO_2, e.g., from power plants, as feedstock for the manufacturing of products. Since CCU products are novel and have a low public awareness, a specific product label might be helpful to inform the public about and build trust in CCU products. However, product labels should not only target at the merchantability of novel products but should integrate users' information needs and their requirements towards trust and reliability of the product and the production process. In an online survey with 147 German laypeople, requirements for a trusted CCU label were investigated to derive recommendations for a successful, trust-building label and certification process design. Results revealed a positive trust in the CCU label. CCU label trust tended to be higher in persons with higher trust in other people and product labels in general. Purchase intentions for labeled CCU products were increased by a higher CCU label trust and environmentally aware behaviors and decreased by a higher technical self-efficacy. Trusted sources informing about the label were identified as focal point for increasing label trust at this early stage of market entering for CCU products.

1 INTRODUCTION

To address the global challenge of climate change, various measures are taken worldwide to reduce greenhouse gas emissions and fossil resource use (UNEP, 2017). One technological approach to re-use CO_2 emissions from industrial sources, e.g., power plants, and decrease fossil resource depletion is carbon capture and utilization (CCU). There is a large variety of carbon capture and utilization options, such as the production of urea, fuels, or plastic products (Zimmermann and Schomäcker, 2017). A main advantage of CCU is that the consumption of fossil resources in plastic product manufacturing can be reduced because CO_2 is used as a substitute for fossil carbon sources (Von der Assen and Bardow, 2014).

A decisive factor for the successful market introduction of CO_2-derived products will be their favorable acceptance by the public. This includes not only a passive tolerance of the CCU technology infrastructure but also an active willingness to buy and use CCU products (Jones et al., 2017). To raise public awareness of CCU and enable laypeople an informed decision whether or not they want to buy a CCU product instead of a conventionally produced alternative, a CCU product label could be used to mark CCU products and highlight the differences to conventional manufacturing.

Recently, there have been efforts to develop seals of approval for products (e.g., Olfe-Kräutlein et al., 2016). However, these single efforts are mainly limited to a public discourse of the topic without substantial empirical base to validate the appropriateness of such seals. It is mandatory for a successful and accepted label to include a theoretical knowledge but also an empirical validation of how label trust is constituted and how an accepted label certification process looks like.

Instead of merely focusing on the merchantability of a product, it is reasonable to understand in a first step, which information and communication needs are prevailing at all and how and why the characteristics of novel products are perceived as risky or beneficial by the consumers. Thus, prior to investigating the specific design of a CCU label (how to display which information, preferred color scheme and design elements), the framework conditions for a trusted label design and certification process need to be determined. Therefore, the present study aims at identifying requirements for such a trust-building CCU product label. Using data from an online survey, the level of trust in a CCU label and the influence of

CCU label trust on the purchase intention for labeled CCU products are investigated. Moreover, it is examined which user- and label-related factors impact CCU label trust and the purchase intention for labeled CCU products.

The paper is structured as follows: In Section 1.1 and 1.2, an overview is given on the state of research on CCU product acceptance and on the importance of trust for a successful product label. Subsequently, the study's methodological approach, the sample, and the procedure of data analysis are presented (Section 2). In Section 3, the study findings are described. Finally, results are discussed and recommendations for a trust-building CCU label are derived (Section 4).

1.1 Social Acceptance and Awareness of CCU Products

CCU products are innovative products which require a favorable social acceptance for their successful market adoption (Jones et al., 2017). Although previous studies have revealed a positive general acceptance of the CCU technology and products, awareness of CCU was found to be low (e.g., Arning et al., 2019; Offermann-van Heek et al., 2018). One way to increase the public awareness of CCU products are tailored information concepts, which have to be timely integrated to be effective (Bögel et al., 2018). Especially as CCU products do not observably differ from conventional products (only the manufacturing process distinguishes them, Von der Assen and Bardow, 2014), a possible approach to both raise the public awareness of CCU products and foster trust in CCU industry and products is an adequate product labeling. So far, studies on CCU acceptance have mainly focused on benefit and risk perceptions of the CCU technology and products and on trust and distrust in stakeholders involved in the implementation of CCU technologies, such as CCU industry, government, and research institutions (e.g., Arning et al., 2019; Offermann-van Heek et al., 2018). Although past research has identified the need for raising public awareness of and clearly labeling CCU products (Offermann-van Heek et al., 2018; Olfe-Kräutlein et al., 2016; Van Heek et al., 2017), no study has yet looked into laypeople's requirements for a successful and informative CCU product label.

1.2 The Importance of Trust in Product Label Design

Missing trust in stakeholders has been revealed as crucial barrier to the successful introduction of energy technologies and innovative products (Huijts et al.,

2012). Trust is a multidimensional concept with no uniform definition across research disciplines. The trust framework of McKnight and Chervany (2001), originally explaining trust in the ICT- and e-commerce context, differentiates between trust as disposition, belief, intention, and behavior: While trust disposition refers to the general trust a person has in other people (i.e., the willingness to depend on general others), trusting beliefs refer to the trustor's (= the person who trusts) evaluations of the trustee's characteristics (trustee = the person or institution who is to be trusted). A trustee is evaluated as trustworthy to fulfill a task if this person is believed to possess the ability or power to fulfill the task (competence), to be willing to act in the trustor's interest (benevolence), to be truthful and to keep promises (integrity), and to act consistently (predictability). On the basis of one's trusting beliefs, trusting intentions are developed, which then lead to trust-related behavior. In line with other previous research (e.g., Van de Walle and Six, 2014), distrust is distinguished from trust as the opposite, but separate concept: Hence, trust and distrust can exist to a differing extent at the same time, depending on the specific evaluation of a situation.

Past research on credibility of information sources in the CCU context revealed that trust in CCU industry and governmental institutions was on a medium level and received lower trust ratings compared to research institutions and NGOs (Offermann-van Heek et al., 2018). Further, consumers request to be informed whether a product was manufactured using the CCU or conventional technology, even if the CCU alternative does not noticeably differ from the conventional products, and withholding this information might thus evoke distrust (Offermann-van Heek et al., 2018; Van Heek et al., 2017). If tailored to laypeople's requirements, a CCU product label could act as a trust-building measure by transparently informing about CCU products and their characteristic features.

One approach to make production-related characteristics "visible" is the eco-label. Eco-labels inform buyers about a product's environmental qualities (Atkinson and Rosenthal, 2014). It was found that eco-labels can positively impact consumer purchase decisions for labeled products (e.g., Feucht and Zander, 2018) and they are the most preferred source for environmental information about a product (European Commission, 2013).

As the purpose of a product label is to convey the most essential information at a glance within a very limited space, it needs to be carefully designed. Integrating laypeople's requirements and wishes in

the development of product labels is crucial to make sure the label is comprehensible, unambiguous, and regarded as trustworthy. Otherwise, a newly introduced product label might confuse consumers, get lost in the shuffle of existing labels, or create distrust (e.g., Moon et al., 2017). Studies on eco-label acceptance identified argument specificity (i.e., detailed information about the environmental qualities of the product) and additional information on the label (e.g., about the label meaning and certification conditions and regulations) as requirements for an accepted and trusted product label (Atkinson and Rosenthal, 2014; Emberger-Klein and Menrad, 2018). Especially for carbon labels it was difficult for laypeople to comprehend the presented label information and to put it into perspective (Upham et al., 2011). In a study by the European Commission (2013), most respondents believed that existing eco-labels provided not enough and/or not sufficiently clear environmental information about labeled products. Also, unknown labels were found to elicit low trust (e.g., Sirieix et al., 2013).

Beyond the specific label design and displayed information, the process of label certification is a factor that also needs to be carefully considered. Particularly when product manufacturers or supermarket brands award a label themselves, consumers have been suspicious (particularly in Germany), whereas governmental certification evoked higher trust and was preferred to producers' claims (Atkinson and Rosenthal, 2014; European Commission, 2013; Sirieix et al., 2013). In a previous study on CCU acceptance, where a seal of approval for CCU products was assessed as important for trust in the CCU industry, interviewees mentioned the requirement of label source: A certification by independent sources such as governmental institutions or specific institutes was preferred (Offermann-van Heek et al., 2018).

Furthermore, it is important for a successful implementation of a product label to identify consumer groups which are responsive to the label and which are reluctant in trusting the label. Yet, the impact of user factors (person-related characteristics such as sociodemographic factors and general attitudes) on attitudes towards eco-labels is not sufficiently clear (Waechter et al., 2015). Individual factors associated with attention to and preference for eco-labels were, for example, young age, higher education, pro-environmental attitude, knowledge about eco-labels, and personal innovativeness related to eco-labels (e.g., Brécard et al., 2012; Thøgersen, 2000; Thøgersen et al., 2010).

Results on the influence of gender on eco-label attitudes were mixed: Whereas Brécard et al. (2012) found that men are more willing to adopt eco-labels, Sønderskov and Daugbjerg (2011) revealed a higher eco-label trust for women. Other influence factors for eco-label trust identified by Sønderskov and Daugbjerg (2011) were a younger age, a higher environmental awareness, and a higher general trust in other people and institutions.

1.3 Research Questions

The present research is the first systematic attempt to investigate laypeople's requirements for a trust-building product label for CO_2-derived products. In order to explore trust in a label for CCU products and to identify requirements for fostering label trust, the following questions were examined:

RQ1. Do laypeople trust in a CCU label?

RQ2. Does trust in the CCU label affect the willingness to buy CCU products?

RQ3. Is trust in the CCU label affected by user characteristics?

RQ4. Which factors related to label and certification process design build trust in CCU product labels?

2 METHODOLOGY

In the following section, the structure of the online questionnaire and the survey sample are described.

2.1 Questionnaire Structure

The questionnaire consisted of three parts. An overview of questionnaire items can be found in the Appendix (Table A.1).

In the first part, demographic data (age, gender, education) and attitudinal characteristics (environmentally aware behavior, technical self-efficacy, trust disposition, and self-reported knowledge about CCU) were assessed. Respondents' environmentally aware behavior was measured by six items (Cronbach's alpha = 0.78) based on a study conducted for the European Commission (2008) and on Wippermann et al., (2008). Technical self-efficacy, i.e., one's general attitude towards technology, was assessed by four items (Cronbach' alpha = 0.90) from Beier (1999). Trust disposition was measured using the 12-item-scale from McKnight et al., (2002) (Cronbach's alpha = 0.84). Self-reported knowledge about CCU was covered by

four items (Cronbach's alpha = 0.92) specifically developed for the research topic: Respondents were asked to evaluate their familiarity with different aspects of carbon utilization (storage, utilization, product spectrum), partly based on the scale used by Arning et al., (2019). The scale was validated in pre-studies.

The second part captured participants' perception of product labels in general and the CCU label in particular. General trust in product labels was measured using the item "I totally trust in product labels." To assess trust in the CCU label, a scale was developed that covered essential trust dimensions identified in McKnight and Chervany (2001) and specified them for the topic of CCU labels. The scale consisted of five items measuring trusting beliefs (benevolence and integrity) related to the label certification and the intention to trust a CCU product label (Cronbach's alpha = 0.81). Items on CCU label trust were developed based on an interview pre-study and previous research on label trust (Moussa and Touzani, 2008) and had been validated in pre-studies. Also, the purchase intention for labeled CCU products was measured by five items related to actively searching for labeled CCU products, preferring labeled CCU products to conventional products, and the willingness to buy novel and unfamiliar products marked by the CCU label (Cronbach's alpha = 0.87).

In the third part of the questionnaire, respondents had to evaluate conditionals for trust and distrust in a CCU product label (see Table A.2, Appendix). They were asked which factors (related to the certification process, the label design, and the provided information) would foster their trust or distrust in a CCU product label. The 14 trust- and 15 distrust conditional items were derived from interviews with laypeople and experts conducted prior to the study and from the current state of research on eco-label trust (see Section 1.2). Trust and distrust conditionals were assessed separately since past research identified trust and distrust to be separate concepts.

All questionnaire items were answered on six-point Likert scales ranging from "do not agree at all"(1) to "fully agree"(6). Accordingly, mean values > 3.5 signify approval to and values < 3.5 indicate rejection of a statement.

2.2 Sample

Data was collected online in fall 2017. The survey link was disseminated by e-mail, discussion forums, and social media. 186 respondents participated in the study. They were not financially rewarded but volunteered to participate. Excluding incompletes and speeders (response time < 10 min), 147 data sets remained for the analysis (response rate: 79.0%).

Participants' age ranged between 17 and 70 years ($M = 33.3$ years, $SD = 13.2$). 49.0% were female and 51.0% were male. 56.5% had a university degree or higher, 27.9% a university entrance certificate, and 14.3% reported a secondary school diploma or lower secondary school leaving certificate as highest educational qualification, whereas 1.4% stated to have another type of qualification.

The sample reported environmentally aware consumption behaviors ($M = 4.03$, $SD = 0.86$), a positive technical self-efficacy ($M = 4.38$, $SD = 1.19$) and a positive trust disposition, i.e., general trust in other people ($M = 3.80$, $SD = 0.60$). Self-assessed knowledge about the CCU technology and products was low ($M = 2.27$, $SD = 1.17$): 84.4% felt rather uninformed ($M < 3.5$), whereas 15.6% felt (rather) knowledgeable about the topic of CCU ($M \geq 3.5$).

2.3 Data Analysis

Mean values for all constructs with multiple item-measurement were computed. Data was analyzed using descriptive and inference statistics. To compare mean values for label trust ratings (related to the CCU label and product labels in general) and purchase intention for labeled CCU products, t-Tests for paired samples were used. If multiple t-Tests were conducted, the adjusted value for statistical significance was considered. A principal component analysis was conducted to explore the factor structure in the questionnaire and to identify (dis)trust factors in the CCU label context. Finally, the influence of user factors and (dis)trust factors on CCU label perceptions was investigated using regression analyses. Regression diagnostics were carried out to determine if model analysis assumptions were fulfilled. Multicollinearity (i.e., biasing effects due to intercorrelating factors, Hair, 2011) could be ruled out because VIF values were below 10 and tolerance values above 0.2 for all predictors used in the model.

3 RESULTS

First, results for trust in the CCU label and purchase intention for labeled CCU products are reported. Then, the effect of user factors on CCU label trust and intention to buy CCU products is examined. In a last step, the impact of label- and certification process-related factors on CCU label trust is investigated.

3.1 CCU Label Trust and Purchase Intention for CCU Products (RQ1)

As Figure 1 shows, general trust in product labels was rather low ($M = 2.96$, $SD = 1.21$). In contrast, trust in a specific label for CCU products was positive and significantly higher ($M = 4.04$, $SD = 0.74$; $t(146) = 12.77$, $p < 0.001$). However, compared to CCU label trust, the purchase intention for labeled CCU products was neutral ($M = 3.47$, $SD = 0.86$) and significantly lower ($t(146) = -8.75$, $p < 0.001$).
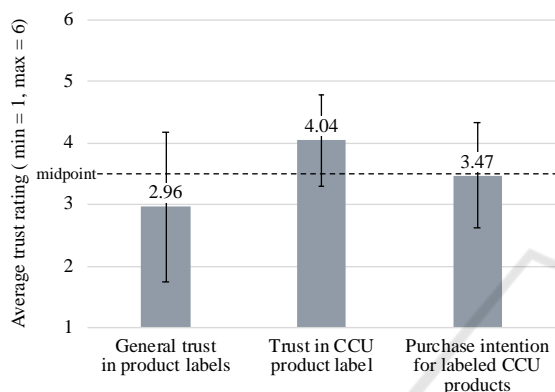

Figure 1: Ratings of general trust in product labels, trust in the CCU product label, and purchase intention for labeled CCU products (n = 147).

Examining CCU trust in more detail (see Figure 2), it can be seen that both trusting beliefs (related to benevolence and integrity) and trusting intentions were rather positive.
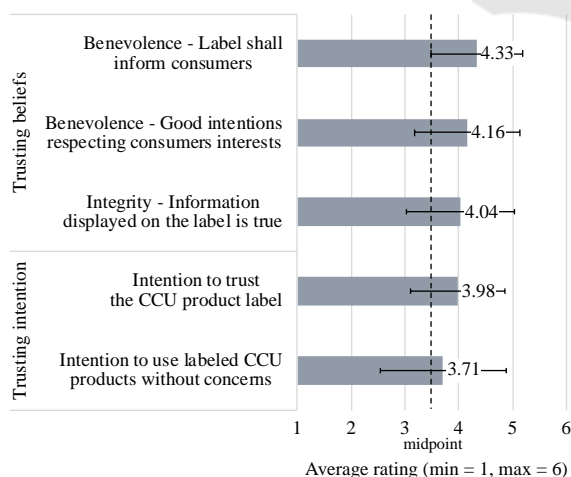

Figure 2: Ratings of trusting beliefs and trusting intention related to the CCU product label (n = 147).

In order to analyze whether trusting intention significantly differed from trusting beliefs, mean values were calculated over the three belief- and two intention-items. Results showed that trusting beliefs ($M = 4.17$, $SD = 0.77$) were on average significantly more positive than the trusting intention related to the CCU product label ($M = 3.85$, $SD = 0.86$; $t(146) = 6.10$, $p < 0.001$).

3.2 Impact of User Factors on CCU Label Trust and Purchase Intention (RQ2 and 3)

To investigate how trust in the CCU label and purchase intention for CCU products are developed, it is also important to consider which person-related factors (user factors) influence CCU label trust and the intention to buy labeled CCU products. Therefore, a stepwise regression analysis was run to examine whether trust in a CCU label is impacted by user factors (i.e., whether some groups are more trusting of CCU product labels than other groups of persons). The measured demographic and attitudinal variables (age, gender, education, environmentally aware behavior, technical self-efficacy, trust disposition, self-assessed knowledge about CCU, and general trust in product labels) were entered as independent variables and trust in the CCU label as dependent variable.

Results are displayed in Figure 3. It was found that age, trust disposition, and general trust in product labels significantly affected trust in the CCU label and explained together 35.4% of variance in CCU label trust ($F(3,143) = 27.64$, $p < 0.001$). All other factors were excluded from the regression model, meaning they did not significantly impact trust. General trust in product labels was identified as strongest driver of CCU label trust ($\beta = .48$, $p < 0.001$), followed by trust disposition ($\beta = .25$, $p < 0.001$): A higher trust in general others and in product labels in general increased specific trust in the CCU label. Moreover, a younger age was linked to a higher trust in the CCU label ($\beta = -.17$, $p < 0.05$).

In a next step, influence factors for the intention to purchase labeled CCU products were analyzed using stepwise regression. Alongside demographics and general attitudes, also the specific trust in the CCU label was included as predictor and the purchase intention was entered as criterion. The resulting regression model (Figure 3) explained 43.8% of variance in the intention to buy labeled CCU products ($F(3,143) = 38.86$, $p < 0.001$). The sole variables contributing significantly to purchase intention were "trust in the CCU label" ($\beta = .49$, $p < 0.001$), environmental awareness ($\beta = .39$, $p < 0.001$), and technical self-efficacy ($\beta = -.22$, $p < 0.001$).
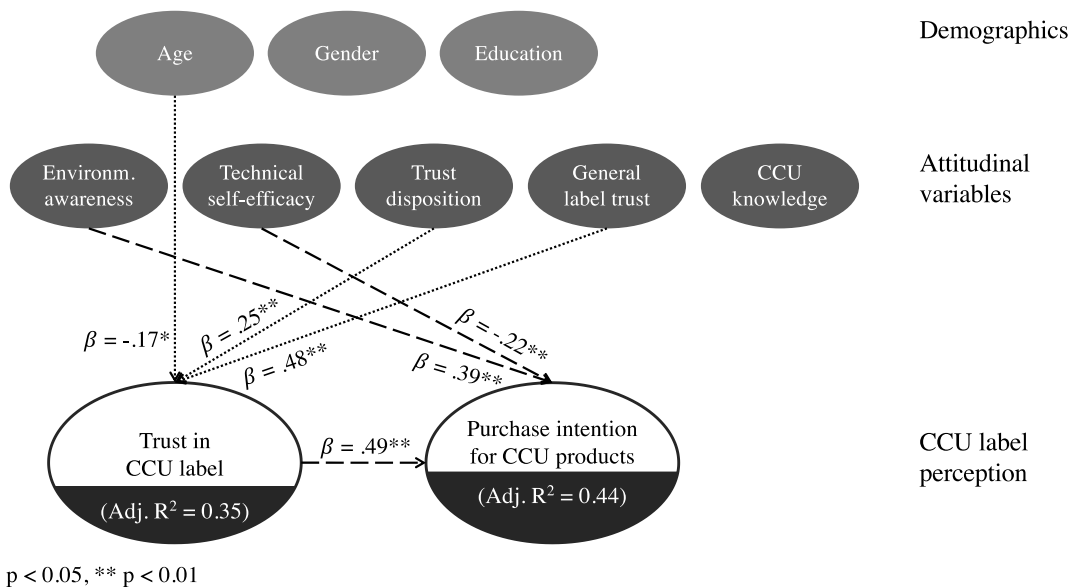
Figure 3: Regression models for the impact of user factors on CCU label trust and purchase intention for labeled CCU products (n = 147).

Whereas a higher CCU label trust and a more environmentally aware behavior increased the intention to buy labeled CCU products, a more positive general attitude towards technology tended to lower the purchase intention.

3.3 Trust and Distrust Factors Impacting CCU Label Trust (RQ4)

So far, trust and purchase intentions for a CCU label have been examined and it was analyzed to which extent they are influenced by user factors. Still, it is unclear if there are possibilities to increase (or barriers which lower) the trustworthiness of the CCU label. To identify trust- and distrust-building factors for CCU labels, a principal factor analysis (PCA) was conducted for the 29 (dis-)trust items to determine the factorial construct structure (see Table A.2, Appendix).

Selection of factors retained in analysis was based on two conditions: 1) visual diagnostics of the scree plot (using the point of inflexion in the scree plot as cut-off point), 2) Kaiser's criterion (checking for eigenvalues of factors > 1) (Field, 2009). Due to the small sample size, only items with a factor loading > .512 were retained (which is the cut-off for a sample with n = 100, Field, 2009). Quality criteria for PCA proved that the data matrix was suitable (Bartlett's test of sphericity $p < 0.001$) and that there was a high level of sampling adequacy (KMO = .775) (Hair, 2011). The obtained factorial structure (Table A.2, Appendix) revealed five (dis)trust factors:

1. Unknown and private certifying organization (*distrust factor*, Cronbach's alpha = 0.82)
2. Transparent and independent certification process (*trust factor*, Cronbach's alpha = 0.76)
3. Information sources (*trust factor*, Cronbach's alpha = 0.76)
4. Provided label information (*trust / distrust factor*, Cronbach's alpha = 0.66)
5. Unusual label design (*distrust factor*, Cronbach's alpha = 0.80)

The five extracted dimensions explained 46.5% of the total variance.

The first factor *"unknown and private certifying organization"* was related to a private, dependent organization awarding the label, which was unknown to respondents and about which no information was available (*"unknown auditor"*).

The second factor *"transparent and independent certification process"* was comprised of transparent awarding criteria and regulations for product controls, transparent information about the CO_2 footprint of the CCU product, and an independent certifying organization that awards the label.

The third factor was related to *"trusted sources"* informing respondents about the label (meaning how respondents got in touch with the label, e.g., via media coverage or friends).

The fourth factor referred to *"information,"* i.e., both the information provided on the label (extent of information, reference to additional information) but also available information about the certifying organization were summarized.

The fifth factor concerned *"label design"* (unusual label shape and design).

Most factors were exclusively trust *or* distrust factors (they included only trust *or* distrust conditionals). The only factor which consisted of both trust and distrust conditionals was *"provided label information."*

In a second step, mean values were calculated for the five obtained (dis)trust factors to see which of these factors participants evaluated as most relevant for their trust or distrust in the CCU product label (Figure 4).

Figure 4 shows that on a descriptive level all factors were assessed as (rather) relevant for trust or distrust in the CCU label except for the *"unusual label design,"* which was rated as rather unimportant. All differences in relevance ratings for the five factor levels were statistically significant on a level of $p < 0.001$ (except for the difference between *"unknown and private certifying organization"* and *"provided label information"* with $p < 0.01$).
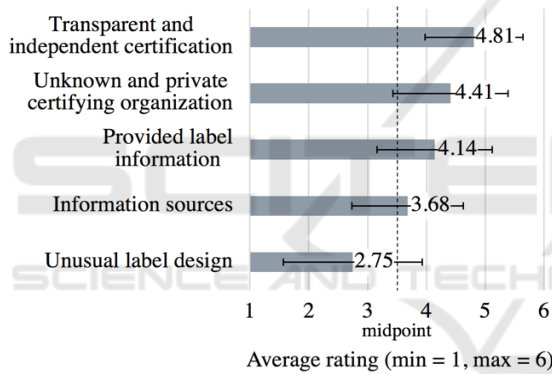

Figure 4: Ratings of relevance of (dis)trust factors for increasing (dis)trust in the CCU product label (n = 147).

To test whether the (dis)trust factors had a statistically significant impact on CCU label trust and purchase intention, stepwise regression analyses were conducted using the five (dis)trust factors as input factors and CCU label trust and purchase intention for labeled CCU products as dependent variables.

The regression models (Figure 5) revealed that both CCU label trust and intention to buy labeled CCU products were affected by *"information sources"* as strongest driver and purchase intention for CCU products additionally by a *"transparent and independent certification process,"* whereas the other (dis)trust factors had no significant impact and were excluded from the models. The *"information sources"* factor explained 24.4% of variance in CCU label trust ($F(1,145) = 48.08$, $p < 0.001$). With 16.1%, *"information sources"* in combination with *"transparent, independent certification"* explained a

comparably lower amount of variance in purchase intention ($F(2,144) = 15.01$, $p < 0.001$).
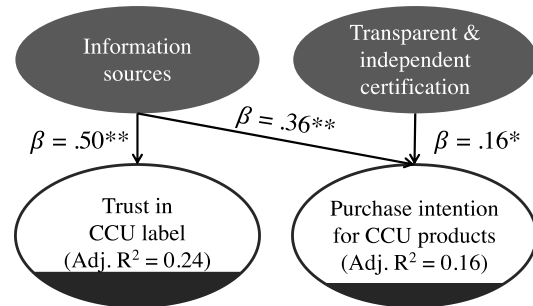
* p < 0.05, ** p < 0.01

Figure 5: Regression models for the impact of information sources and transparent, independent certification on CCU label trust and purchase intention (n = 147).

Given the relevance of information sources for both CCU label trust and purchase intention, it should be examined which sources of information are most appropriate for fostering label trust. Mean values for trust conditionals related to information sources are displayed in Figure 6. As shown, respondents evaluated *"media"* and *"friends and acquaintances"* most positively. On the other hand, *"political information sources"* and *"famous label ambassadors"* were rather not seen as relevant to increase one's trust in the CCU label. All differences between information sources were statistically significant with $p < 0.001$ (except for the difference between *"media"* and *"friends and acquaintances"* with $p < 0.01$).

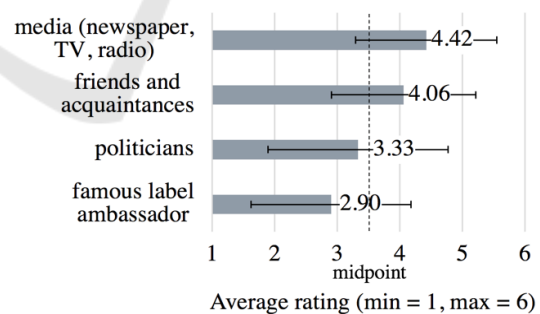

Figure 6: Ratings of relevance of information sources for increasing trust in the CCU product label (n = 147).

4 DISCUSSION AND CONCLUSION

4.1 Perception of and Trust in Labels

The present study investigated requirements for a trust-

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building CCU label to raise public awareness of CCU products and enable consumers an informed decision whether they want to buy a CCU alternative instead of a conventional product. Results revealed a positive trust in the CCU label, but the purchase intention for labeled CCU products was neutral.

Apart from identified trust levels, the present study also allowed insights into the factorial structure of the (dis)trust construct. (Dis)trust factors for CCU labels were based on the dimensions *"unknown and private certifying organization," "transparent and independent certification process," "sources informing about the label," "provided label information,"* and *"unusual label design."* Interestingly, the (dis)trust factors had a lower effect on CCU label trust and purchase intention than user factors. On a descriptive level, respondents evaluated certifying organization, certification process and monitoring, label information, and sources informing about the CCU label as (rather) relevant for fostering trust in the CCU label. However, it was revealed that only the information sources disseminating information about and familiarizing laypeople with the CCU label did significantly impact both CCU label trust and intention to buy products carrying the CCU label. The purchase intention for labeled CCU products was furthermore increased by a *transparent and independent certification process*. This might be due to the (currently) early phase of market entering of CCU products. In the current study, respondents' awareness of the CCU technology and CCU products was very low, which is in line with results from other recent research (e.g., Offermann-van Heek et al., 2018). So, in this early implementation stage characterized by low public awareness and product availability, the first spread of information (i.e., how the public comes into touch with CCU products) is crucial. Because CCU products and the corresponding product label are unfamiliar to them and they cannot rely on personal experience, laypeople might need assurance by a well-known and trusted information source to develop trust in a label for novel, innovative products.

The present study identified media coverage and talks with friends and acquaintances to be the most preferred information sources for familiarizing respondents with the CCU product label, whereas political actors and famous label ambassadors were rather not evaluated as important to build trust in CCU labels. Here, a kind of "chicken-and-egg" problem or "double relevance" of (dis)trust gets apparent: Previous research on consumer skepticism towards companies' claims about their environmental actions has found that distrust in these claims (e.g., perceived greenwashing) motivates laypeople to spread negative word of mouth about the companies' products in their circle of friends and acquaintances (Leonidou and Skarmeas, 2017). This means, if trust in the CCU product label and CCU products in general fails to be developed and mistrust is built at the early implementation stage (e.g., by a misleading, ambiguous information campaign that ignores laypeople's requirements), this might prevent a successful market adoption of CCU products in later stages due to dynamics of negative word of mouth.

The findings of this study should be interpreted with caution: It should not be concluded that parameters related to the certification process and label design are unimportant for trust-building in the CCU label because respondents evaluated certifying organization and process criteria as most relevant for their trust and distrust in a CCU product label. When CCU products become more widely available on the market, there might be a shift in importance: Once people know about the products and the label, other factors like unambiguity and comprehensibility of presented information, argument specificity of label claims, label familiarity, and governmental / third-party certification may come into play since these are important parameters influencing trust and preferences for eco-labels (Atkinson and Rosenthal, 2014; Moon et al., 2017; Sirieix et al., 2013).

From a perspective on trust theory and conceptualization, the present results corroborate findings from past research (e.g., McKnight and Chervany, 2001; Van de Walle and Six, 2014) that trust and distrust are in a wide array separate concepts because the obtained factor structure for trust and distrust conditionals represented mostly pure trust *or* distrust factors. There was only one "mixed" factor containing both, trust and distrust conditionals.

4.2 One Label for All? Or the Impact of Individual Factors on CCU Labels

Analyzing the impact of user factors on CCU label perceptions, it was found that CCU label trust and purchase intention for CCU products were (directly) influenced by different antecedents. Whereas CCU label trust was mainly affected by trust-related factors (trust disposition and general trust in product labels) and by age, the purchase intention for labeled CCU products was increased by a more environmentally aware behavior and a lower technical self-efficacy. These findings partly mirror results from (Sønderskov and Daugbjerg, 2011) on eco-label trust, which was also found to be affected by general trust constructs (general social and institution-based trust)

and to be higher in younger people, but they are not in line with the influence of environmental awareness and gender identified in that study. Interestingly, in the present study environmental awareness came into play for the purchase intention related to labeled CCU products, which corroborates findings from past research on attention to and preferences for eco-labels (e.g., Thøgersen, 2000). An explanation for the identified negative influence of technical self-efficacy on intention to buy labeled CCU products could be that people who feel generally more affine to technology do not want or need to rely on a product label for decision guidance but tend to rely rather on their individual knowledge and experience for product selection. This explanation attempt needs to be investigated in future studies. Although trust disposition and general trust in labels did not directly influence CCU product purchase intention, there might have been an indirect impact of these general trust attitudes via CCU label trust, which was found to be the biggest driver for the intention to buy CCU products. The effect of label trust on purchase intention mirrors previous research on eco-label adoption (e.g., Konuk, 2018; Teisl et al., 2008).

4.3 Methodological Considerations

The present study suffers from some methodological issues that should be addressed by future research. One limitation is the small, young, and highly educated sample. Though appropriate for a first exploration of trust in a CCU label, the study should be replicated with a census representing sample to measure the view of the entire German population.

A further methodological consideration is the way the relevance of trust and distrust factors for building trust was assessed: If survey respondents are presented with a list of predefined factors and asked to indicate if these aspects might raise their trust, their attention is artificially drawn to these aspects. Thus, respondents might tend to find every aspect offered to them important, although they might not have thought of these factors themselves, leading to an overestimation of trust-relevance (over-trust, Goel et al., 2005). Therefore, a strength of the present study is the additional investigation of impact factors on trust using regression analysis, which revealed that only sources informing about the CCU label significantly affected trust in CCU labels. Future studies should investigate if trust and distrust are affected by similar certification-related characteristics or whether impact factors differ.

The obtained (dis)trust factor structure was not completely distinct, e.g., in some cases items with a similar semantic content loaded on different factors. Therefore, the factorial structure of trust and distrust in CCU labels should be replicated in future studies with a bigger and more balanced sample to more precisely "carve out" the factors and subdimensions.

Moreover, the present research focused exclusively on the trusting belief dimensions of benevolence and integrity related to the CCU label certification. Since the framework of McKnight and Chervany (2001) also includes trusting beliefs related to competence and predictability as factors influencing trusting intentions, these should be examined in future studies on CCU label trust. The impact of these missing dimensions might explain the significant difference between trusting beliefs and trusting intention in the current study, assuming that trusting intentions are a function of adding up and weighing different dimensions of trusting beliefs.

4.4 Recommendations for a Trust-Building CCU Product Label

Summarizing the study's results, the following recommendations ("Do's" and "Don'ts") for a trust-building CCU product label can be derived:

What policymakers and CCU industry *should do*…

- Integrate the user perspective in early stages of CCU product development and CCU label design to achieve user-centered innovations.
- Enable consumers to make an informed purchase decision for CCU products.
- Assign the awarding decision of the CCU label to an independent organization.
- Make CCU label awarding criteria and time frame transparent.
- Provide comprehensible, unambiguous, neutral, and verifiable information on and about the CCU label.
- Develop transparent and credible information campaigns involving trusted information sources such as the media to raise awareness and familiarity of the CCU label.

What you *should not do* (anymore)…

- Do not solely target at the merchantability of CCU products but include laypeople's needs and concerns in the development of novel products and product labels.
- Do not try to persuade people to accept novel technology – acceptance is a fragile good which needs to be donated by consumers.
- Do not include user requirements only out of moral or social justice reasons but because they

are valuable information sources for designing targeted communication strategies and tailoring products to consumer needs.

- Do not use famous label ambassadors as testimonials for a CCU product label.
- Avoid misleading label claims that elicit misconceptions and distrust.
- Avoid a label awarding by CCU industry or a dependent organization.

From an overarching perspective, trust is only one (but a very essential) aspect of a successful label design. Thus, after identifying the trust-building conditions for the CCU label development, future studies should expand the scope to consumer requirements for comprehensibility and preferred label design (i.e., label wording, color scheme, design elements). This would help label developers to gain a deeper understanding on how to create a socially-accepted label, which raises public awareness of CCU products, assists laypeople in informed purchase decisions, and subsequently supports the market adoption of CCU products.

ACKNOWLEDGEMENTS

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APPENDIX

Table A.1: Items used for construct measurement.

Constructs	Items
Environmentally aware behavior (Cronbach's alpha = 0.78) Item sources: European Commission (2008); Wippermann et al. (2008)	When buying household appliances, I pay attention to a low energy consumption.
	When buying textiles, I make sure that they do not contain any harmful substances.
	I purposefully buy products that cause as little harm as possible to the environment both during their production and use.
	I pay attention that the devices and products I buy are durable and repairable.
	I purposefully buy regionally produced fruits and vegetables.
	I try to avoid waste caused by unnecessary packaging, unnecessary plastic bags, etc.
Technical self-efficacy (Cronbach's alpha = 0.90) Item source: Beier (1999)	I really enjoy solving technical problems.
	I can solve many of the technical problems I am confronted with on my own.
	Because I could cope well with technical problems so far, I am optimistic about future technical problems.
	I feel so helpless when interacting with technical devices that I rather keep my hands off them.
Self-reported knowledge about CCU* (Cronbach's alpha = 0.92)	I feel well informed about the topic of CCU.
	I feel well informed about CO_2 capture.
	I feel well informed about the utilization of CO_2 as feedstock.
	I feel well informed about the CCU product spectrum.
General trust in labels*	I completely trust in product labels.

Table A.1: Items used for construct measurement(cont.).

Trust in the CCU product label* (Cronbach's alpha = 0.81)	I would trust the CCU product label. *(trusting intention)*
	I would use products with a CCU label without any concerns. *(trusting intention)*
	I believe that the idea of a CCU product label is well-intentioned with regard to consumer interests. *(trusting belief – benevolence)*
	I believe that the CCU product label shall inform consumers. *(trusting belief – benevolence)*
	I trust that the information displayed on the label is true. *(trusting belief – integrity)*
Purchase intention for labeled CCU products* (Cronbach's alpha = 0.87)	I would prefer products with the CCU label to conventional products.
	The CCU product label would convince me to buy novel / unfamiliar products.
	I would actively search for products with the CCU label.
	While shopping, I would purposefully look out for the CCU product label.
	I would rather like to use products with the CCU label compared to conventional alternatives.

*Items were specifically developed for the topic of CCU labels and validated in pre-studies. Item development was based on results from an interview pre-study and on research literature (for CCU label trust: Moussa and Touzani, 2008).

Table A.2: Rotated factor loadings of (dis)trust conditionals for a CCU product label on the extracted factors.

Trust / Distrust (T/D)	I would (dis)trust a CCU label if...	1 Unknown, private certifying organization	2 Transparent, independent certification process	3 Infor-mation sources	4 Provided label information	5 Unusual label design
D	the product manufacturers awarded the label.	.819				
D	it was not awarded by an independent organization.	.795				
D	a private organization awarded the label.	.663				
D	there was no information about the certifying organization which awards the label.	.570				
D	I did not know the certifying organization.	.520				
T	the criteria and conditions for awarding the label process were transparent to me.		.799			
T	it informed me about figures for the CO_2 footprint compared to conventional products.		.734			
T	the guidelines and timeframe of the product controls were transparent to me.		.604			
T	the certifying organization was independent.		.555			
T	politicians drew attention to the label and recommended it.			.808		
T	it was disseminated and explained by the media (newspapers, TV, radio).			.717		
T	it was represented by a famous label ambassador.			.689		
T	my friends and acquaintances told me about it.			.654		
D	there was no reference to additional information (weblink or QR code).				.797	
D	it contained only little information.				.614	
T	information about the certifying organization (e.g., the organization's headquarters) was available.				.534	
D	it had an unusual design compared to other labels.					.854
D	it had an unusual shape compared to other labels.					.764

Bartlett's test of sphericity $p < 0.001$, KMO = .775

Items that did not load on the 5 identified factors with a factor loading > .512 were excluded.