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Development of a culture-based support method for creativity in distributed product development

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ABSTRACT

Understanding the impact of cultural diversity on team creativity is essential as global business operations evolve. This research is motivated by the increasing number of distributed teams in product development and the need to increase their creative potential amidst cultural differences. Using the Design Research Methodology (DRM) to structure this research systematically, this contribution aims to explore cultural factors influencing creativity, define specific requirements for supporting creativity in multicultural environments, and develop a method for supporting creative problem-solving in these contexts. The resulting Cultural Synergy Spectrum Method addresses these aspects by integrating tools from methodologies like the Nominal Group Technique and De Bono's Six Thinking Hats. Initial validations of this method, through practical applications and expert feedback, highlight its strengths in fostering intercultural understanding and collaboration while identifying areas for improvement. These findings underline the importance of systematically addressing cultural factors to enhance the creativity of distributed product development teams. This contribution emphasizes the role of integrating cultural considerations into product development processes, adding to the field of intercultural team management and creative problem-solving in a global context.

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Creativity techniques; creative problem-solving; distributed product development; Intercultural collaboration; virtual teams

1. Introduction

As businesses increasingly operate globally, distributed teams have become integral to product development, as the process requires integrating diverse competencies to meet evolving product demands (Dumitrescu et al., 2021; GmbH, 2023). The development process is intrinsically creative, requiring originality and suitability in its outputs (Deigendesch, 2009). Team members distributed in different regions and countries make the different cultures and their impact on creativity an important consideration, as culture influences how individuals interact (Anderson et al., 2018; Bouncken et al., 2016; Cagiltay et al., 2015; Craven et al., 2022; L.-Y.-Y. Kwan et al., 2018; Taras et al., 2021; Wang et al., 2019).

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The cultural diversity within these teams significantly impacts their creativity, affecting the following aspects:

- Communication: valuing direct and assertive, or indirect and implicit communication (Anderson et al., 2018; Bouncken et al., 2016; Cagiltay et al., 2015; Jarvenpaa & Leidner, 1998; Taras et al., 2021)
- Approaches to problem-solving: valuing innovation and risk-taking, or tradition and stability (Bouncken et al., 2016; Landes et al., 2022; Taras et al., 2021)
- Trust-building: valuing personal relationships and social connections, or professional credentials and competence (De Smet et al., 2021; Reiter-Palmon & Millier, 2023)

These aspects are all crucial for fostering a creative and psychologically safe team environment which is relevant due to the influence of creativity on a team's innovative potential. Creativity is one of the prerequisites for successful product engineering (Alahuhta et al., 2014; Wang et al., 2019).

Recognizing the influence of culture on creativity within distributed product development teams is essential for organizations aiming to improve their innovation capacity. By acknowledging cultural factors and adopting effective strategies, organizations can build an environment that promotes creativity, enables distributed teams to strive, and secures competitive advantages.

This research focuses on developing a support method for enhancing creativity in multicultural teams within the context of distributed product development. The support method aims to help overcome cultural barriers within a team and to enhance the cultural success factors that influence creativity. To do so, the participants switch perspectives and learn to understand the cultural differences. This task is methodologically supported with a step-by-step guide and various ways to share one's own perspectives. This freshly gained or reactivated cultural sensitivity is taken into the creative problem-solving task to improve teamwork and use different perspectives.

The results of this research are based on and derived from an unpublished master's thesis conducted and supervised by the authors of this contribution.

1.1. Challenges and impact of distributed teams in product development

The development of increasingly complex products requires the collaboration of experts, some of whom have historically operated from different locations (A.-K. Bavendiek et al., 2018). When individuals involved in a product development project work from geographically distributed locations, product development transforms into distributed product development. Here, virtual, remote, or distributed teams must be considered. These are defined as individuals collaborating across organizational, temporal, and geographic limits and constraints (E.-M. Kern, 2016) using technology to accomplish a shared objective (Lipnack & Stamps, 1998). When teams can operate without physical co-presence, increased flexibility in coordination is apparent because of increased virtual mobility (A. Larsson, Törlind, Karlsson, Mabogunje, Leifer, Larsson, & Elfstrm, 2003; Lindner, 2020). Moreover, these teams can be formed based on the required skills and

expertise independent of the location (E.-M. Kern, 2016). Furthermore, distributed product development is characterized as the collaborative execution of multiple subtasks (Krause et al., 1994), with cooperation, coordination, and communication as its fundamental attributes (A. Albers et al., 2016; L. T. M. Blessing & Chakrabarti, 2009). In this contribution, distributed product development is understood as follows:

"Distributed product development describes the form of product development in which the collaboration to carry out the product development activities is characterized by an operating system in which at least one individual is spatially separated from the other individuals. The following arbitrarily combinable characteristics characterize product development as distributed product development:

- The spatial separation can be extended to organizational and temporal separation.
- Information and communication technologies (ICT) must be used for collaboration.
- The collaboration can take place both synchronously and asynchronously." (A. Albers et al., 2022; Dühr, 2022; Müller, 2023)

Collaboration among geographically distributed product development teams results in improved cost, time, and quality metrics. Benefits include lower travel and relocation costs and effective knowledge sharing across locations (H.-D. Gaul, 2001; Ivanov, 2017; A. Larsson, Törlind, Karlsson, Mabogunje, Leifer, Larsson, & Elfstrm, 2003; Zorn et al., 2021). Leveraging different time zones can also accelerate development cycles (H.-D. Gaul, 2001). Distributed collaboration promotes new forms of communication and collaboration (H.-D. Gaul, 2001; Grieb, 2007) and enables better alignment with market-specific customer needs due to closer market proximity, enhancing market presence (Ivanov, 2017; Meyer-Eschenbach et al., 2008). Additionally, the diversity in cultures, personalities, and work methodologies that comes with a globally distributed team enhances creativity in the development process (Boos et al., 2017; H.-D. Gaul, 2001; Ivanov, 2017).

Nonetheless, product development teams working from various geographic locations face challenges related to physical distance and communication barriers (Ahuja, 2017). Challenges include information loss and decreased communication frequency due to the absence of informal or spontaneous interactions (A. Larsson, Törlind, Karlsson, Mabogunje, Leifer, Larsson, & Elfstrm, 2003; Stöger et al., 2019). Cultural and linguistic differences can lead to potential conflicts, challenges in achieving a shared understanding of goals, and misunderstandings (Herbsleb et al., 2000). These differences can also hinder trust building within teams and the broader organization (Schmalzl, 2011; Stöger et al., 2019). Moreover, the increased time devoted to coordination reduces the time available for other activities in product development (A.-K. Bavendiek et al., 2018). Empirical research highlights these challenges to be universally relevant across industries, encompassing coordination difficulties, communication challenges, increased time requirements, diminished work quality, and inadequate interface management (Stöckert, 2011). The following table gives an overview of the major benefits and challenges of distributed product development.

Table 1. Overview of major benefits and challenges of distributed product development.

Benefits	Challenges
– location-independent bundling of (interdisciplinary) knowledge (H.-D. Gaul, 2001; Ivanov, 2017; E.-M. Kern, 2016) – improved market presence (Meyer-Eschenbach et al., 2008) – knowledge of customer needs and requirements due to increased market proximity (Meyer-Eschenbach et al., 2008) – reduction in travel and location costs (H.-D. Gaul, 2001) – shortening development times through clever use of different time zones (H.-D. Gaul, 2001; Lipnack & Stamps, 1998) – increased creative potential due to heterogeneity in culture, personalities, and working methods in the team (Boos et al., 2017; H.-D. Gaul, 2001; Ivanov, 2017) – creation of new communication and collaboration scenarios (H.-D. Gaul, 2001) – increased flexibility in the development process through increased virtual mobility (A. Larsson, Törlind, Karlsson, Mabogunje, Leifer, Larsson, & Elfstrm, 2003; Lindner, 2020)	– communication difficulties due to physical distance (Ahuja, 2017) – loss of information and reduced frequency of information exchange due to a lack of informal or spontaneous communication (Herbsleb et al., 2000; A. Larsson, Törlind, Karlsson, Mabogunje, Leifer, Larsson, & Elfstrm, 2003; Stöger et al., 2019) – lack of non-verbal communication (Kuster et al., 2008) – misunderstandings, potential for conflict and problems in creating a common understanding of goals through heterogeneity in language and culture (Herbsleb et al., 2000) – difficulty in building trust in the team due to lack of identification with the team and company (Schmalzl, 2011; Stöger et al., 2019) – data security risks, interdependencies, and uncoordinated organizational processes (H.-D. Gaul, 2001) – less time available for synthesis activities due to increased coordination effort (A. -. Bavendiek et al., 2018) – loss of quality of the work results (Stöckert, 2011) – shortcomings in interface management (Stöckert, 2011)

Different methodologies have been developed to aid distributed teams, each focusing on different aspects of team collaboration. Examples are given in the following not with the claim of completeness but to give an overview of the different orientations of the support methods and to introduce which ones already include creativity support. The introduction follows the order in which support focus the methods have. For each support focus, the methods are introduced in chronological order of their design.

The Anytime/Anyplace-Matrix created in 1994 supports the selection of suitable communication media by assigning communication media to the dimensions of space (same or different) and time (synchronous or asynchronous) (O'Hara-Devereaux & Johansen, 1994). The Media-Synchronicity Theory builds on the Media-Richness-Theory (Daft & Lengel, 1983, 1986) and also pursues the goal of assisting in the selection of suitable communication media (Dennis & Valacich, 1999). For this purpose, communication media is selected based on five different characteristics: feedback, symbol variety, parallelism, editability, and reusability (Dennis & Valacich, 1999). In 2007 Grieb (2007) introduced a media model for communication in distributed product engineering. The media model classifies situations and communication media of distributed development at an abstract level and enables the selection of suitable communication media (Grieb, 2007). The model was further developed by Benjamin Walter, Rapp, and Albert (2016) not only with a different way of describing stations and tools but with additional elements that show the influencing factors as boundary conditions for the selection process. Furthermore, operational and strategic levels are distinguished (Benjamin Walter et al., 2016). All these models allow for the selection of suitable communication media, which is important for the successful application of creativity methods in distributed settings. The model by Benjamin Walter et al. (2016) can assist in the appropriate tools to perform creativity methods but has no means to support

creativity as such or to pay attention to the requirements that are imposed not by the distributed setting but by the creativity methods as such.

The Team Virtuality by Kirkman and Mathieu (2005) characterizes virtuality as a multidimensional construct based on the crossing of boundaries, number of team members, team size, task complexity, competencies, availability of tools, and stage of team development and enables team collaboration to be described in the continuum of virtuality. This model, in contrast to the previously introduced ones, assists in conceptualizing virtuality as a multidimensional construct. It does not have direct creativity support but helps understand the multiple dimensions of virtuality in which distributed method application takes place.

H.-D. Gaul (2001) developed a matrix for distributed development processes with 15 features and their characteristics which assists in describing the distributed state of a development process. The model has no connection to supporting creativity, but the learnings on describing a distributed situation can be valuable for understanding the situation of a distributed team. More focus on the design of the distributed situation is given to the model introduced by Gierhardt (2001). The process model supports the utilization of the potential of global product development at an operational level by guiding on the optimal distribution status in the development project. The model is based on a comprehensive analysis of learnings in distributed settings (Anderl et al., 1999; Gierhardt et al., 1999).

To describe the current situation within a collaborative design and to determine supportive elements, the Process Communication Model (PCM) has been designed (A. Bavendiek et al., 2017). The PMC model describes the current situation in the collaborative development process using the three layers of processes, methods and tools, skills and qualifications and enables the selection of elements that need to be supported. Within this model, the current situation concerning the use of creativity methods can be described, and creativity methods can be the outcome of the search for supportive elements that are still needed. The model does not help with the application or adaption of these methods to the distributed environment (A. Bavendiek et al., 2018).

The Virtual Team Maturity Model (VTMM) focuses on team processes to compensate for missing direct communication. According to the model, 11 meta processes (organize to get to know each other, agree on rules, set goals, perform task management, give and receive feedback, organize decision-making, conduct meeting management, engage in trust building, define information management, give reward and recognition, arrange ramping down) exist that can assist with forming an effective virtual team (Friedrich & Keil, 2017). The processes are designed based on the theory of the phases a team undergoes by Tuckman and Jensen (1977). Current team processes are analyzed to categorize the team into one of the four maturity phases. This complex task is supported by a set of questionnaires that build the basis for an algorithm to calculate the phase. With the model's goal to assist in understanding the current state of virtual team maturity and basic recommendations for performance improvement on the learnings generated through the model, there is no direct connection to creativity support (Friedrich, 2017).

Dühr et al. (2019) designed a support with a focus on product development teams. The method includes determining the suitability of development methods for distributed development situations (Dühr et al., 2019). Based on the seven factors: virtuality, organization, development task, activity in the development process, team, communication, and technology, the selection of suitable methods for use in the prevailing distributed development situation is supported (Dühr et al., 2019). This method can be used for the selection of creativity methods for virtual applications as well. Furthermore, the more comprehensive method Enabling Distributed Teams (EDiT) includes a multitude of activities in four phases to improve the overall distributed teamwork (Dühr, 2022). The first phase's goal is the identification of critical activities due to loss of efficiency and effectiveness and the identification of potential for improvement, followed by the analysis of improvement potential and definition of measures. Phase three aims to implement these measures to exploit the potential for improvement. The final phase includes the evaluation of improvement measures and method applications as well as follow-up and learning. The design of the method follows the SPALTEN problem-solving methodology (A. Albers et al., 2016). Within the application of the EDiT method, the use of creativity methods can be one of the potentials found and improved, and the method does not include the adaption of methods to fit the distributed setting (Dühr, 2022).

However, some approaches include forms to support creativity within distributed teams but not with a clear focus only on a superficial level, for example support with method selection. None of the models bring cultural aspects to the center of attention. The learnings generated on supporting distributed teams should be taken into consideration and used as a basis for further support.

1.2. Creativity in distributed product development

Creativity and collaboration are crucial for team success, presenting unique challenges in distributed settings (Stempfle & Badke-Schaub, 2002). Research indicates that collaboration is more effective in physical proximity than in virtual environments, where creative processes often face difficulties (Alahuhta et al., 2014; Silvia & Iryna, 2012). Face-to-face interactions foster better idea generation though the quality of ideas and selection may be independent of the collaboration mode (Brucks & Levav, 2022). Furthermore, virtual settings hinder creativity due to the limited information transmission and visual focus (Brucks & Levav, 2022). Supporting creativity in distributed teams is essential, as it plays a vital role in product development and requires tailored support (Dühr, 2022).

Stein (1953) provides a foundational definition of creativity, describing it as the generation of something new that is recognized as useful by a group. Novelty is defined as something that has not previously existed in the same form, often emerging from the recombination of existing knowledge with new elements. It is characterized by divergent thinking, which generates multiple solutions without following a linear pattern (Alahuhta et al., 2014; Elliot & Nakata, 2013; Ocker, 2005). Deigendesch (2009) identifies two perspectives on creativity: one views the creative process as valuable only if the outcome is socially beneficial, while the other considers an activity creative if it holds intrinsic value for the individual, regardless of its social usefulness. Creativity is

a fundamental driver of invention, playing an important role in the innovation process and the creation of ideas with high innovative potential (Deigendesch, 2009; Howard et al., 2008; Schlicksupp, 1977). It acts as a catalyst for social progress and prosperity (Deigendesch, 2009) and is influenced by cultural contexts (L. Y. Kwan et al., 2018). Policymakers have long recognized the importance of creativity for societal development. For instance, the European Union designated 2009 as the European Year of Creativity and Innovation to enhance creativity and innovative capacity on a broad scale (European Parliament and Council of the European Union, 2008). Despite its widespread use, there is no single, consolidated definition of creativity in the literature. The term is often associated with positive attributes, such as emotional freedom, uninhibited expression, and relaxation (Deigendesch, 2009). The early rise of concepts like the creative economy and creative society show the early recognition of creativity as essential to knowledge advancement (Rhodes, 1961).

Creativity is a multifaceted psychological construct that can be interpreted in various ways, encompassing the four Ps: Product, People, Process, and Press (environment) (Rhodes, 1961). It leads to creative development characterized by originality and appropriateness. Here, the creative process aims to highlight the approach to developing a creative product (Deigendesch, 2009). Creativity can be categorized into individual and group creativity. Individual creativity is influenced by cognitive abilities, such as fluency, flexibility, originality, and elaboration, as well as personality traits. Factors that enhance creativity include autonomy, self-confidence, and intellectual honesty, along with intrinsic motivation. The creative capacity of a group is influenced by the individual creativity of its members, as well as factors like group composition, characteristics, processes, and contextual influences. Generally, teams have a higher potential for idea generation compared to individuals (Alahuhta et al., 2014; Chamakiotis et al., 2010; Ocker, 2005).

Historically, creativity has been viewed from different perspectives as a prerequisite for new products, a personality trait, something similar to a skill, a cognitive process, or a construct shaped by social dynamics (Götz 1981; M. S. Kim et al., 2006; Preiser, 1976).

In product development, creativity is a prerequisite for success (MacGregor & Torres-Coronas, 2007). In the design literature, creativity is linked to outcomes (the creative product), individuals (the designer), and processes (the creative process) (Chamakiotis et al., 2010). It is also a critical component of engineering development (Howard et al., 2008). The Integrated Product Development Model (iPeM) describes product development as a complex endeavor that integrates multiple disciplines and interfaces with operational and knowledge management processes (A. Albers et al., 2016). Development teams must consider various requirements and constraints, often implicit in the system of objectives (Deigendesch, 2009). Creative product development teams generate new ideas and solutions, offering new products and services to their markets. Solutions often arise from integrating existing products and processes, characterizing the product development process as a problem-solving process (A. Albers & Meboldt, 2006; Albers et al., 2002; Ehrlenspiel & Meerkamm, 2017) characterized by iterative steps leading to alternative solutions. Thus, product development is a creative endeavor leading to the production of innovative products (Deigendesch, 2009).

A creative result in general within this contribution is understood according to Stein (1953) as a ‘A creative work is a novel work that is accepted as tenable, useful, or

satisfying by a group at some point in time. Novel means that the creative product did not exist previously in the exact same form. That it arises from a reintegration of already existing materials or knowledge, but when it is completed, it contains elements that are new' (Stein, 1953, pp. 311–316).

In the context of product development creativity is understood as technical creativity. Technical creativity includes aspects specifically to product development or the technical context. This form of creativity is targeted and used in analyzing and synthesizing processes or systems. Furthermore, something novel with a specific goal is created. Technical creativity requires motivation, imagination, experience, and expertise and can be applied to all technical fields (Albert A. Albers et al., 2025, Submitted for Publication).

A methodological and targeted approach fosters an environment suitable for creative thinking. Consequently, various methods have been developed to enhance creativity (Albert A. Albers & Schweinberger, 2001). Recent research in cognitive science indicates that employing creativity techniques can significantly increase creative performance by providing stimuli and facilitating hands-on idea generation (Glück, 2022). Creativity methods can be categorized into three types: intuitive, discursive, or a combination of both. Intuitive methods emphasize associations and idea generation through stimuli, resulting in high output. Examples of such methods include Brainstorming and the Gallery Method. In contrast, discursive methods produce fewer but more comprehensive ideas, employing a more analytical and strategic approach as exemplified by the SCAMPER method. Combining intuitive and discursive methods often aids in shifting perspectives (Glück, 2022). Notable examples include the TRIZ-Box, De Bono's Six Thinking Hats, and the Nominal Group Technique (NGT) (Glück, 2022). Creativity techniques due to their different designs vary greatly in their complexity and need different levels of prior knowledge to be successfully applied (Ritter & Mostert, 2017).

Additionally, research in this area looks into the adaptation of existing methods, the selection of methods based on specific situations, their implementation in industrial settings, and the evaluation of their effectiveness (B. Walter et al., 2016). The abundance of available techniques makes selecting the appropriate method for the development team challenging (Gerst, 2003).

In distributed contexts, fostering creativity within teams presents significant challenges. Idea generation is particularly difficult in distributed settings (Brucks & Levav, 2022). Brucks and Levav (2022) found that virtual application of creativity methods generated fewer ideas compared to in-person use. Extensive research underscores the importance of creativity in product development and the application of supportive methods (Deigendesch, 2009; Dühr, 2022; Landes et al., 2022; Lindemann, 2016; Ocker, 2005; Benjamin Walter et al., 2016). However, there is a notable lack of creativity methods tailored for distributed settings (Bastian, Kassem, et al., 2023; Bastian, Wasserbäch, et al., 2023). Creativity techniques adapted for virtual environments show varying results, highlighting the need for techniques suitable for these settings (Birkhofer et al., 2005; Walter et al., 2016). For methods to be successful in virtual applications, requirements need to be met (Taplick & Gräßler, 2018). This is often not the case by purely transferring existing methods into a virtual setting (Benjamin B. Walter et al., 2017). Therefore, creativity techniques need to be adapted, to ensure they meet the

requirements for virtual applications (Rice et al., 2007; Taplick & Gräßler, 2018; Benjamin; B. Walter et al., 2017).

Within this contribution, the Nominal Group Technique and DeBonos Six Thinking Hats have been used as references for the method creation since they both include intuitive and discursive elements. They are therefore introduced in more detail here.

The Nominal Group Technique (NGT) is an advanced form of brainstorming. The idea is to eliminate the disadvantages of brainstorming and give introverts room to participate and every one time to think. It is designed for small to medium-sized groups. The NGT consists of quietly generating ideas in writing, and sharing the ideas with the group, followed by discussion and ranking or voting on the ideas to reach a decision that is agreed upon by all members. This technique is designed to prevent the dominance of any one member and to ensure that each member's opinion is given equal consideration (Delbecq et al., 1971; Gallagher et al., 1993; Van de Ven & Delbecq, 1972).

De Bono's Six Thinking Hats method helps to see problems from different perspectives. In this technique, participants choose a perspective and think and generate ideas together before switching to a new perspective (Gassmann & Sutter, 2010). It is a decision-making creativity technique where each hat represents a different perspective or thinking style: white for facts and information, red for emotions and feelings, black for critical thinking and identifying potential problems, yellow for optimism and exploring benefits, green for creativity and new ideas, and blue for managing the thinking process (DeBono, 2016).

To understand what influences creativity and therefore to better understand how to support it, the simple application of creativity techniques is not sufficient. The literature identifies 72 success factors influencing creativity across seven categories – Team, Individual, Organization, Technology, Culture, Leadership, and Time – and 47 barriers, primarily within Team and Individual categories, influencing creativity in distributed product development (Bastian, Kassem, et al., 2023; Bastian, Wasserbäch, et al., 2023). The methods introduced in 1.1 to support distributed product development can assist, for example, with factors within the category organization or technology, even if not directly targeting to support creativity. The category culture, if not seen as the organizational culture, is not in the focus of the existing methods and will therefore be in the focus in the following.

1.3. Culture's impact on creativity

The relationship between culture and creativity can be viewed from two perspectives: the cultural influence the creative individuals have or the influence culture has on assessing the creative output designed by the creator (Hempel & Sue-Chan, 2010). The focus of this contribution is on the prior since the creator is to be supported by the method designed. Even though this contribution has this clear focus, the assessment of creative output generated by using the method should be subject to further research.

Cultural contexts influence creativity significantly, highlighting the role of culture in creative processes (Dubina et al., 2016; Tang & Werner, 2017). Culturally diverse teams are particularly adept at producing innovative solutions because they bring varied perspectives and experiences. However, these teams may also encounter communication challenges and misunderstandings due to differing cultural norms and communication

styles (Plucker et al., 2004). Thus, while they have high creative potential, realizing this potential requires effective communication strategies and a focus on mutual understanding. Culture serves both to integrate and differentiate within groups. It provides individuals within a cultural group with a sense of identity and behavioral norms. At the same time, those from different backgrounds may experience barriers due to unfamiliar cultural attributes, possibly leading to disengagement (Landes et al., 2022; Morgan, 1999). The influencing factors on creativity contributing to cultural success in teams include heterogeneity, diversity, geographical distance, cultural differences, different backgrounds, organizational culture, and social and psychological dispersions (Bastian, Wasserbäch, et al., 2023), while barriers include cultural and language differences, different expectations, and conflict-solving (A. Bastian, Kassem, Kempf, & Albers, 2023). Recognizing the overlap between cultural barriers and success factors is crucial, as a barrier can also act as a success factor if leveraged appropriately.

One way to make the complex construct of culture graspable is by applying the Cultural Dimensions by Hofstede, which was initially designed in the 1980s and iteratively improved (Hofstede, 2011; Hofstede et al., 2010). Using Hofstede's cultural dimensions, the basis for targeted cultural support for creative problem-solving is based on findings indicating the vast amount of research his model has influenced since its creation. A study examining co-authorship networks shows that more than 1000 publications in relation to his work have been published until 2018 (Zhou & Kwon, 2020).

The model outlines five cultural dimensions: Power Distance Index, Individualism vs. Collectivism, Masculinity vs. Femininity, Uncertainty Avoidance Index, and Long-term vs. Short-term Orientation. Michael Minkov later added a sixth dimension, Indulgence vs. Restraint (Hofstede et al., 2010). Hofstede's theoretical framework facilitates understanding of cultural differences, enhances intercultural communication, and provides guidance for tailored communication strategies. It is a valuable tool for multinational corporations to manage culturally diverse teams and understand the impact of culture on work dynamics and business practices. In addition, it serves as a basis for academic research, enabling empirical studies and facilitating intercultural training programs (Agodzo, 2015; Hofstede, 2011; The Mind Tools Content Team, 2024; Wale, 2024).

Building on Hofstede's model, each dimension provides insight into different aspects of a culture's value system. The Power Distance Index measures the extent to which less powerful members of organizations and institutions accept and expect power to be distributed unequally, influencing the hierarchical dynamics and authority structures within a society (Kang & Mastin, 2008). Individualism vs. Collectivism assesses whether people prefer a distant social framework in which individuals are expected to care only for themselves and their immediate families, or a harmoniously integrated framework in which individuals can expect their kin or members of a particular in-group to care for them (Holden, 2014). Masculinity vs. Femininity reflects the distribution of gender roles, where masculine societies are driven by competition, achievement, and success. In contrast, feminine society value caring for others and quality of life.

Taking the learning from Hofstede's cultural dimensions further, implications can be made for different cultures, making, for example, the comparison of Eastern and Western cultures possible. In Western cultures, creativity is often seen as a cognitive trait or process involving the creation of tangible, novel products through various methods. In contrast, Eastern Asian cultures view creativity as a mental attribute for acquiring

information, building understanding, and applying new solutions to problems. This perspective is more collaborative, less tangible, and closely linked to traditions (Gong et al., 2023; Paletz & Peng, 2008). However, Paletz and Peng (2008) note that there are variations in how East Asian cultures perceive creativity. Cultural values significantly influence what is considered desirable or undesirable. Cultures that prioritize collectivism, adherence to social norms, uncertainty avoidance, and high power distance may inhibit individuals from expressing unique ideas and deviating from established norms (Harzing & Hofstede, 1996; Westwood & Low, 2003). Conversely, cultures that emphasize individualism, low power distance, and low uncertainty avoidance foster an environment that encourages the expression of unique ideas and the exploration of new approaches (M. Brewer & Chen, 2007; M. B. Brewer & Gardner, 1996; H. Kim & Markus, 1999). This influences the behavior of such individuals within the creative process resulting in different ways support is needed. Erez and Nouri (2010) have concluded as the managerial consequences of designing a working environment differently based on implications by the cultural differences. Their research concludes with recommendations for mono-cultural settings or for teams that have similar characteristics according to the cultural dimensions (Erez & Nouri, 2010).

Since this contribution aims at supporting intercultural teams, these learnings are not directly applicable. An intercultural approach can be defined as the integration of methods, knowledge, and thinking styles from different cultures to address common questions or tasks, allowing each culture to benefit more than it would independently. Creativity and innovation are inherently tied to cultural contexts, where they are perceived, expressed, and evaluated (Ludwig, 1992; Tang & Werner, 2017). Creative processes differ between cultures. Eastern cultures tend to follow the 'S route' (spontaneous), which emphasizes adaptability, processes, intuition, and metamorphism. In contrast, Western cultures prefer the 'D route' (divergent), focusing on disruptiveness, results, rationality, and literalism (Elliot & Nakata, 2013). With intercultural teams in focus, the tools designed by Hodgson (2015) designed to analyze where culture is likely to influence the underperformance of a team by describing a desired team culture profile and an actual team culture profile (Hodgson et al., 2013). This model cannot be assisted with tools or methods that can be directly implemented in the next creative problem-solving process. Another recent and comprehensive model on this matter is the VICTORY model by Tang (2019). The model aims to design and prepare teams systematically by taking motivation, emotion, and environment into consideration. The acronym stands for Vision, Ideation, Combine, Team, Openness, Risk-taking, and Yes-I-can mind-set. Focusing on team creativity, the model ensures that the barriers and success factors of intercultural settings are taken into consideration. The model makes sure that the individuals are supported according to their diverse backgrounds, to enable them to strive in problem-solving tasks (Edmondson, 2012). To work on this aspect of the *team* as the basis of the VICTORY model, different tasks that require team collaboration need to be performed in a coaching setting, e.g., solutions to a task need to be found through joint efforts across disciplines or participants with different cultural backgrounds needed to work on problems using their cultural perspective. For creative ideation brainwriting methods, e.g., 6-3-5 method (Rohrbach, 1969) and electronic brainstorming (Nunamaker et al., 1987) are used. The methods are applied in a training style with the help of individuals outside the team. Furthermore, the coaches introduced additional

creativity methods and encouraged the team to apply them in the future. Creative ideation as a step within this model teaches the participants that creativity is based on references. Therefore, revolutionary innovations are analyzed to teach this learning to the participants. This step includes a schedule for continuous meetings of the team in different combinations. The VICTORY model provides support for teams that are applied over a long duration and requires coaches to support. It can be seen as a form of training as a team to gradually increase team performance (Tang, 2019).

This support includes a variety of methods and tools to support creativity and various approaches to allow for cultural learning. The method's application needs a lot of time, is designed for on-site application, and requires room and time for continuous meetings and activities that fill up the schedule.

Existing models offer a variety of comprehensive analytical tools, with the VICTORY model providing comprehensive support for continuous improvement of team performance.

2. Research profile

2.1. Research goal and research questions

The research gap left open is for support that can be quickly applied with little preparation and that kick-starts cultural sensitivity right before an actual problem-solving process. A support that can be used in a modular way, implemented before and after a creative problem-solving process that has to be tackled anyway. Switching perspectives need to be possible within the method to improve cultural understanding. Furthermore, the model needs to be ready-to-use and can be applied without a long analytical process. It's to be seen as a direct start to a deeper understanding of each other. Finally, the model needs to be designed in a modular way, to be applied around a creative problem-solving process that needs to be carried out by the team. The model does not claim to be a comprehensive tool for increasing overall team performance, but to fill this exact gap described.

For this purpose, the following research questions have been deduced:

Research Question 1 (RQ1)
What are the specific requirements for supporting creativity in multicultural and distributed product development teams?

Research Question 2 (RQ2)
How can a support method for creativity in multicultural and distributed product development teams be developed and designed?

Research Question 3 (RQ3)
How can the support method be validated in an initial validation phase?

2.2. Research methodology

Developing support as a method can be described as a separate development task. Included are aids, tools, and measures that help improve the development process (L. T. M. Blessing & Chakrabarti, 2009). The Design Research Methodology (DRM)

(L. T. M. Blessing & Chakrabarti, 2009) was used as a reference to structure this research. The DRM consists of four stages that can be performed at different levels of detail. The stages of Research Clarification, Descriptive Study 1 (DS1), Prescriptive Study (PS), and Descriptive Study 2 (DS2) can be carried out in parallel, iteratively, and/or sequentially. Within this research, the initially sequentially conducted stages were improved iteratively. From the seven types of research projects that are distinguished in the DRM, this contribution can be classified as type 5.

The types vary based on the degree of comprehensiveness applied to the various studies at each stage and how they are carried out. A review-based study is usually only based on a literature review, while a comprehensive study includes a study in which the researcher produces results, e.g., an empirical study. Initial studies involve the first steps of a particular stage (L. T. M. Blessing & Chakrabarti, 2009).

In this research, the Research Clarification is review-based, the DS1 and the PS are performed comprehensively, and the DS2 initial.

The first research question is answered within the DS1, the second research question within the PS, and the third research question within the DS2. Figure 1 shows the stages of the DRM, the goal of each stage, and the expected result.

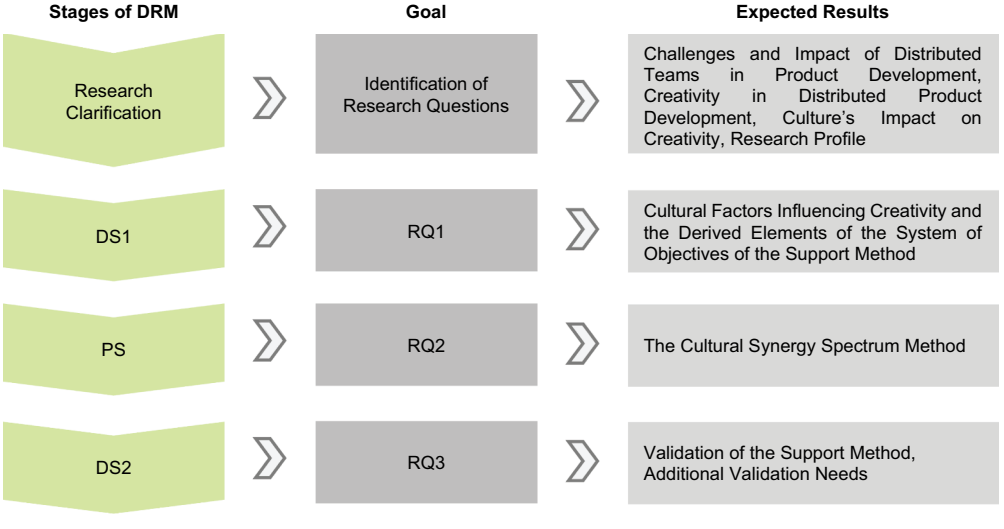

Figure 1. Structure of the contribution based on the DRM Framework by L. T. M. Blessing and Chakrabarti (2009).

2.3. Research approach

A literature review is performed by the authors in Research Clarification to identify the research goal and the three research questions and to establish the state of the art on distributed product development and the influence of culture on creativity within this area. Afterward, an empirical study is conducted to ensure the validity of the literature review results leading to a comprehensive DS1. A comprehensive PS is necessary to show how these findings can be implemented best and successfully develop the support method. An initial

DS2 was conducted to evaluate the results achieved, consisting of two parts. The first part involves integrating the support method into an interactive session within the EU.FFICIENT project (Bastian & Kempf, 2024). This session focuses on employing a creativity technique to explore trends, emerging drivers, and technologies. Subsequently, the second part entails conducting a workshop where product and methods development experts engage in discussions. During this workshop, the support method and its sequential phases are comprehensively elucidated alongside the elements of the system of objectives. The experts were then invited to provide feedback on the support method's efficiency, its sequential phases, and the elements of the system of objectives. Additionally, the participants were encouraged to share their overall impressions of the method and offer suggestions for potential improvement. This process, split into two parts, shows exemplary iterative improvement of the results achieved within the phases of the DRM.

3. Results: the cultural synergy spectrum method

Delineating the support method's objectives becomes essential for conceptualizing and developing it. The formulation of these objectives as elements of the system of objectives for the support method is grounded in a systematic approach based on the results of the review-based Research Clarification and the empirical study conducted for the comprehensive DS1. These elements build the basis for the design and development of the support method. They are first analyzed, then results are synthesized, and measures for implementation in the support method are derived. Additionally, a support method called the Cultural Synergy Spectrum (CSS) is designed and developed as a result of the PS to address the unique challenges recognized in multicultural and distributed team environments.

3.1. Elements of the system of objectives of the support method

The objectives and requirements are called elements of the system of objectives. The objective describes a key feature of the method under development, while the requirement is a necessary condition that the method must meet to achieve this objective (Ebel, 2015; Pohl, 2007). According to Müller (2023), 'A system of objectives comprises all explicit objectives of a product that is to be developed, including their dependencies and boundary conditions, within a defined area of interest (i.e., within a system of interest) at a certain time.' Understanding this definition is essential for maintaining methodological coherence throughout the development process. By defining the elements in the system of objectives, the basis is built to develop a support method that aligns with the previously identified cultural influencing factors.

Therefore, this section focuses on identifying the elements of the system of objectives, method elements, and measures for a method that supports the improvement of creativity of multicultural and distributed product development teams. For this method's system of objectives, 15 elements were derived, which can be classified with the DRM evaluation types: Success Contribution (SC), Support Performance (SP), and Applicability (A). All the elements of the system of objectives. The fundamental target and the need for methodical support are specified by the elements of the system of objectives of SC and formulated as objectives. The elements of the system of objectives of SP are formulated as objectives

specifying the verification of a method in terms of functionality. Finally, the elements of the system of objectives of A are formulated as requirements.

The 15 identified elements of the system of objectives of the support method for increasing creativity in multicultural and distributed product development teams are shown in the respective columns of the respective analysis Table 2, Table 3, and Table 4).

3.1.1. Systematic operationalization of the elements of the system of objectives

To present the elements of the system of objectives of the support method and their interrelations, the findings are transferred to the framework according to Gericke et al. (2017). Figure 2 summarizes the findings on the support method to be developed based on the five aspects of the framework.

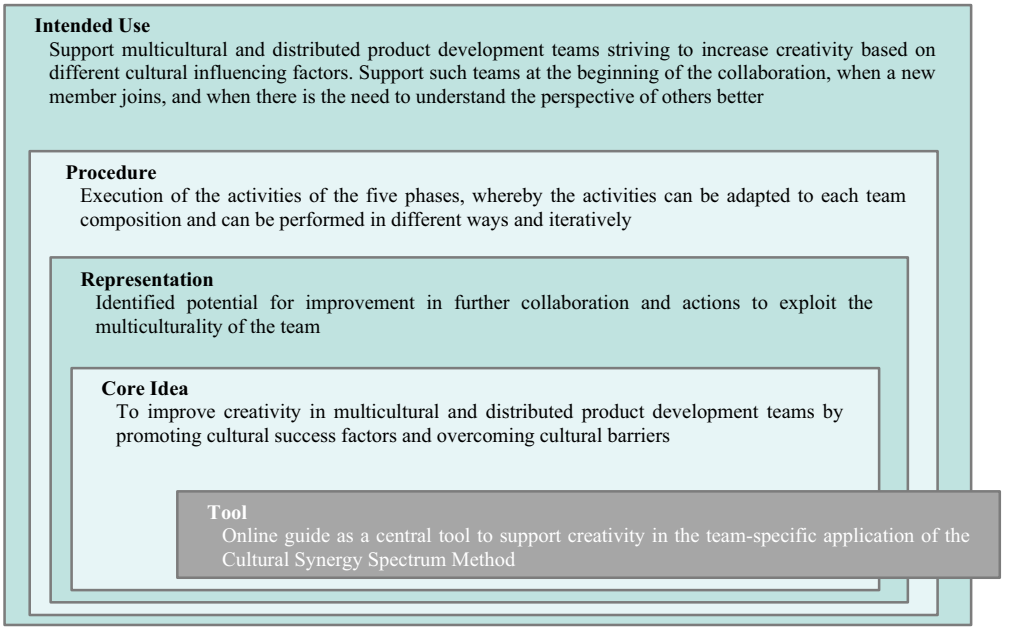

Figure 2. System of objectives concretized with elements of the method and their relationships, based on Gericke et al. (2017).

3.1.2. Measures for operationalizing the elements of the system of objectives

Based on the 15 elements of the system of objectives of the support method, method elements, and measures are derived. These support a situation-appropriate and user-centered application. The analysis of the elements of the system of objectives of SP, A, and SC.

The consideration and integration of specific activities and discussions are shown in the analysis of the elements of the system of objectives of SP (SP1 – SP8) in Table 2 as the premise of many elements. Hence, the elements of the system of objectives are implemented in five consecutive phases, to which the required activities and discussions are assigned:

- Phase 1: Warm Up
- Phase 2: Knowledge Baseline

- Phase 3: Change of Perspectives
- Phase 4: Creativity Session
- Phase 5: Evaluation

Additionally, explanations and tools (Sticky note sets, timers) are provided to support and ensure the performance of the respective discussions and activities. Further support, including templates for documentation, must be provided for all elements of the system of objectives and needs to be specified in the individual phases.

Table 2. Method elements and measures for operationalizing the elements of the system of objectives of SP.

Nr.	Elements of the system of objectives	Method elements and measures
	The CSS Method is intended to …	Introduction of the activity …
SP1	… support creativity in multicultural and distributed product development teams.	… 'Silent Brainstorming' in Phase 1 and the provision of the generated ideas for the creativity session of Phase 4. Introduction to the activity 'Cultural Dimension Thinking Caps' in Phase 3 to gain new perspectives. Placeholder for the creativity technique in Phase 4 with instructions to use the gained perspectives and keep an open mind while conducting the creativity session.
SP2	… promote cultural success factors within multicultural and distributed product development teams.	… 'Opening Questions' in Phase 2 and 'Cultural Dimension Thinking Caps' in Phase 3 and provision of different cultural dimensions to include cultural sensitivity and time for teams to discuss different aspects of collaboration.
SP3	… support overcoming cultural barriers within multicultural and distributed product development teams.	… 'Silent Brainstorming' in Phase 1 to allow everyone to ideate in silence; 'Opening Questions' and 'Consolidation' in Phase 2, 'The Cultural Dimensions Thinking Caps' in Phase 3, and 'Feedback & Learning' in Phase 5 to address the existence of diverse cultural backgrounds within the team and the necessity of navigating those differences to optimize team performance.
SP4	… support the development of strong multicultural product development teams.	… 'Opening Questions' and 'Consolidation' in Phase 2 and 'Feedback & Learning' in Phase 5 to give time for teams discuss different aspects of collaboration and get everyone to contribute to the formation of team-specific norms and collaboration rules/best practices. Introduction of the standard rules for the method at the beginning.
SP5	… support the establishment of rules and standards for the collaboration of distributed and multicultural product development teams.	… 'Opening Questions' and 'Consolidation' in Phase 2 and 'Feedback & Learning' in Phase 5 to get everyone to contribute to the formation of team-specific norms and collaboration rules/best practices.
SP6	… support the creation of a personal level among the members of distributed and multicultural product development teams.	… 'Opening Questions' in Phase 2 and 'Cultural Dimension Thinking Caps' in Phase 3, and discussion rounds throughout the method where everyone can share their cultural background and talk openly.
SP7	… support the promotion of cultural sensitivity within members of distributed and multicultural product development teams from the beginning.	… 'Opening Questions' and 'Consolidation' in Phase 2 to acknowledge cultural gaps openly and allow team members to discuss cultural differences by sharing their cultural background and expectations about communication strategies and working style.
SP8	… support the identification and engagement of ethnocentrism in multicultural and distributed product development teams.	… 'Cultural Dimensions Thinking Caps' and the 'Cultural Dimensions' in Phase 3 to allow a discussion on a collaboration topic from one's perspective and the perspective of others.

Method elements and measures for operationalizing the elements of the system of objectives of A are given in Table 3.

Table 3. Method elements and measures for operationalizing the elements of the system of objectives of A.

Nr.	Elements of the system of objectives	Method elements and measures
	The CSS Method is intended to be ...	
A1	... individually customizable for each multicultural and distributed product development team.	Presentation of the phases of the CSS Method forms the basis for using the method across teams and contexts. Access to application variants and availability of the method as a template in Miro enables flexible and situation-specific and user-centered implementation.
A2	... easy to use for multicultural and distributed product development teams.	Provision of step-by-step instructions and availability of the method as a template in Miro for independent implementation by product development teams.
A3	... easy to understand for members of multicultural and distributed product development teams.	
A4	... structured in logical steps and phases.	The division of the phases of the CSS Method into individual activities, explanations, and discussions, which are compiled in corresponding blocks and can be carried out step by step.
A5	... integrated around a creativity technique.	Placeholder in Phase 4 of the CSS Method for a creativity session where the creativity technique chosen by the team will be performed.

From the analysis of the elements of the system of objectives of the support method in Table 3, the following method elements and measures are derived:

- A1: Different variants of the CSS Method are provided implicitly in the template. These variants can be implemented differently depending on the team's context, challenges, and composition, allowing complete flexibility in performing the activities of the method.
- A2 and A3: A step-by-step guide and a template in Miro are provided to allow the autonomous implementation of the CSS Method by multicultural and distributed product development teams. Additionally, these two aspects allow teams to appropriately use the support method according to their own context and team composition without needing an expert specially trained to implement the method.
- A4: The CSS Method is divided into five consecutive phases, each subdivided into blocks (e.g., activities, discussions, and explanations). Clear instructions and implementation options are provided for each phase and block.
- A5: To allow complete flexibility in executing the activities of the planned creative session, Phase 4 of the CSS Method serves as a placeholder. Each team plans a creative session based on their requirements and preferences.

The analysis in Table 4 of the SC (SC1 and SC2) elements of the system of objectives for the CSS Method reveals that SC1 achievement, which structures the method's five phases, relies on various creativity techniques and Hofstede's Cultural dimensions. SC2, which focuses on enhancing collaboration in multicultural and distributed product development teams, depends on acknowledging diverse cultural perspectives and fostering open discussions about collaboration aspects.

Table 4. Method elements and measures for operationalizing the elements of the system of objectives of SC.

Nr.	Elements of the system of objectives	Method elements and measures
	The CSS Method is intended to …	
SC1	… reinforce the cultural understanding among team members and the different perspectives.	The structure of the method is based on different creativity techniques, open discussion rounds, and Hofstede's Cultural Dimensions.
SC2	… support the improvement in collaboration of multicultural and distributed product development teams.	Support in recognizing different cultural perspectives and aspects of collaboration. In addition, the activity 'Consolidation' in Phase 2 asks for further team-specific rules of collaboration and communication strategies.

3.2. Measuring the support method's success

This section examines the critical control variables for evaluating the effectiveness of the method. Control variables are essential in experimental design, providing benchmarks that separate the impact of the method from external factors, ensuring that the observed outcomes are directly attributable to the method itself (Bevans, 2019; Bhandari, 2021; Björk & Ottosson, 2007; Frost, 2021; Kuechenhof & Krause, 2023).

Identifying and implementing these control variables is crucial for evaluating a support method's success (Björk & Ottosson, 2007; Kuechenhof & Krause, 2023). This section discusses these variables' selection and measurement strategies, aiming to establish a comprehensive framework for analyzing the method's effectiveness while emphasizing the role of control variables in ensuring reliable and valid results.

Transitioning to the evaluation of the Cultural Synergy Spectrum Method, it is vital to adopt the DRM's Success Criteria and Measurable Success Criteria (L. T. M. Blessing & Chakrabarti, 2009). These criteria serve as benchmarks to objectively assess the method's impact, ensuring outcomes are linked to the method rather than external influences. Measurable Success Criteria further define these benchmarks in quantifiable terms, facilitating data collection that is both accurate and reflective of improvement in a quantitatively and qualitatively meaningful way (Dühr, 2022).

An interactive session with product development experts was conducted to define specific Measurable Success Criteria (L. T. M. Blessing & Chakrabarti, 2009) for the CSS Method. Experts were asked to identify potential measures for supporting cultural influences within the method. After noting pertinent criteria and discussing their implications, the session yielded a set of Measurable Success Criteria, refined through subsequent analysis. These criteria are:

(1) Idea Generation Metrics: the volume, quality, and diversity of ideas generated are assessed here. Comparing brainstorming outputs from Silent Brainstorming in Phase 1 to a creativity session in Phase 4 is involved. This allows researchers to measure the method's impact on idea generation. Idea quality is evaluated through peer or expert reviews, while a range of topics and unique problem-solving approaches assess diversity.
(2) Communication Patterns: Team communication dynamics are analyzed here, including speech distribution, response types, and cooperation levels. Factors such as personality types (introverted versus extroverted) and the use of native versus foreign languages in content delivery are also considered. More specific measures involve

tracking the minutes spent on explanations and the frequency of linguistic ambiguities. These measures help gauge the method's effectiveness in enhancing communication efficiency and inclusivity within multicultural teams.

(3) Team Dynamics Survey: This survey is critical for understanding team integration and collaboration, conducted before and after the method implementation, and divided into three parts:
   (a) Understanding of Team Diversity: Questions such as 'Do you know the geographical origin of your team members?' 'To what extent do you perceive cultural differences in your team?' 'In which and how many aspects do the team members differ?' These questions gauge team members' awareness of each other's geographical origins and perceived cultural differences, evaluating their knowledge of team diversity.
   (b) Perception of Team's Diversity: This section queries team members' views of the advantages of cultural diversity, such as the perceived capabilities of people from different cultures and their overall perception of diversity. This involves questions like 'List aspects you think a person from a different culture is more capable of doing than yourself' and 'Would you describe your team as divers? If yes, how?'
   (c) Operational and Interactional Aspects: This includes assessing how language barriers affect teamwork on a scale from 1 to 5 and changes in expectations, such as punctuality after the method's implementation, aiming to evaluate operational dynamics and cultural assimilation.

These criteria offer a framework for a detailed assessment of the CSS Method's effectiveness. By incorporating qualitative and quantitative measures, this framework enables an in-depth evaluation of the method's impact on team dynamics, idea generation, and communication patterns. This comprehensive approach is crucial for confirming the method's efficiency and success within multicultural and distributed settings. It is to note, that defining these criteria is a subjective process and it cannot be ensured that another team of experts would have decided on the exact same factors. The author team has tried to include insight from all experts and not let personality traits that led to higher participation in the discussion by some experts influence the results.

3.3. Description of the cultural synergy spectrum method

Based on the findings of the previous section, the Cultural Synergy Spectrum Method is designed to foster creativity in multicultural and distributed product development teams by leveraging cultural success factors and addressing cultural barriers. This method integrates different cultural perspectives, similar to a spectrum of various colors, to foster a synergistic effect that enhances teamwork, problem-solving, and creative output. The term *spectrum* underscores the method's commitment to inclusivity and diversity, reflecting its goal to embrace and value diverse cultural viewpoints.

3.3.1. Overview of the cultural synergy spectrum method

The support method comprises five phases:

(1) The goal of the first phase is to overcome the limitations of traditional brainstorming and to ensure that all team members can participate and reflect on the problem statement.
(2) The second phase establishes a knowledge baseline and clarifies individual working expectations through discussions that explore each team member's understanding of their colleagues' cultural backgrounds.
(3) The third phase promotes perspective-changing encouraging team members to adopt and appreciate diverse cultural viewpoints and discuss collaborative practices, such as approaches to deadlines.
(4) The fourth phase focuses on generating creative solutions for specific problems during a creativity session.
(5) The fifth phase provides an opportunity for feedback and learning to synthesize the results and assess the effectiveness of the collaboration process.

Each phase is subdivided into blocks to support its application, i.e., activities, discussions, and explanations. Each block describes the different activities of the method's application. Figure 3 shows an overview of the Cultural Synergy Spectrum Method's phases and blocks.

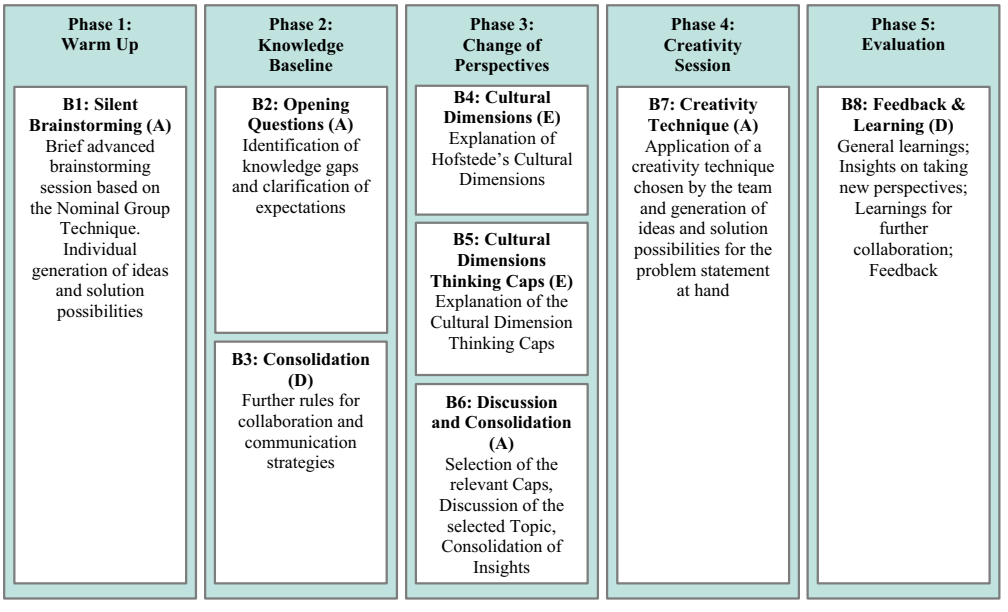

Figure 3. Overview of the phases and blocks of the cultural synergy spectrum method.

The entire team must participate in this process, with one member acting as the moderator to lead the implementation of the method. Aspects like timekeeping or managing the creativity session in the fourth phase can also be delegated.

Other central components of the support method are:

- 15 elements of the system of objectives for a method that supports the improvement of creativity of multicultural and distributed product development teams,
- a brief, silent Brainstorming based on the Nominal Group Technique integrated in Phase 1,
- a short questionnaire composed of six questions integrated in Phase 2,
- brief explanations of the six Cultural Dimensions based on Hofstede integrated in Phase 3,
- 12 Cultural Dimension Thinking Caps based on Hofstede's Cultural Dimensions and De Bono's Six Thinking Hats integrated into Phase 3.

To facilitate the method's situation-specific adaptation and user-centered application, it is integrated into a guide on the online collaboration platform Miro (Ember & Ember, 2009; https://miro.com/, 2024), chosen for its user-friendliness and location-independent accessibility. Before beginning Phase 1, users receive a brief introduction to the essentials of working with Miro, which are necessary for following the guide of the support method.

The recommended duration of the CSS Method depends on the duration of the creativity session conducted in Phase 4 and the team's size. Without considering this phase, the duration of the method is limited to approximately 95–120 minutes. An overview of the method designed on Miro is given in Figures 4 and 5.

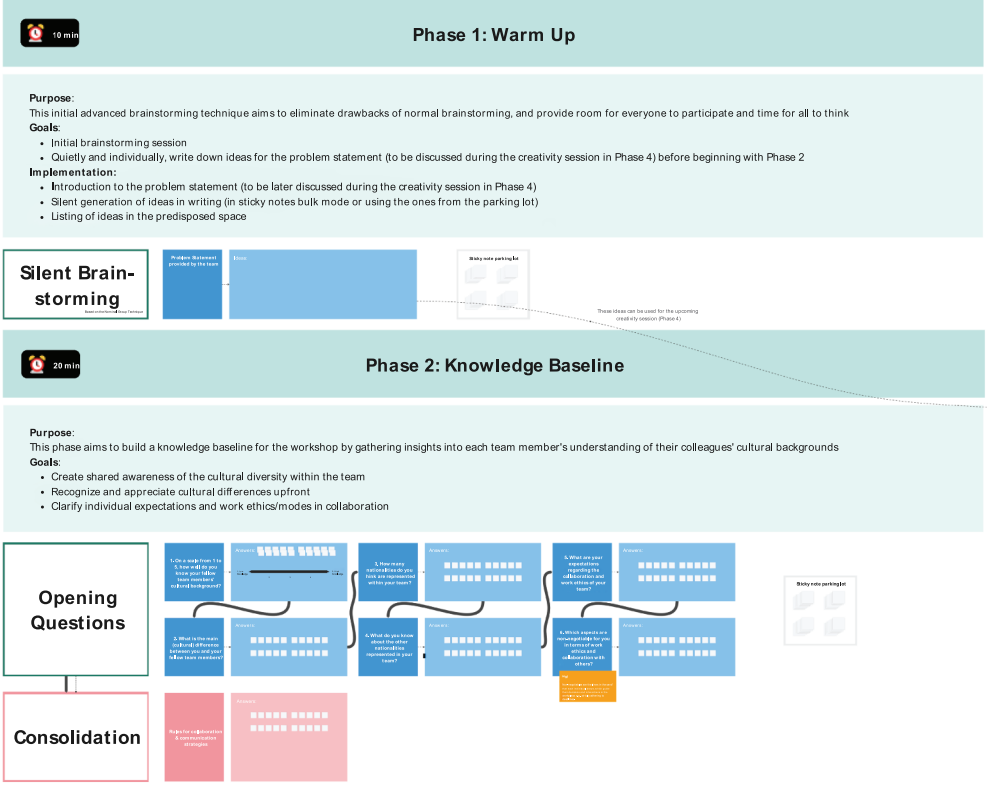

Figure 4. Overview of the implementation of the cultural synergy spectrum method in Miro (phase 1 and 2).

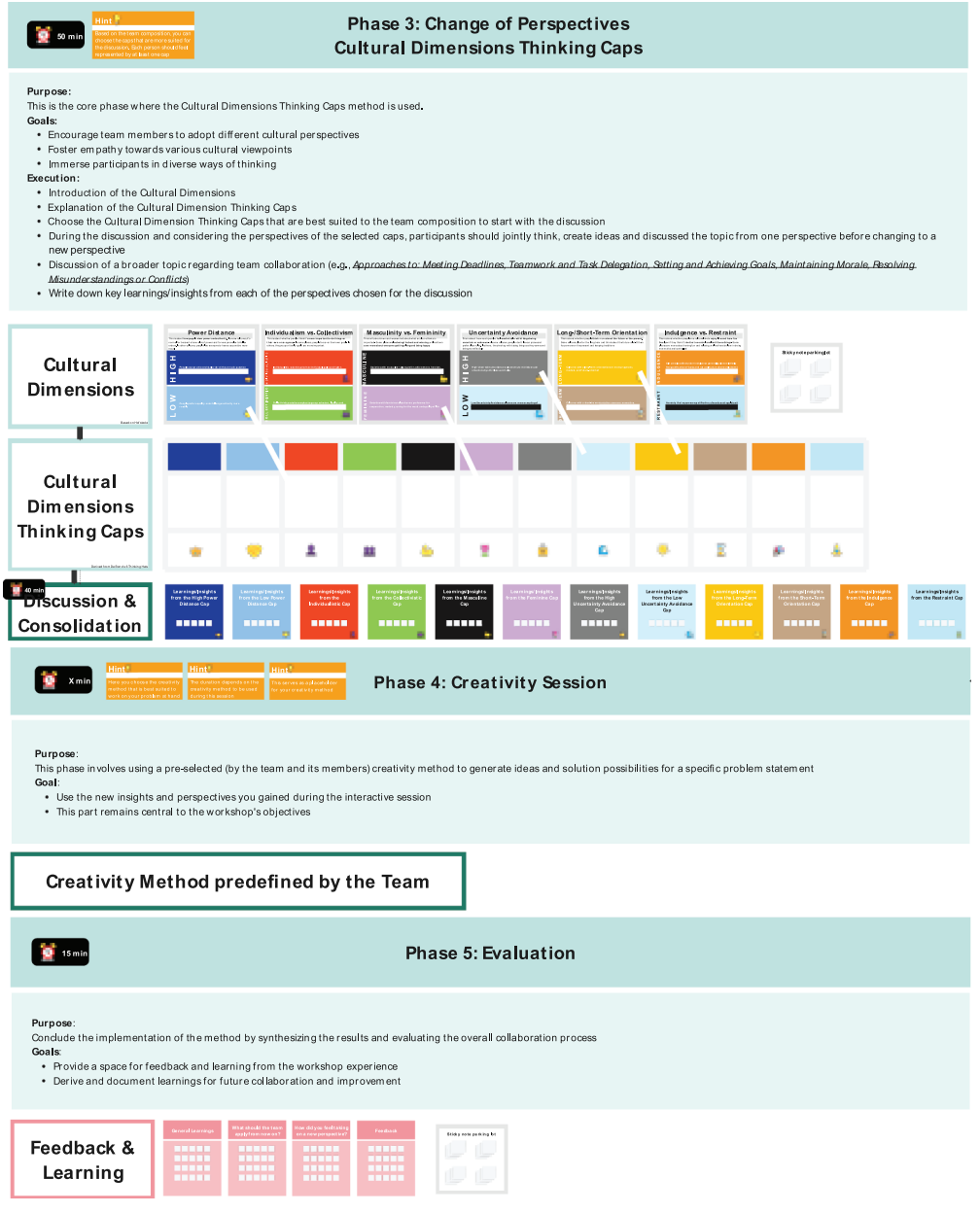

Figure 5. Overview of the implementation of the cultural synergy spectrum method in Miro (phase 3, 4, and 5).

3.3.2. Phase 1: warm up

The initial phase of the CSS Method addresses traditional-brainstorming limitations by introducing a concise, 10-minute Silent Brainstorming session based on the Nominal Group Technique. This phase serves as a preparatory warm-up with only one activity block, Team members individually brainstorm solutions to a team-specific problem statement, recording their ideas on post-its in Miro. This silent brainstorming ensures

equal participation and thoughtful consideration of the problem, setting a foundational base for the creativity session in Phase 4.

3.3.3. Phase 2: knowledge baseline

The second phase of the CSS Method is designed to establish a foundational understanding of effective teamwork and method applications. This phase, lasting about 20 min, involves two blocks: Opening Questions (activity) and Consolidation (discussion).

During the Opening Questions block, team members answer the following six questions to reveal their knowledge of colleagues' cultural backgrounds, expectations about work ethics and modes, and key cultural differences.

(1) On a scale from 1 to 5, how well do you know your fellow team members' cultural backgrounds?
(2) What is the main (cultural) difference between you and your fellow team members?
(3) How many nationalities do you think are represented within your team?
(4) What do you know about the other nationalities represented in your team?
(5) What are your expectations regarding the collaboration and work ethics of your team?
(6) Which aspects are non-negotiable for you in terms of work ethics and collaboration with others?

This activity helps establish a baseline understanding among team members. In the Consolidation block, team members discuss and address any identified differences, leading to a consensus on future collaboration norms and communication strategies. The outcomes of this discussion are systematically documented in designated spaces on the Miro board, ensuring all team members are aligned on agreed-upon norms and strategies moving forward.

3.3.4. Phase 3: change of perspectives

The third phase of the CSS Method facilitates a shift in team member perspectives, aiming to transcend individual viewpoints and encourage a broader understanding of issues through peers' cultural perspectives. This phase, lasting over 50 minutes, consists of three blocks: Cultural Dimensions (explanation), Cultural Dimensions Thinking Caps (explanation), and Discussion and Consolidation of the Cultural Dimensions Thinking Caps (activity).

Initially, the Cultural Dimensions block introduces Hofstede's six cultural dimensions, providing a foundation without focusing on specific regional or national cultures. Here, colors and pictograms for visual comprehension are used.

Building upon Hofstede's dimensions, follow the Cultural Dimensions Thinking Caps using a consistent color scheme and pictograms to facilitate understanding and association. This segment adapts De Bono's Six Thinking Hats into a cultural context.

The final activity block, Discussion and Consolidation of Cultural Dimensions Thinking Caps, encourages dynamic exchanges of viewpoints. Team members select caps to represent the cultures within the team to discuss various topics crucial for collaboration, such as meeting deadlines and conflict resolution. The discussion follows a structured format, cycling through selected perspectives, each for a set duration. This

structure ensures that all viewpoints are considered and integrated, culminating in a documentation phase where insights and learnings from each cap are recorded. This comprehensive approach fosters a deeper understanding among team members and solidifies the integration of varied cultural perspectives within the team.

3.3.5. Phase 4: creativity session

The fourth phase of the CSS Method focuses on generating new ideas and solutions for a team-specific problem statement, with the duration varying depending on the chosen creativity technique. This phase consists solely of a creativity session, which acts as a placeholder for applying the team's selected creativity technique. During this session, team members are expected to actively apply and integrate the insights and perspectives gained from earlier phases, ensuring that the diverse viewpoints of all colleagues are considered in the ideation process. By representing a placeholder for the creativity session, this phase ensures the modularity and flexibility of the support method.

3.3.6. Phase 5: evaluation

The fifth and final phases of the CSS Method focus on feedback and learning to synthesize outcomes and assess the collaborative process, with a recommended duration of 15 min.

In this closing phase, team members individually reflect on key areas, such as general learnings, actionable strategies, personal experiences of new perspectives, and overall feedback. They then document their thoughts using post-its and discuss to share and consolidate these insights.

The discussion establishes a robust foundation for future collaboration enhancing team dynamics and effectiveness.

4. Discussion

The method was designed based on various references. To increase cultural understanding between the participants Hofstede's cultural dimensions have been used due to their wide acceptance. The development of Hofstede's theory continued in a lot of different directions, with no clear author network given for the more than 1000 publications that are based on his works. Therefore, one limitation also to this development process is the choice of references. The main references for cultural support build on Hofstede et al. (2010) and Hofstede (2011) as well as the VICTORY model designed by Tang (2019) that already drew a connection between culture and creativity. The creativity methods that have been used for the design process also highly influence the outcome. Here it is to say that the six thinking hats by DeBono (2016) have been chosen since they allow for a quick switch of perspectives and are easy to learn. For NGT (Delbecq et al., 1971) a variety of alternative options exist. This method was only used for the aspect of including ideas first in writing and then in sharing them out loud to make sure to give introverts room to participate and everybody time to think. Choosing different methods as a baseline might have led to different outcomes, which needs to be acknowledged here. For ensuring the suitability for distributed settings, reference has been taken mainly from Dühr (2022) and Friedrich (2017) for suitability for distributed settings and from Taplick and Gräßler (2018). Eleven processes in the

Virtual Team Maturity Model can be found in the CSS as well. On this matter, the use of different references would not have changed the design of the method greatly since the authors agree on the requirements for a successful virtual method application.

The scope of this method was to fill the gap of an easy and quickly implementable method to increase cultural sensitivity directly for the creative problem-solving process to follow. The method 'hugs' a problem-solving process that the team has to undertake anyway and is designed to make sure to raise awareness for cultural differences and to increase the understanding for them to then start into the creative process with an open mind. Furthermore, CSS closes the bracket around the creative problem-solving process to ensure that learnings and cultural sensitivity are remembered and taken further into daily life as a team. This method is not a complete support for increasing overall team effectiveness, it is designed according to its concrete focus and does not claim to replace team coaching and additional methods to improve team productivity. It is designed as a quick start to improved cultural understanding and a direct support for the creative problem-solving that it is built around. Multiple applications might make sense, especially when new team members join or when cultural barrier is recently encountered by the team.

A two-step process is chosen to initially validate the support method developed in the previous chapter. The CSS Method is applied to an interactive session held by a team within the EU.FFICIENT project. In the second step, the method and its application are discussed with experts for product and method development. The aim of this initial validation is to test the Support Performance (SP), Applicability (A), and Success Contribution (SC) of the newly developed support method. To measure the success of the application, a template has been developed in which the fulfillment of the elements of the system of objectives can be inserted. In the template, 1 equals to *not fulfilled*, and 5 equals to *fully fulfilled*. Furthermore, the template features a field *Application* for all information such as impressions, specific problems during the application, the possible potential for improvement, resources required for application, and specific questions and difficulties during the entire application of the method. The field *Further Development* is designated for learnings generated on rules for application or the implementation of the phases. This field can be used during the entire validation iteration of the method and can target all elements of the system of objectives. Figure 6 shows the template.

Application	**Further Development**

Fulfillment of the Elements of the System of Objectives

Support Performance (n=x)					
	1	2	3	4	5
SP1					
SP2					

Applicability (n=x)					
	1	2	3	4	5
A1					
A2					

Success Contribution (n=x)					
	1	2	3	4	5
SC1					
SC2					

Figure 6. Template for the core results of the validation of the cultural synergy spectrum method.

Within the scope of this contribution, only an initial DS2 was feasible. Therefore, assessing the elements of the system of objectives that are allocated to the SC is not possible. The reason for this limitation is due to the study's preliminary nature, and the missing opportunity to evaluate before the application and after to be able to clearly compare the difference made through the application of the support method.

4.1. Step 1: validation through the support method's application in the EU.FFICIENT project

4.1.1. Environment and goal

The first validation step of the CSS Method is performed through the application in the EU.FFICIENT project. The goal was to apply the method exactly how it was designed and should be applied. The project consortium builds a relevant team for the application since it has 15 beneficiaries from 12 European countries (Belgium, Spain, Italy, France, Slovenia, Portugal, Lithuania, Sweden, the Netherlands, Austria, and Ireland). The project's goal is to build a platform where expert facilitators exchange on leading and guiding co-creation processes.

The main goal of the initial validation iteration is to put the CSS Method into practice during an interactive session with an intercultural team. This session is designed to evaluate how effectively the method is used, facilitate further development, and examine the elements of the system of objectives related to SP and A.

4.1.2. Procedure

This first iteration of the CSS Method validation supplies different learnings, highlighting challenges and areas for potential improvement. All phases of the support method are completed during the session except for Phase 1, which has been designed in a later iteration of the CSS Method. The time available for the application of the entire method is restricted to 50 min, with 30 min dedicated to the creativity session in Phase 4 and 20 min for the remaining phases.

Due to time constraints, only the first activity block of Phase 2 is executed, including the opening questions, without any further discussion or time to develop team-specific collaboration rules. In Phase 3, the Cultural Dimensions Thinking Caps and discussion topics were preselected to save time. The team's composition influenced the selection and quantity of caps, ensuring each perspective was represented by at least one participant. The group is divided into three smaller units for discussion, each focusing on a distinct perspective, again influenced by time constraints. Caps were prepared before the interactive session to optimize time management and efficiency during the implementation of the CSS Method in the interactive session for EU.FFICIENT.

Phase 4 is executed as planned, including a previously prepared creativity session with a moderator. The topic was prioritizing trends, new drivers, and technologies in the field of co-creation. The final phase, Phase 5, is restricted to only written feedback again due to limited time, preventing further discussion.

4.1.3. Results and identified improvements

The application of the method was observed by the designers, and feedback was collected during the session. The observations and feedback indicate the value of the CSS Method. Participants rate the method positively, confirming its relevance and utility in fostering intercultural synergies. The participants stressed that the active discussions and exchanges in Phase 3 are especially effective in improving the understanding of and reflection on different cultural perspectives. Those who resonate with the cap in use kickstart the conversations, drawing from personal experiences that enhance the dialog. The participant's openness to understanding others' viewpoints is a vital aspect of embracing and understanding diverse cultural backgrounds.

The enthusiastic participation and vibrant interaction enhance the interactive session, making the method implementation enjoyable and enriching. This dynamic engagement underscores the crucial role of active involvement in ensuring the success of intercultural workshops and methodologies. Nonetheless, the primary constraint remains the inadequate time allocated for the method's complete execution, impacting the breadth and depth of activities, particularly in Phases 2, 3, and 5.

Several recommendations are proposed to improve the effectiveness and implementation of the method. It is suggested that the timeframe for implementation, particularly for the activity and discussion blocks in Phases 2, 3, and 5, be extended to allow for more extensive engagement. In addition, there is a need to further develop the rules, definitions, and more detailed recommendations and instructions for the method to improve clarity and facilitate a smoother implementation. Distribution of materials to participants in advance is also recommended to ensure adequate time use. These improvements are expected to refine the CSS Method for future implementations.

Due to the team's limited insight into the preparation and evaluation of the CSS Method, the assessment of the elements of the System of Objectives of Support Performance and Applicability is undertaken by the method's researcher and developer. This assessment is based on careful observation of participant interactions during the session, together with participant feedback and comments. A significant limitation in this iteration is the limited time allotted for applying the method in the interactive session. This time constraint hinders the evaluation of the elements of the system of objectives related to Success Contribution, as they cannot be fully assessed within this validation iteration.

In addition, the analysis of how well the elements of the system of objectives are fulfilled is limited because the method is not applied in its complete form or according to the recommended durations for each phase and block. In particular, the discussion blocks in phases 2 and 5 are not performed in this validation iteration. Consequently, the average rating for the evaluation of the elements of the system of objectives relating to SP is only 3, reflecting the partial evaluation (see Figure 7).

4.2. Step 2: validation of the support method's concept with experts

4.2.1. Environment and goal

As the second validation iteration of the CSS Method, an online workshop is conducted. The participants are seven experts in the field of product and method development. The main objective of this iteration is to validate both the concept and the elements of the system of objectives by involving the experts in a thorough review process.

Application

- Phase 2: questions of the first block without any discussion
- Phase 3: previous selection of the Caps and discussion topics, subdivision into three small groups for the discussion, with only one perspective per small group
- Phase 4: previously prepared creativity session around Trends, New Drivers, and Technologies
- Phase 5: written feedback without discussion
- Evaluation as an Observational Study

Further Development

- Expansion of the timeframe recommended for the method, especially for the activities and discussions of Phase 2 and 3
- Further development of rules, recommendations, instructions, and definitions

Fulfillment of the Elements of the System of Objectives

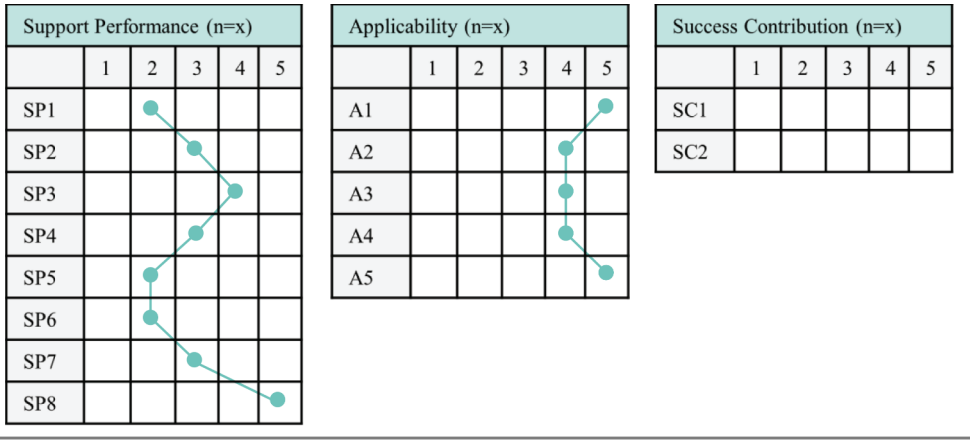

Figure 7. Results of the first validation iteration.

During this workshop, the experts are first guided through the elements of the CSS Method's system of objectives and then through the method's phases and individual activities, explanations, and discussion blocks. As the team of experts is not the target group for which the method is intended, the method's applicability and the validation and verification of the elements of the system of objectives as such during the application are not considered during this validation iteration.

4.2.2. Procedure

The workshop starts with a detailed explanation of the elements of the system of objectives of the method. This explanation is done in two ways: first, by aligning it with the three types of evaluation (L. T. M. Blessing & Chakrabarti, 2009), and second, by illustrating the method based on the elements described by Gericke et al. (2017). This part is followed by a discussion leading to key observations on the elements of the system of objectives.

4.2.3. Results and identified improvements

Foremost among these is the suggestion that the 'intended use' component of the method required more specific articulation. This involved detailing the purpose of the method and its applicable use cases and clarifying its application context. Further scrutiny has been applied to the 'representation' component, with experts arguing for a more apparent distinction between this component and the 'tool' and suggesting a reformulation of its articulation.

The experts found that blocks based on established methods and models would benefit from being renamed to avoid direct references to the original methods. A more general name should be chosen instead of naming the blocks directly after the original methods and models. The original methods should be cited as references under the new names. This strategy aims to reduce potential confusion for users (Do I need to apply a method outside this method?), discomfort (I do not know this method, do I need to tell the moderator?), and inconvenience (Do I need to start researching this method during the workshop?).

Finally, it is emphasized that the structure of the CSS Method should be understood and explained as modular. In particular, it is stressed that the fourth phase of the method should be described to users as a placeholder for the creativity session. They point out that it should be clearly communicated that the creativity technique to be used in this phase is not predetermined by the CSS Method itself. Instead, the selection and preparation of the creativity session is the responsibility of each team. This note emphasizes the flexibility of the method and its suitability to be individually tailored to the needs of the teams using it. The results of this validation iteration are shown in Figure 8.

Application

- Introduction and explanation of the elements of the system of objectives with an illustration based on Gericke et al. (2017)
- Introduction and explanation of the Phases 1 to 5
- Evaluation as feedback

Further Development

- Renaming of some of the blocks
- Reformulation of the elements "Representation", "Tool", and "Intended Use" basted on Gericke et al. (2017)
- Need for a clear visualization that Phase 4 serves as a placeholder for a previously selected and prepared creativity session

Fulfillment of the Elements of the System of Objectives

Support Performance (n=x)	1	2	3	4	5
SP1					
SP2					
SP3					
SP4					
SP5					
SP6					
SP7					
SP8					

Applicability (n=x)	1	2	3	4	5
A1					
A2					
A3					
A4					
A5					

Success Contribution (n=x)	1	2	3	4	5
SC1					
SC2					

Figure 8. Results of the second validation iteration.

4.3. Additional validation needs

The need for further validation and verification activities for the CSS Method has been identified on multiple levels.

(1) For the next validation phase, the teams applying the method need to be composed of product developers with different combinations of cultural backgrounds. Furthermore, teams comprising non-European members are needed to ensure the method's validity for a multitude of teams.
(2) The elements of the system of objectives should be subjected to additional refinement, validation, and verification by product development and experts in the domain of teamwork through, e.g., expert interviews.
(3) The implementation of the CSS Method should be tested independently of the method's developer. It must be considered, that the validation iteration conducted within this contribution was moderated by the method's developer. For a more objective evaluation of the method's efficiency, a validation iteration should be conducted without the method's developers being present. This would provide an objective assessment of the method's usability and adaptability in multicultural and distributed team settings.
(4) A validation iteration should be performed without time constraints, giving enough time for the team to go through each phase to its full extent and engage in discussions.
(5) Subsequent steps should also include the evaluation of the method's success with the Success Measurement Criteria.

These next steps for validation and verification activities on multiple levels would not just improve the credibility of the research results but also enrich the more comprehensive conversation surrounding intercultural collaboration in product development. Although the CSS Method marks a substantial advancement in comprehending and boosting creativity within multicultural and distributed product development teams, it is evident that continuous research and iterative improvement are crucial. By addressing the noted shortcomings and broadening the scope of research to encompass a broader range of cultural contexts and domains, the method could evolve into an even more effective tool for supporting distributed product development.

5. Conclusion and learnings

The specific requirements needed to support creativity in multicultural and distributed product development teams have been analyzed (RQ1) leading to the knowledge basis to successfully define the elements of the system of objectives. A support method has been systematically developed with respect to planning the evaluation of its success. The Cultural Synergy Spectrum Method is the result developed and explained in Chapter 4 (RQ2). Two separate steps to validate the support method have been carried out to ensure an initial validation based on the DRM (RQ3). A more robust evaluation strategy is recommended in the next step to address the constraint detailed in Chapter 4. Specifically, to thoroughly assess all types of evaluation, it would be advantageous to

survey the degree of fulfillment of the elements of the system of objectives. This survey should ideally occur before the start of the validation iteration and toward its conclusion, following Phase 5 of the SCC Method. Such timing would allow the comparison of the users' answers before and after the application of the method and the respondents' understanding of the method's effectiveness, success, and applicability.

It has to be taken into consideration that the sample size of the participants in the two validation iterations of the CSS method is limited. The participants have intercultural experience and are experts in their field, but they only bring together a limited number of various cultures. Therefore, they do not represent the entirety of intercultural teams. While valuable insight can be drawn from validation iterations, further studies with different team settings should be performed to also test applicability in settings with cultures that are currently underrepresented (for detailed validation needs please refer to Section 4.3). Additionally, it is to state that culture is not the only aspect that makes teams unique. Due to the very individual traits every member of a team brings to the table comparisons between teams also in the application of a method pose difficulties. It is important to consider carefully which aspects can be compared. Some conclusions we draw concerning the aspect of culture might also be influenced by other aspects. At this point, it is to make clear that the CSS Method is designed in a way that can be adapted and fitted to the team to ensure the best possible fit, but additional aspects that are important to the team (e.g., recent conflicts or interpersonal dynamics) should be taken into consideration when planning the application of the CSS by the team and its leaders. Open communication is very important also prior to the application to make sure the team members feel comfortable addressing the topic of culture which can feel very personal even if stating one's culture is never required during the method application. Furthermore, it should be made clear to the participants why addressing culture can help their creative performance.

The results from validation iteration with the experts for product and method development also have to be reflected critically. The experts have great knowledge concerning 'how' a method has to be designed and 'why' it should be that way, but since the amount of culture-sensitive support methods in the field of product engineering is very limited, their expertise in developing in a culture-sensitive way is also limited. We hope that this is an aspect our research contributes to improving in the future as well and that cultural sensitivity is more often taken into consideration in method design.

In the process of designing the CSS method, the author team generated learnings that go beyond the method as such. When researching cultural influences, researchers are confronted with their own cultural imprint. It is important to understand that the cultural influence is not limited to the team under observation. The author team themselves are an intercultural team and recommend to other researchers working on cultural influences to work in such a setting. The chance to show a colleague that his or her assumption might be based on one's own cultural imprint can strengthen the results. Having more than one cultural perspective is therefore not only to be seen as an opportunity within the team under observation but also within the team of researchers. Of course, the challenges that come with intercultural teams do not stop at researchers, but our experience with this topic here has shown that the opportunities are worth working to overcome the challenges.

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