Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA DOI: 10.46254/EU08.20250151
Published: July 2, 2025

Implementation and Evaluation of the Cultural Synergy Spectrum Method in a Real Case Scenario

Annika Bastian and Albert Albers
Institute of Product Engineering (IPEK)
Karlsruhe Institute of Technology (KIT)
Karlsruhe, Germany
annika.bastian@kit.edu, albert.albers@kit.edu

Abstract

In today's globalized landscape, product engineering teams are increasingly composed of engineers with diverse nationalities. Multinational companies, with operations spread across various countries, naturally form multinational engineering teams. Similarly, national companies often recruit globally due to local skill shortages, cost-effectiveness, or the need to offer flexible work locations to attract top talent. Global competition has also driven companies to operate in distributed settings, making multinational composition in product engineering teams the norm rather than the exception. A significant aspect of modern product engineering teams is their distributed nature. Team members frequently work from different countries, facilitated by new home office regulations and advancements in information and communication technologies (ICT). While this distributed setting offers numerous advantages, it also presents unique challenges, particularly in problem-solving processes that require creativity. ICT-mediated communication often lacks the richness of face-to-face interactions, leading to potential misunderstandings and missed indirect communication signals. This is especially critical in creative processes, where clear communication is necessary to convey new ideas effectively. The objective of this study is to apply and validate a support method targeted at helping intercultural distributed product engineering teams improve their creative problem-solving. The method used is the Cultural Synergy Spectrum (CSS) Method. The method is applied in an industry team working on an actual problem that the team was facing. The learnings include insights on the necessary knowledge for a moderator of the CSS method, the situation and specific adaptation of the method, and the limitations encountered with a method that was developed in a theoretical research environment and is brought to real-life application. By addressing these questions, the study seeks to enhance the creative problem-solving capabilities of intercultural distributed engineering teams, thereby contributing to more effective and innovative product development in a globalized context.

Keywords
Cultural Influences on Creativity, Method Development, Product Engineering, Real Case Application, Validation.

1. Introduction
In today's globalized landscape, product engineering teams are often composed of engineers from diverse nationalities (Matney, 2022). Multinational companies, with sites spread across various countries, naturally form multinational engineering teams. Similarly, national companies often recruit talent globally for several reasons: the unavailability of required skills locally, cost-effectiveness, or the need to offer flexible work locations to attract top talent. Global competition is another factor that pushes companies to operate in distributed settings (Ledwith and Ludden, 2016). Consequently, multinational composition in product engineering teams is becoming the norm rather than the exception. (Gaul, 2001; Kern, 2016; Duehr, 2023; Nicklas et al., 2023; Zukunftsinsitut, 2023).

Another significant aspect of modern product engineering teams is their distributed nature (Duehr, 2023). Team members frequently work from different locations, facilitated by new home office regulations and advancements in

© IEOM Society International

information and communication technologies (ICT) (Bouncken et al., 2016). The distributed setting, while offering numerous advantages, also presents unique challenges, particularly in problem-solving processes requiring creativity (Bergström and Törlind, 2007; Bastian et al., 2023a; Bastian et al., 2023b). ICT-mediated communication often lacks the richness of face-to-face interactions, leading to potential misunderstandings and missed indirect communication signals (Bouncken et al., 2016). This is especially critical in creative processes, where clear communication is necessary to make an idea understandable that contains new elements (Lamm et al., 2012; Bouncken et al., 2016; Taras et al., 2021; Landes et al., 2022; Duehr, 2023).

1.1 Objectives

Creativity needs to be supported in a way specific to the distributed environment. When the interculturality of the team members also comes into play, targeted support for intercultural distributed teams to improve their creative problem-solving is needed.

Therefore, the objective of this contribution is to apply and validate a support that is targeted at helping intercultural distributed product development teams to improve their creative problem-solving. The method used is the Cultural Synergy Spectrum (CSS) Method (Bastian et al.2024).

1.2 Research Questions

1. How can the Cultural Synergy Spectrum Method be applied successfully in a real-world intercultural distributed engineering team?
2. How can the methods problem-solving phase be implemented successfully for the KPI-related problem the team is facing?
3. Which guidance is necessary for a new user who guides through the CSS method as a moderator?

1.3 Research Environment

To answer the research questions, the CSS was adapted to suit a creative problem-solving situation at a multinational company in the aeronautical sector. The team in which it was applied works in a distributed setting from two offices in Europe and consists of eight members from four different countries, as pictured in Figure 1. One office is in Spain, the other in Germany. Furthermore, the team members have the option to work from home. On group meeting days, the team members are encouraged to come to the office, but they are not required. It has become part of the team's habits to only miss being onsite on team meeting days if absolutely necessary.

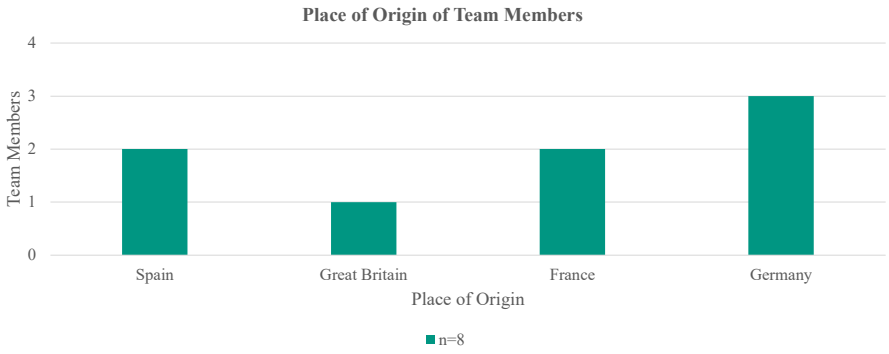

Figure 1. Place of Origin of Team Members

The team is not directly a product development team, but is involved in organizing the supply chain for ongoing production as well as planning for upcoming production and production lines, and therefore a product engineering team in this broader context. To find out more about the team members' background, they have been asked about their course of study. Five team members hold an MBA, and three team members have a degree in aerospace engineering. Therefore, the team has the intercultural prerequisites as well as the technical prerequisites to be supported by the CSS method.

© IEOM Society International

2. Literature Review

2.1 Intercultural Product Development Teams

Defining culture is challenging due to the numerous interpretations, conceptual frameworks, and classification attempts (Mueller, 2023). This complexity arises from the intricate nature of culture, making it difficult to fully grasp (Usunier and Walliser, 1993). When viewed through the lens of origin and identity, culture is essential for understanding the dynamics of any organizational structure (Rieger, 2018), as corporate culture cannot exist without the culture of individuals. This contribution primarily focuses on individual culture, but it is important to acknowledge that corporate culture fosters creativity within teams and cannot be ignored when looking at the interplay of cultures within a team. Essentially, corporate culture stems from the collective cultural background of its employees. The workforce's intrinsic beliefs, values, and traditions form the foundation of an organization's unique ideology. The interaction between individual identities and the overarching corporate identity is the basis from which corporate culture develops (Ellinas et al., 2017). Therefore, it is crucial to focus on the individual cultures within a team to gain a basic understanding of the factors that define intercultural teamwork. This step provides essential context and depth for analyzing the teams' unique cultural backgrounds. (Ellinas et al., 2017).

In product development teams, the human is at the center of the development process (Albers et al., 2019). Especially when working on the development of ideas with high innovative potential, product development teams are dependent on the human (Albers et al., 2019). The most recent AI tools can design fantastic things, but the capability to develop something that has actual high innovative potential is still the work of the humans (Dégallier-Rochat et al., 2022). The capability to generate more than the combination of existing references to generate ideas with high innovative potential is something only humans are capable of doing with creativity (Lakhani, 2023; Magni et al., 2024). Especially teams in which people from different cultures come together have the potential for ideas with high innovative potential. At the same time, cultural diversity can also lead to specific barriers that harm the team's success. (Lamm et al., 2012; Bouncken et al., 2016; Taras et al., 2021; Landes et al., 2022)

In today's globalized landscape, intercultural product engineering teams are common (Matney, 2022). Multinational companies operating across diverse geographical locations inherently establish multinational engineering teams. Similarly, domestic companies frequently engage in global talent acquisition due to various factors, including the scarcity of requisite skills locally, cost-efficiency considerations, and the necessity to provide flexible work environments to attract talent. As a result, the multinational composition of product engineering teams is increasingly becoming a standard practice rather than an exception. (Gaul, 2001; Kern, 2016; Duehr, 2023; Nicklas et al., 2023; Zukunftsinsitut, 2023)

2.2 Distributed Product Development Teams

Product development is defined by the VDI as an interdisciplinary corporate process aimed at creating a marketable product, with goals and requirements initially set and continuously adapted (VDI Verein Deutscher Ingenieure e.V., 2019). Blessing and Chakrabarti (2009) see it as a dynamic, complex phenomenon involving people, products, processes, knowledge, methods, and tools within organizational and economic contexts. Albers and Meboldt (2006) emphasize similar aspects, focusing on the technical systems creation. Ehrlenspiel (2003) views product development as integrating all influencing factors, making it central to product creation and crucial for company success (Albers and Meboldt, 2006).

The reasons for distributed product development settings are various, as introduced in Sections 1 and 2.1. Initially observed in the USA in the 1990s, distributed product development has gained momentum, with companies establishing distributed networks (Lindemann and Kern, 2016)). By 2015, nearly 20% of German managers participated in distributed product development networks (Detecon, 2015), a trend that continues beyond the COVID-19 pandemic (Ebert, 2020). In 2018, another survey with executives of major organizations found that 89% of the 1.620 respondents work in distributed teams, and 62% say that these teams are composed of members from three or more cultures (Matney, 2022).

Distributed product development describes a form of collaboration with spatial, organizational, and temporal separation facilitated by information and communication technologies (ICT) for both synchronous and asynchronous collaboration (Albers et al., 2022). Methods like the Virtual Team Maturity Model (VTMM) (Friedrich et al., 2011) and EdiT (Enabling distributed Teams) supports distributed teams by focusing on team processes and continuous improvement of collaboration (Albers et al., 2022).

© IEOM Society International

Knowledge management is vital in product development, involving the exploitation of existing knowledge, the creation of new knowledge, and integration into usable resources (Fagerström and Olsson, 2002). van Aken and Weggeman (2002) highlight knowledge as a strategic factor that is essential for companies. Effective knowledge transfer requires cooperation and a common communication language, especially in distributed settings (van Aken and Weggeman, 2002). Information technology facilitates knowledge management by enabling transactions, storage, and processing of explicit knowledge, and supporting tacit knowledge flow through coordinated interfaces and collaboration (van den Brink, 2003).

2.3 Creativity in Intercultural Distributed Product Development Teams

Collaboration and creativity are crucial for teams' successful achievement of their goals (Stempfle and Badke-Schaub, 2002). These aspects are particularly challenging for distributed teams. Research indicates that collaboration is easier when teams are co-located compared to being distributed (Silvia and Iryna, 2012). In distributed teams that work together virtually, creative processes are often problematic (Alahuhta et al., 2014). Brucks and Levav (2022) found that communication methods significantly influence creativity, with personal contact enhancing idea generation. However, they also concluded that the quality of ideas might not depend on whether collaboration is in-person or virtual, attributing differences to the amount of information transmitted through screens (Brucks and Levav, 2022).
Supporting creativity in distributed settings is essential, as highlighted by (Duehr, 2023), who emphasized the need for creative teamwork in product development. The EdiT Method supports distributed collaboration, for example, by applying creativity methods (Duehr, 2023). Previous research shows that creativity methods used in virtual environments often yield less effective results compared to in-person settings, depending on the method's suitability for virtual use (Birkhofer et al., 2005). Therefore, creativity methods need to be adapted for virtual settings. Various methods have been adapted for virtual use and can be successfully implemented for distributed teams (Albers et al., 2009; Taplick and Gräßler, 2018; Bastian et al., 2024a). To be suitable for application in distributed settings, the methods need to comply with prerequisites: ensure vocal communication, make a shared virtual space available, enable documentation, be intuitive, and make interaction possible (Taplick and Gräßler, 2018; Bastian et al., 2024a). The 6-3-5 method is a basic method for teams to improve creative idea generation (Rohrbach, 1969) and is introduced in more detail since it is used in the method application of the Cultural Synergy Spectrum in this contribution. It is an adaptation of the traditional brainstorming technique, starting with the presentation of a problem statement. The participants are then instructed to document three potential solutions on structured solution sheets. These solution sheets are then circulated among their peers, who contribute additional ideas or further develop the initial suggestions. With six participants, this iterative process continues until each of the three solution approaches has been expanded upon by the other five participants. This method is thus named 6-3-5 (Bender and Gericke, 2021). When the method is adapted to meet the prerequisites of the application in distributed settings, it can be successfully applied in a distributed team.

The Nominal Group Technique (NGT) also represents an advanced method for structured brainstorming designed to overcome the limitations inherent in traditional brainstorming sessions. This method is introduced in more detail, since it has been used in designing the CSS. This technique is particularly beneficial for small to mid-sized groups, as it fosters inclusive participation by providing an environment suitable for both introverts and extroverts, allowing time for individual contemplation. The NGT process involves several stages: initially, participants generate ideas by themselves and in writing. These ideas are then shared within the group, followed by a structured discussion. The last stage involves ranking or voting on the ideas to reach a decision together. This method is specifically structured to prevent the dominance of any single participant, ensuring that all members' opinions are equally considered. (Delbecq and van de Ven, 1971; van de Ven and Delbecq, 1972; Gallagher et al., 1993)

2.4 The Cultural Synergy Spectrum (CSS)

As shown in the preliminary chapters, there are various methods for supporting distributed teams, as well as for supporting creativity. None of these methods directly includes the aspect of intercultural team settings. To fill this gap, Bastian et al designed the Cultural Synergy Spectrum (CSS) method. It is a method for supporting specifically intercultural teams with their creative problem-solving processes.
The Cultural Synergy Spectrum Method (Bastian et al.) consists of five phases designed to enhance the team's intercultural collaboration and creativity.

Phase 1: Warm Up

© IEOM Society International

This phase addresses the limitations of traditional brainstorming by incorporating a brief advanced brainstorming session using the Nominal Group Technique. This method ensures that every team member can participate and provides time for thoughtful consideration of the problem statement before moving on to the next phase.

Phase 2: Knowledge Baseline
In this phase, the goal is to establish a foundational understanding for implementing the method and fostering collaboration. It involves gathering insights into each team member's cultural background through questions and open discussions, which helps clarify individual expectations regarding work modes.

Phase 3: Change of Perspective
This phase encourages team members to embrace their own cultural perspectives and those of their colleagues. Using the Cultural Dimensions Thinking Caps method (Bastian et al., 2024b), based on De Bono's Six Thinking Hats (Bono, 2016), team members discuss various aspects of collaboration, such as approaches to meeting deadlines.

Phase 4: Creativity Session
During this phase, the focus is on generating ideas and potential solutions for a specific problem statement. As a problem statement, an actual KPI problem that the team needs to work on should be chosen. This creativity session leverages the diverse perspectives and insights gained in the earlier phases.

Phase 5: Evaluation
The final phase provides an opportunity for feedback and learning. It involves synthesizing the results of the method's implementation and evaluating the overall collaboration process to identify areas for improvement. (Bastian et al.)

This contribution shows the application and validation of the CSS method adapted to suit the team's needs.

3. Methods

To answer the research questions, a questionnaire was distributed to the team members to assess the current knowledge the team members have concerning their fellow team members and the composition of different cultures within the team. The questionnaire was sent digitally and collected before the CSS workshop. Then, the Cultural Synergy Spectrum method has been adapted to match the team's needs and the problem that should be solved in the application. Afterwards, a workshop was carried out applying the CSS method. The answer to the third research question concerning the guidance for a first-time moderator was found by combining the learnings of the application. The person adapting and applying the CSS prepared for this task with literature research on the method and its background, as well as through discussions with the method designers. The person adapting and applying it in this team has been a team member of the team in Spain for two years and moved to the German office half a year before the application. This person is applying the CSS for the first time. The adaptation was assisted by the designers of the CSS method, and the adaptation and application in the team took place in the context of a thesis.

This contribution is structured using the Design Research Methodology (DRM) (Blessing and Chakrabarti, 2009), an approach for systematically conducting applied research. DRM is segmented into four stages, beginning with Research Clarification (RC). In the Descriptive Study I, a review of existing literature was performed to gather the necessary information and knowledge for designing and implementing a workshop at a multinational engineering consortium. The results have been presented in Chapter 2. The subsequent phase, the Prescriptive Study (PS), entailed the planning and execution of the workshop to apply the Cultural Synergy Spectrum method. The primary objective was to enhance creativity within the multicultural team, thereby improving Key Performance Indicators (KPIs) and addressing specific issues such as reducing lead times for spare parts. During the workshop, participants from various departments and cultural backgrounds collaborated in multidisciplinary teams to identify and tackle the key challenges associated with decentralized production. In the workshop, the 3-6-5 method was used within the fourth phase of the Cultural Synergy Spectrum Method to generate creative solutions in a systematic way. The Descriptive Study II of the DRM focused on evaluating the outcomes of the workshop. This evaluation was conducted through KPI analysis, comparing the results obtained during and after the workshop with pre-workshop forecasts over a performance period from July to October.

© IEOM Society International

4. Results and Discussion

4.1 Results of the questionnaire

After the demographics part of the questionnaire, it started with the question of how well the team members know their fellow team members' cultural backgrounds. Figure 2 shows the results. 1 indicates little knowledge, while 5 indicates full knowledge.

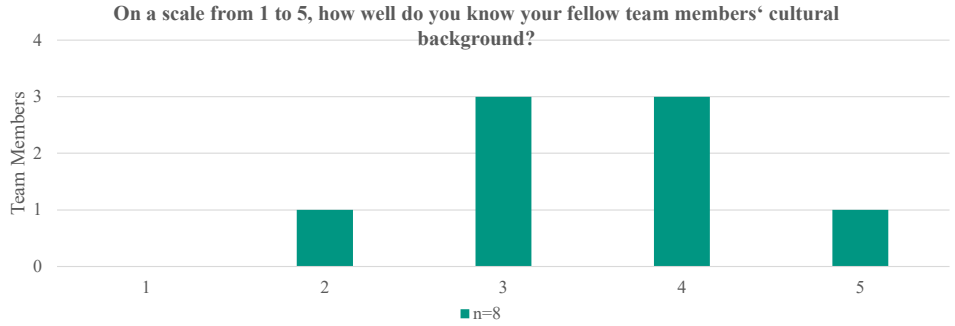

Figure 2. Knowledge of team members' cultural background

The results show that none of the participants is absolutely certain about the other's background, but a majority of team members at least know parts about it, showing that the intercultural setting is recognized. To find out in more detail how aware the team is about the intercultural setting, they were asked to name the number of nationalities within the team (Figure 3). This question was presented with a free text field so as not to influence the participants through the options given.

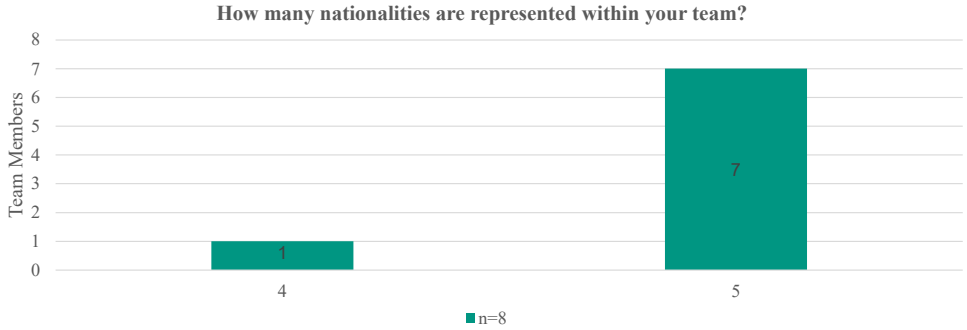

Figure 3. Perceived number of nationalities within the team

Seven out of the eight team members thought it was five nationalities represented, while one person thought it was four. The demographics part of the questionnaire showed that four nationalities were represented within this team.
In the third question, the participants were given the opportunity to write about their knowledge of the different cultures. The responses were notably consistent. The team demonstrated the most familiarity with German culture, likely due to most participants' long residence in Germany. Knowledge of Spanish culture was primarily associated with Spanish cuisine, the tradition of siestas, and the late daily schedule. British culture was identified with the Royal Family and the characteristic politeness in communication, often referred to as British Politeness. French culture was also recognized for its cuisine, wine, and bread traditions, and haute couture.

The final question was on work ethics and collaboration, where results were also very similar. All team members emphasized respect, a positive working atmosphere, and commitment.

4.2 Results of the Application of the Cultural Synergy Spectrum Method

Due to the limited time frame given for the application, the CSS needed to be applied in a hybrid workshop with a total of two hours. Six participants were on site in Germany, and two participants were on site in Spain and joined the meeting using Microsoft Teams. The first phase, the warm-up up was skipped since most of the warm-up questions

© IEOM Society International

had been answered in the questionnaire. To ensure that the setting is still friendly and it's not a harsh start, the workshop has been placed after a shared lunch.

Phase two, the knowledge baseline, was carried out through the moderator's introduction and a recap of the questionnaire's questions. The participants were asked how they felt answering the questions, and every participant got the chance to introduce his or her cultural background again. Since the participants in this team are quite familiar with each other and have been working together for a long time already, this reminder was sufficient.

For the third phase of the CSS, the change of perspectives with the Cultural Dimensions Thinking Caps, only 30 minutes were given. Within this time, the moderator explained four different caps. The high power distance, the low power distance, as well as the masculinity and the femininity cap. Since most participants were not familiar with the cultural dimensions of Hofstede, the questions they had slowed down the progress of the workshop. The moderator answered the questions, which were very important for the understanding of the concepts, but due to that, the time was only sufficient to let the participants talk through the high and the low power distance cap. The time was not sufficient to let the participants experience the other two caps that were introduced, and it was described as difficult by the moderator to perform the time-keeping and help the team move forward.

The fourth phase, the creativity session, had a duration of one hour. The 6-3-5 method was chosen to let the participants work on the KPI problem. The problem to be solved had two dimensions to it. Therefore, the 6-3-5 method was carried out twice, once for each of the problem dimensions separately. The 6-3-5 method is carried out in two steps, the team step and the collaborative step.

Team step of the 6-3-5 method

Due to two factors within the team, adaptations to the 6-3-5 method have been made to optimize it for the application in this setting. Some of the team members are more senior and have been involved in the process of the KPI definition and working on achieving them for a longer time. Therefore, their ideas might come out more elaborate than the ideas of the less experienced team members. But, since the less experienced team members might have great ideas that are very creative and should also be heard, pairs of two have been formed with one more experienced team member and one less experienced team member. The second factor was the fact that there were eight participants, making teams of two a suitable setting. Two participants were online and formed their team of two online. Each participant got to write down three ideas on their template and hand the template over to the next colleague, who improved the three ideas and gave the template back to the colleague, one after noting his or her three improved ideas. Then colleague one, who again had time to improve the ideas once more, completed the template. The colleagues who participated online each had their template on a digital whiteboard and participated in the session via Microsoft Teams. With this new setting, the results were 36 ideas in each of the two rounds of application. Figure 4 shows the process.

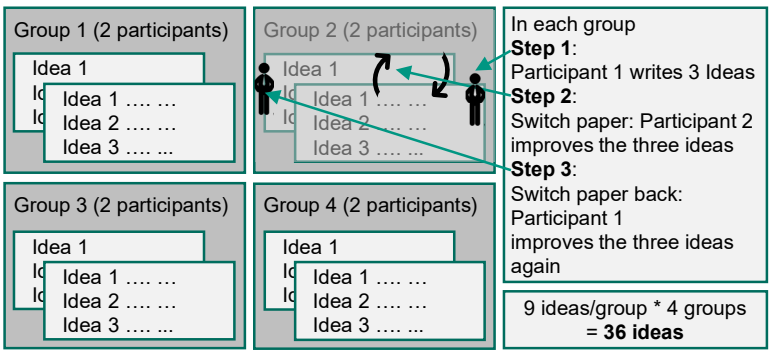

Figure 4. Adapted 6-3-5 method

Collaborative step of the 6-3-5 method

After the team step of the adapted 6-3-5 method was carried out, each team chose their favorite three ideas and pitched them to the other teams. Each team had three minutes to explain the three ideas. After the pitch, the other teams were allowed to ask questions and discuss the ideas they had just heard for five minutes. Then, two minutes were given for each team to change the selection of ideas if they had selected similar ideas. After that, the process

© IEOM Society International

started again with the next team: three minutes to pitch the three ideas, five minutes to discuss, and two minutes to change the selection of ideas for the teams that have not yet pitched in case similar ideas have been selected.

This process led to 36 collected ideas and twelve ideas that were discussed in more detail. All ideas have been saved so they can be used again in the future.
In the final phase for evaluation and feedback, it was noted that the ideas and their progress should be evaluated over time, and their impact on the KPIs closely monitored. Furthermore, it was noted that the time was not enough and that a longer time slot would not have been available. The participants also mentioned that they liked the 6-3-5 method in small teams and were encouraged to be creative by the time pressure imposed through the method. They said it was not too much time pressure, but just enough to successfully note the three ideas. The moderator mentioned again the difficulties in getting the team to move forward and the hesitation he had, especially when his manager was engaged in a discussion that was supposed to come to an end.

4.3 KPI Influence of the Ideas Generated in the CSS Workshop

Due to confidentiality constraints, the specific Key Performance Indicators (KPIs) cannot be disclosed. However, this chapter monitors the changes in KPIs following the implementation of ideas generated during the workshop. The analysis focuses on whether the KPIs improved and met the target, improved but missed the target, or worsened. The performance period spans from July to October. Since the workshop took place in July, the KPIs for that month remain unaffected. Consequently, the forecasts of the KPIs for August, September, and October, calculated on the first working day of August, are compared with the actual results for August and the forecasts for September and October, calculated on the last working day of August. For August, the actual KPIs were used instead of the forecasts, since they are already available. The forecasts predict if and which KPIs will be reached in which month. For calculating the forecasts, the 36 ideas from the workshop have not been taken into consideration. Therefore, they are used as reference points to compare the actual KPIs. It needs to be taken into consideration that other factors might have influenced the KPIs, and the implementation of the ideas is not the only potential influence on the KPIs. The KPIs for each month are calculated independently of the previous months since each month has individual goals based on contractual duties.

For the first dimension of the KPI issue addressed in the CSS workshop, the evaluation revealed that all proposed ideas were influenced by external factors, limiting the team's direct impact on KPI changes. Therefore, this evaluation focuses on the second dimension of the KPI issue and the 36 ideas generated for this aspect. This dimension is related to the shipment and delivery of spare parts, for which the company has a contractual target. This KPI is measured in days after the target shipment and delivery date for each spare part. Earlier than planned shipment and delivery dates do not influence his KPI, neither negatively nor positively. Five KPIs are assessed each month. The forecasts calculated in July will be compared with the actual results obtained in August.

In August, two KPIs remained unchanged, the other three were below target, two of them improved and reached the target, and the last one improved but did not reach the target (Figure 5).

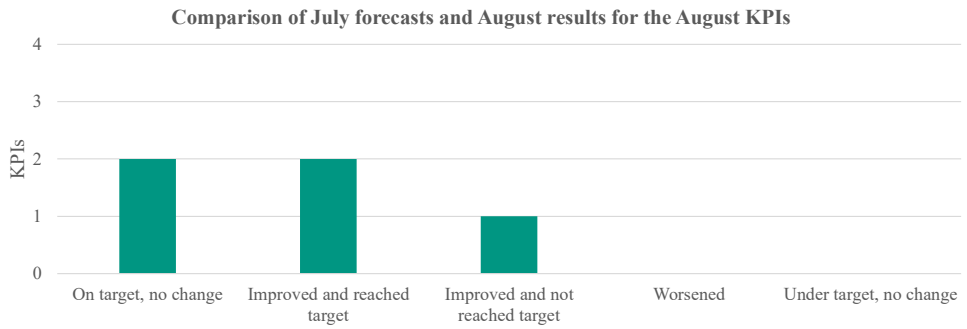

Figure 5. Comparison of July forecasts and August results for the August KPIs

In September, one KPI was on target and did not change, one KPI improved and met the target, two KPIs improved but did not meet the target, and one KPI worsened (Figure 6).

© IEOM Society International

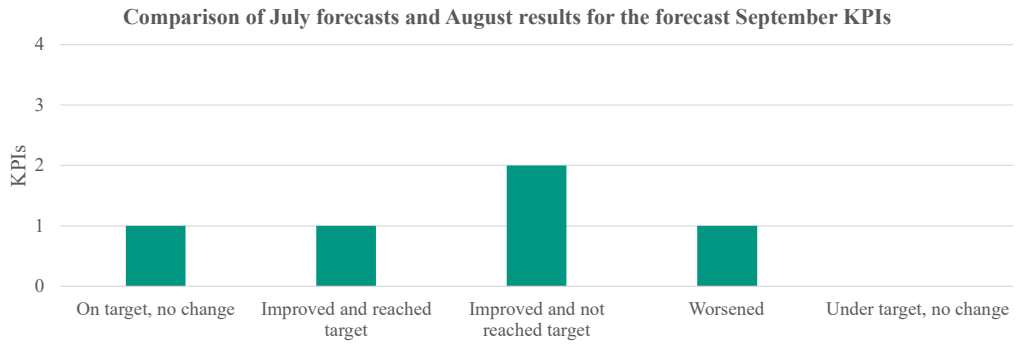

Figure 6. Comparison of July forecasts and August results for the forecast September KPIs

In October, one KPI improved and met the target, two KPIs improved but did not meet the target, and the other two KPIs worsened, both below the target (Figure 7).

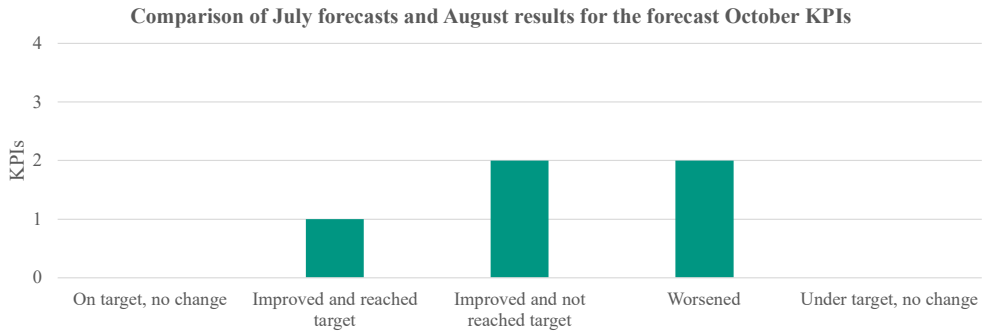

Figure 7. Comparison of July forecasts and August results for the forecast October KPIs

4.4 Discussion

The findings from the questionnaire (Chapter 4.1) indicate that the team is well-suited for support by the CSS. The application of the method required adaptation to the team's specific situation and needs. It was noted that not conducting the CSS in its entirety has drawbacks, as cultural factors could not be explored as thoroughly as the method suggests. However, the team was constrained by time limitations. Despite the restricted application time, the team successfully generated ideas to address their KPI issues. Furthermore, it was possible for an inexperienced moderator who learned the CSS by reviewing the literature to lead a team through it. In this case, it might have been more appropriate to provide the management with a tool to design a workshop without needing a moderator.

The evaluation of the KPIs revealed that there was no direct improvement related to the implementation of the ideas generated by the team. A significant difficulty is that the ideas and actions taken by the team after the CSS workshop are not the only factors influencing the KPIs. Therefore, this measure of success must be critically assessed. Solely comparing KPI changes with forecasts may not be an adequate method for evaluating the success of the generated ideas. Even if the KPIs had improved, it would not directly validate the method's success. It is crucial to conduct a more comprehensive evaluation of the ideas generated during the workshop. One approach could involve having the team leader and closely related teams assess the ideas based on criteria such as implementation speed, the likelihood of implementation, and the impact on other processes. It is worth noting that the team believed that implementing these ideas could positively influence the KPIs. Furthermore, a positive effect for the team was the shared awareness for current and predicted KPI, which sparked discussion and motivation for finding solutions together. Additionally, the short duration of KPI evaluation should be considered, as results might differ if evaluated over a longer period.

© IEOM Society International

5. Conclusion

The application of the CSS method was possible, but not ideally suited for a long-standing industry team. For teams with stable compositions, a shorter version of the method is preferred. This approach can uncover new insights about team members while starting at a level appropriate for those already familiar with each other. Focus can be directed towards addressing cultural barriers and identifying areas for improvement in Phase 3, allowing for a more direct approach given the team's existing familiarity. For industry teams, fitting the full-length workshop into a working schedule is challenging. A shorter, situation-adapted version not only integrates more easily but also enhances participant motivation and ensures successful application. Obtaining management approval is also more feasible for shorter sessions. While two hours were insufficient to cover phases three and four comprehensively, this duration was still lengthy compared to typical workshops for this team. Phase one needed to be completely left out and replaced by a questionnaire to save time. The questionnaire led to the same results as phase one would have, but with less engagement of the team members. Therefore, a shorter version of the CSS, or one that can be conducted in multiple sessions, is necessary. The hybrid setting did not pose a difficulty for the application of the CSS. The answer to the first research question, of the Cultural Synergy Spectrum Method being applied successfully in a real-world intercultural distributed engineering team, is therefore answered with yes, but with major adaptations.

To answer the second research question, if the method's problem-solving phase can be implemented successfully to the KPI-related problem, the answer is yes, but the evaluation of the success has to be pre-planned carefully. It is important to plan how exactly the success of the ideas generated in the workshop should be measured. The direct connection from the ideas to the KPIs is not suitable and should, therefore, not be used as an evaluation approach, at least not as the only evaluation approach.

Additionally, it was feasible but challenging for someone not well-versed in the CSS to lead the workshop. In this context, it would have been more effective for a manager to facilitate the session. The difficulty arose partly because the moderator was perceived as a young team member rather than an external equal. An external moderator might have altered the dynamics. There is a need for a tool that enables users unfamiliar with CSS to design a context-appropriate creative problem-solving workshop that still provides the desired cultural support and sensitivity. The answer to the third research question, which guidance is necessary for a new user who guides them through the CSS method can be answered as well. A new user needs a full understanding of the method and experience with moderating workshops in general. Furthermore, the situation needs to be assessed beforehand. It is important that the moderator is seen as equal or as external. If that is not the case, an adapted version of the CSS is needed that enables the industry team themselves to prepare a workshop to support their intercultural creative problem-solving. Designing such an adapted version of the CSS is the next step.

References

Alahuhta, P., Nordbäck, E., Sivunen, A., and Surakka, T., 'Fostering Team Creativity in Virtual Worlds', *Journal For Virtual Worlds Research*, Vol. 7, No. 3, 2014.

Albers, A., Deigendesch, T., and Schmalenbach, H., 'TRIZ-box-Improving creativity by connecting TRIZ and artifacts', in , *TRIZ Future Conference 2009. Procedia Engineering 9*, 2009.

Albers, A., Duehr, K., Zech, K., and Rapp, S., 'The EDiT method guideline - enabling distributed teams through situation-adequate method application', in , *Procedia 32th CIRP Design Conference. Design in a Changing World*, 2022.

Albers, A., Heimicke, J., Spadinger, M., Reiss, N., Breitschuh, J., Richter, T., Bursac, N., and Marthaler, F., 'A systematic approach to situation-adequate mechatronic system development by ASD - Agile Systems Design', *Procedia CIRP*, Vol. 84, 2019.

Albers, A., and Meboldt, M., 'A NEW APPROACH IN PRODUCT DEVELOPMENT, BASED ON SYSTEMS ENGINEERING AND SYSTEMATIC PROBLEM SOLVING', in , *AEDS Workshop*, 2006.

Bastian, A., Cadavid Restrepo, P., Willerscheid, J., and Albers, A., 'Development of a Culture-Based Support Method for Creativity in Distributed Product Development', *International Journal of Design Creativity and Innovation*, accepted for publication 2024.

Bastian, A., Hirt, P., Schwarz, S. E., Fischer, M., and Albers, A., 'Identification of requirements for the transfer of creativity techniques in virtual environments by using TRIZ-Box', in , *Procedia CIRP*, Elsevier, 2024a.

Bastian, A., Kassem, Y., Kempf, C., and Albers, A., 'Barriers to Creativity in Distributed Product Development', in , *Proceedings of the International Conference on Industrial Engineering and Operations Management*, IEOM Society International, 2023a.

© IEOM Society International

Bastian, A., Restrepo Cadavid, P., Grau, R., and Albers, A., 'DESIGNING A METHOD FOR IMPROVED (DISTRIBUTED) CULTURAL UNDERSTANDING – THE CULTURAL DIMENSIONS THINKING CAPS', in , *Asia Design and Innovation Conference*, 2024b.

Bastian, A., Wasserbäch, M., and Albers, A., 'INFLUENCING FACTORS ON CREATIVITY IN DISTRIBUTED TEAMS — SYSTEMATIC LITERATURE REVIEW', *International Journal of Innovation Management*, Vol. 27, No. 5, 2023b.

Bender, B., and Gericke, K. (eds.), *Pahl/Beitz Konstruktionslehre. Methoden und Anwendung erfolgreicher Produktentwicklung,* Springer Berlin Heidelberg, 2021.

Bergström, M., and Törlind, P., 'EXAMINING CREATIVE COLLABORATION IN DISTRIBUTED AND CO-LOCATED DESIGN TEAMS', in , *International Conference on Engineering Design, ICED'07*, 2007.

Birkhofer, H., Jaensch, J., and Kloberdanz, H., 'An extensive and detailed view of the application of design methods and methodology in industry', in , *DS 35: Proceedings ICED 05, the 15th International Conference on Engineering Design*, 2005.

Blessing, L. T., and Chakrabarti, A., *DRM, a Design Research Methodology,* Springer London, 2009.

Bono, E. de, *Six Thinking Hats,* Penguin Books, 2016.

Bouncken, R., Brem, A., and Kraus, S., 'Multi-cultural teams as sources for creativity and innovation: the role of cultural diversity on team performance', *International Journal of Innovation Management*, Vol. 20, No. 01, 2016.

Brucks, M. S., and Levav, J., 'Virtual communication curbs creative idea generation', *Nature*, Vol. 605, No. 7908, 2022.

Dégallier-Rochat, S., Kurpicz-Briki, M., Endrissat, N., and Yatsenko, O., 'Human augmentation, not replacement: A research agenda for AI and robotics in the industry', *Frontiers in robotics and AI*, Vol. 9, 2022.

Delbecq, A. L., and van de Ven, A. H., 'A Group Process Model for Problem Identification and Program Planning', *The Journal of Applied Behavioral Science*, Vol. 7, No. 4, 1971.

Detecon, *Virtuelle Zusammenarbeit im unternehmerischen Kontext*, 2015.

Duehr, K., *EDiT - Enabling Distributed Teams: Eine Methode zur Identifikation und Erschließung von Verbesserungspotenzialen in der standortverteilten Produktentwicklung*. Doctoral dissertation, 2023.

Ebert, C., *Verteiltes Arbeiten kompakt: Virtuelle Projekte und Teams: Homeoffice: digitales Arbeiten,* Springer Vieweg, 2020.

Ehrlenspiel, K., *Integrierte Produktentwicklung,* Hanser, 2003.

Ellinas, C., Allan, N., and Johansson, A., 'Dynamics of organizational culture: Individual beliefs vs. social conformity', *PloS one*, Vol. 12, No. 6, 2017.

Fagerström, B., and Olsson, L.-E., 'Knowledge Management in Collaborative Product Development', *Systems Engineering*, Vol. 5, No. 4, 2002.

Friedrich, R., Bleimann, U., Stengel, I., and Walsh, P., 'VTMM - Virtual Team Maturity Model', in , *Proceedings of the 7th European Conference on Management, Leadership and Governance*, SKEMA Business School, 2011.

Gallagher, M., Hares, T., Spencer, J., Bradshaw, C., and Webb, I., 'The Nominal Group Technique: A Research Tool for General Practice?', *Family Practice*, Vol. 10, No. 1, 1993.

Gaul, H.-D., *Verteilte Produktentwicklung - Perspektiven und Modell zur Optimierung*. Dissertation, 2001.

Kern, E.-M., 'Verteilte Produktentwicklung', in U. Lindemann (ed.), *Handbuch Produktentwicklung*, Hanser, 2016.

Lakhani, K. R., 'AI won't replace humans — but humans with AI will replace humans without AI', *Harvard Business Review*, 2023.

Lamm, A. J., Roberts, T. G., Irani, T. A., Snyder, L. J. U., and Brendemuhl, J., 'The Influence of Cognitive Diversity on Group Problem Solving Strategy', *Journal of Agricultural Education*, Vol. 53, No. 1, 2012.

Landes, M., Steiner, E., and Utz, T. (eds.), *Kreativität und Innovation in Organisationen,* Springer Berlin Heidelberg, 2022.

Ledwith, A., and Ludden, P., *A Typology Framework for Virtual Teams*, 2016.

Lindemann, U., and Kern, E.-M., 'Verteilte Produktentwicklung', in , *Handbuch Produktentwicklung*, Hanser, 2016.

Magni, F., Park, J., and Chao, M. M., 'Humans as Creativity Gatekeepers: Are We Biased Against AI Creativity?', *Journal of Business and Psychology*, Vol. 39, No. 3, 2024.

Matney, M., 'Global Virtual Work Survey', *RW3 culturewwizard*, 2022.

Mueller, S., *Interkulturelles Marketing,* Franz Vahlen, 2023.

Nicklas, S. J., Michalides, M., Gadzo, E., and Koch, A., 'A Multi-Dimensional Analysis of the Current State of Research into Globally Distributed Product Development', in , *Proceedings of Symposium Design for X (DfX2023)*, 2023.

© IEOM Society International

Rieger, V., *Kultur und Innovationen: Empirische Studien auf Ebene von Ländern, Organisationen und Teams,* Springer Fachmedien Wiesbaden, 2018.
Rohrbach, B., 'Kreativ nach Regeln – Methode 635, eine neue Technik zum Lösen von Problemen' Creative by rules - Method 635, a new technique for solving problems, *Absatzwirtschaft*, Vol. 12, 1969.
Silvia, R.-D., and Iryna, B., 'The Influence of Online Communication and Web-Based Collaboration Environments on Group Collaboration and Performance', *Procedia - Social and Behavioral Sciences*, Vol. 46, 2012.
Stempfle, J., and Badke-Schaub, P., 'Thinking in design teams - an analysis of team communication', *Design Studies*, Vol. 23, No. 5, 2002.
Taplick, P., and Gräßler, I., 'Virtual Reality unterstützte Kreativitätstechnik: Vergleich mit klassischen Techniken', in , *Proceedings of DFX 2021 32nd SYMPOSIUM DESIGN FOR X*, 2018.
Taras, V., Baack, D., Caprar, D., Jiménez, A., and Froese, F., 'Research: How Cultural Differences Can Impact Global Teams', *Harvard Business Review*, 2021.
Usunier, J.-C., and Walliser, B., *Interkulturelles Marketing: Mehr Erfolg im internationalen Geschäft,* Gabler Verlag, 1993.
van Aken, J. E., and Weggeman, M. P., 'Managing learning in informal innovation networks: overcoming the Daphne-dilemma', *R&D Management*, Vol. 30, No. 2, 2002.
van de Ven, A. H., and Delbecq, A. L., 'The nominal group as a research instrument for exploratory health studies', *American Journal of Public Health*, Vol. 62, No. 3, 1972.
van den Brink, P., *Social, organizational and technological conditions that enable knowledge sharing*. Doctoral Thesis, 2003.
VDI Verein Deutscher Ingenieure e.V., *VDI-Richtlinie 2221: Entwicklung technischer Produkte und Systeme*. *Modell der Produktentwicklung,* Beuth, VDI 2221 Blatt 1, 2019.
Zukunftsinsitut, *Globalisierung*. *We better be nice : europäische Zukunftspotenziale in einer globalen Wirtschaft,* Zukunftsinstitut, 2023.

Biographies

Annika Bastian graduated with a bachelor's degree in International Management in 2021 and a master's degree one year later in 2022 from the Hochschule Karlsruhe - University of Applied Sciences (HKA). She now is a doctoral researcher in the research group Design Methods and Design Management at the Institute of Product Engineering of the Karlsruhe Institute of Technology, where she started in 2022. Her research interests include creativity in product development, cultural influences on creativity and managing distributed or virtual teams in product development. The opportunity to combine the knowledge obtained through studying the economic perspective on development processes at HKA with the view of mechanical engineers at IPEK on development processes offers interesting insides and perspectives. Her research focus is chosen right where engineering and management perspectives meet.

Albert Albers has been full professor for product development and head of IPEK - Institute of Product Engineering at the Karlsruhe Institute of Technology (KIT) since 1996. He received his doctorate in 1987 under Prof. Palandan of the University of Hannover. Before his appointment to Karlsruhe, Prof. Albers worked for LuK GmbH & Co. OHG, most recently as head of development and deputy member of the management board. He is a founding and former board member of the scientific society for product development WiGeP, a member of the German Academy of Science and Engineering (acatech) and a member of the Advisory Board of the Design Society. Since 2008, he has been President of the Allgemeiner Fakultätentag (AFT e. V.). In addition, Prof. Albers engages in the VDI and serves on the advisory boards of several companies. In 2016, he and the IPEK team were awarded the Honorary Award of the Schaeffler FAG Foundation for excellent achievements and competencies in science, research and teaching in the technical-scientific field.

© IEOM Society International