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International Conference on Industry Sciences and Computer Science Innovation

An intelligent platform-based tool for the development of digital transformation strategies

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Abstract

Digital transformation strategies are of elementary importance for organizations competing in the digital age. Challenges such as faster changing customer needs, new value creation structures in digital eco-systems, or the use of collective intelligence to innovate business models require leveraging digital technologies. To achieve this and remain competitive, appropriate digital transformation strategies need to be in place. Yet, studies show that organizations struggle with strategy formulation and implementation. Based on workshops with practitioners the authors obtained concrete needs, pains, and gains as requirements for the development of an own, new intelligent and platform-based assessment tool. The proposed tool collects, calculates, and visualizes in a self-service manner, relevant company data to support decision-makers and organizations in digital transformation strategy development and implementation.

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Keywords: Digital Strategy Development, Digital Maturity Assessment, Online Assessment

1. Introduction

Organizations today face manifold challenges related to digitalization. For example, influenced by digitalization, customers become prequalified, self-determined, individual with specific needs, multi-optional, and hybrid [1], making it more difficult for organizations to address and convince customers or group them into segments. Digitalization also enables a reduction of transaction costs. Organizations can reduce their sizes and become more agile while being able to focus on their unique value contribution and reacting faster on changing customer needs [2], [3]. Also, new structures of value creation, such as digital eco-systems can be observed. For organizations, the question becomes relevant of whether they want (or are able) to participate in new value creation structures [3]. The use of collective intelligence offers opportunities to discover new business ideas [4]. These and other challenges force

organizations to rethink and innovate their business models constantly, to continuously offer innovative products, services, and processes, since value creation is a fundamental element of the digital transformation and ultimately of the organization's strategy and vision [5]. The digital transformation of the organizations offers a competitive edge to gain higher efficiency as well as cost reduction. In the process, fundamental changes are necessary to harvest the opportunities offered by the usage of digital technologies [6]. Our research shows, in an organization, different personas with different requirements, pains and gains need to be addressed and included into digital transformation strategy development. In this paper, the authors present an intelligent and web-browser accessible platform-based tool supporting the digital transformation strategy development, called Digital Backpack Assessment. The tool helps companies understanding and assessing their current strategy. This leads to increased transparency about the current situation and helps to build the foundation for the definition of the target state and of the strategic goals for achieving this target state. The tool provides user-friendly data collection, real-time data calculation, and target-group oriented data visualization, and offers the opportunity to include relevant stakeholders according to their requirements, and pains and gains into the digital transformation strategy development process. The tool has been developed in several research projects and is already used in industries like hospitality, trustee, energy, health, and construction. The paper is organized as follows: Section 2 examines the existing literature with regards to digital transformation strategy development and discusses its importance from an organizational point-of-view, also considering difficulties and implications for solutions. Section 3 introduces the methodological approach, before in section 4 the identified requirements, and prevailing pains and gains from organizational stakeholders during the digital transformation strategy development are addressed which form the basis for the development of the proposed tool. Section 5 presents the creation and functionalities of the proposed tool, including detailed explanations with regards to data collection, calculation, and visualization. Section 6 concludes this contribution and opens avenues for future research.

2. Literature review on the development of digital transformation strategies

For organizations to leverage digital technology in a sustainably advantageous and value adding way, a clear strategy needs to be in place [7], which is essential for the long-term success of a business [8]. A digital transformation strategy is needed to govern the processes of deploying and operating digital technologies in organizations [8], and digital initiatives need to be aligned in a clear digital transformation strategy [9]. According to [6] a digital transformation strategy needs to cover different areas in an organization, such as customer centricity, the business model, organizational excellence, and operational excellence. Also, the interdependencies between the different areas must be identified and treated accordingly, and the derived strategic goals must be placed in a roadmap. Every digital transformation strategy is uniquely configured to fit the organizational circumstances and needs [10]. For a company and its decision-makers, it is necessary to know their current situation, needs, and capabilities to develop such a unique digital transformation strategy [6], [11], but also to be aware of the technological possibilities to develop a strategy around technologies [12]. In that sense, the digital transformation strategy must be clearly defined, with clear outcomes, and aligned with the business strategy and digital efforts [13], [14]. An important part in a digital transformation strategy is the vision which must be clearly defined first [13]. The vision then needs to be operationalized by defining clear strategic goals [15], formulated in a formal document, and defined and accompanied by a roadmap [16]. Yet, organizations struggle with implementing digital transformation strategies as studies show. For example, according to [17] 66 to 84 percent of digital transformation projects fail. A major challenge is the consistency between strategy formulation and implementation [18]-[20]. For organizations in the digital age, to consider more open strategy-based approaches that aim at more transparency and at the inclusion and participation of stakeholders, respectively the people that formulate and implement the strategy, into the strategy-making process to make the best use of the collective intelligence available to an organization, offer an alternative to traditional closed approaches, and to increase consistency between formulation and implementation [4], [21], [22]. Yet, this goal is difficult to achieve, since the "to-be involved" stakeholders need to be addressed and included in the process in a target group-oriented manner, depending on their requirements, and pains and gains. To enable this participation of the selected relevant stakeholders into the process of digital transformation strategy development is one of the main requirements of the tool proposed in this paper. Maturity models help organizations to assess their current state and

identify areas to improve. The data collected through the assessments help organizations to gain transparency about their current state and to compare this through benchmarking with other organizations in the same or other industries. Especially when it comes to making decisions where to invest in innovation and digitalization, decision-makers often require decision support [23]. Digital maturity models offer a structured and analytical method to measure different digital aspects of an organization.

3. Methodology

The research methodology for the development of the tool follows the design science research (DSR) approach [24] which strongly integrates the relevant environment and the knowledge base into the research to ensure relevance and rigor of the research in multiple development cycles. Following previous research [25], the authors have subdivided the design cycle of the DSR approach into the phases awareness, suggestion, development, evaluation, and conclusion. In the awareness phase, the authors recognized the practical needs for the tool and conducted research for publications and existing solutions in the market to identify only insufficient coverage of advanced intelligent solutions, therefore marking a research gap. A comparative analysis of related existing solutions is available upon request to the corresponding author. In the suggestion phase, the requirements analysis and design (software architecture, interfaces, etc.) took place, based on findings from the literature and extended. In the development phase, the authors have started to create iterations of the artifact to solve the problem considered in the awareness phase. This corresponds to programming and implementation in software development. The development phase was based on iteratively implementing prototypes which were evaluated during five workshops with each 7 to 10 hospital representatives and healthcare consultants, and by using their pilot user accounts. Feedback was collected and integrated into the further development of the final prototype. Hence, as suggested in the DSR concept, several iterations of the design cycle were conducted for continuous improvement of the prototypes. Our previous experiences in developing practitioner-oriented solutions for maturity analysis were valuable as well. The most specific input for requirements, however, resulted from the workshops conducted with the practitioners consisting of hospital representatives and consultants in the healthcare field. Five workshops have been conducted to get feedback about information relevant for maturity analysis, about aspects regarding relevant and information-rich analysis of the collected data, its usage for benchmarking purposes, and about aspects regarding a preferred user interface including specific roles of users, and user-friendly visualizations. Artifacts were used for specifying the design of the solution such as mock-ups of user interfaces, slides, and technical documents for specifying the ideas of the maturity model, the questions and workflow for maturity assessment, approaches to the analysis of data for internal and external benchmarking purposes and regarding further analysis based on machine learning. The workshops for defining the requirements specifications were based on [26] moderation method aiming to actively involve and lead the participants in a structured manner to explore a topic and stimulate a creative exchange. The moderation method can be used to investigate complex subject areas or during planning and change processes [26]. The five workshops with between 7 and 10 participants from healthcare were held from October 2021 to January 2022. Every workshop had an overall introduction of the topic and specific goals. For each task, participants were asked to generate ideas. Either the participants or the researchers took notes. After each workshop there was a debriefing where the findings were discussed in the group. Each subsequent workshop built upon the findings of the previous one. In between the workshops the results were revised and analyzed. At the beginning of each workshop, the revised results were then presented to the group. For workshop 1 (WS1) the objective was to develop different personas to gain an understanding of the future users of the platform-based tool. WS2 required the participants to formulate specific requirements for the tool. In a second step extensive literature analysis took place to define a first set of questions and the maturity levels. More information can be found in [32]. In further workshops the authors have evaluated the questions and the first prototypes of the tool. The goal was to directly involve potential end-users to the development steps of the tool. The feedback was used to improve the tool in several iterations. The moderation method used in the workshops was characterized by using visualizations, focusing, streamlining, and simplifying the content for the group [26]. In addition, targeted question and answer tools further stimulate the process. In all workshops, visual artefacts, such as frameworks or models as well as the platform were used as tools.

4. Defining the requirements

In WS1, the goal was to develop personas of future end-users of the platform, on which the future requirements and user-roles were derived. Eight personas were created. Persona boards were used as templates. Figure 1 shows two examples of persona boards.

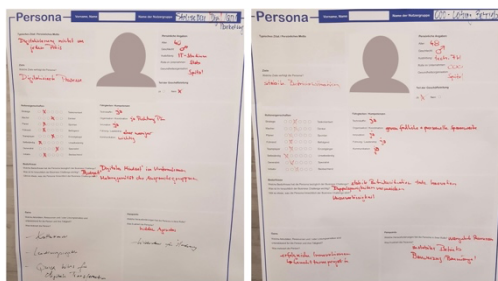


Fig. 1. Examples of two filled-out persona boards during the workshops.

Each group was given between three and four boards to fill out. Participants were divided into groups of two to three persons. Table 1 shows the results of the WS1, with the eight personas and their roles.

Table 1. Overview of the requirements.

Persona	Requirements	Pains and Gains
Executive Board	Efficient and effective operations	Restriction of entrepreneurial freedom good networking and cooperation, good press
Chief Executive Officer (CEO)	Transparency of the current state, input to the desired state, comparison to the benchmark	No transparency, difficulty in setting priorities, silo thinking, lack of resources. Legitimization of strategic priorities, involvement organization, less resistance, Cooperation with other companies/organizations
Operations management	Understand where to invest (prioritization of investments) / non-implementability interferes	Legitimacy (towards CEO), lack of resources for innovation topics, lack of adequate structures and acceptance, errors, quality deficiencies A wealth of expert knowledge, new services for customers, lighthouse projects as example of successful innovation
Chief Operations Officer (COO)	Stable operating situation despite innovation, avoid redundancies	Lack of resources, unstable operation construction delay / construction defects Successful innovations, lighthouse projects
Head of finance and controlling	High Return on Investment (ROI), compliance with regulations, standards, etc., reduction of costs	Low Information and Communication Technology (ICT) quality, failure to achieve Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA) target, planning uncertainty, business case. Process optimization, Efficiency increase, cost reduction, increasing revenues, decreasing costs, Key Performance Indicators (KPIs), comparative data to gain knowledge
Head of technology	Solutions should be on the equal level with competitors, support own work and be innovative	Fear of job loss, lack of measurability and comparability Argumentation for investments (“others have also...”)
Sustainability management	Solutions that are not only state-of-the-art, but are also sustainable	Lack of prudence, lack of sustainability in procurement Possible insights into which solutions pay off in terms of sustainability: lower energy costs, longer service life

WS2 expanded on the defined pains and gains for each persona, delineating requirements specifications to overcome pains and enhance gains. The output of this WS2 served as direct guidance for the development of the tool. The participants voiced the requirements to differentiate the specified priorities for action using a gradation of strategic, tactical, and operational levels. This corresponds to a common approach in defining hierarchical functions in business management [27]. For each of these hierarchical levels, the participants expressed the desire to have the current digitalization level assessed. Thereupon, the fields of action should be indicated, as well as the necessary digital requirements specified. At the strategic level, according to the requirements expressed by the workshop participants, it should be possible to compare sectors per segment. On the tactical and operational level, dependencies on the process

level and best practices would be desirable. Particularly at the tactical level, with focus on middle management, requirements for skills management were deemed important. The participants agreed that the platform should help companies to make the right decisions. Summarizing, the derived requirements are the following: (1) Holistic, the entire company needs to be illuminated, so that detailed analyses can be performed as needed (extensive maturity models). (2) Objectivity, participation of multiple stakeholders needs to be ensured to obtain 360-degree transparency and to break down silos. The platform needs to help identify the divergence of opinions among stakeholders. (3) Measurement of progress, it must be possible to conduct the assessments periodically, so that the platform can show and assess the progress of transformation. (4) “Self-image” vs. “external image”, the comparison of a company's own strategy vs. the experts’ opinion needs to be enabled. (5) Real-time analysis with the dashboard, assessment participants need access to benchmarking function directly after participation to cut out waiting times and loss of momentum and motivation. (6) Access system, an easy-to-use philosophy needs to be followed. The company administrator as key user registers the company, invites stakeholders to participate, starts the assessments, and has access to the overall analysis via the dashboard. Users (invited stakeholders) can complete the assessment and see their own analysis on the dashboard. (7) Personalized assessments, to increase participation and inclusiveness, assessments need to be formulated in a personalized and inclusive (but anonymized) manner depending on participants. (8) Flexibility, to better cover the needs of each industry or focus of the assessment, the questions should not hard coded in the tool but editable. The analysis of existing tools for maturity analysis showed that none of them fulfil requirements (3) to (7).

5. The functionality of the assessment tool

In this section the Digital Backpack Assessment tool is discussed. At the core of the data collection is the maturity model, as described by [28] previous work which determines the areas where questions are asked. According to [29] previous work, the tool can be abstracted in the three main areas “data collection”, “data analysis”, and “data visualization”. Within “data collection”, participating organizations are registered, including the organization’s assessment participants (i.e., employees, referred to as users), and invited for participation. Section 5.1 discusses the questionnaire in more detail. Within “data calculation”, the collected assessment data is analyzed, following the structure of the maturity model [28]. The calculation formulas have been described by [29] previous work extensively. The equations are shown in section 5.4 in a summarizing manner. Within “data visualization”, the assessment results are made visible in the self-service management dashboard, as described in more detail in section 5.5. The tool has been implemented with a content management system and thus several maturity models can be supported. This allows that the assessment tool includes specific questions for industries or for specific topics such as digital leadership. Figure 1 shows the maturity model for the health sector which captures five core areas (level 1) “organizational excellence”, “operational excellence”, “customer centricity”, “process excellence”, and “ecosystems”. For each core area, several categories (level 2) with several indicators (level 3) are asked as questions during the data collection. The goal of the data collection is to identify, through self-assessment, the areas of the organization where action priorities should lie by picking up the current strategic direction of the company, and the satisfaction of its implementation. Below the main features of the data collection are discussed.

5.1. The structure of the assessment questionnaire

To get a 360-view over the organization, several stakeholders of the company are invited to participate in the assessment. The “company administrator” who defines in the assessment tool the organization’s structure, invites the stakeholders, and assigns the appropriate roles. Figure 2 illustrates an example of maturity questions. On the left, the whole maturity model is visible. In the middle, the questioned indicators are visible. As described by [29] previous work, the organizational areas of interest (i.e., the questionnaire items) are structured along three levels of detail, starting with a “strategic question” (level 1) to the overall strategic relevance of a topic in question, continuing with a “strategic question” (level 2) to the strategic relevance of a respective more specific sub-topic, and finishing with a

“maturity question” (level 3) to the perceived importance of, and the perceived satisfaction with the respective sub-topic.

Fig. 2. An example of a questionnaire on the platform.

5.2. Roles in organizations

In organizations, people fulfil different roles needed to fulfil the organization’s purpose, and to achieve the organization’s goals [30]. Following this, these roles are relevant for the existence of the organization, otherwise the roles would not exist in the first place. Also, via these roles, employees can influence the organization [31]. Therefore, these roles can be considered relevant for the organization’s future existence, its development, and digital transformation. The authors argue that successful digital transformation can only be achieved and sustained if such relevant roles, and therefore the people in an organization who fulfil these roles, are included in the transformation process, its underlying process steps, and the activities conducted to move forward the transformation. The proposed tool offers the possibility to include the voice of different relevant roles existing in an organization with role-specific assessment questions. These role-specific assessment questions consider role-relevant topics and are formulated using terminology which is commonly understood by representatives of a specific role.

5.3. Dynamic assessments

Even though organizations are aware of the importance of the assessment and development of digital transformation strategies, they do often not have the required resources to spend much time and effort on the proper conduct of such assessments, and the monitoring and re-assessment of the successful implementation of the defined strategic measures. Reasons can be a lack of top management support, inadequately trained staff or team composition, wrong selection of improvement strategies and techniques, an inadequate rewarding system, or resistance to change [32], which lead to poor commitment of the involved parties. Often only an initial assessment is performed, and only initial measures are defined, but the value of the assessment and the measures cannot be captured by the organization, since the process is not pursued till the end, and the commitment of the involved stakeholders vanishes over time. To overcome this issue, the proposed approach offers the possibility to conduct dynamic assessments on an ongoing basis to constantly monitor the progress of the successful implementation of measures, and to keep alive the commitment and sense of urgency of the involved stakeholders for the digital transformation strategy, and to induct the change step-by-step.

5.4. Data calculation

Calculation of the action priorities. The core of the data calculation is the calculation of action priorities, as shown by the following six equations which have been discussed by [29] previous work. Equation 1 shows the “need for action on level 2”. Equation 2 shows the “relevance on level 2”. Equation 3 shows the “action priority on level 2”.

Equation 4 shows the “relevance on level 1”. Equation 5 shows the “need for action on level 1”. Equation 6 shows the “action priority on level 1”.

$$NfA_2 = \frac{(\text{SatVal}_3 + \text{ImpVal}_3)}{2} \quad (1)$$

$$Rel_2 = StVal_2 \quad (2)$$

$$ActPrio_2 = \frac{(NfA_2 + Rel_2)}{2} \quad (3)$$

$$Rel_1 = \frac{(StVal_2 + \sum_{k=0}^n Rel_{2k})}{2} \quad (4)$$

$$NfA_1 = \frac{\sum_{k=0}^n NfA_{2k}}{n} \quad (5)$$

$$ActPrio_1 = \frac{Rel_1 + NfA_1}{2} \quad (6)$$

For the organizations under assessment, the results regarding action priorities offer valuable insights. Yet, this is not sufficient. For decision-support to be of value for decision makers, the results need to be comparable and be put into perspective. For that, also benchmarks are calculated, as discussed in the following.

Calculation of the benchmarking. The aim of benchmarking is to offer a more detailed view over the collected data with several comparisons. Additional calculations must be considered. The actual values to be compared can be selected as “need for action”, “satisfaction”, “importance”, “strategic relevance” or “maturity level”. To decide the granularity of the comparison in the internal benchmark, the values can be filtered according to “units”, “users” or “assessments”. When comparing the “need for action” or the “strategic relevance”, the level 2 values within the company are averaged for all level 2 categories. For “satisfaction” and “importance”, the values from all level 3 maturity questions are averaged into the corresponding level 2 categories. To compare “maturity levels”, the approach is the same as for “satisfaction” and “importance”, with the difference that only certain selected level 3 maturity questions are considered (so that they represent a specific maturity level) and averaged into ten different maturity levels. The calculated averages are then grouped into the selected filter criteria (“units”, “users” or “assessments”) so that they can be properly compared. Besides a general comparison of all level 2 categories in a spider diagram, it is possible to view deviations and overlaps of two “units”, “users” or “assessments”. At what point a level 2 category is considered overlapping or deviant is based on already collected data in the industry. For each category, difference-thresholds are calculated for each of the filter criteria. To calculate these thresholds, data is averaged into level 2 categories and grouped into “users”, “units”, or “assessments” from the entire industry. Then, all the groups are compared with one another, and the absolute difference is calculated. This results in $n*(n-1)/2$ absolute values (with n being the number of groups), of which the 20 and 80 percent-quantiles form the difference-thresholds. Categories which differ less than the 20 percent-quantile are considered overlapping, whereas categories which differ more than the 80 percent-quantile are considered deviant. Similarly for the calculation of the outstanding “users”, “units” and “assessments”, thresholds are calculated. This time, however, the actual values of the groups are considered, of which the 20 and 80 percent-quantile form the value-thresholds. In the external benchmark, the values are averaged over the entire company, comparing it with the average of all the other companies in the same industry (excluding the company itself).

5.5. Data visualization with a user-friendly dashboard with selectable information

The collected data is analyzed in real-time, and the results are displayed in a dashboard for decision-makers and other involved stakeholders such as strategy consultants. The dashboard covers a 360-degree view, including focus areas, internal and external benchmarking, and a zoom-in function, which allows to obtain more information about the opinions of the participants. The dashboard allows decision-makers to use collective intelligence, and to base decisions

on the consideration of input coming from individual members of the organization. It highlights focus areas that are of particular importance for a company and presents possible recommendations for actions to improve focus areas which are underdeveloped. Furthermore, it provides an internal and external benchmarking where the assessed maturity levels of the different company internal departments, or of external competitors operating in the same industry are displayed in radar charts to be compared. Figure 3 shows an example.

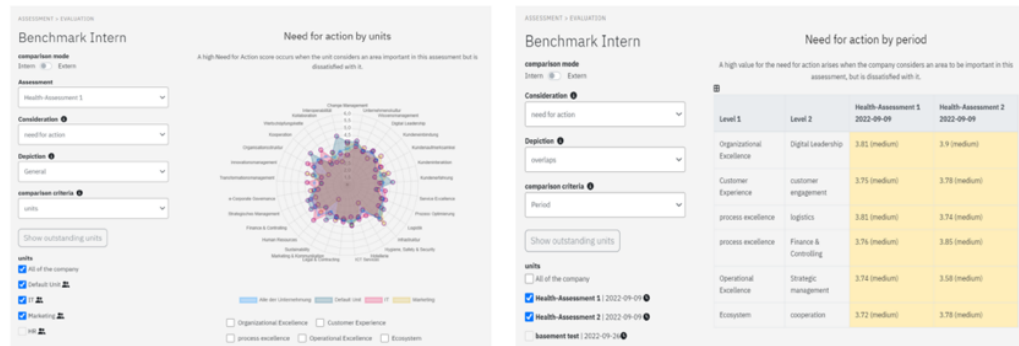


Fig. 3. An example of the dashboard.

To ensure user-friendliness and readability with a meaningful user interface, stakeholders are supported with different colors for the focus areas, each spider diagram (radar chart), and for the internal and external benchmarking. A spider diagram is suitable to get a quick overview. It is also possible to show or hide different comparison factors, and to make differences and similarities visible through overlay. For its implementation Vue.js and JavaScript were used. The data stored in the back-end of the platform will be displayed. It is possible to interactively show or hide different depths of information, depending on the stakeholder needs, to reduce complexity. The internal and external benchmarking offer a good starting point for decision-makers. With the different filtering options and charts, it reveals (dis-)agreements within the company on different levels, as well as allows for an in-depth comparison of “users”, “units” and “assessments”. The analysis of data not only within the company, but also within the entire industry, offers a valuable basis for an external analysis to identify weaknesses and strengths in comparison to the industry. Moreover, thresholds for level 2 categories can be calculated to represent overlaps and deviations more realistically within the company, as it is based on empirical data. For decision-makers, it is difficult to use collective intelligence without investing more time and resources than the output would justify. This is where the authors want to start with the dashboard and harness collective intelligence. As also described in the data collection, the assessment collects various dimensions of interest about the company. This allows decision-makers to determine precisely which areas are underdeveloped and where to focus their efforts on. This is made visible in the dashboard with the zoom-in function. This results in data points that reflect various dimensions how assessment participants have classified a particular issue on an ordinal scale. In addition, a free text from the assessment participants is stored for each of these data points (e.g., the explanation why an area has been rated in a certain way). To make the free text visible in an intelligent way, custom graphs are created. This can be represented like a map with N corners, where each corner stands for one of the evaluation dimensions. On this, all data points, i.e., the evaluations, are classified. When a user clicks on a data point, the free text is displayed.

6. Conclusion

Digital transformation strategy development is a task of elementary importance for organizations competing in the digital age. Digitalization poses manifold challenges, such as faster changing customer needs and expectations, new value creation structures in digital eco-systems, and the use of collective intelligence to innovate business models and to remain competitive. But these challenges can also be seen as opportunities. To leverage digital technologies and

harvest opportunities, organizations need to develop and implement a digital transformation strategy. Nevertheless, studies show, that organizations struggle in doing so. By identifying needs, pains and gains of potential organizational stakeholders, the authors extracted concrete requirements needed for the creation of an own, new intelligent and platform-based tool which helps organizations to overcome these struggles. Via an online assessment questionnaire, the tool collects, calculates, and visualizes in real-time relevant company data. The goal of the data collection is to identify, through self-assessment, the areas of the organization where action priorities should lie by picking up the current strategic direction of the company and defining the target strategy goals. To create transparency about this current strategic direction and the satisfaction of its implementation, the tool offers benchmarking functionality with different filtering options and user-friendly charts. This allows to reveal (dis-)agreements within the company on different levels.

Limitations. The calculation of the thresholds for the deviations and overlaps is currently based on the absolute deviations between different groups (users, units, or assessments), which results in $n*(n-1) / 2$ total calculations. The computational complexity of said formula exhibits a time complexity of $O(n^2)$ and therefore poses a notable technical limitation, particularly in scenarios where large values of n are encountered, as it leads to rapidly increasing computational requirements that may hinder the efficiency and scalability of the algorithm or system under consideration. Furthermore, it is worth noting that the limited availability and quality of data may have constrained the robustness of these calculations, and more data could potentially enhance the benchmarking in general.

Future research. In a next step the tool can be improved by collecting and managing expert knowledge towards offering recommendations about possible target strategic goals which fit to the current state of the organization. Using machine learning approaches the tool can learn from previous cases and act as a human consultant. The tool can be extended with a chatbot, which starts a conversation with the users to understand more about their current situation by asking more than the existing questionnaires today. Further, exploring more computationally efficient algorithms or heuristic methods to similarly derive thresholds for the deviations and overlaps assessment, especially for large-scale datasets, presents an interesting avenue for improving the scalability and practicality of the benchmarking process.

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