KlimaKarl – A Chatbot to Promote Employees' Climate-Friendly Behavior in an Office Setting

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Abstract. Environmental protection is a central challenge these days. At the same time, digital technologies have experienced tremendous technical progress in recent years and their potentials to support firms' sustainability strategies and corporate social responsibility efforts are intensively discussed. In this respect, companies search for efficient ways to trigger a change of employee behavior in terms of climate-friendly practices. We propose chatbots as a promising technology to promote the climate-friendly behavior of employees. Following a Design Science Research (DSR) procedure, we develop a chatbot prototype called KlimaKarl to sensitize the workforce to behave in a more climate-conscious way in the everyday office life. We show that chatbots may be a suitable instrument to promote employees' climate-friendly behavior.

Keywords: Chatbot · Green office · Sustainability · Digital technologies

1 Introduction

Environmental and climate protection are crucial challenges of our time. The United Nations recognizes the importance of these challenges as part of the Agenda 2030, which was passed by the member states in 2015 [48]. The core of the Agenda 2030 are 17 global goals – the sustainable development goals (SDGs). Given the little time left to reach the SDGs by 2030, enterprises should use the disruptive potential of digital technologies [1, 8] to meet their corporate social responsibility (CSR) and thereby to support the achievement of the SDGs. Innovative technologies comprise various solutions and tools and their possible application fields to promote sustainability are manifold [e.g., 12, 41]. One promising technology that has attracted a lot of attention from practitioners in recent years are chatbots. In a business context, chatbots have a variety of uses for external communication purposes (e.g., customer service, sales, marketing), but also for promoting the communication within a company (e.g., employee training, knowledge management) [32]. Given their interactive and communicative character [6], chatbots have the potential to encourage employees to behave in a climate-friendlier way in everyday office life. Nevertheless, the literature about chatbots to promote sustainability within companies is scarce yet. Hence, we strive for the design and development of a

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chatbot to endorse employees' "green behavior" [14] in this paper. Designing a chatbot to motivate climate-friendly behavior serves companies' CSR measures for two reasons. First, human behavior is the main source of negative environmental influences, and hence, the most important mechanism for achieving ecological sustainability [33, 47, 51]. Second, the commitment of employees is supportive for implementing a company's sustainability strategy. A chatbot could familiarize employees with sustainable measures and behavioral patterns in a playful way. During the interaction with the chatbot, users may additionally promote their own ideas for more climate protection within a company. Generally, chatbots have proven as highly effective for supporting communication processes [33], and we believe this potential of chatbots is also given for the domain of sustainability, which motivates us to conduct the study.

This paper illustrates how a chatbot-based mobile app can be used to reach environmental and climate protection goals within an enterprise. The following research question guides our DSR project: *What can a chatbot to promote employees' eco-friendly behavior in everyday office life look like?* We consider DSR as a suitable approach, because on the one hand, we contribute to the scientific knowledge base on how chatbots may promote climate-friendly office behavior [2, 18, 20] and on the other hand, we create a corresponding IT-artifact for the problem domain described [21, 31]. The paper is structured as follows: In the next section, we provide theoretical foundations. Subsequently, we show the research methodology and the requirements on our prototype. After a description of the prototype development, demonstration and first evaluation, the paper concludes with a discussion and outlook.

2 Foundations and Related Work

2.1 Digital Technologies and Environmental Sustainability

In the recent past, enterprises have increasingly shown interest in the effects of digital technologies on the environment while their awareness regarding social and environmental challenges has risen tremendously [12, 41]. In this respect, environmental sustainability is seen as an essential feature of CSR these days [12]. On this occasion, digital technologies are judged to be major drivers for ecological sustainability and promoting green behavior within the workforce (green office) [25, 40]. The impact of information technology on the environment is specified by Berkhout and Hertin [3] in more detail, who differentiate between "direct" (e.g., reduced pollution), "indirect" (e.g., substitution of materials by information goods) as well as "structural and behavioral" effects (e.g., changes in peoples' lifestyle or structural changes in the economy). Similar thoughts can be found in Li and Found [29], who propose a series of environmental benefits caused by digital technologies. From the perspective of DSR in particular, Seidel et al. [45] investigate the role of information systems (IS) to implement sustainable work practices within companies and identify functional affordances of IS that are supportive in green transformation projects. Thereby, the authors differentiate between sensemaking and sustainable practicing affordances and develop an integrated model of functional affordances [45]. In a latter publication, design principles for IS that support organizational sensemaking in sustainability transformation projects are derived [44]. In addition, Schoormann et al. [42] define design principles with corresponding design features for tools that enable

the development of sustainable business models. Particular these Design Science (DS) research streams are highly relevant for our approach, because they help to derive design requirements for our solution later on. To sum up, a lot of research about digital technologies on environmental sustainability is performed. However, the role of chatbots – to induce a sustainable environmental behavior within the workforce – seems to be an under-researched topic yet.

2.2 Entrepreneurial Chatbot Usage for Internal and External Communication

The first chatbot ELIZA, which was created by Joseph Weizenbaum in the '60s [50], simulated a psychotherapist and triggered the search for further beneficial application fields for chatbots [cf. 10]. These days, chatbots are used in various functional areas for internal as well as external communication purposes. In terms of an organization's external communication with consumers, many companies and institutions have introduced chatbots as a means to support the customer service [e.g., 17]. Horzyk et al. [23] point out that chatbots may also increase the customer experience during online shopping, while the Bank of America uses chatbots to analyze customers' behavior for being able to provide consumer-specific offerings [28]. Other application fields for chatbots include e-government [e.g., 40], education [e.g., 16], healthcare [e.g., 5, 9] and law [e.g., 11]. Moreover, chatbots are increasingly discussed to support the internal communication within organizations [26, 38]. According to a recent interview study by Meyer von Wolff et al. [32], practitioners see internal/external support, human resources, (employee) self-service, employee training and knowledge management as promising areas for chatbots to foster the communication within the workforce [e.g., 27, 37, 52]. However, using chatbots as part of companies' ecological sustainability efforts – generally or within the workforce – is neither covered in current research nor tested by practitioners so far. In this paper, we address this research gap by the design, development and first evaluation of the chatbot KlimaKarl that promotes environmental sustainability within the workforce. While singular chatbots to support environmental education, e.g., AluxBot for school-age children [cf. 34] or to encourage sustainable mobility behavior exist [cf. 13], our target audience is the company employee in particular.

3 Methodology and Research Design

To come to a prototype of our app KlimaKarl, we conduct a DSR project [cf. 18, 21] and follow the procedure of Peffers et al. [35]. Figure 1 summarizes the steps of the design procedure. The problem statement (Step 1) has been formulated in the introduction. In Step 2 (Objectives of a Solution), we derive requirements on our prototype (1) by reviewing corresponding fields of literature, (2) by examining the German B2B market for similar chatbots, (3) by discussing the chatbot usage in an office environment with company representatives at a workshop, and (4) by conducting a survey at a city fair where we asked 98 office employees about their requirements for KlimaKarl. Hence, we consider the existing field of literature (DS rigor cycle) but also the practical application context (DS relevance cycle) [e.g., 20]. Step 3 (Design & Development) includes design-related decisions as well as the implementation of the prototype by help of suitable

frameworks and open source solutions. The next step (Demonstration) deals with the demonstration of the prototype at two companies from the energy and retail sector to assess its general practicality. In Step 5 (Evaluation) the usefulness, applicability and usability [cf. 21] of the prototype are to be analyzed in more-depth in a larger field study. Subsequent to the evaluation, the app will be revised and further optimized before a large-scale roll-out across German companies will be performed.

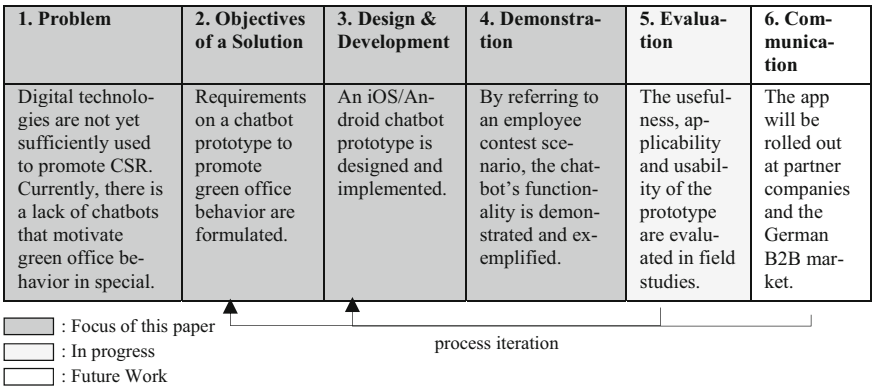


Fig. 1. DSR procedure by Peffers et al. [35] adapted for this research.

4 Objectives of a Solution

To collect and select specific requirements for the chatbot's design and functionalities, we considered different perspectives from research, market, customer, and user. Figure 2 visualizes the collection and selection process.

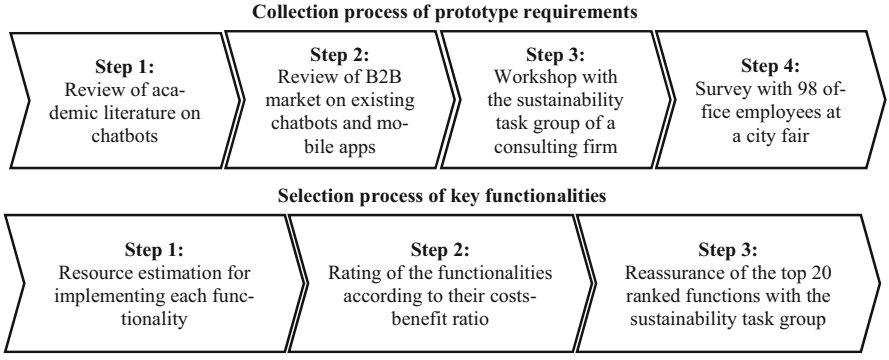


Fig. 2. Collection and selection process of functionalities and requirements.

To derive design requirements, we scrutinized the literature [49] about chatbot design at first to find generally acknowledged design propositions concerning the implementation of chatbots [e.g., 4, 15, 22, 24]. Moreover, design principles for IS in green

transformation projects were considered [e.g., 44]. In a second step, the B2B market was searched for similar digital technologies and chatbots. Although there are a number of technologies to promote climate protection in companies (e.g., PlanA, Planetly, CoZero), we could not find any chatbots nor innovative solutions to promote green office in particular. While existing innovative technologies enable the analyses of a company's CO_2 emissions based on data, the promotion of employees' behavioral change is not sufficiently covered. When expanding our search from innovative technologies to common mobile apps we found existing services (Changers and Stadtradeln), which offer activity tracking and contest design functionalities. Although the appstore ratings for these apps contain some user reservations, they inspired us in designing gamification and tracking functionalities for our chatbot prototype. In a third step, we gathered additional requirements in a workshop at a multinational consulting company. In total, three company representatives, one of the authors and one research associate participated. All company representatives held the position of a "consultant". The company representatives were selected for the workshop because they were members of a sustainability task group. This group's major aim is to develop measures for integrating climate protection and sustainability efforts within the corporate strategy. In a five-hour-workshop, the participants first brainstormed new ideas on functionalities that were not covered by our initial collection yet. The attendees then jointly ranked the ideas in terms of their perceived value for users. Fourth, a survey was conducted at Breminale, a German city fair. In total, 98 office employees were asked about their personal requirements on a prototype to foster environmental-friendly behavior in an office setting. The city festival which took place in July 2019 in a large German city was chosen for the survey, because it usually attracts a very heterogeneous group of people. Visitors were randomly approached and asked whether they worked in an office environment. If so, they were explained the KlimaKarl project and requested to fill out an online questionnaire that could be accessed via their private mobile phones (by help of QR codes) or via provided iPads.

For realizing a first version of the chatbot KlimaKarl, the 32 initially collected requirements were condensed and prioritized in three steps. First, the authors, a research associate and a developer performed an initial resource estimate for each functionality. Second, this group rated the functionalities according to their ratio of potential value and development effort to come to a distinction between must-have and nice-to-have functionalities. Finally, the resulting ranking of must-have functionalities was rechecked with abovementioned workshop attendees at the consulting company. Lastly, our group came up with a manageable set of 19 must-have design requirements (DR). Table 1 lists and shortly explains the requirements. Thereby, the requirements for the first four categories have been identified as specific for our solution, whereas the requirements considering "user management & backend system" are generally acknowledged for this type of technology at large [e.g., 24].

Table 1. Requirements.

Design requirements	Description
Principal functionalities	
DR 1: Push-notifications with daily information about climate protection topics	Users receive notifications and interesting facts regarding climate protection topics [44]. They have the opportunity to rate the relevance of each notification from their personal point of view by help of a star rating-scale
DR 2: Chat function to document completed tasks related to green office behavior	A chat function is realized, which allows to mark completed tasks (e.g., vegetarian lunch, turning off lights, using public transportation) by help of buttons in the categories of nutrition, energy and mobility. Each button is associated with certain credit points regarding CO_2 savings [44, 45]
DR 3: Calculation of the kilometer distance of a route	The chatbot queries how users have covered a distance, e.g., by bike or train. If desired, the chatbot calculates the number of kilometers of the distance automatically in case the user enters a start and end address
DR 4: Continuous feedback to scores	The chatbot reacts with the total number of points scored and with mimic art to give user feedback [4, 15, 24]. Hence, employees are motivated to continue their climate-friendly behavior
DR 5: Instructions for team challenges	Employees (and teams) are provided with "green" challenges [44–46]. When they complete a challenge, employee teams trigger a green donation from the employer, such as the compensation of distance kilometers or the planting of a tree
DR 6: Employee surveys	The chatbot gives employees the opportunity to submit their own ideas for more climate protection in the company in a weekly survey [42, 44]. For this purpose, an additional button appears in the chat, which leads to a freeform text entry
DR 7: Quizzes	The chatbot conducts a weekly quiz with employees, through which they can earn additional points [39, 46]

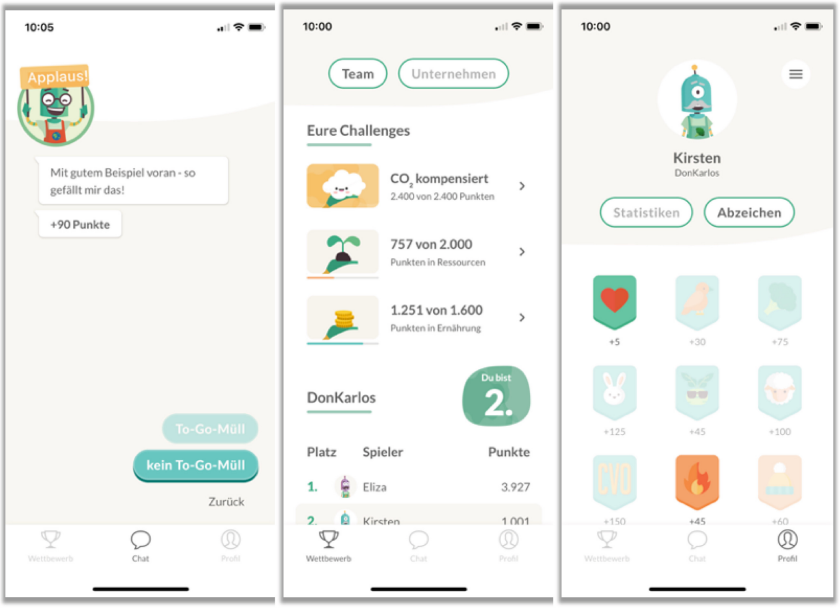
(*continued*)

Table 1. (*continued*)

Enterprise dashboard	
DR 8: Ranking and current position of all teams	Employees form teams and the scores of each single employee are aggregated. In a dashboard, the ranking of each team is shown [46]
DR 9: Donations for "green projects"	The total amount of money, which was triggered by all employees and donated by the company for green projects is listed
Team dashboard	
DR 10: Individual ranking	The ranking of each employee within each team is provided [46]
DR 11: Progress indicator for the team challenges	Each employee team can perform challenges [39, 46], which require a particular score of points per category, e.g., nutrition or mobility (see DR 2). The progress of a team's task fulfillment is indicated by the chatbot
User dashboard	
DR 12: Badges	Every employee can collect badges [19]. To receive these badges, they must have completed certain green tasks several times in a row. The more difficult the badge is to reach the more extra points are generated
DR 13: Personal statistics	Each employee receives an overview of personal statistics, e.g., a weekly overview of the points achieved daily, the amount of CO_2 emissions avoided and points achieved per category
User management & backend system	
DR 14: FAQ-section	A section with answers to FAQs is provided
DR 15: Support for finding teams	The chatbot helps to form teams by proposing users that are still in search for a team
DR 16: User data management	The user can modify her/his master data (e.g., nickname, name, password) any time
DR 17: Backend system	The backend system allows to modify the provided content, the chatbot's layout or granted scores amongst others
DR 18: Transition design	The chatbot follows the transition design guidelines [cf. 30] to promote sustainable design
DR 19: Branding	The backend system allows to brand the mobile app with the company logo on the loading and setting screens

5 Design and Development

The prototype's general architecture was developed to be executable via the operating systems iOS and Android. For that purpose, the Google Flutter framework was used for implementing the frontend and the Express framework for the backend. Thereby, the programming languages Dart and TypeScript were applied and we built on the integrated development environments Xcode, Android Studio and Visual Studio Code. Furthermore, the bcrypt solution was used to create the login functionality. The communication between the front- and backend – but also the internal communication within these blocks (front-/backend) – was realized by help of REST (Representational State Transfers) APIs and the standards HTTP and JSON. In addition, MongoDB was drawn upon to establish the database and the database management system. A first design of the user interface, that matched with the design requirements, was discussed and revised by the development team using wireframes. Initial wireframes of the KlimaKarl prototype were sketched by hand and prepared the ground for a more fine-granular design produced via the Adobe XD Design Kit. In the course of the implementation, templates of Google Material Design and icons of Evil Icons were used. As an external service, the Google Distance Matrix API was referenced to realize the calculation of distances (see DR 3). Figure 3 shows three selected design examples of the prototype's principal functionalities. We plan to extend the chatbot's functionalities, e.g., by the capability to give answers to open questions, in future revisions.



(DR 4) Feedback by text and mimic art

(DR 10) Individual employee ranking

(DR 12) Badges

Fig. 3. Selected screenshots of the app.

6 Demonstration and First Evaluation

For demonstration and evaluation purposes, the KlimaKarl prototype was field-tested in September 2020 in cooperation with two companies and 74 voluntary office employees to see, whether the artifact is practicable in an entrepreneurial context. One company provides advice on energy efficiency in a German federal state and recruited 21 participants to take part in our field test. The other company is globally operating in the retail sector and recruited 53 participants at its German headquarters. The chatbot was tested as part of the two-week CO_2 saving competition with KlimaKarl. As part of the contest (1) employees entered completed tasks via buttons in the chat and received feedback on the points achieved, (2) they took part twice in an employee survey, (3) they received and rated the daily tips with stars, (4) they could achieve team challenges and thus trigger various donations, (5) they could unlock badges for repeated tasks and (6) they had an overview of their ranking and statistics in the company, team and user dashboard. Finally, the winning team was announced by releasing the ranking and a newsletter to all participants. From a technical point of view, the test of the prototype worked well, except for a few minor details. Two participants stated that the chatbot was not accessible on one day. One participant did not receive any push notifications, although he declared to have activated them. From a content perspective, the field test revealed potentials for improvement, particularly considering the documentation of completed tasks. The rankings, tips, badges and some other features were praised. However, the participants wished for more variety in the dialogue with KlimaKarl. A concrete suggestion was to add more tasks or days on which tasks count double points.

Besides the general demonstration of the prototype's practicability, we further wanted to test its usability and see whether it can promote behavioral change. Therefore, the employees taking part in the field-test were asked to fill out an online survey[1]. Of the 74 employees, 25 filled out the questionnaire. To test the usability, we used the System Usability Scale [7] on a five-point Likert-scale. Participants rated the usability of the prototype with an average score of 3.89 (standard deviation: 0.56; max. score: 5; min. score: 1). Thus, the app was rated as rather easy to handle and user-friendly, but still leaves room for improvement. To check whether employees have the intention to behave in a more climate-friendly in future, we used designated question items for "desire" and "intention" from the expanded Theory of Planned Behavior [36] with a five-point Likert-scale. The 25 respondents rated their desire to behave in a more climate-friendly way after using KlimaKarl as an average of 3.5 (standard deviation: 0.88; max. score: 5; min. score: 1). Their concrete intention to do so was rated as an average of 3.3 (standard deviation: 1.23; max. score: 5; min. score: 1). Hence, the results of the first evaluation indicate the chatbot's potential to increase employees' climate-friendly behavior. To test whether the participating employees behaved in a more climate-friendly way while using the prototype, we asked them to indicate whether they performed a certain set of climate-friendly tasks more frequently than before using KlimaKarl. Figure 4 summarizes the results. Eating habits changed significantly: 18 of 25 respondents (72%) have eaten vegan or vegetarian food more often during the use of KlimaKarl than previously.

[1] The questionnaire is available at: https://tinyurl.com/y6mbbwnf.

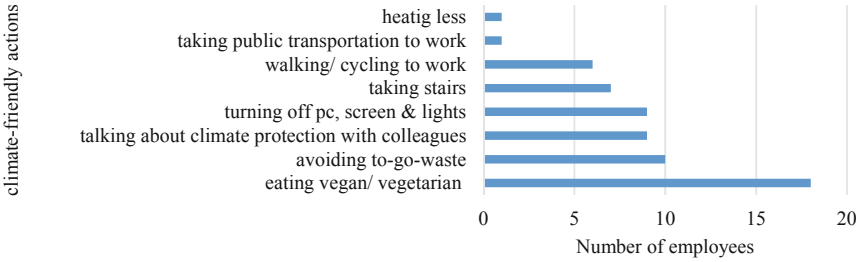


Fig. 4. Climate-friendly activities performed more often while using the prototype.

7 Discussion and Conclusion

Although chatbots have received increasing attention in literature, their use as part of companies' environmental sustainability efforts is not sufficiently covered by current research yet. A review of existing apps and chatbots on the German market shows that companies are already using digital technologies in a business and office context. However, they do not yet sufficiently do so to promote their CSR. Considering that climate protection is one of the most important challenges of our time, our research aims to address this research gap and to trigger a discussion of whether chatbots can promote climate protection or not. We therefore developed a chatbot prototype called KlimaKarl that promotes climate-friendly behavior of employees within companies. Results from the demonstration and first evaluation are encouraging. We could show that our prototype is of rather high usability and may motivate people to behave in a more climate-friendly way. However, this first evaluation of the KlimaKarl prototype has limitations. First, only employees of two particular companies participated. Since corporate cultures and sustainability strategies can differ considerably, additional study participants from more companies have to be recruited in future evaluation steps. More, since the respondents filled out the online survey voluntarily, a self-selection bias could probably be given. Furthermore, future evaluation measures for behavioral change should be based on revealed rather than self-reported behavior, e.g., by means of experiments. However, at this stage of the chatbot development, the goal was not to precisely quantify the desired effects, but to find out whether KlimaKarl has the potential to influence employees' behavior or not. The contribution of this research for practice is twofold. At first, managers will receive a running chatbot solution to motivate their employees for green office behavior and integrate climate protection into the company culture. Therefore, means to support running CSR efforts are given. Second, the use case of KlimaKarl may provide inspiration for managers to examine the appropriateness of other digital technologies to promote climate protection within an enterprise (e.g., big data analytics). We contribute to research by complementing the lively discussion of how chatbots may be purposefully used for internal purposes [e.g., 32]. In this respect, we introduce "green office behavior" [14] as a further application field, that may profit from the chatbot technology. Finally, the results from the evaluation conducted so far may trigger further investigations in the IS community to analyze the sustainability of changes in employee behavior by help of digital technologies.

In future steps, we plan to extend the chatbot's functionalities (e.g., by the possibility to ask open questions) and to run more evaluations at several companies with varying cultures. We also intend to evaluate the app more in-depth in order to maximize the chatbot's ecological impact in the office environment. After a corresponding revision of the prototype, we plan to make the chatbot available to German companies this autumn. Depending on how KlimaKarl will be accepted in practice, we would be happy to translate the app to other languages and make it available on an international level.

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